2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.xxxxx
Woree to Kamerunga 132kV Transmission Line Rebuild

CP.xxxxx – Woree to Kamerunga 132kV Transmission Line Rebuild

Project Status: Not Approved

1. Network Need

The Woree to Kamerunga 132kV transmission line (commissioning in the 1960s) is a 13.5km double circuit 132kV line which is essential to the supply of Northern Cairns and connects Barron Gorge Hydro Power Station to the transmission network. An outage of this line would leave up to 67MW and up to 1,192MWh of customer load per day at risk[2].

A Condition Assessment (CA) carried out in March 2020 showed that many components of the line are exhibiting significant signs of corrosion[1]. An estimated 24% of steel members are showing Grade 2 (Low) corrosion and more than 4% of members have progressed to Grade 3 (Medium). Corrosion modelling based on the condition of original members indicates that Grade 4 (High) corroded members will start compromising structural integrity and adversely affect asset reliability by 2026. 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. Additionally, 37 of 43 structures have insufficient live line clearance compared with the current standard requirements. This rules out many live maintenance tasks. The CA recommends reinvestment in the asset prior to 2026 to manage these risks and ensure network reliability.

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply to the local Cairns and northern beaches areas. The removal of the Woree to Kamerunga 132kV transmission line would have a major impact on loads in these areas and would violate Powerlink's Transmission Authority reliability obligations (for N-1-50MW/600MWh). These lines also provide the point of connection for Barron Gorge Hydroelectric Power Station. 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 establish a new 132kV double circuit transmission line on an alternative route using a combination of overhead lines and underground cables by December 2026[4].

The following options were considered but not proposed:

- Do Nothing – rejected due to non-compliance with reliability standards and safety obligations
- Like for like replacement of the existing overhead line – rejected as it is not feasible to rebuild the whole line as overhead conductor due to land access and easement constraints.
- Supply Kamerunga from Woree with 22kV – rejected due to technical feasibility.
- Barron Gorge and Kamerunga operated as an island – rejected due to technical feasibility without additional generation capacity and storage.
- Non Network Option parameters identified – no viable non network option identified

Figure 2-1 below shows the current recommended option reduces the forecast risk monetisation profile of the Woree to Kamerunga line to by over $1m p.a. from 2027. Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset escalates from 2026 to over $5m p.a. in 2030, followed by a significant escalation of risk cost up to $80m p.a. in 2035. This is predominantly due to safety risks to the public in a densely populated residential area, as a result of

failed structures as members and bolts on the built section become increasingly corroded, followed by network risk and unserved energy[3].

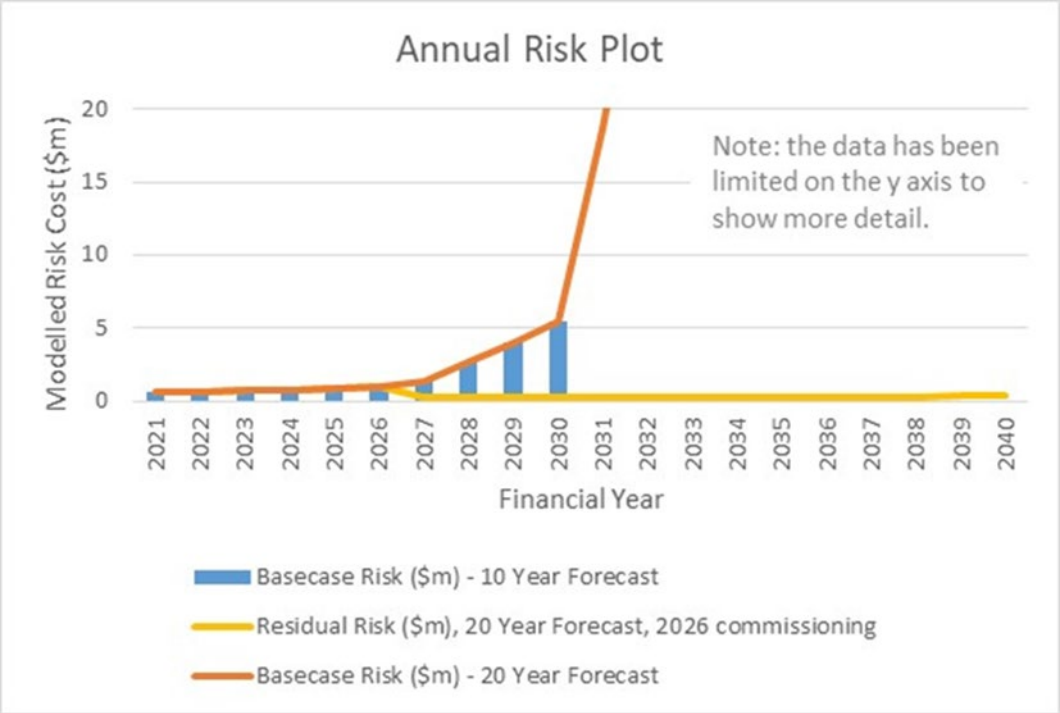

Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to rebuild the Woree to Kamerunga 132kV line is $47.6m ($2019/20 Base)[5].

Target Commissioning Date: November 2026

4. Documents in CP.xxxxx Project Pack

Public Documents

1. Transmission Line Condition Assessment – Report BS1252 Kamerunga to Woree
2. CP.xxxxx Woree – Kamerunga 132kV Transmission Line Rebuild – Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report – CP.xxxxx Woree-Kamerunga 132kV Transmission Line Rebuild
4. Project Scope Report CP.xxxxx Woree to Kamerunga 132kV Transmission Line Rebuild
5. Concept Estimate for CP.xxxxx – Woree to Kamerunga 132kV Transmission Line Rebuild

Supporting Documents

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

Transmission Line Condition Assessment – Report

BS1252

Kamerunga to Woree

Record ID	A3310977	
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Approved by	Asset Strategies Manager	[redacted]

Version history

Version	Date	Section(s)	Summary of amendment	Author	Approver
1.0	5/03/2020	All	Original Document	[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

BS1252 is a 13.5km long, double circuit, 132kV transmission line between Kamerunga (T053) and Woree (H039) Substations. The line was commissioned in 1963 under contract number BR/15. BS1252 consists of 43 structures: 19 double circuit steel lattice suspension towers, 22 double circuit steel lattice tension towers and 2 tension single circuit steel poles.

The easement within which the line is constructed is twenty metres wide, very narrow for a transmission line. Since construction the land surrounding the line easement has been heavily impacted by urban development, restricting access to towers and increasing both risk and complexity for maintenance activities.

Out of 43 structures on the line, 37 are deemed to have insufficient maintenance approach distance and live line clearance compared against the current standard requirements. This rules out many live maintenance tasks.

Following extensive refurbishment works between 2012 and 2016 that included improvements of foundations, fasteners, insulators and associated hardware the condition of line is, at the time of this condition assessment, sound and not at an elevated risk of structural failure. An estimated 3.6% of tower nuts and bolts exhibit grade 2 corrosion with only low quantities of grade 3 and grade 4 corrosion present on the towers.

In contrast, an estimated 24% of steel members are showing grade 2 corrosion and more than 4% of members have progressed to grade 3. This relatively high level of member corrosion must be considered when planning the future of the line as it is highlighting that there will be a need for the repair or replacement of tower members in the medium term of several years. Such intervention would be difficult and expensive task because of a range of factors that include:

- The line sits in a high corrosion environment with high humidity, high rainfall, salt and high temperature. It has been life extended once already.
- Increasing numbers of larger members will require painting or replacement in the near future.
- The line runs in a very narrow easement with limited or no vehicular access to some structures. The easement is unsuitable for the heavy vehicle access necessary for refit, emergency restoration or rebuild.
- The line has high levels of encroachment, with dwellings in close proximity and potentially high safety consequences in the event of structure failure.
- Line maintenance is hindered by an insufficient Maintenance Approach Distance and Live Line Clearance on many structures.

The condition of other line components is as follows:

- The insulator hardware and all tension and suspension insulators throughout the built section are in very good condition.
- The OHEW is in serviceable condition with an estimated remaining life of a minimum of 8 years.
- The ACSR/GZ conductors are in sound condition and are considered to have at least another 43 years remaining life.

Corrosion modelling based on the condition of original members indicates that grade 4 corroded members will start compromising structural integrity and adversely affect asset reliability in less than six years. Some outlying lighter members will require maintenance work before that.

Based upon the 2018-2019 photographic evidence, SAP Notifications and SAP Measuring Documents used in this report, the estimated remaining service life for BS1252, without any refurbishment, life extension or increased maintenance is a maximum of 6 years with a technical end of life in 2026.

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	Hardware	Dampers	Spacers	EW	OPGW	Earthing	Foundations	Foundation Grillage	Structures	Ins.Bdg.Disc	Ins.Susp.I.Disc	Ins.Ten.Disc
2043	2049	2040	N/A	2027	N/A	2027	2027*	N/A	2026^	2044	2044	2049

* Predicted EoL for foundations is based on the refurbishment design parameters (i.e. 15 years life extension).

^ Predicted EoL in 2026 assumes reasonable maintenance work in repairing and replacing a small number of tower members before then.

2. Purpose

This report outlines the assessed condition of Built Section 1252 which runs between Kamerunga and Woree substations, 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 assigning 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 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:

As described in detail in section 4.1 this line underwent several refurbishment and life extension projects in last eight years. Those projects improved the condition of the line by replacement of the most corroded components. The following summary describes the current condition of the components and determines an end of life (EoL) date based on the worst components; in this case tower members.

Usually, life limiting components for typical structures are lighter components such as hardware, bolts and nuts. However, as a result of the previous replacement of all hardware, insulators and the majority of the original bolts it is in this case steel members that are becoming the critical components defining asset the end of life date.

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 collated in M drive.

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		1963	0	
Legs	99.4	0.5	0.1	0	20			
Structure Overall	G1	G2	G3	G4	32	1963	5.5	6
Fasteners	96	3.6	0.4	0	32			
Members	71.9	23.9	4.2	0	32			
Climbing Aids	G1	G2	G3	G4				
Fasteners	100	0.0	0	0	32			
Tower Base	G1	G2	G3	G4				
Fasteners	92.4	7.1	0.5	0	28			
Members	80.9	18.5	0.6	0	28			
Tower Body	G1	G2	G3	G4				
Fasteners	92.6	6.1	1.3	0	30			
Members	64.7	28.7	6.6	0	30			
Superstructure	G1	G2	G3	G4				
Fasteners	96.4	3.4	0.2	0	32			
Members	70.7	24.8	4.5	0	32			
Cross Arms	G1	G2	G3	G4				
Fasteners	97.8	1.9	0.3	0	32			
Members	73	23	4	0	32			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	97.5	1.3	0.9	0.3	32			
EW Peak	G1	G2	G3	G4	28			
Fasteners	96.7	2.6	0.6	0.1	27			
Members	71.5	26.4	2.1	0	28			
	Min	Max	Avg					
Structure Earthing Resistance	0	0			0			

The condition of the overhead earthwire (OHEW) is assessed mostly from the ground level and from a small quantity of condition data acquired during climbing inspections.

The worst observed condition of the OHEW is G3L. The OHEW hardware including dampers were replaced under the project OR.01730.

The life of the originally installed OHEW will be the limiting factor for this component group with expected remaining service life between 8 and 10 years.

All insulators and associated hardware on the towers were replaced in 2016 under project OR.01730 and are in very good condition.

Two tension single circuit steel poles are installed with tension insulator strings and bridging ceramic insulator posts in 2012 and are also in good condition.

The minimum expected life for the insulator components in this environment is 25 years.

Built Section Meter	Installation Date	Corrosion Grade/Comment	Estimated Remaining Service Life (years)
Earthing	2012	Ground line corrosion G2	7
Conductor	1963	No visible deterioration	23
Conductor Hardware	2015	Very good condition	29
Conductor Mid-Span Joints	1963	None visible	N/A
Signage	2015	Good condition	15

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 6-10 years.***

4. Transmission Line Parameters

4.1 Overview and history

Today's Built Section 1252 is part of the line originally built in 1963 between Barron Gorge hydro generation and Cairns substation. Kamerunga substation was cut into the line in 1976 and Woree substation in 2002 forming the current configuration of the line. BS1252 was built on a 20m wide easement that was gradually surrounded with urban development in the Cairns area with multiple buildings within line collapse distance.

In more recent time the line went through a series of life extension projects to improve its condition and reliability.

In 2012, all 38 towers with corroded grillage foundations were reinforced by micro-piling under project CP.01420, in order to improve tower structural integrity.

In the same year, tower 1564 was replaced with two steel poles to provide sufficient electrical clearance over the Bruce Highway upgrade.

In 2015, all remaining towers were refitted under CP.02121 by:

- removal and replacement of all nuts, bolts and washers that were at corrosion Grade 2 or higher;
- removal and replacement of all members and plates that were at corrosion Grade 3 or higher;
- installation of new step bolts and fall arrest brackets to the climbing legs;
- replacement of all structure signage; and,
- replacement of the existing anti-climb devices.

In 2016, insulators, insulator hardware and earthwire hardware were replaced under project OR.01730.

Built Section 1252 is 13.53km in length and consists of 22 Steel Lattice Tension Towers, 2 Tension Steel Poles and 19 Steel Lattice Suspension Towers.

Figure 1: Built Section 1252 geographical overview

4.2 Summary Table

Item	Specification
Commissioning Date	05.08.1963
Voltage	132kV

Contract Number	BR/15
No. of Circuits	2
Circuits	F7141_7142
Route Length (km)	13.53
No. of Towers	22 Tension Towers 2 Tension Poles 19 Suspension Towers
Type	Galvanised Steel Lattice Tower and Steel Poles
Foundations	Original GRILLAGE; Reinforced by micro-piling in 2014
Conductor 1 Sub-Conductor /Phase	TIGER - 30/7/2.36 ACSR/GZ
Conductor Line Clamps	AGSU
No. of OHEW	2
Earthwire	T053 to STR-0163: PETREL - 12/7/.093 ACSR/GZ (13.48 km) STR-0163 to H039: VOLLEYBALL - 8/7 + 7/2 AACSR/AC (0.05 km)
No. of OPGW	None
OPGW	N/A
OHEW Line Clamps	AGSU
Conductor Vibration Dampers	Stockbridge
OPGW Line Clamps	N/A
Earthwire Vibration Dampers	SPIRAL
Suspension Insulators	Porcelain, NGK, Fog, 9 Discs, Installed 2015
Bridging Insulators	Porcelain, NGK, Fog, 9 Discs, Installed 2015 2 Poles fitted with NGK, Ceramic Posts, Installed 2012
Tension Insulators	Porcelain, NGK, Fog, 10 Discs, Installed 2015
AVG Easement width	20m

5. Location and Environment

5.1 General Location

The transmission line under review, BS1252, is located in Far North Queensland, between Powerlink's T053 Kamerunga and H039 Woree Substations.
The northern most portion of the line is located in low lying, poorly drained sugar cane fields, while the central section traverses Bayview Heights, rising to a height of 100m. The line concludes at the Woree Substation, 6m above sea level on the western edge of the Trinity Inlet Tidal Marine Park.
Continuous urban sprawl of Northern Cairns since the line was built has made access to many towers difficult and some would not have any access possible for the heavy machinery that would be required should major repairs be necessary.

