2023-27
POWERLINK QUEENSLAND REVENUE PROPOSAL

Project Pack – PUBLIC

CP.02415
Greenbank to Mudgeeraba 275kV Transmission Line Refit

CP.02415 – Greenbank to Mudgeeraba 275kV Transmission Line Refit

Project Status: Not Approved

1. Network Need

The Greenbank to Mudgeeraba transmission line is over 45 years old (commissioned in 1974/75) and runs from south west Brisbane to the southern Gold Coast. The line consists of two single circuit 275kV feeders that are critical to the supply of the Gold Coast and Northern NSW. An outage of one of these two feeders would leave up to 282MW and up to 3024MWh of customer load per day at risk[2].

A Condition Assessment (CA) carried out in January 2020 identified many of the line's tower bolts, members and some insulators are exhibiting Grade 2 (Low) and Grade 3 (Medium) corrosion which is expected to decline further[1]. Approximately 20% of bolts are expected to reach Grade 3 (Medium) and 4% expected to reach Grade 4 (High) corrosion by 2029. 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. The CA recommends reinvestment in the asset prior to 2028 to manage these risks and ensure network reliability.

Energy Queensland forecasts confirm there is an enduring need to maintain electricity supply to the Gold Coast area. The removal of the Greenbank to Mudgeeraba transmission lines would have a major impact on loads in Southern Gold Coast and would violate Powerlink's Transmission Authority reliability obligations (for N-1 and -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, options and potential benefits 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 Greenbank to Mudgeeraba feeders by 2028[2].

The following options were considered but not proposed:

- Do Nothing – rejected due to non-compliance with reliability standards and safety obligations.
- Rebuild new 275kV feeders – rejected due to additional cost over refit.
- Non Network Option parameters identified – at this stage no viable non network option identified.

Figure 2-1 below shows the current recommended option reduces the forecast risk monetisation profile of the Greenbank to Mudgeeraba line by over $50m p.a. from 2035.

Where a 'Do Nothing' scenario is adopted, the forecast level of risk associated with the asset escalates to over $10m p.a. in 2030. This is predominantly due to safety risks associated with the proximity of the line to built-up residential areas, highways and road crossings[3].