Crossing of:	Rail	Highway	Minor Roads	Urban Property (<10m from easement)
Quantity:	9*	4	28	85

* - includes 5 crossings of cane railway

Table 1: BS1252 Span undercrosss information

5.2 Land Use and Environment

About two thirds of the transmission line traverses built up residential and some commercial/industrial areas. Approximately one third of the line transvers flat land with mixture of agricultural areas, sports fields and parks. There are a number of major and minor road crossings as well as sugar train and major train railways.

Figure 2: BS1252 land use area and weather

5.3 Atmospheric Corrosion

Built Section 1252 is located on average about 5km from the coast and experiences an average rainfall of 2000mm. Mean annual morning humidity is more than 70%. The area 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 BS1252 exhibit high levels of grade 2 and grade 3 corrosion on the structure members, and some bolts (those not replaced during 2015) are also showing signs of grade 3. These observations are consistent with 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	C4 (11)
Members ≤ 6mm	70	C4 (17)
Members > 6mm	85	C4 (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 photographic evidence was collected in 2018 and 2019.

Based on the photographs used for assessment, there is extensive G2, G3 and G4 corrosion on BS1252 structures.

Figure 31 in Appendix shows the distribution of tower members with G2 and G3 corrosion observed on the assessed sample of structures.

6.1 Structure – Overview

The following table outlines the type and numbers of towers and poles that make up Built Section 1252. Tower body extensions vary between -3 and +15 feet. Two strain steel poles were installed on the line to increase clearance over the Bruce Highway upgrade.

Tower Types	Number	Body Extensions
CC2* (Suspension)	17	-3 TO +9
CC10* (Tension)	10	-3 TO +9
CC30* (Tension)	6	-3 TO +3
CC60* (Tension)	2	-3 TO +3
CC90* (Tension)	1	+3
CCH* (Suspension)	1	0
AA2 (Suspension)	1	+9
AA10 (Tension)	1	+15
SS1T10G1 (Steel Tension Pole)	2	N/A
TOTAL	**41**	

* - denotes towers with Insufficient Maintenance Approach Distance and Live Line Clearance

6.2 Foundation Condition

Originally installed grillage foundations were reinforced in 2012 by installing micropiles and connecting pile caps. The design brief was to achieve a life extension of 15 years. Foundations and concrete interfaces generally appear to be in good condition (Figure 3).

Figure 3: 1252-STR-1559 TOWER LEGS (2019)

A small number of cases of G3 corrosion are noted in the interface area (Figure 4).

Figure 4: 1252-STR-1557 TOWER LEG (2019)

6.3 Structure Condition

All towers on the line were refurbished in 2015 with the following scope:

- Removal and replacement of all nuts, bolts and washers that are at corrosion Grade 2 or higher;
- Removal and replacement of all members, and plates that are at corrosion Grade 3 or higher;
- Installation of new step bolts and fall arrest brackets to the climbing legs.

The refurbishment was scoped to achieve 10 to 15 years of additional life.

6.3.1 Climbing Aids

BS1252 had all climbing aid replaced and upgraded to the current Powerlink standard which includes incorporation of climbing attachment points.

Corrosion of climbing aids was not observed on any of the sampled towers (seen in Figure 5)

Figure 5: Typical corrosion free climbing aids - example STR - 1528 (2019)

6.3.2 Anti-Climbing Barriers

BS1252 had all anti-climbing barriers replaced and upgraded to the current standard barb wire anti-climbing devices (refer Figure 6 and 7)

No corrosion or damage was noted on supporting steel members nor barbed wires.

Figure 6 Typical corrosion free anti-climbing device supports - example STR - 1546 (2019)

Figure 7: Climbing devices replaced - example STR - 1549 (2019)

6.3.3 Tower Base

Surface rust has been observed on approximately 20% of members, while, as a result of extensive bolt replacements during the project in 2015, bolts are in good condition.

Figure 8: Typical example of corrosion with bolts in better condition than members- example STR - 1546 (2019)

6.3.4 Tower Body

Surface rust has been observed on approximately 35% of members, while, as a result of extensive bolt replacements during the project in 2015, bolts are in good condition with only one tower (STR - 1565) exhibiting a high percentage of the G3 bolts in the body area.

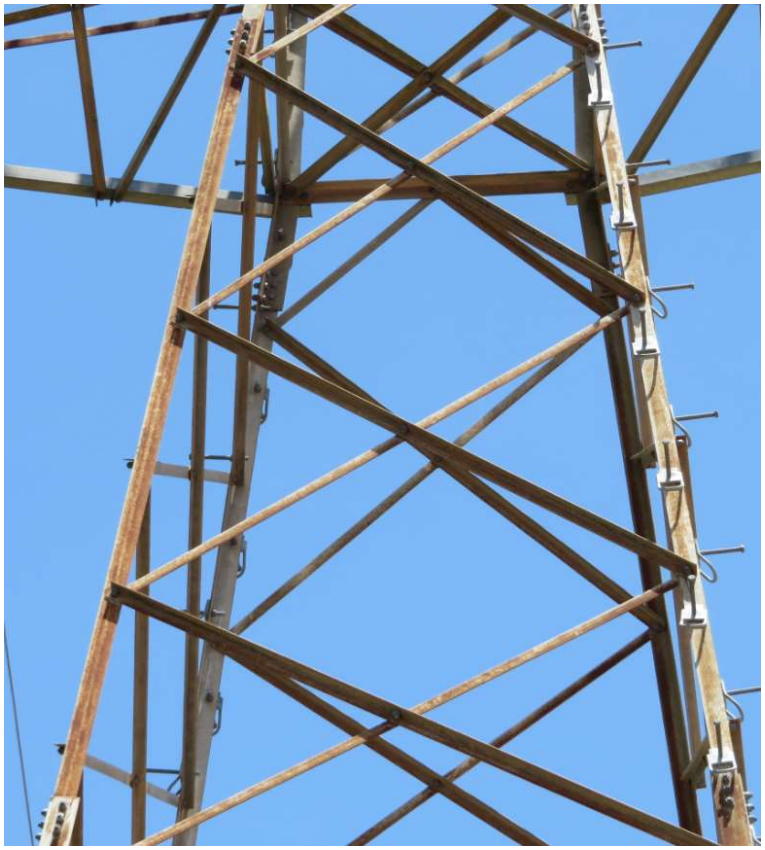

Figure 9: Instances of G3 corrosion on the body members - example STR - 1547 (2018)

Figure 10: Rare instances of G3 bolt corrosion are more pronounced on tower STR - 1565 (2019)

6.3.5 Superstructure

Surface rust has been observed on approximately 30% of members, while, as a result of extensive bolt replacements during the project in 2015, bolts are in generally good condition with only a small number of G3 bolts observed in the superstructures.

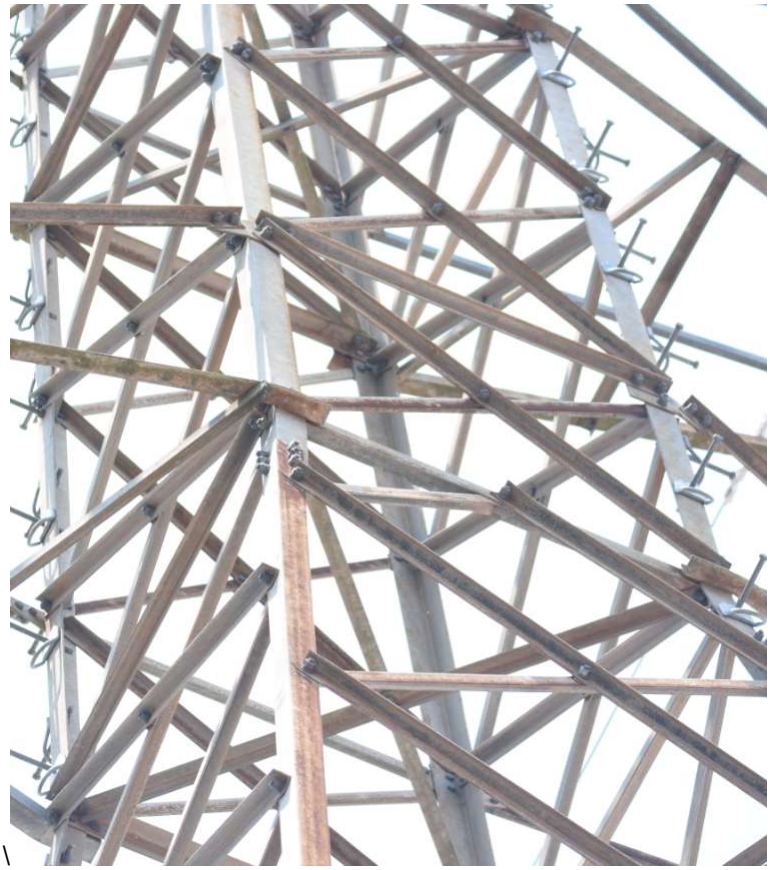

Figure 11: Typical example of corrosion with bolts in better condition than members STR - 1547 (2018)

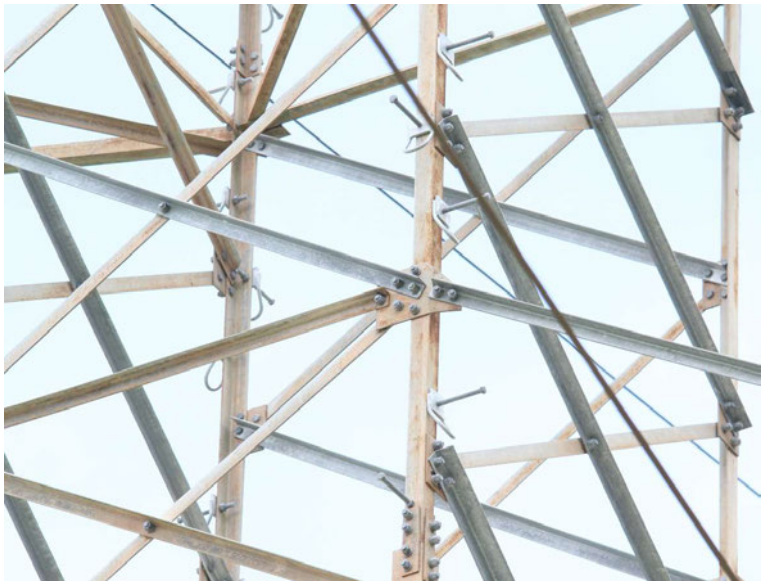

Figure 12: Replaced bolts and members in superstructure of tower STR - 1544 (2019)

6.3.6 Conductor Attachment Plate Bolts

Most of bolts in the attachment area have been replaced, sometimes complete with attachment plates.

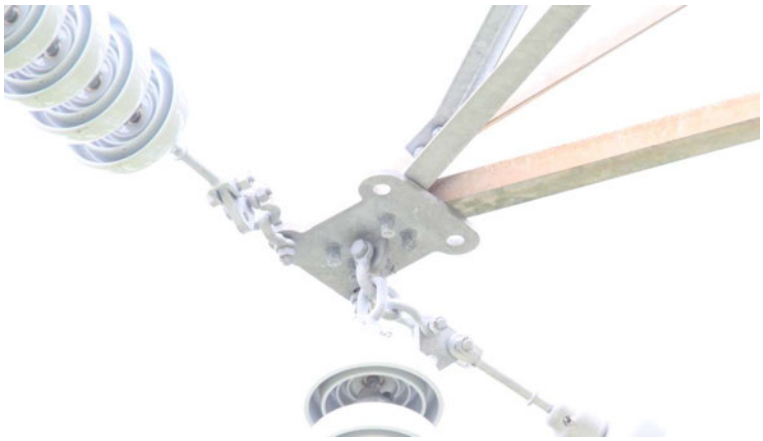

Figure 13: Replaced components in the conductor attachment area of tension tower STR - 1544 (2019)

Figure 14: Replaced components in the conductor attachment area of suspension tower STR - 1544 (2019)

Figure 15: A small number of towers will need maintenance as in example of tower STR - 0163 (2019)

6.3.7 Cross-arms

Grade 3 rust is observed on about 4% of the original (not replaced) members. Corrosion modelling indicates that the remaining original members will begin to reach corrosion grade 4, and will begin to compromise structural integrity and asset reliability in less than seven years.

Figure 16: Replaced and original components in the crossarm of suspension tower STR - 1540 (2017)

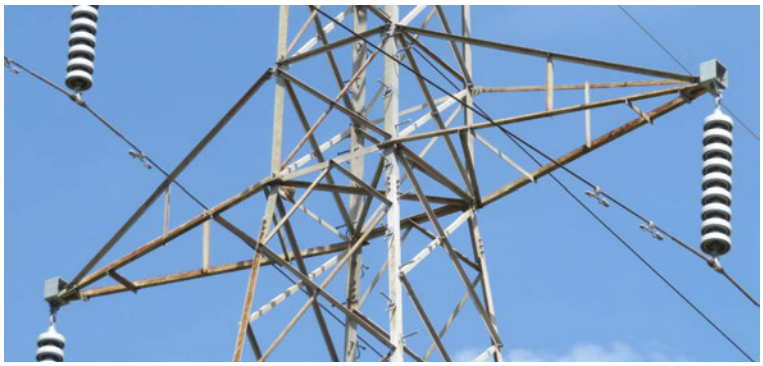

Figure 17: Typical appearance of crossarm of suspension tower STR - 1536 (2018)

6.3.8 Earthwire Peak

On some towers, Grade 3 corrosion is observed on 10 to 20% of the original (not replaced) earth wire peak members. Corrosion modelling indicates that grade 4 corroded members will start compromising structural integrity and adversely affect asset reliability in less than seven years. The replacement of the earthwire peak members will be extremely difficult due to the design that inter connects top crossarms and earthwire peak, particularly as access tracks are not suitable for deployment of the heavy cranes required for the member replacement.