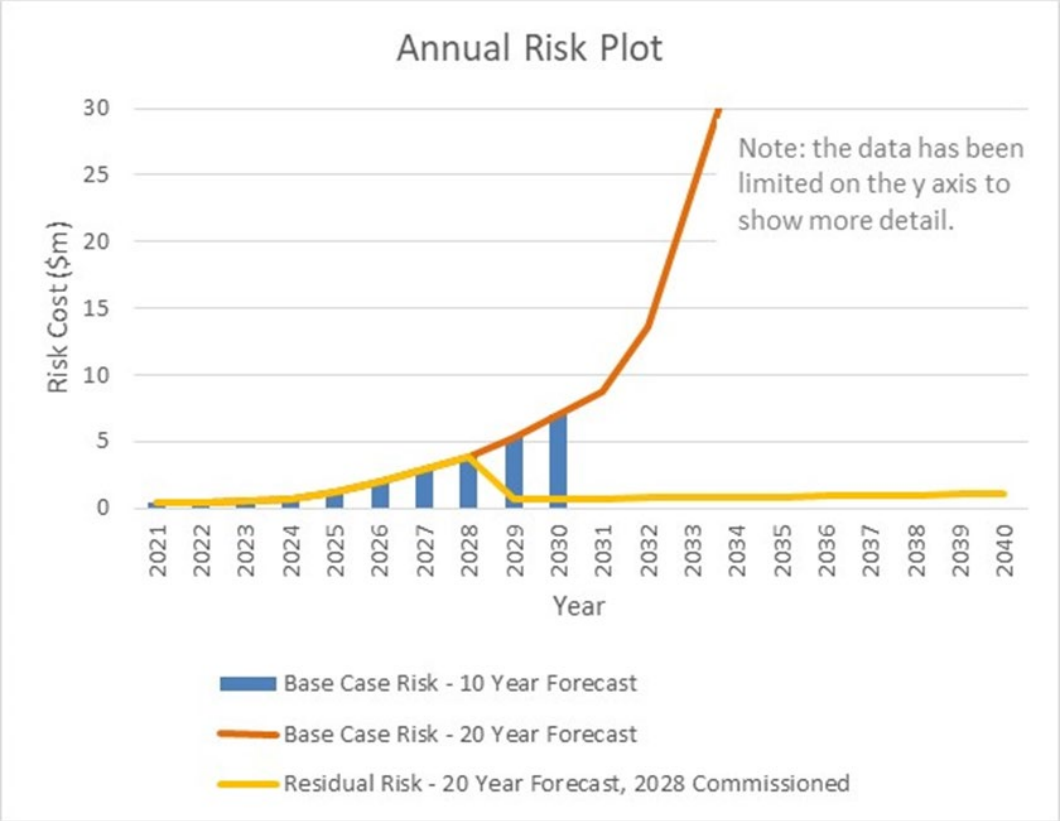


Figure 2-1 Annual Risk Monetisation Profile (Nominal)

3. Cost and Timing

The estimated cost to refit the two Greenbank to Mudgeeraba 275kV line feeders is $50.7m ($2022/23 Base)[5].

Target Commissioning Date: June 2028

4. Documents in CP.02415 Project Pack

Public Documents

1. Transmission Line Condition Assessment – Report – BS1018 and BS1019 Greenbank to Mudgeeraba 275kV
2. CP.02415 Greenbank – Mudgeeraba 275kV TL Refit – Planning Statement
3. Base Case Risk and Maintenance Costs Summary Report – Greenbank to Mudgeeraba T/L Reinvestment
4. Project Scope CP.02415 Greenbank – Mudgeeraba 275kV TL Refit
5. Concept Estimate of CP.02415 – Greenbank – Mudgeeraba 275kV TL Refit

Supporting Documents

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

Transmission Line Condition Assessment – Report

BS1018 and BS 1019

Greenbank to Mudgeeraba 275kV

Record ID	A3284164	
Team	Delivery & Technical Solutions – Technology & Planning – Asset Strategies – Transmission Lines	
Authored by	Line Strategies	[redacted]
Reviewed by	Team Leader Line Strategies	[redacted]
Approved by	Asset Strategies Manager	[redacted]

Version history

Version	Date	Section(s)	Summary of amendment	Author	Approver
1.0	17/01/2020	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 a summary of the built section condition 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

Built Sections 1018 and 1019 are single circuit 275kV feeders which run together between Powerlink's Greenbank substation in south west Brisbane and Mudgeeraba substation in the southern Gold Coast. They are critical feeders supplying the Gold Coast and Northern New South Wales. BS1018 consists of 165 steel lattice structures (52 Tension, 113 Suspension) commissioned in 1975 under contract number 70/18. BS 1019 consists of 165 steel lattice structures (54 Tension, 111 Suspension) commissioned in 1974 under contract number 72/30.

The atmospheric corrosion environment in which the feeders run has been classified as C3[1] with a section at the southern end classified as C4 according to Australian Standards. This is due to reduced proximity to Moreton Bay, with higher salt levels. It is also likely that the slight elevation of some structures through the Nerang Conservation area exposes these structures to salt laden winds, creating "hot-spots" of increased Corrosivity.

As a result, particularly in the more exposed and elevated locations, many galvanised tower bolts and members are exhibiting evidence of Grade 2 corrosion with a growing proportion classed as corrosion grade 3, and occasional bolts, particularly at the southern end of the line, at corrosion grade 4. These observations are consistent with past Powerlink inspections. Based on current corrosion rates, it is predicted that some 20% of bolts would reach G3 and 4% would reach G4 by 2029 (assuming no significant intervention). It is estimated that this would accelerate to 37% G3 and 19% G4 by 2035.

Projects OR.01026 and OR.01027 facilitated the replacement of all suspension insulators by 2014. OR.02120 also facilitated the replacement of high risk tension and bridging insulators prior to the 2018 Commonwealth games. However, original hardware remains in service, and as the projects did not replace the majority of tension insulators and a small number of bridging insulators, a large number of original insulator strings remain in service. The remaining insulators are now exhibiting G3 corrosion and will require replacement in the short term to medium term.

The tower design type used for suspension structures on both built sections was the S2S2 types. Due to an insufficient climbing corridor on this type of structure, access to structures must be under outage with a suitable method for earthing conductors from below in order to maintain exclusion zones. Obviously, this complicates inspection and other maintenance activities.

The estimated end of life timing dates for Built Sections 1018 and 1019 are provided in the following sections. Due to very similar ages and environments, both lines will exceed Health Index 7 in approximately 2025, and reach Health Index 8 in 2028/2029 approximately. Beyond this time, the risk of structural failure will increase, and reinvestment before this time is recommended. The dates are based on trigger levels of structure nut, bolt and member corrosion, although it is noted that other components also require replacement or refurbishment in this time frame.

[1] Refer to Section 7.3 for definitions of corrosion regions

1.1 BS 1018 Summary of Condition

Figure 1 below highlights the average structure corrosion level along BS1018 based on visual estimates from a sample of towers. It can be seen that the Mudgeeraba Substation (southern) end of the line appears worse than the Northern Greenbank end.

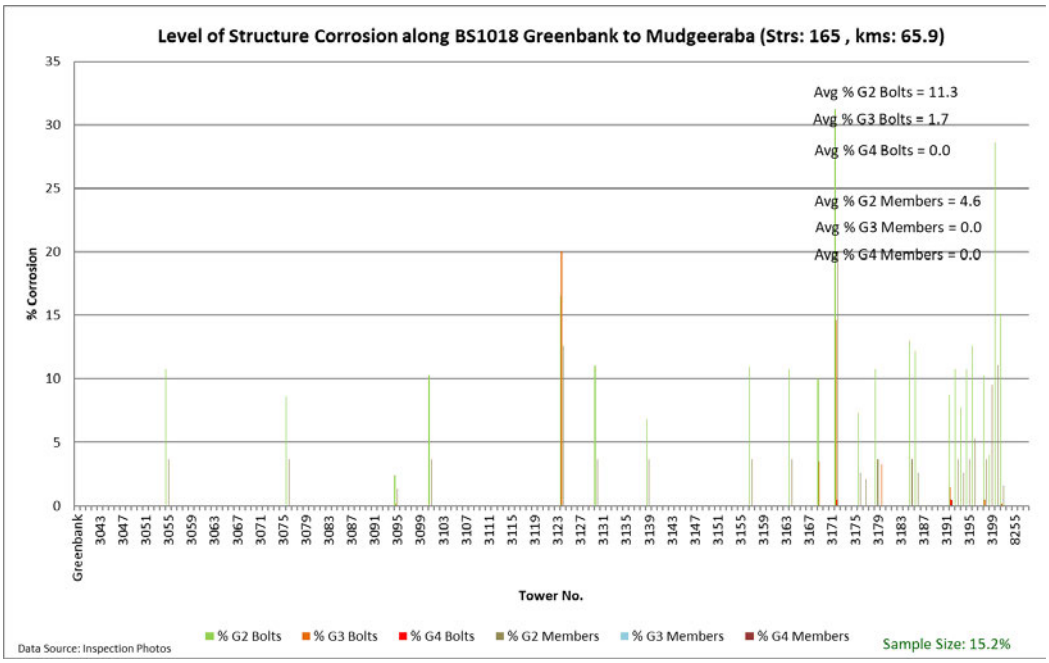


Figure 1: Structural Corrosion Level BS1018

Based upon the data presented in this report and measurement documents for 15% of structures, this line will require intermittent maintenance to keep it in a serviceable condition. As shown in Table 1-1 below, by 2025 it is estimated that across the built section, some 63% of bolts will have reached grade 2, 9% of bolts will be Grade 3, and 1% Grade 4. Beyond this point, corrosion levels will quickly accelerate.