Figure 18: Typical example of corrosion on earthwire peak; STR - 1540 (2017)

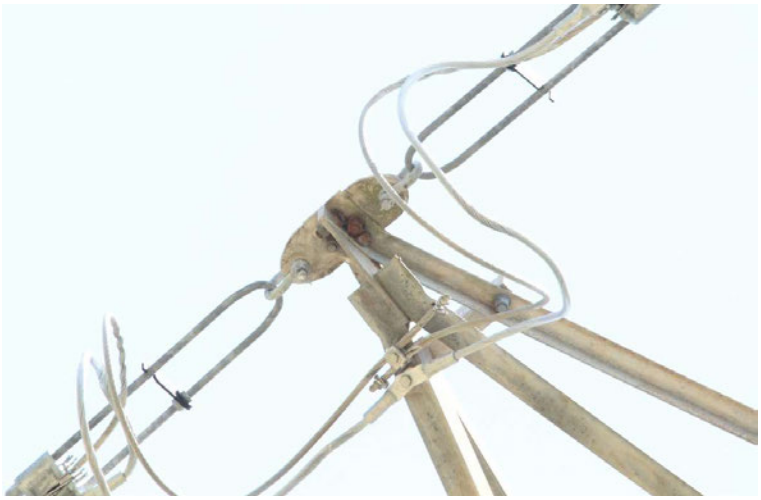

Figure 19:Small number of bolts recorded with G3/4 corrosion in earthwire peaks; example - STR - 1538 (2018)

6.4 Earthing

Earth straps appear to be in the good condition and it is likely they were all replaced during the foundation upgrade project in 2012.

Figure 20: Examples of earth straps in good condition (2019)

6.5 Conductor

The transmission line is strung with single ACSR Tiger, 30/7/2.36 conductor, containing a galvanised and greased central steel core, rated to a maximum temperature of 120°C.

The Tiger ACSR/GZ conductor is terminated with a hairpin wedge type end fitting. The end fittings are showing signs of Grade 2 corrosion.

6.6 Conductor Hardware

Dampers were replaced in 2016 under project OR.01730 together with insulators and insulator hardware.

Figure 21: STR-1553 Example of dampers in good condition shown (2019)

6.7 Conductor Mid-Span Joints

No mid-span joints are recorded in SAP.

6.8 Earthwire and Optical Ground wire

The condition of the overhead earthwire (OHEW) has been assessed mostly from the ground level and by using the condition data acquired during climbing inspections (a small quantity).

The worst observed condition of the OHEW is G3L.

Optical ground wire (OPGW) is not installed on this line.

6.9 Earthwire and Optical ground wire Hardware

Overhead earthwire (OHEW) hardware was replaced in 2016 under the project OR.01730.

6.10 Suspension and Bridging Insulators

In 2016 all insulators, insulator hardware and earthwire hardware were replaced under the project OR.01730.

Figure 22: Suspension Insulators in good condition - examples (2019)

6.11 Suspension Insulator Hardware

In 2016 all insulators, insulator hardware and earthwire hardware were replaced under project OR.01730.

Figure 23: STR-1540 – Cold end hardware in good corrosion (2018)

Figure 24: STR-1551 – Cold end hardware in good corrosion (2019)

6.12 Tension Insulators

In 2016 all insulators, insulator hardware and earthwire hardware were replaced under project OR.01730.

Figure 25: STR-1557 Tension Insulator (2019)

6.13 Tension Insulator Hardware

In 2016 all insulators, insulator hardware and earthwire hardware were replaced under project OR.01730.

Figure 26: STR-1554 Tension and Bridging Insulator Hardware (2019)

6.14 Signage

Signage was replaced in 2015 under project CP.02121 and is in good condition.

6.15 Easement

A recent project, OR.02117, performed a study of the existing easement and concluded that approximately 267 properties are impacted by the BS1252 transmission line corridor. Of these, there are 9 properties to which Powerlink has no registered rights.

There are 92 activities and encroachments on or near the easement that appear to be without approval:

- 60 of these are structural i.e. patios, carports, sheds, pergolas, house
- 2 of these are shade sails
- 8 pools
- 2 sand quarry activities
- 8 vegetation matters
- 6 vegetation matters relating to possible tenure
- 1 vegetation/ fence matter
- 3 caravan park type activities
- 1 storage of boats/ vehicles on easement
- 1 potentially off easement ground work

Overall, more than one third of the corridor is encroached in some manner, and it is clear that this level of encroachment will make maintenance activities very difficult with increased, maintenance costs and land owner interactions.

It is also noted that the existing easement is typically 20m wide, with multiple buildings within collapse distance. Re-use or widening of the existing corridor is not considered feasible due to encroachments, environmentally sensitive areas and construction constraints. As such, the consequences of a structure collapse in a cyclone or high wind event would be extremely high, with a high likelihood of property damage and a high safety risk. In the longer term, the use of this corridor may become more problematic with subdivision, and rebuilding on the same

route while keeping the line live is not feasible. A project has been underway for some time to investigate alternative long term route options.

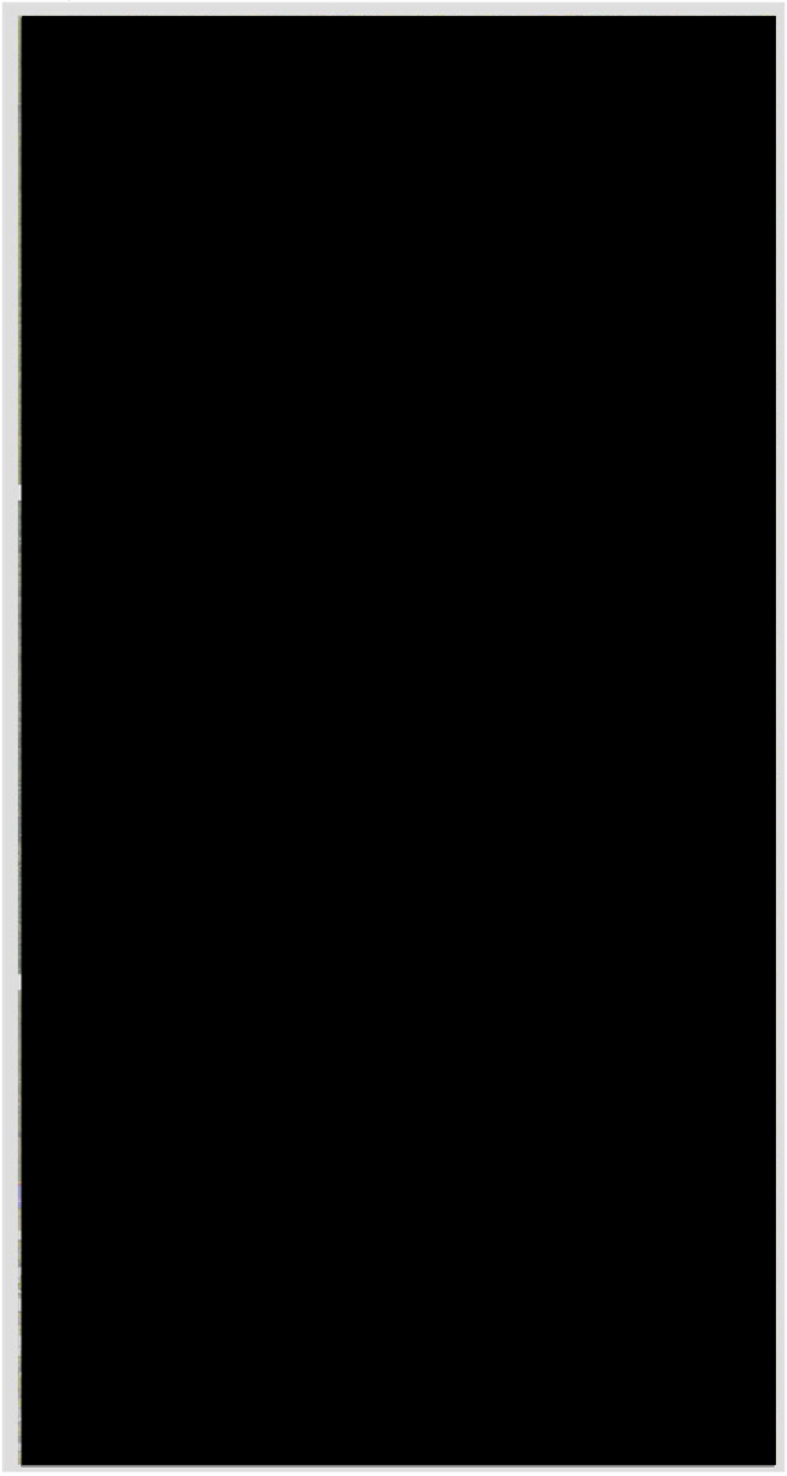

Figure 27: Examples of co-uses and encroachments as detailed in a document: 'OR.02117 B1 Co use and encroachments mapping Kamerunga Woree'

7. Appendices

7.1 SAP Notifications

The figures below show Outstanding Notifications (Figure 28) and Completed Notifications (Figure 29) since the refit and refurbishment projects finished.

Notification	O	Notification date	C...	Description	Functional Location	System status	Mn.wk.ctr	Reported by	Priority text
10350103		11.01.2018		G4 rust on leg plates all legs	1252-STR-1527	OSNO	C35	JMCLENNA	Actioned by End Date
10350107		11.01.2018		g3 rust e/p members 7141	1252-STR-1551	OSNO	C35	JMCLENNA	Actioned by End Date
10350108		11.01.2018		g3 rust horiz member top	1252-STR-1551	OSNO	C35	JMCLENNA	Actioned by End Date
10376025		08.11.2018		high poll. bridge insul stem/underskirt	1252-STR-0163-INSTEN_B	OSNO	C35	JMCLENNA	Actioned by End Date
10378350		10.01.2019		G3 24mm splice plate bolts x10	1252-STR-1565	OSNO	C35	JMCLENNA	Actioned by End Date
10400379		25.09.2019		Crackling at tower reproted to be lusual	1252-STR-1544-INSBDG_B	OSNO	C35	JCURTIN	Monitor & Review

Figure 28: SAP Outstanding Notifications for Corrosion on Structures

Notification	Order	Notif.date	Completion	Description	Functional Location	System status	Mn.wk.ctr	Reported by	Priority text
10350105	5414233	11.01.2018	01.05.2018	G4 16mm bolt leg 1 below waist 7142	1252-STR-1537	NOCO ORAS	C35	JMCLENNA	Actioned by End Date
10350106	5414233	11.01.2018	22.11.2018	G4 e/pk strain plate bolt F7141	1252-STR-1542	NOCO ORAS	C35	JMCLENNA	Actioned by End Date
10350280	5414233	12.01.2018	04.10.2018	G4 hang brack bolt 7142 TMB bridging	1252-STR-0163	NOCO ORAS	C35	JMCLENNA	Next Sched Outage
10374128	5414233	04.10.2018	04.10.2018	G4 70kN cold end shack 7142 TMB bridging	1252-STR-0163	NOCO ORAS	C35	JTAYLOR1	Next Sched Outage
10378346	5437062	10.01.2019	27.02.2019	G4 dble nut 16mm hang brkt bolt tmb 7141	1252-STR-0163	NOCO ORAS	C35	JMCLENNA	Actioned by End Date
10378347	5437062	10.01.2019	27.02.2019	G4 16mm bolt under x-arm x4 7141 bot	1252-STR-0163	NOCO ORAS	C35	JMCLENNA	Actioned by End Date
10378348	5437062	10.01.2019	27.02.2019	G4 12mm bolt under e/pk x 5	1252-STR-0163	NOCO ORAS	C35	JMCLENNA	Actioned by End Date

Figure 29: SAP Completed Notifications for Corrosion on Structures

Despite best possible intentions of the project some components are corroding faster than anticipated and maintenance needs to react correctively in some cases.