Table 1-1: BS1018 Estimated Average Percentage of bolts at Corrosion Grade 2, 3 and 4

Year	%G2 Bolts	% G3 Bolts	% G4 Bolts
2019	11	1.7	0.00
2020	43	2.0	0.11
2021	48	2.8	0.17
2022	52	3.9	0.28
2023	57	5.2	0.43
2024	60	6.8	0.66
2025	63	8.8	0.98
2026	65	11.2	1.45
2027	66	13.9	2.08
2028	65	16.9	2.94
2029	64	20.1	4.08

The health index for the built section primarily reflects the condition of nuts, bolts and members. However there is a need do some work in the short term, particularly a small number of foundation interfaces, where more advanced corrosion is already evident. Figure 2 below graphs the Built Section health index by year based on a threshold of 90% of towers (i.e. excluding the worst 10% of towers). Based on this it is estimated that BS1018 will exceed the trigger Health Index 7 (HI7) in 2025 and exceed HI8 in 2028.

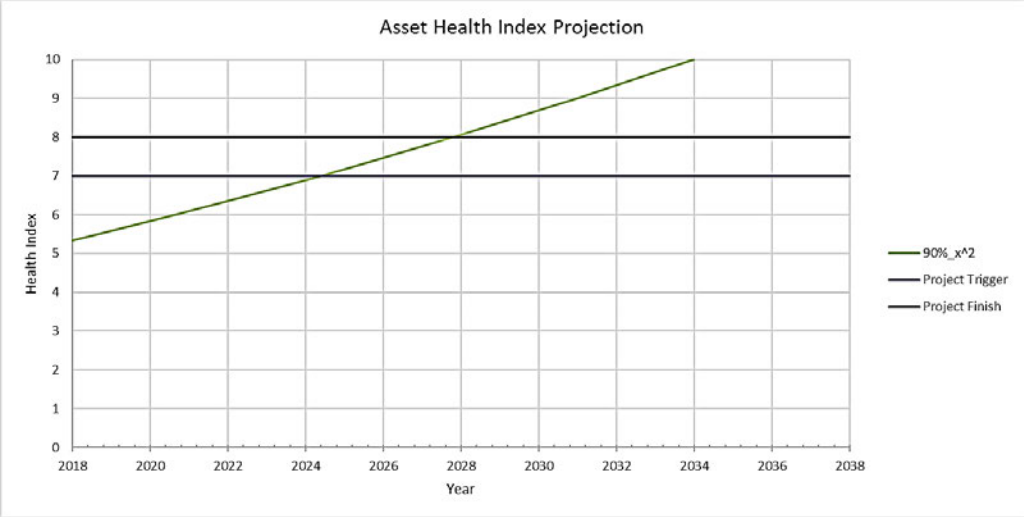


Figure 2: Projection of Health Indices BS1018

Insulator condition on BS1018 is variable due to the range of insulator ages found on the line. The original tension insulator assemblies and hardware are in slightly worse condition (corrosion grade 2 and 3) although those in higher risk (transport crossing) locations have been replaced. Suspension Insulators have all been replaced, although hardware is original and some deterioration has been observed in the V-strings, mainly concentrated on the last 4 – 6 discs towards the live end. While most bridging insulators were replaced in 2017, a small number are original with G2 or G3 corrosion. Bridging insulator hardware has similar levels of corrosion.

Both earthwires are satisfactory, with low levels of corrosion on wires and hardware, which will need to be addressed in the medium term. Braided earthing bonds have been installed on suspension assemblies, which are seen to be broken over a number of structures.

Figure 1: OHEW Hardware Corrosion

The conductors are in sound condition and are considered to have at least another 30 plus years remaining life.

Table 1-2 summarises the remaining life for all BS1018 components.

Table 1-2: Predicted EOL Summary 1018

Predicted end of service life summary table								
Conductor	EW	OPGW	Foundation Bored	Foundation Grillage	Structures	Bridging.Strings	Suspension Strings	Tension.Strings
2051	2034	N/A	2022#	N/A	2030	2025[1]	2029[2]	2025[1]

1 - EOL prediction is in reference to the remaining insulators which were not changed out during projects in 2013 – 2017.

2 – EOL of Suspension insulators is driven by hardware corrosion.

EOL is based on worst interface condition only, not the average of the line. While many interfaces remain in good condition, the sample indicates that a significant quantity are already requiring corrective maintenance.

1.2 BS 1019 Summary of Condition

Figure 4 below highlights the average corrosion levels along BS1019 based on visual estimates from a sample of towers. As with BS1018, the Mudgeeraba Substation (southern) end of the line, appears worse than the Northern Greenbank end.

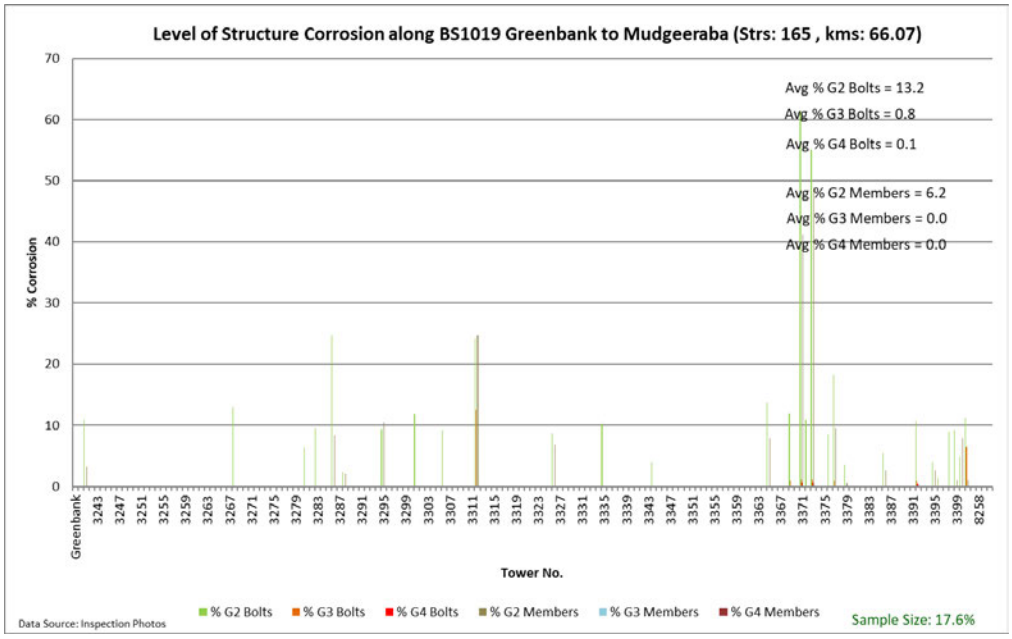


Figure 4: Structural Corrosion Level BS1019

Based upon the data presented in this report and measurement documents for 15% of structures, this line remains in serviceable condition, but will require more intensive maintenance or reinvestment in the medium term.

As shown in Table 1-3, by 2025 it is estimated that across the built section, some 63% of bolts will have reached grade 2, 8% of bolts will be Grade 3, and close to 1% will be Grade 4. Beyond this point, corrosion levels will quickly accelerate.