7.2 Percentage of Structure Corrosion

				FOUNDATION							STRUCTURE																																											
			Qty ->	0	0	0	23	23	23	36	32	32	32	29	29	29	29	29	29	31	31	31	31	31	31	32	32	32	32	32	32	32	32	32	32	32	32	32	32	32	27	27	27	28	28	28	32	32	32	32	32	32	43	0
			Avg ->				0.39	0.04	0	2.0	0.0	0.0	0.0	7.6	0.3	0.0	18.2	4.4	0.0	6.7	1.2	0.0	27.6	9.4	0.0	3.4	0.2	0.0	25.1	5.5	0.0	1.9	0.3	0.0	22.5	6.0	0.0	1.3	0.9	0.3	2.8	0.6	0.1	26.1	5.7	0.0	3.7	0.4	0.0	23.6	6.8	0.0	4.0	
				HOLD DOWN FASTENERS			CONCRETE				CLIMBING AID			TOWER BASE - FASTENERS			TOWER BASE - MEMBERS			TOWER BODY - FASTENERS			TOWER BODY - MEMBERS			SUPERSTR - FASTENERS			SUPERSTR - MEMBERS			CROSS ARMS - FASTENERS			CROSS ARMS - MEMBERS			ATTACH ZONE - FASTENERS			EW PEAK - FASTENERS			EW PEAK - MEMBERS			STRUCTURE - FASTENERS			STRUCTURE - STEELWORK				
Functional Location	Component	Str No	Row No in MDs	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	HEALTH INDEX	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	CORROSION - G2	CORROSION - G3	CORROSION - G4	HEALTH INDEX	EARTH RESISTANCE
1252-SPN-036A-OHEW	OHEW	036A	5																																																			
1252-SPN-036B-OHEW	OHEW	036B	10																																																			
1252-SPN-041A-OHEW	OHEW	041A	15																																																			
1252-SPN-041B-OHEW	OHEW	041B	19																																																			
1252-STR-0163	STR	0163	23								0	0	0	2	0	0	1	0	0	2	0	0	10	0	0	0	0	0	0	0	0	10	0	0	5	0	0	40	30	10	10	10	0	0	0	0	3.5	0.8	0.1	3.3	0	0	4.9	
1252-STR-0163-FNDN	FNDN	0163	66				0	0	0																																													
1252-STR-1525	STR	1525	69								0	0	0	0	0	0	5	0	0	10	0	0	10	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	20	0	0	4.5	0	0	3.7	0	0	3.6	
1252-STR-1525-FNDN	FNDN	1525	112				0	0	0																																													
1252-STR-1525-INSBDG_A	BDG	1525	115																																																			
1252-STR-1525-INSTEN_A	TEN	1525	120																																																			
1252-STR-1525-INSTEN_B	TEN	1525	125																																																			
1252-STR-1526	STR	1526	130																																																		5.1	
1252-STR-1526-FNDN	FNDN	1526	131							2																																												
1252-STR-1527	STR	1527	132																																																		5.1	
1252-STR-1528	STR	1528	133								0	0	0	10	0	0	10	2	0	20	1	0	20	30	0	10	1	0	20	5	0	5	0	0	10	2	0	0	0	0	0	0	0	30	0	0	10	0.6	0	17.4	9.1	0	4.4	
1252-STR-1528-FNDN	FNDN	1528	176				0	0	0	2																																												
1252-STR-1529	STR	1529	180																																																		5.1	
1252-STR-1529-FNDN	FNDN	1529	181							2																																												
1252-STR-1530	STR	1530	182								0	0	0	1	0	0	5	0	0	10	0	0	20	30	0	10	0	0	20	40	0	2	0	0	20	30	0	0	0	0							6.5	0	0	17.4	29.5	0	3.8	
1252-STR-1530-FNDN	FNDN	1530	219				2	0	0	2																																												
1252-STR-1531	STR	1531	223								0	0	0	20	0	0	20	2	0	5	0	0	40	5	0	5	0	0	30	2	0	10	1	0	20	10	0	0	0	0							7	0.2	0	27.4	4.2	0	3.8	
1252-STR-1531-FNDN	FNDN	1531	260				0	0	0	2																																												
1252-STR-1532	STR	1532	264								0	0	0	20	0	0	10	2	0	10	0	0	30	50	0	5	0	0	60	20	0	2	0	0	50	5	0	0	0	0	2	0	0	50	10	0	6.5	0	0	45.8	20.7	0	3.8	
1252-STR-1532-FNDN	FNDN	1532	307				0	0	0	2																																												
1252-STR-1533	STR	1533	311								0	0	0	1	0	0	5	0	0	2	0	0	5	0	0	2	0	0	5	0	0	1	0	0	2	0	0	0	0	0							1.5	0	0	4.1	0	0	3.1	
1252-STR-1533-FNDN	FNDN	1533	348				0	0	0	2																																												
1252-STR-1534	STR	1534	352																																																		5.1	
1252-STR-1534-FNDN	FNDN	1534	353							2																																												
1252-STR-1535	STR	1535	354																																																		5.1	
1252-STR-1535-FNDN	FNDN	1535	355							2																																												
1252-STR-1536	STR	1536	356								0	0	0	5	0	0	10	40	0	5	0	0	5	60	0	0	0	0	10	1	0	5	0	0	5	40	0	0	0	0	5	0	0	10	40	0	4.6	0	0	6.4	47.3	0	3.6	
1252-STR-1536-FNDN	FNDN	1536	399				0	0	0	2																																												
1252-STR-1536-INSSUS_A	SUS	1536	403																																																			
1252-STR-1536-INSSUS_B	SUS	1536	411																																																			
1252-STR-1537	STR	1537	419																																																		5.1	
1252-STR-1537-FNDN	FNDN	1537	420							2																																												
1252-STR-1538	STR	1538	421																																																		5.1	
1252-STR-1538-FNDN	FNDN	1538	422							2																																												
1252-STR-1539	STR	1539	423																																																		5.1	
1252-STR-1539-FNDN	FNDN	1539	424							2																																												
1252-STR-1540	STR	1540	425								0	0	0	20	0	0	10	1	0							20	1	0	10	1	0	10	1	0	30	5	0	0	0	0	0	0	0	30	20	0	12	0.6	0	13.2	2.6	0	4.4	
1252-STR-1540-FNDN	FNDN	1540	462				0	0	0	2																																												
1252-STR-1541	STR	1541	466								0	0	0	0	0	0	30	0	0	2	0	0	5	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0.4	0	0	6.8	0	0	2.7	
1252-STR-1541-FNDN	FNDN	1541	509							2																																												
1252-STR-1542	STR	1542	510								0	0	0	20	0	0	20	0	0	30	0	0	20	0	0	30	2	0	30	1	0	2	0	0	40	1	0	0	0	0	0	2	2	40	2	0	12.4	0.9	0.1	23.2	0.7	0	4.9	
1252-STR-1542-FNDN	FNDN	1542	553				1	0	0	2																																												
1252-STR-1542-INSTEN_A	TEN	1542	557																																																			
1252-STR-1542-INSTEN_B	TEN	1542	562																																																			
1252-STR-1543	STR	1543	567								0	0	0							0	0	0	40	0	0	0	0	0	10	0	0	10	0	0	20	0	0	0	0	0	5	0	0	10	0	0	2.3	0	0	17.4	0	0	3.3	
1252-STR-1543-FNDN	FNDN	1543	604							2																																												
1252-STR-1544	STR	1544	605								0	0	0	5	0	0	30	0	0	1	0	0	30	0	0	0	0	0	40	2	0	0	0	0	5	0	0	0	0	0				30	0	0	0.7	0	0	28.9	0.8	0	2.9	
1252-STR-1544-FNDN	FNDN	1544	645				0	0	0	2																																												
1252-STR-1545	STR	1545	649								0	0	0	10	1	0	40	1	0	0	0	0	70	2	0	0	0	0	70	0	0	0	0	0	50	0	0	0	0	0	0	0	0	50	0	0	1	0.1	0	61.6	0.5	0	3.3	
1252-STR-1545-FNDN	FNDN	1545	692				0	0	0	2																																													
1252-STR-1545-INSSUS_A	SUS	1545	696																																																			
1252-STR-1545-INSSUS_B	SUS	1545	704																																																			
1252-STR-1546	STR	1546	712								0	0	0	2	0	0	50	1	0	1	0	0	80	2	0	0	0	0	80	0	0	0	0	0	80	1	0	0	0	0	0	0	0	60	0	0	0.4	0	0	75.8	0.7	0	2.7	
1252-STR-1546-FNDN	FNDN	1546	755							2																																												
1252-STR-1547	STR	1547	756								0	0	0	0	0	0	30	70	0	0	0	0	30	70	0	0	0	0	30	70	0	0	0	0	30	70	0	0	0	0	0	0	0	30	70	0	0	0	0	30	70	0	2	
1252-STR-1547-FNDN	FNDN	1547	799				0	0	0	2																																												
1252-STR-1547-INSSUS_A	SUS	1547	803																																																			
1252-STR-1547-INSSUS_B	SUS	1547	811																																																			
1252-STR-1548	STR	1548	819								0	0	0							0	0	0	40	30	0	0	0	0	30	20	0	0	0	0	30	10	0	0	0	0							0	0	0	27.4	16.8	0	2	
1252-STR-1548-FNDN	FNDN	1548	850				0	0	0	2																																												
1252-STR-1549	STR	1549	854								0	0	0	20	5	0	10	0	0	20	2	0	20	0	0	5	1	0	10	1	0	0	0	0	60	2	0	0	0	0	0	0	0	20	0	0	8	1.3	0	23.2	0.8	0	5	
1252-STR-1549-FNDN	FNDN	1549	897				0	0	0	2																																												
1252-STR-1550	STR	1550	901																																																			5.1	
1252-STR-1551	STR	1551	902								0	0	0	5	1	0	30	2	0	0	0	0	50	1	0	0	0	0	70	2	0	2	0	0	30	5	0	0	0	0	2	0	0	40	5	0	1	0.1	0	51.6	2.6	0	3.3	
1252-STR-1551-FNDN	FNDN	1551	945							2																																												
1252-STR-1552	STR	1552	946								0	0	0	20	0	0	60	2	0	2	0	0	40	0	0	5	0	0	30	0	0	0	0	0	10	0	0	0	0	0	10	0	0	20	0	0	4.9	0	0	30.5	0.2	0	3.6	
1252-STR-1552-FNDN	FNDN	1552	989				1	0	0	2																																												
1252-STR-1553	STR	1553	993								0	0	0	10	0	0	10	0	0	0	0	0	40	2	0	0	0	0	30	1	0	0	0	0	20	0	0	0	0	0	0	0	0	10	0	0	1	0	0	26.8	0.8	0	3	
1252-STR-1553-FNDN	FNDN	1553	1036							2																																												
1252-STR-1554	STR	1554	1037								0	0	0	1	0	0	5	0	0	10	1	0	20	1	0	2	0	0	30	1	0	0	0	0	50	0	0	0	0	0	0	0	0	70	0	0	2.9	0.2	0	31.6	0.6	0	3.7	
1252-STR-1554-FNDN	FNDN	1554	1080							2																																												
1252-STR-1555	STR	1555	1081								0	0	0	1	0	0	10	0	0	0	0	0	10	0	0	0	0	0	10	0	0	1	0	0	2	0	0	0	0	0	0	1	0	20	0	0	0.3	0.1	0	8.8	0	0	2.9	
1252-STR-1555-FNDN	FNDN	1555	1124							2																																												
1252-STR-1556	STR	1556	1125								0	0	0	10	1	0	20	0	0	20	2	0	40	1	1	0	0	0	40	2	0	0	0	0	30	10	0	0	0	0	0	0	0	0	0	0	5	0.5	0	33.7	3.2	0.2	4.3	
1252-STR-1556-FNDN	FNDN	1556	1168							2																																												
1252-STR-1557	STR	1557	1169								0	0	0	20	0	0	2	0	0	10	0	0	20	2	0	1	0	0	20	0	0	0	0	0	30	0	0	0	0	0	0	0	0	20	0	0	4.4	0	0	20.2	0.4	0	3.5	
1252-STR-1557-FNDN	FNDN	1557	1212				1	1	0	2																																												
1252-STR-1558	STR	1558	1216								0	0	0	1	0	0	1	0	0	5	0	0	30	0	0	0	0	0	20	1	0	0	0	0	2	0	0	0	0	0	0	0	0	30	1	0	1.1	0	0	16.8	0.5	0	3	
1252-STR-1558-FNDN	FNDN	1558	1259				1	0	0	2																																												
1252-STR-1559	STR	1559	1263								0	0	0	5	0	0	30	0	0	10	0	0	40	0	0	0	0	0	30	0	0	0	0	0	10	0	0	0	0	0	0	0	0	20	0	0	2.5	0	0	27.4	0	0	3.4	
1252-STR-1559-FNDN	FNDN	1559	1306				3	0	0	2																																												
1252-STR-1560	STR	1560	1310								0	0	0	5	0	0	20	0	0	1	0	0	2	0	0	0	0	0	2	0	0	0	0	0	10	0	0	0	0	0	0	0	0	5	0	0	0.7	0	0	5.7	0	0	2.9	
1252-STR-1560-FNDN	FNDN	1560	1353				0	0	0	2																																												
1252-STR-1560-INSSUS_A	SUS	1560	1357																																																			
1252-STR-1560-INSSUS_B	SUS	1560	1365																																																			
1252-STR-1561	STR	1561	1373								0	0	0							0	0	0	40	1	0	0	0	0	20	0	0	0	0	0	30	1	0	0	0	0	2	0	0	40	1	0	0.1	0	0	25.3	0.5	0	2.4	
1252-STR-1561-FNDN	FNDN	1561	1410							2																																												
1252-STR-1562	STR	1562	1411								0	0	0	0	0	0	10	0	0	2	1	0	10	0	0	0	0	0	10	0	0	1	1	0	30	1	0	0	0	0	10	0	0	20	0	0	1.1	0.4	0	14.7	0.2	0	4.2	
1252-STR-1562-FNDN	FNDN	1562	1454				0	0	0	2																																												
1252-STR-1563	STR	1563	1458								0	0	0	5	0	0	5	0	0	0	0	0	10	0	0	0	0	0	10	0	0	0	0	0	5	0	0	0	0	0	0	0	0	5	0	0	0.5	0	0	8.2	0	0	2.8	
1252-STR-1563-FNDN	FNDN	1563	1501				0	0	0	2																																												
1252-STR-1565	STR	1565	1505								0	0	0	0	0	0	40	5	0	30	30	0	30	5	0	10	0	0	20	5	0	0	5	0	5	0	0	0	0	0	20	2	0	40	10	0	11	7.1	0	22.1	4.2	0	6.6	
1252-STR-1565-FNDN	FNDN	1565	1548				0	0	0																																													
1252-STR-1565-INSBDG_A	BDG	1565	1551																																																			
1252-STR-1565-INSTEN_A	TEN	1565	1556																																																			
1252-STR-1565-INSTEN_B	TEN	1565	1561																																																			
1252-STR-9558	STR	9558	1566																																																		5.3	
1252-STR-9559	STR	9559	1567																																																		5.3	
Only insert or delete rows above this line																																																						
									Avg	2.0																																			Avg	3.68	0.4	0.01	23.6	6.78	0.01	4.0	0.0
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									95%	2.0	36																																								95%	6.1	1
									99.7%	2.0	36																																								99.7%	7.2	0
										HI	No.																																					User defined input				85.0%	5.1	12

Figure 30: Condition Review Spreadsheet

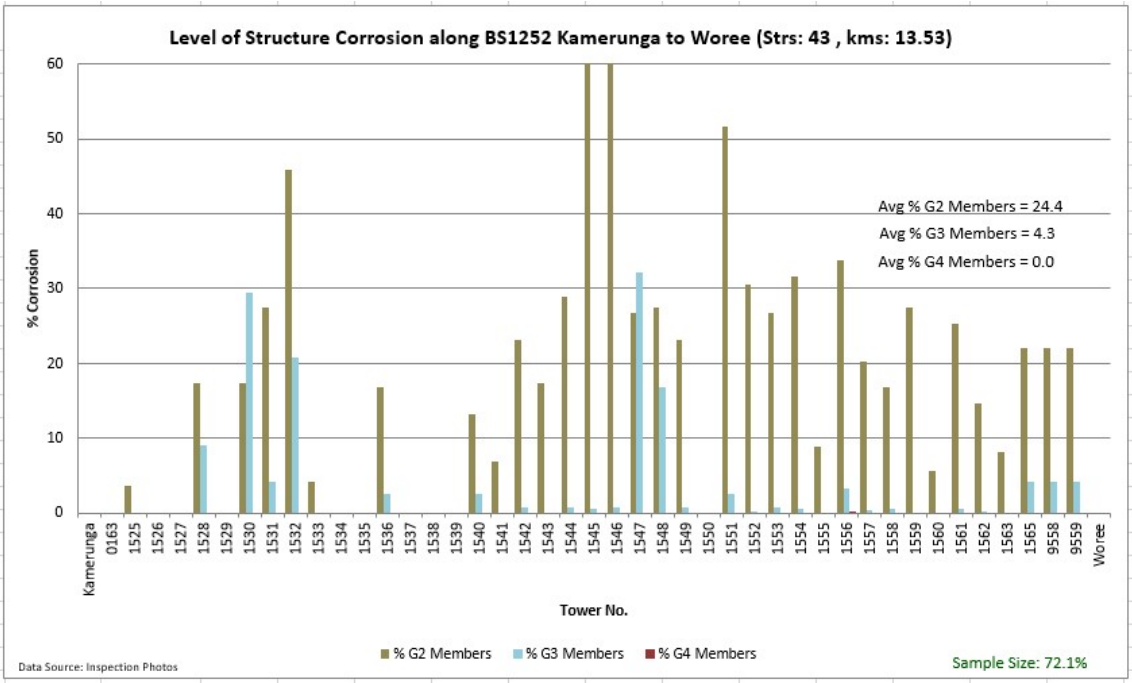


Figure 31: Structure Corrosion Levels (Members Only)

7.3 Health Index

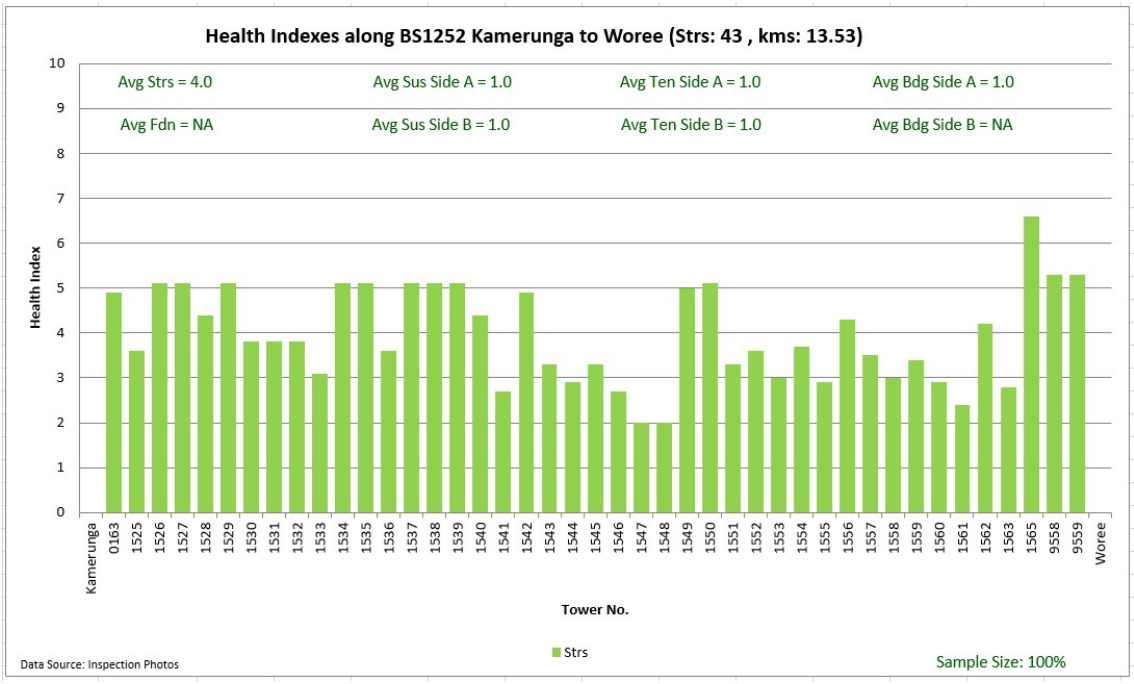


Figure 32: Structure Health Indices

7.4 Built Section Meters

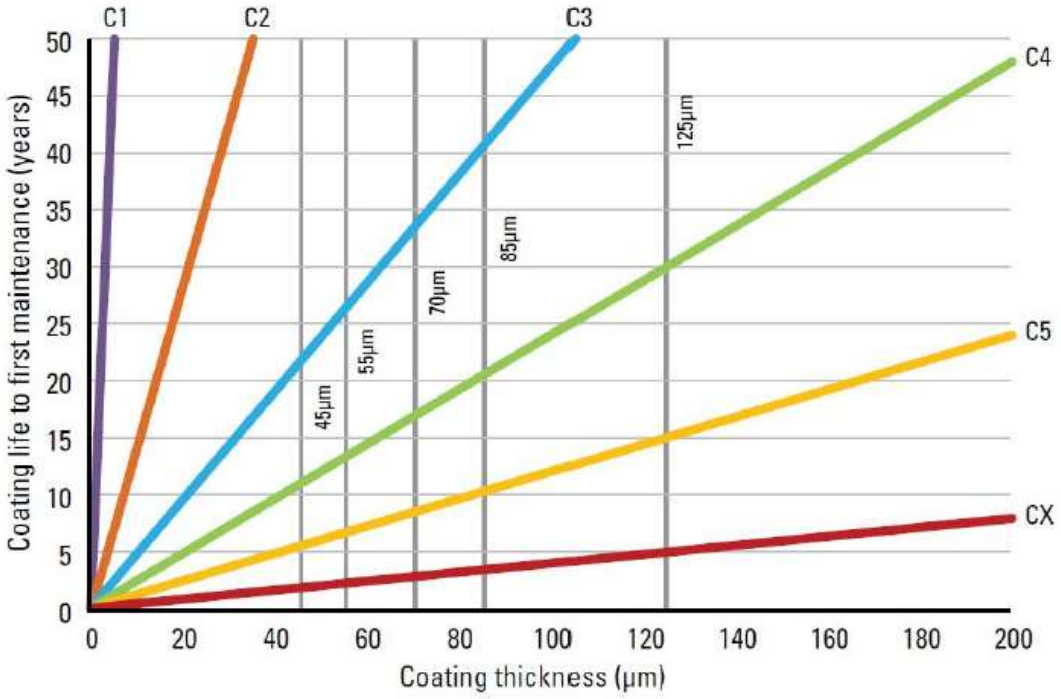
Functional Location	Measurement document	Measuring point	Description of measuring point	Date	Valuation code	Coding code text	Text
1252-STR	19092059	433271	STRUCTURE (ABOVE K-POINT ANTICL MB OPGV	4/06/2019	0005	INVESTIGATED FOLLOWUP REQD	G3/4 Bolt plate&membs OHEW horizmemb G3
1252-STR	19088291	433269	EARTH NG (GRAD NG RING ETC)	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088292	433270	FOUNDATIONS	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088297	433272	SUSPENSION INSULATORS	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088296	433273	SUSP H'WARE (HANGERS SUSP UNIT)	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088299	433274	TENSION INSULATORS	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088298	433275	TENSION H'WARE(H'WARE,DEADEND,GRAD TU	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088293	433276	OHEW H'WARE(DEADEND,H'WARE,CLAMP,DAM	4/06/2019	0006	INVESTIGATED OK	
1252-STR	19088294	433277	SIGNAGE (CIRCUIT ID WARNING PLATES)	4/06/2019	0006	INVESTIGATED OK	
1252-SPN	19088287	433384	CONDUCTORS	4/06/2019	0006	INVESTIGATED OK	
1252-SPN	19088288	433385	CONDUCTORS MIDSPAN JOINTS	4/06/2019	0006	INVESTIGATED OK	
1252-SPN	19088286	433386	CONDUCTOR HARDWARE (DAMPERS, SPACER	4/06/2019	0006	INVESTIGATED OK	
1252-SPN	19088289	433387	OHEW/OPGW	4/06/2019	0006	INVESTIGATED OK	
1252-SPN	19088290	433388	OHEW/OPGW M DSPAN JOINTS	4/06/2019	0006	INVESTIGATED OK	

Figure 33 - Recent Built Section Meters Measurement Document List

7.5 Estimated Service Life of Galvanised Steel

BS1252 Transmission Line

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.



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.

Region	Rate	Bolts & Nuts (45µm)		Members <= 6mm (70µm)		Members > 6mm (85µm)	
		Min Yrs	Max Yrs	Min Yrs	Max Yrs	Min Yrs	Max Yrs
C2 (B)	0.7	64	450	100	700	121	850
C3 (C)	2.1	21	64	33	100	40	121
C4 (D)	4.2	11	21	17	33	20	40
C5 (E)	8.3	5	11	8	17	10	20

Figure 34 - Time to First Maintenance of Galvanised Steel

7.6 Estimated Service Life of Carbon Steel

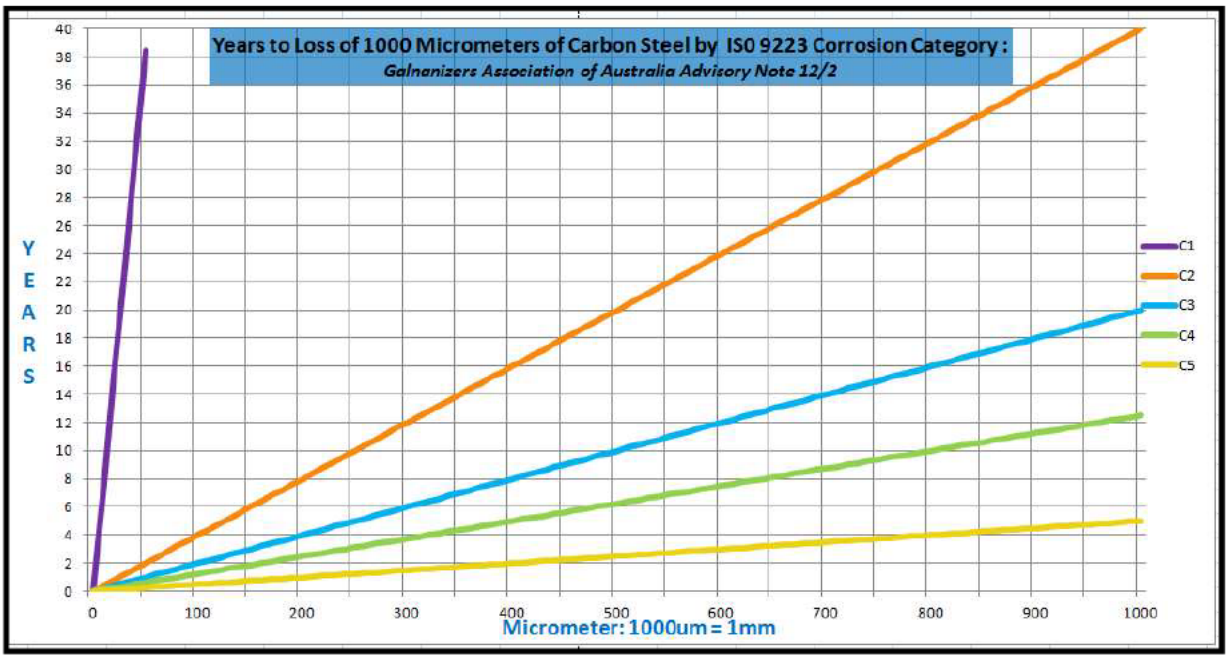


Figure 35 - Rate of Carbon Steel Loss

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

7.7 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	17/04/2020
Title	CP.xxxxx Woree – Kamerunga 132kV Transmission Line Rebuild – Planning Statement[1]
Zone	Far North Queensland
Need Driver	Condition assessment of the Woree – Kamerunga 132kV Line March 2020. Recommended reinvestment by December 2026 to maintain ongoing compliance with requirements of the Electricity Act 1994, Electrical Safety Act 2002 and Electricity Safety Regulation 2013[2].
Network Limitation	Needed to meet Powerlink Queensland's N-1-50MW/600MWh reliability obligations, and maintain connectivity to Barron Gorge Hydroelectric Power Station.
Pre-requisites	None

Executive Summary

The Woree – Kamerunga 132kV TL was commissioned in the early 1960s to supply a growing demand in the Cairns area.

A recent condition assessment report has recommended reinvestment in the line by 2026 to ensure ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations.

Energy Queensland's forecasts have confirmed there is an enduring need to maintain electricity supply to the local Cairns and northern beaches areas. Removal of the Woree – Kamerunga 132kV Transmission Line to address emerging condition risks would result in Powerlink breaching its N-1-50MW/600MWh reliability obligations.

These lines also provide the point of connection for Barron Gorge Hydroelectric Power Station.

The preferred network solution for Powerlink to continue to meet its statutory obligations is to replace the line by December 2026.

[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 bade 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)

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1. Introduction

The Woree to Kamerunga line is a 13.5km double circuit 132kV transmission line constructed in the early 1960s. It comprises 24 tension and 19 suspension structures. The line is an essential component of the transmission network supplying the Northern Cairns area and connects Barron Gorge Hydro Power Station to the national grid.

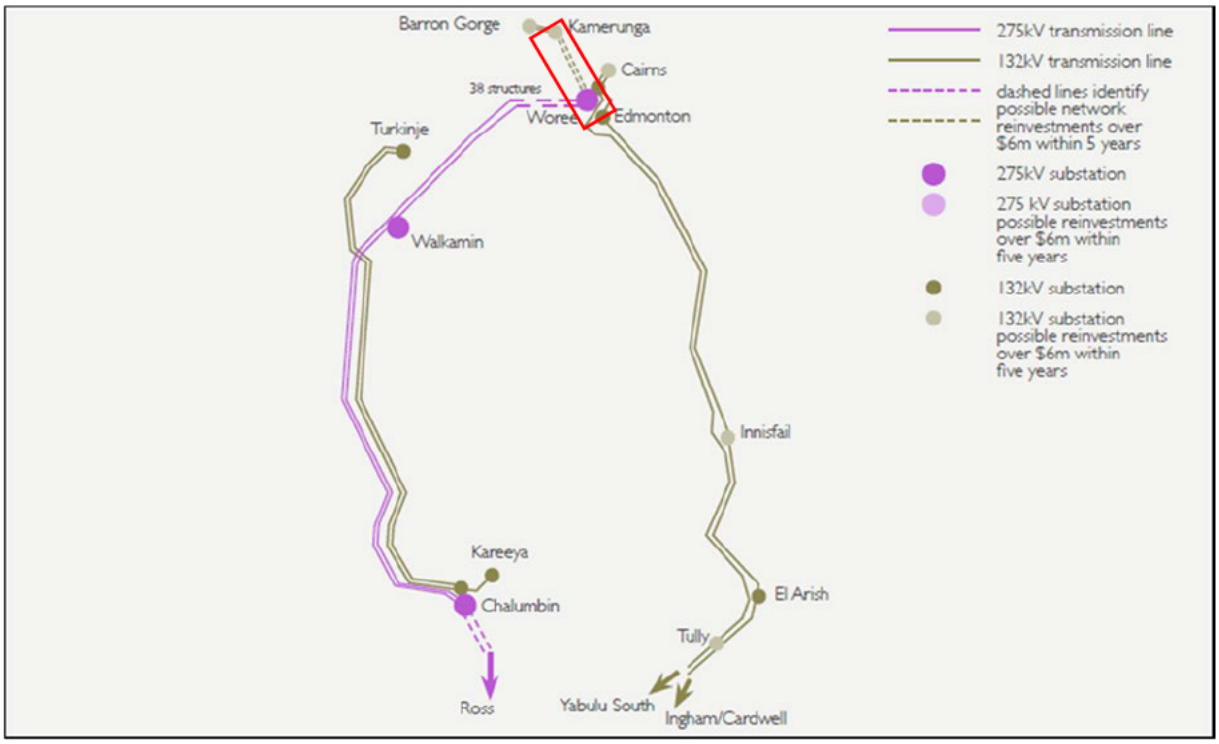

Figure 1: Woree – Kamerunga 132kV Transmission Line – Far North Queensland

A Condition Assessment of the line in March 2020 recommended the 132kV line be rebuilt by December 2026 to address condition issues, which would ensure ongoing compliance with statutory safety obligations and reliability of supply standards.

The proposed route of the new 132kV double circuit transmission line between Woree and Kamerunga will be approximately 14km long (refer Figure 2). The line between Kamerunga and Redlynch is intended to be built as overhead line while the line between Redlynch and Woree will need to be underground cable due to the density of domestic and commercial developments. The indicative route is shown in Figure 2. The new underground alignment is to the west of the existing overhead feeders.

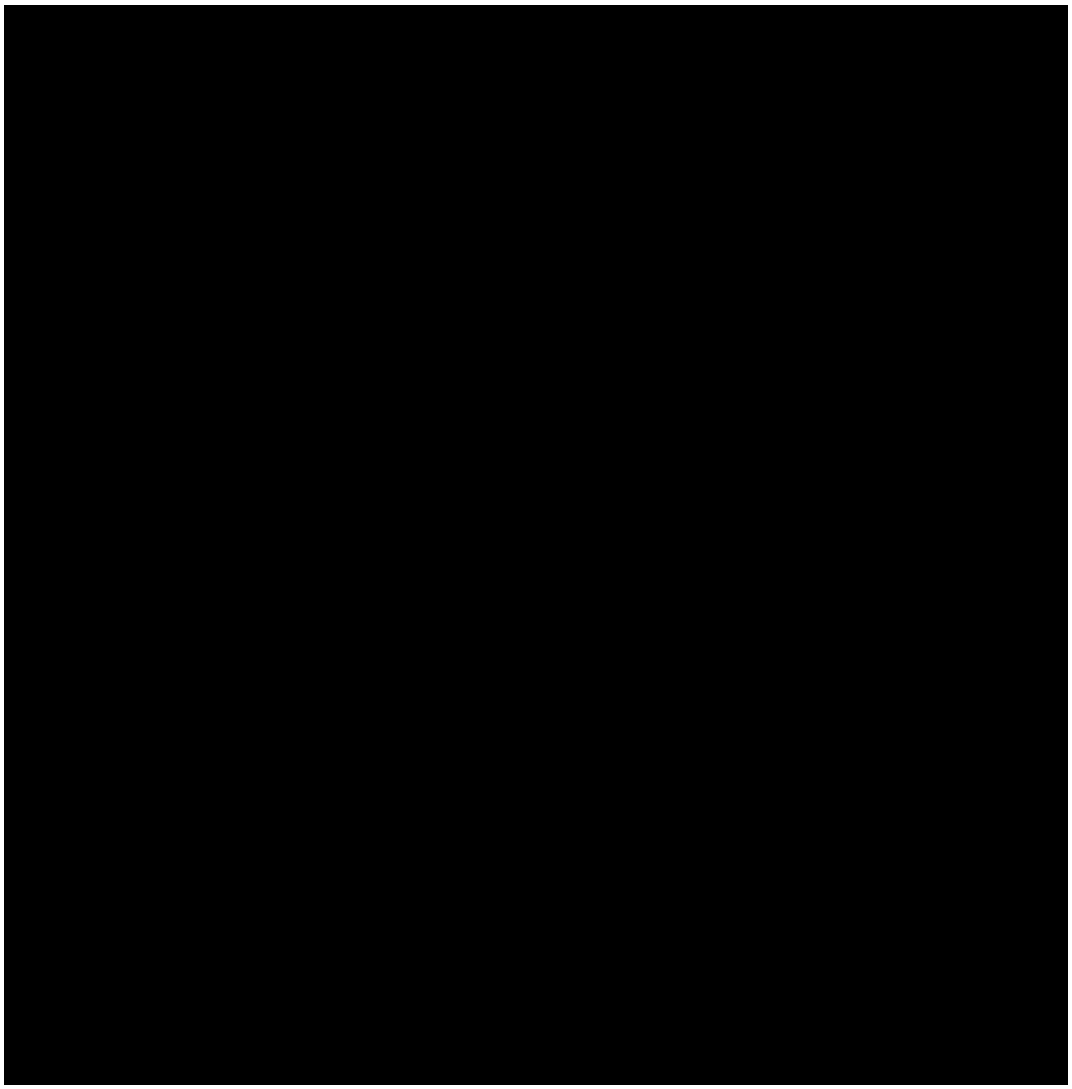

Figure 2: Line route for new Woree to Kamerunga line

This report assesses the impact that removal of the at-risk lines 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 provided by the Woree to Kamerunga feeders.

2. Kamerunga Demand Forecast

2.1 Historical and forecast demand

The historical and forecast maximum load for Kamerunga is shown in Figure 3**Error! Reference source not found.**. As shown there is an expected increase in demand over the next 10-years. However, longer-term load forecasts have been considered when determining the required rating of the underground cable. The longer-term load forecast is described in Section 2.2.

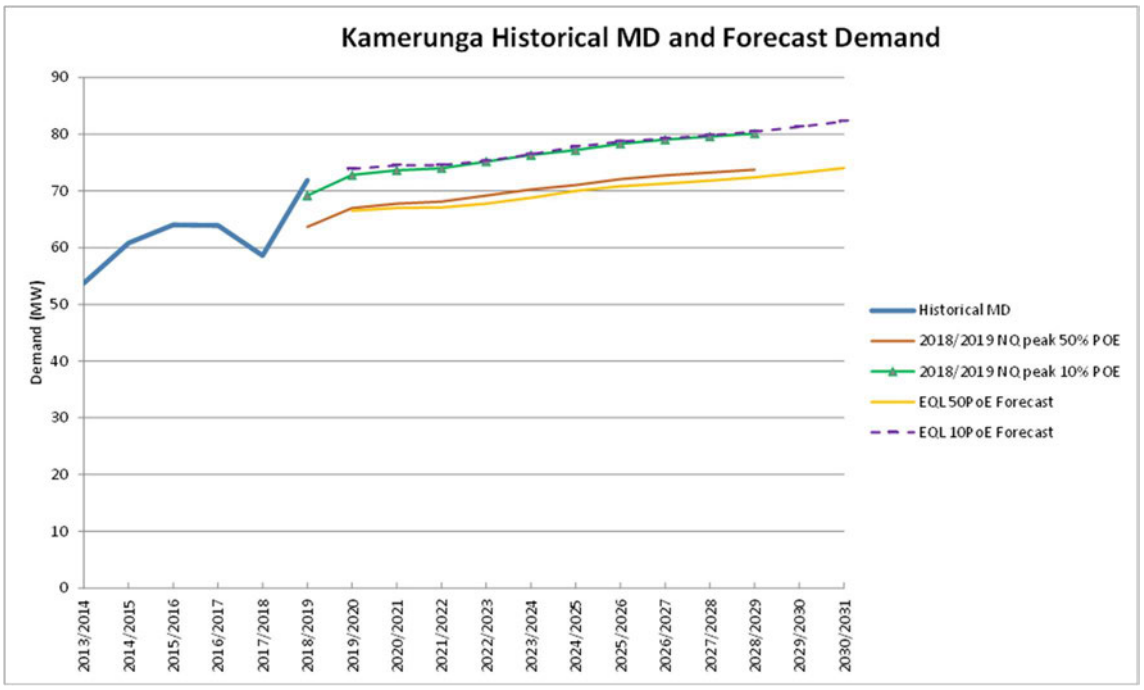

Figure 3: Kamerunga Load History and Forecast

The annual load duration curves from 2014/15 to 2019/20 are shown in Figure 4.

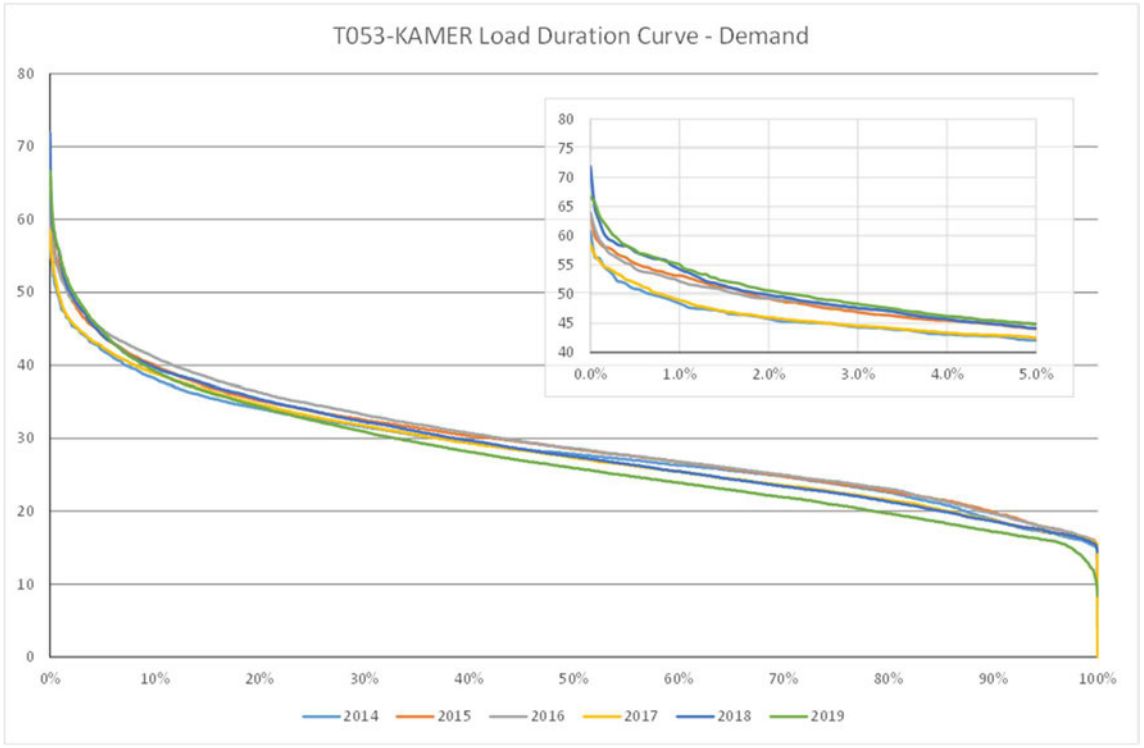

Figure 4: Kamerunga Load duration curves from 2014/15 to 2019/20

2.2 Long term demand forecast

Energy Queensland's strategic plan for the area concludes that future load at Kamerunga and nearby substations (including future Smithfield and Redlynch) will all be supplied from these Woree to Kamerunga 132 kV circuits. The 50-year projected maximum demand forecast depends on the commitment and timing of a large resort and casino development. Table 1 shows the sensitivity of the long-term loads to this development.

Table 1: 50 years and Ultimate forecast projection

Forecast	load without Aquis Resort (MVA)	Load with Aquis Resort[3] (MVA)
50 years	125.5	151.2
Ultimate	154.4	180.2

3. Cable rating

Due to easement constraints the new circuits between Woree and Kamerunga are required to be a combination of underground cable and overhead line. The underground cable is expected to be 9.8km.

Given the technical difficulty and cost to uprate cable capacity after it is built, it is import to consider a cable rating that can meet the long-term load growth requirements. Another consideration is that given the typical Mean Time to Repair (MTTR) for a cable the normal steady state rating of one cable should be capable of supplying the full load.

Typical steady state cable ratings are shown Table , reduced by 10% due to anticipated unfavourable installation conditions.

Table 2: Typical cable ratings

Cable Size	Single Cct Trefoil 145kV Rating (MVA)	Single Cct Flat 145kV Rating (MVA)
400 mm^2 (Cu)	113.2	126.5
800 mm^2 (Cu)	168.7	183.1
1600 mm^2 (Cu)	226.3	246.9

Based on ratings in Table 2 and the forecast over the anticipated life of the cable it is likely that the 400mm^2 cable will meet the need in the absence of the development of the Aquis Resort. There considerable uncertainty on the timing of this development, and for that matter long-term forecasts given the expected developments in disruptive distributed energy resource (DER) technologies.

Whether or not additional conduits should be laid with the initial cable installation to facilitate an economic future upgrade will the decided at the time of the formal business approval process (RIT-T).

4. Statement of Investment Need

Energy Queensland forecasts have confirmed there is an enduring need to maintain electricity supply to the northern beaches and Cairns areas. Consequently, the removal of the Woree to Kamerunga transmission line to address emerging condition-based safety issues would have a major impact on loads in the Cairns area and breach Powerlink's N-1-50MW/600MWh reliability obligations.

These lines also provide the point of connection for Barron Gorge Hydroelectric Power Station. Powerlink must therefore preserve the functionality of the Woree to Kamerunga Transmission Line to ensure ongoing compliance with its Transmission Authority reliability obligations for the supply of electricity to the Cairns area.

[3] Aquis is a major Resort and Casino complex proposed for Cairns.

5. Network Risk

Table 3 summarises results of analysis to determine the load and energy at risk, if the existing Woree to Kamerunga feeders are decommissioned.

Table 3: Load and energy at risk (without the Aquis Resort)

Year	2020	2030	2040	2050	2060	2070
Max (MW)	67.0	74.0	84.5	96.4	110.0	125.5
Average (MW)	30	31	35	40	46	53
24h Energy Unserved Max (MWh)	1192	1223	1395	1592	1817	2073
24h Energy Unserved Average (MWh)	729	744	849	969	1105	1261

Another consideration independent of the supply to Kamerunga is the connection of the Barron Gorge Hydroelectric Power Station.

The Barron Gorge Hydroelectric Power Station is located in the Wet Tropics World Heritage Area 20 kilometres north-west of Cairns and consists of two generating units that were commissioned in 1963. The combined capacity of the units is 66MW. The two 33MW generators were refitted in 2011, extending the power station's life for supplying renewable energy to Queensland.

Table 4 shows the historical operation of the Barron Gorge Power Station. This is indicative of the energy that world be forfeited if the Woree to Kamerunga feeders are not available.

Table 4: Historical output of Barron Gorge Hydroelectric Power Station

At Risk	Contingency	Metric	2014	2019
Barron Gorge PS	Kamerunga feeders 7141 and 7142	Max (MW)	66	66
		Average (MW)	20	19
		24h Energy Constrained Maximum (MWh)	1606	1609
		24h Energy Constrained Average (MWh)	486	450
		24h Max Time Constrained (h)	24	24
		24h Average Time Constrained (h)	14	15

In addition, the Barron Gorge Power Station is a "run of river" hydro power station with very limited storage capacity at the weir. Therefore, during dry periods generation will be limited. As such there will be extended periods when there will be no generation. Therefore, the operation of the Barron Gorge Power Station will not impact on the required rating of the Woree to Kamerunga feeder/cable.

6. Non Network Options

Potential non-network solutions would need to provide supply to the 132kV network at Kamerunga and other future 132kV substation as per Table 3. That is, up to 67 MW and 1192 MWh per day in 2020, increasing with load growth. The non-network solution would be required on a continuous basis and be able to meet reliability criteria under contingencies, i.e. N-1-50MW/600MWh.

Powerlink is not aware of any non-network solutions, including demand side management solutions, in the area. 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 prior to project approval.

7. Network Options

7.1 Proposed Option to address the identified need

To address network transfer capability after the end of life of the existing 132kV double circuit transmission line between Woree and Kamerunga, it is recommended to rebuild a new 132kV double circuit transmission line between Woree and Kamerunga on the proposed route.

The proposed network solution ensures ongoing reliability of supply obligations are met for Kamerunga load (Cairns and northern beaches) and connectivity for the Barron Gorge Power Station. Considering the uncertainty in the long-term load forecast, a 400 mm^2 cable is recommended. This cable size may not be sufficient should the Aquis Resort proceed.

Powerlink considers the proposed network solution will not have a material inter-network impact.

7.2 Option Considered but Not Proposed

This section discusses alternative options that 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.

7.2.1 Do Nothing

“Do Nothing” would not be an acceptable option as the primary drivers (primary system 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 its Transmission Authority.

7.2.2 Like for like replacement of the existing overhead line

There has been significant development of residential and commercial premises in the vicinity of the existing transmission line, since it was first constructed. Consequently, due to land access and easement constraints, it is not feasible to rebuild the whole line as overhead. The 9.8km section between Redlynch and Woree (Alignment East, Figure 2) must be constructed with underground cable.

In addition, the capacity needs to take into account long term load growth in the adjacent area, such as a future substation at Smithfield. The capacity of the existing line is not sufficient to accommodate this.

7.2.3 Rebuild with larger 800mm^2 cable

The 400mm^2 cable may not be able meet the long term load growth in Northern Cairns, particularly if the Aquis Resort proceeds. An 800mm^2 cable would meet this need. However, given the uncertainty in the development and timing of the Aquis Resort, together with uncertainty in the development of future DER it is not considered prudent to propose a larger cable without further analysis.

7.2.4 Supply Kamerunga from Woree with 22kV

It is not feasible to use 22kV feeders to supply the entire load at Kamerunga as well as future loads at Smithfield and Redlynch from Woree.

7.2.5 Barron Gorge and Kamerunga operated as an island

As Barron Gorge is a “run of river” hydro power station it operates as an intermittent energy source and even at maximum capacity may not be able to meet the forecast peak demand. In addition the average generated energy per day is only approximately 2/3 of the energy of the load.

For this option to be technically viable additional generation capacity and energy storage would be required to meet the load and provide the necessary redundancy to satisfy Energy Queensland’s reliability obligations.

8. Recommendations

Powerlink has reviewed the condition of the transmission line between Woree and Kamerunga. The line is anticipated to reach the end of technical service life by 2026.

There is an investment need to maintain the functionality of the Woree to Kamerunga transmission line.

The recommended network solution is to rebuild the double circuit line. Due to easement constraints a 9.8 km section will need to be built underground with 400 mm^2 cable.

It is recommended the line be rebuilt by December 2026 to ensure Powerlink’s ongoing compliance with the Electrical Safety Act 2002, Electrical Safety Regulation 2013 and its Transmission Authority.

9. References

1. BS1252 Transmission Line Condition Assessment Report 2020
2. CP.02731 - Redlynch to Woree 132 kV Easement Acquisition - Concept Proposal Update - Network Property
3. Asset Planning Criteria Framework

Base Case Risk and Maintenance Costs Summary Report

CP.xxxxx Woree-Kamerunga 132kV Transmission Line Rebuild

Version Number	Objective ID	Date	Description
1.0		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 double circuit 132kV transmission line between Woree and Kamerunga (built section 1252, Feeders 7141 and 7142) which is a candidate for reinvestment.

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

2 Topography

The Woree to Kamerunga 132kV transmission circuit is located in North Queensland, and traverses dense tropical environments and built up residential areas. The built section is approximately 13km 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 BS1252, 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 Queensland network;
- The Value of Statistical Life (VSL) published within the OBPR guidance note has been used when calculating safety risk cost;
- The 132kV transmission lines from Woree to Kamerunga supply a mixture of residential, commercial and industrial load types, and 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 are modelled in this assessment.

4.2 Transmission Line Analysis

This section analyses the risks presented by BS1252.

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 structures 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

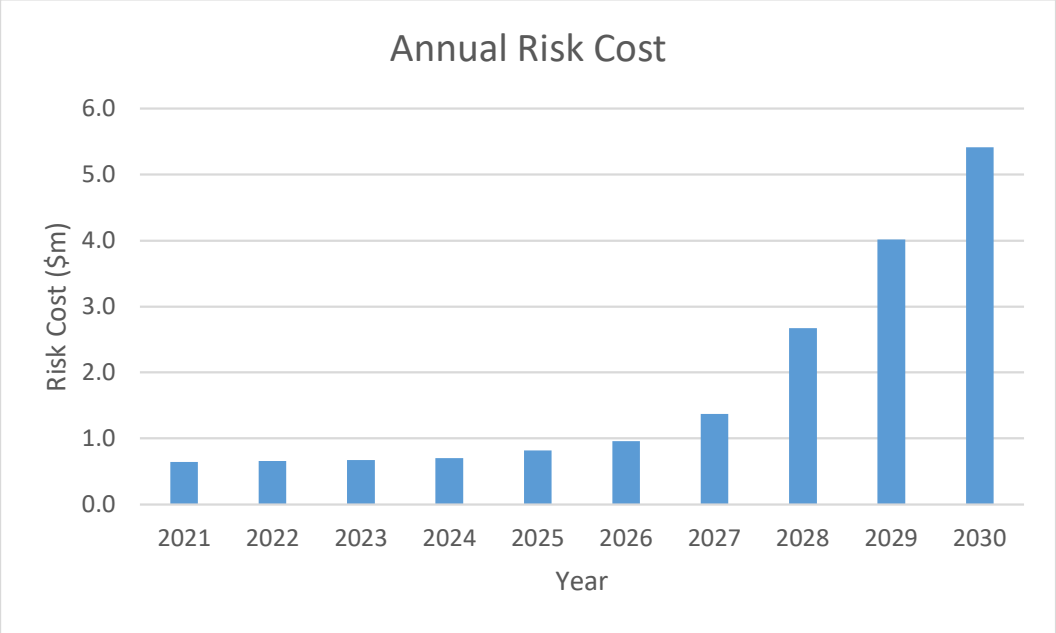

Figure 2 – Risk cost over time (10 years)

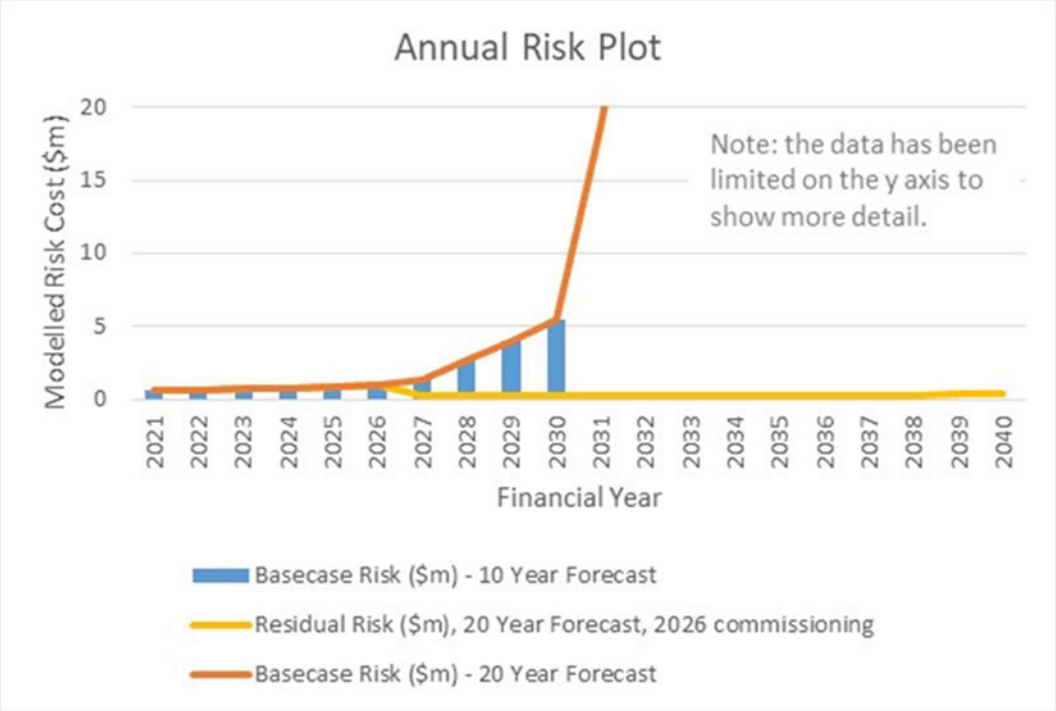

Figure 3 – Risk cost over time (10 years, extrapolated to 20 years)

4.2.2 Structures – Risk Breakdown by Risk Category

Figure 4 – Structure risk cost by category

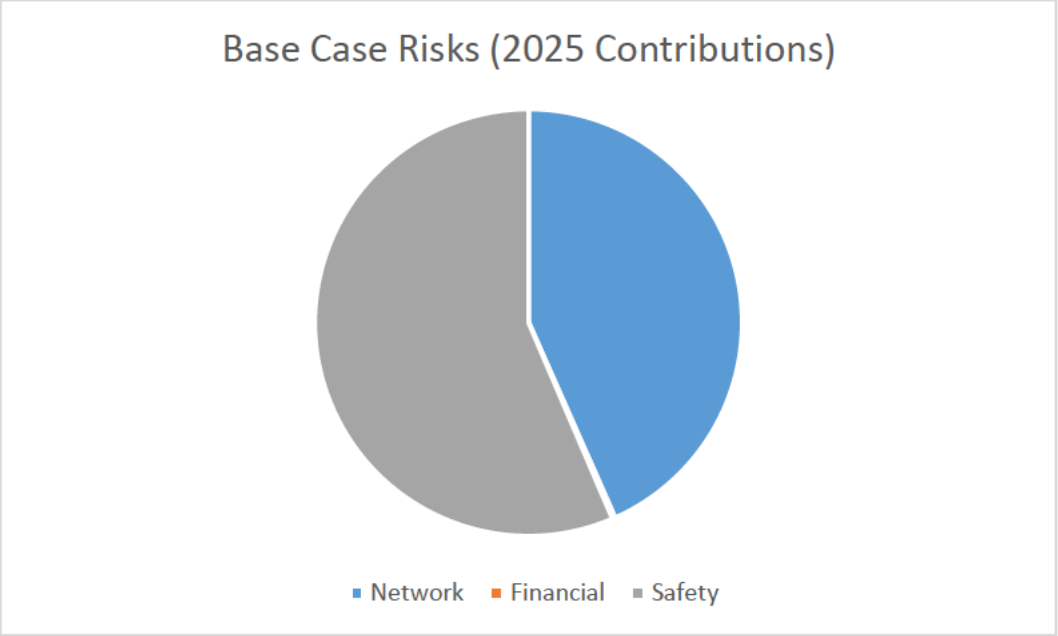

Figure 5 –Structure risk cost by category (2025)

4.3 Base case risk statement

The primary source of risks for the BS1252 Woree to Kamerunga transmission line are safety risks related to failure of the overhead line structures.

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 maintenance costs as a percentage of capital cost.

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

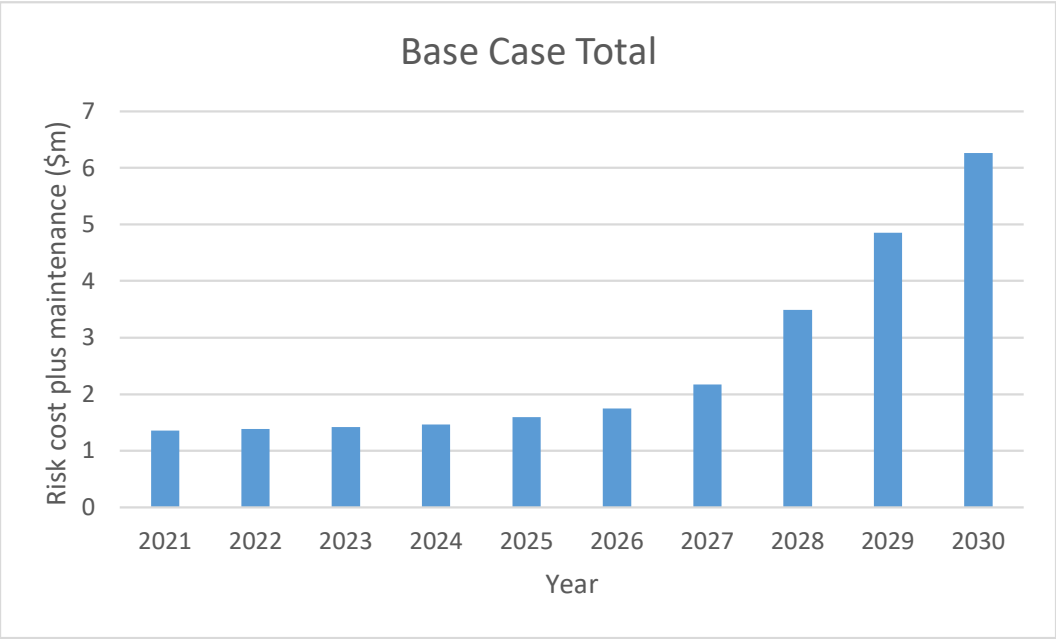

Figure 6 – Base case Total (Risk Cost + Maintenance)

6 Input participation

Risk Category	Input	Value	Unit
Network	VCR	40030	$/MWh
	Restoration time	168	hours
Financial	Tower restoration cost	1	$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 input effect the modelled risk).

A 100% increase in the input values for VCR or tower restoration time will result in the overall risk increasing by approximately 44%.

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

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.

Project Scope Report

CP.xxxxx

Woree to Kamerunga 132kV Transmission Line Rebuild

Concept – Version 1

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
24/04/20	[redacted]	Woree to Kamerunga 132kV Transmission Line Rebuild	Preliminary scope

Related Documents

Issue Date	Responsible Person	Objective Document Name
05/03/20	[redacted]	Transmission Line Condition Assessment Report – BS1252 Kamerunga to Woree (A2766953)

Project Contacts

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Strategist – HV/Digital Asset Strategies	[redacted]	[redacted]
Planner – Main/Regional Grid	<name>	Ext.
Manager Projects	<name>	Ext.
Project Manager	<name>	Ext.
Design Coordinator	<name>	Ext.

Project Details

1. Project Need & Objective

The transmission line between Woree and Kamerunga is over 55 years old and operates in an aggressive tropical environment, which shortens the life of galvanised components that make up most of the line. A recent condition assessment report shows that components of the line are exhibiting significant signs of corrosion.

Between 2012 and 2016 life extension works were performed as certain components of the transmission line were nearing the end of their operational life. The life extension work achieved reliable operation of the asset and postponed need for any significant reinvestment until 2026, per the condition assessment report.

An investigation into the route of the line has been completed and due to extensive impact on residential properties along most of the existing alignment, an alternative option such as constructing a new line on a different alignment is required.

The objective of this project is to construct approx. 14km of new double circuit 132kV transmission line between Woree and Kamerunga, consisting of both overhead line and underground cable, by December 2026.

2. Project Drawing

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 objective of this project is to construct approx. 14km of new double circuit 132kV transmission line between Woree and Kamerunga, consisting of both overhead line and underground cable.

3.1.1. Transmission Line Works

Design, procure, construct and commission approx. 14km of new double circuit 132kV transmission line between Woree and Kamerunga, consisting of both overhead line and underground cable:

- Obtain all necessary permits and approvals for access to the easement corridor from Woree substation to Kamerunga for all Powerlink construction activities.
- Establish a new overhead to underground transition site at Redlynch, including all earthworks and civils.

- Install two (2) new 132kV underground cable circuits between Woree and the proposed transition site at Redlynch:
  - minimum rating of 125MVA per circuit – it is expected that a 400mm^2 cable will satisfy the rating requirement; and
  - the indicative route length is approx. 10km.
- Construct a new double circuit 132kV overhead transmission line between Kamerunga and the proposed transition site at Redlynch:
  - minimum rating of 125MVA per circuit; and
  - the indicative route length is approx. 4km.
- Establish dual optical fibre links for both the underground (one with each circuit) and overhead sections (OPGW) of the lines, as well as the final connections into the substations at each end.
- Decommission and recover the existing 132kV double circuit transmission line (approximately 14km) between Woree and Kamerunga (ex-feeders 7141 & 7142). This includes all towers, foundations, conductors, insulators and line hardware:
  - rehabilitate each tower site, and the cleared corridor, in a manner that suits the location and ensures long term stability; and
  - for access tracks no longer required, rehabilitate to ensure long term stability.
- Update all relevant documentation and data records.

3.1.2. H039 Woree Substation Works

Design, procure, construct and commission two (2) cable sealing end connections to the existing 132kV Kamerunga feeder bays:

- Modify protection, control, automation and communications systems as necessary for the reconnection of feeders;
- Check and confirm bay rating – upgrade any bridging droppers to match line rating;
- Update all relevant documentation and data.

3.1.3. T053 Kamerunga Substation Works

Design, procure, construct and commission two (2) transmission line connections to the existing 132kV Woree feeder bays:

- Modify protection, control, automation and communications systems as necessary for the reconnection of feeders.
- Check and confirm bay rating – upgrade any bridging droppers to match line rating.
- Update all relevant documentation and data.

3.1.4. Telecoms Works

Modify as necessary for the new dual fibre connection.

3.1.5. Easement/Land Acquisition & Permits Works

The provision of easement rights and approvals to be in consultation with the Property team.

3.2. Key Scope Assumptions

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

- Any existing assets to be removed and disposed of as part of this scope must be identified within the estimate together with the forecast early asset write off amounts at time of disposal.
- A detailed review should be undertaken of land access and any additional easement and approval requirements included in the estimate.

3.3. Variations to Scope (post project approval)

Not applicable

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is 31 December 2021.

4.2. Site Access Date

The expected site access date (SAD) is 1 January 2022 and is to be provided under easement project CP.01489 Kamerunga - Redlynch 132kV Easement Acquisition and CP.02731 Redlynch – Woree 132kV Easement Acquisition.

4.3. Commissioning Date

The latest date for the commissioning of the works in this scope, including the recovery of any decommissioned assets, is 31 December 2026.

5. Special Considerations

None

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 and Business Development.

[redacted] will provide the primary customer interface with Ergon Energy. The Project Sponsor should be kept informed of any discussions with the customer.

7. Asset Ownership

The works detailed in this project will be 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

Easement route selection will dictate the ratio between an overhead and underground sections of the new asset.

10. Division of Responsibilities

A division of responsibilities document will be required to cover the changes to the interface boundaries with Ergon Energy. The Project Manager will be required to draft the document and consult with the Project Sponsor who will arrange sign-off between Powerlink and the relevant customer.

11. Related Projects

Project No.	Project Description	Planned Comm Date	Comment
Pre-requisite Projects			
CP.01489	Kamerunga to Redlynch Easement Acquisition	1 January 2022	
CP.02731	Redlynch to Woree Easement Acquisition	31 December 2020	
Co-requisite Projects			
Other Related Projects			

Concept Estimate for CP.xxxxx - Woree to Kamerunga 132kV Transmission Line Rebuild

Record ID	A3354556	
Policy stream	Asset Management	
Authored by	Project Manager	[redacted]
Reviewed by	Team Leader	[redacted]
Approved by	Manager Projects	[redacted]

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1. Executive Summary

The transmission line between Woree and Kamerunga is over 55 years old and operates in an aggressive tropical environment, which shortens the life of galvanised components that make up most of the line. A recent condition assessment report shows that components of the line are exhibiting significant signs of corrosion, and significant reinvestment will be required by 2026.

An investigation into the route of the line has been completed and due to extensive impact on residential properties along most of the existing alignment, an alternative option such as constructing a new line on a different alignment is required.

The objective of this project is to construct approx. 14km of new double circuit 132kV transmission line between Woree and Kamerunga, consisting of both overhead line and underground cable, by December 2026.

The proposed line route is as indicated below, existing overhead feeders to the West, new underground alignment to the East:

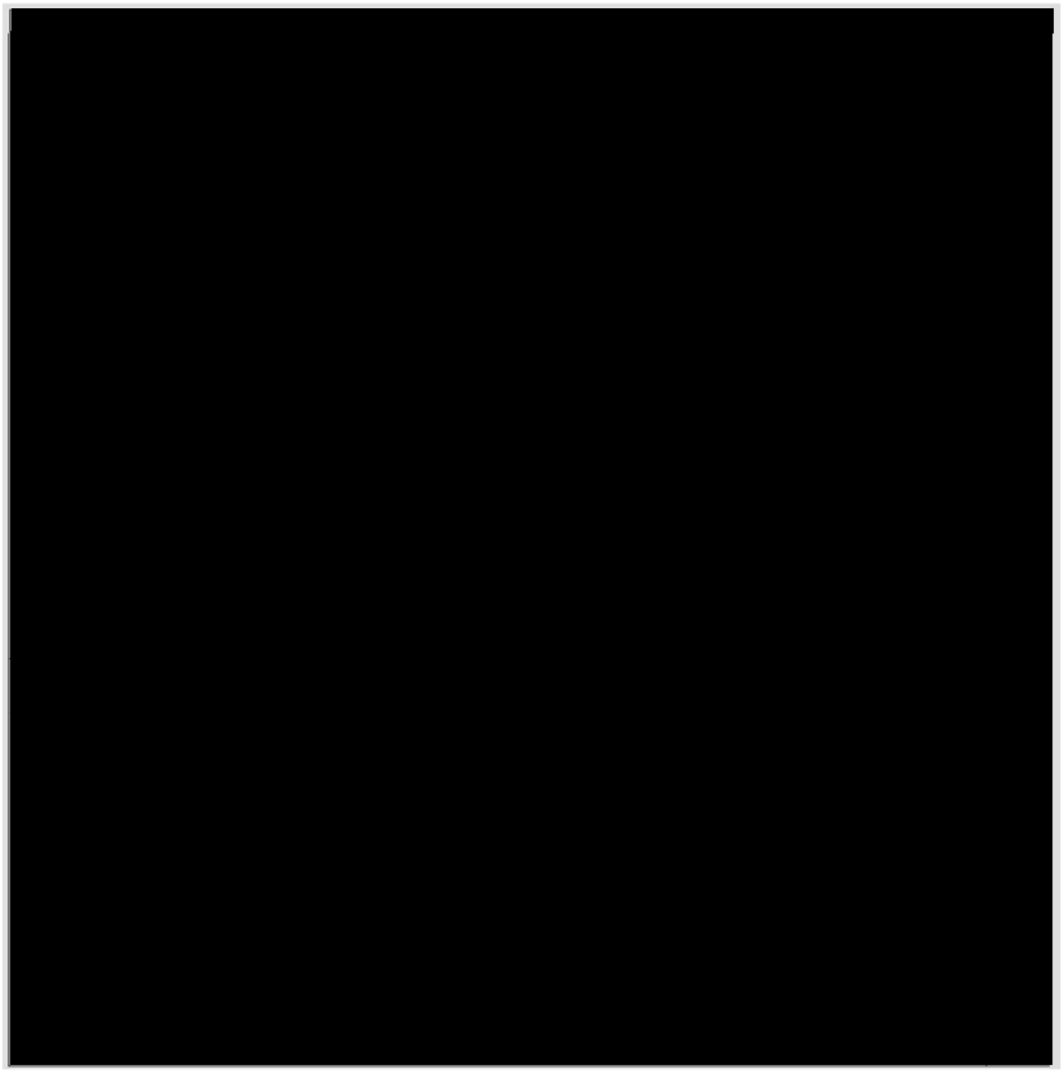

Figure 1-1: Proposed line route

1.1 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**47,605,608**	**55,445,897**
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 2024	17,973,752	20,276,403
To June 2025	21,928,820	25,752,428
To June 2026	7,703,036	9,417,066
TOTAL	**47,605,608**	**55,445,897**

2. Project and Site Specific Information

2.1 Project Dependencies & Interactions

This project is dependent on the completion delivery of the following projects:

Project No.	Project Description	Planned Comm Date	Comment
Dependencies			
CP.01489	Kamerunga to Redlynch Easement Acq.	January 2022	
CP.02731	Redlynch to Woree Easement Acq.	December 2022	
Interactions			
Other Related Projects			

2.2 Site Specific Issues

Issues specific to the project are as follows:

- The project site is located predominantly within the township of Cairns, Far North Queensland,
- Both the existing transmission line and the proposed new line/cable traverses heavily populated areas, housing, roadways, railway/s, cane farms and creeks,
- The site will be subject to considerable rainfalls during traditional wet seasons, historically from December to April every year,
- The site is low lying in general, the new alignment is free of any significant undulating terrain. However, the existing overhead line traverses undulating terrain.

3. Construct a 132kV Double Circuit Transmission Line between Woree and Kamerunga

3.1 Definition

3.1.1 Scope

Briefly, the project scope includes the construction of a new double circuit 132kV transmission line between Woree and Kamerunga, and the decommissioning of the existing 132kV double circuit line, Built Section 1252.

3.1.1.1 Substations Works

The substation scope of works at both H039 Woree and T053 Kamerunga includes protection setting changes as necessary for the reconnection of built feeders, and upgrading of droppers to suit new rating.

3.1.1.2 Transmission Line Works

The scope of works includes the design, construction and commissioning of approximately 14km of 132kV double circuit transmission line between Woree and Kamerunga substations, as well as the demolition/decommissioning of the 14km of redundant transmission line, BS1252.

The new transmission line will consist of an overhead component of approximately 4km, utilising steel lattice towers, and an underground component of approximately 10km, using 400mm^2 cables.

3.1.1.3 Telecommunication Works

The scope of works includes the connection and commissioning of the two new communication paths (OPGW) at each remote end.

3.1.1.4 Easement/Land Acquisition & Permit Works

Easement works do not form part of the scope, however, liaison with the Network Property Group should be considered during the easement widening/procurement process to ensure selection of a suitable, constructible alignment for the new transmission line.

3.1.2 Major Scope Assumptions

It is assumed that:

- Both new underground feeders/cables will share a common trench of approximate 2000mm width in general,
- The same line construction contractor will undertake both the overhead and underground activities,
- The feeders will transition from overhead to underground at a location near Redlynch by means of a free standing steel pole ‘termination structure’,
- The underground cables shall be 400mm^2,

- There will be a number of foundation issues for the overhead line section, i.e. collapse, special foundations required,
- There will be delays during the overall site delivery due to such issues as Cultural Heritage, landholder, adjoining business constraints,
- There will be numerous unforeseen underground obstructions encountered during the trenching/cabling works, which will likely impact the design and delivery of those works,
- There will be a number of special rehabilitation requirements for sections of new and existing alignments, i.e. turf, specialty concrete finishes to driveways etc.

3.1.3 Scope Exclusions

The below is excluded from the scope of works:

- Easement acquisition works, including any permits, approvals, development applications or the like.

3.2 Project Execution

3.2.1 Project Schedule

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

Task / Milestone	Target Date
Project approval	July 2023
Design complete	June 2024
Contract award	July 2024
Transmission line construction, including transition site	Sep 2024 – Jul 2026
Cut-in of new feeders, including landing span and optical fibres	Aug 2026 – Sep 2026
Recovery of old transmission line	Oct 2026 - Nov 2026

3.2.2 Network Impacts

These works will require suitable short duration outages to allow cut-overs onto the new transmission line.

3.2.3 Project Staging

The staging of the project is as detailed below:

Stage	Description/Tasks
1	Transmission line and cable construction works by line contractor
2	Cut-over feeder and communications paths by MSP
3	Demolition/decommissioning of the redundant transmission line by transmission line contractor

3.2.4 Resourcing

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

3.3 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		**47,605,608**	**55,445,897**
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

3.4 Project Financial Year Cash Flows

	June 2020 Base $	Escalated $
To June 2024	17,973,752	20,276,403
To June 2025	21,928,820	25,752,428
To June 2026	7,703,036	9,417,066
TOTAL	**47,605,608**	**55,445,897**

3.5 Project Asset Classification

Asset Class	Asset Life	Base $	Percentage
Secondary systems	15 years	212,490	1%
Communications	15 years	70,988	0%
Transmission line refit	35 Years		
Primary plant	40 years		
Underground Transmission Cable	45 years	36,396,811	76%
Transmission lines	50 years	10,925,318	23%
TOTAL		**47,605,608**	

4. References

Document name	Version	Date
Project Scope Report	1.0	24/04/2020