Table 1-3: BS1019 Estimated Average Percentage of bolts at Corrosion Grade 2, 3 and 5

Year	%G2 Bolts	% G3 Bolts	% G4 Bolts
2019	13	0.8	0.10
2020	43	2.0	0.10
2021	48	2.8	0.17
2022	53	3.8	0.26
2023	57	5.1	0.41
2024	61	6.8	0.62
2025	63	8.7	0.93
2026	65	11.0	1.37
2027	66	13.7	1.97
2028	66	16.6	2.78
2029	65	19.8	3.86

The health index for the built section reflects the need to reinvest in the medium term. Based on this it is estimated that BS1019 will exceed the trigger Health Index 7 (HI7) in 2024/2025 and exceed HI8 in 2029/2030.

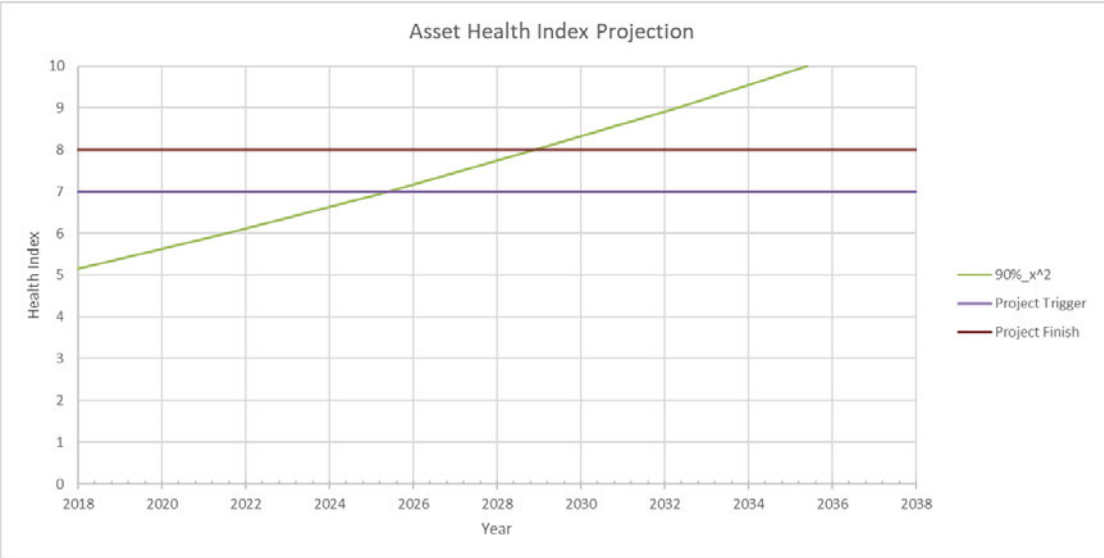


Figure 5: Projection of Health Indices BS1019

Insulator condition on BS1019 is variable due to the range of insulator ages found on the line. The original tension insulator assemblies and hardware are in slightly worse condition (corrosion grade 2 and 3) although those in higher risk locations have been replaced. Suspension Insulators have all been replaced, although hardware is original and some corrosion staining has been observed on some V-strings, mainly concentrated on the last 4 – 6 discs towards the live end. All bridging insulators were replaced in 2017, but bridging insulator hardware is original with grades 2 and 3 corrosion levels.

The earthwires are satisfactory in the short term, however both the earth wire and hardware are showing signs of corrosion which will need to be addressed in the medium term (late 2020s).

A significant number of BS1019 earth wire trunnion clamps have broken earth wire bonds, which were originally copper braids.

Figure 2: 1019-STR-3383 Earthing Bond Broken

The conductors are in sound condition and are considered to have at least another 30 plus years remaining life.

Table 1-4 summarises the remaining life for all BS1019 components.

Table 1-4: Predicted EOL Summary BS1019

Predicted end of service life summary table								
Cond	EW	OPGW	Foundation Bored	Foundation Grillage	Structures	Bridging.Strings	Suspension Strings	Tension.Strings
2051	2028	N/A	2031	N/A	2025	2025[1]	2029[2]	2025[1]

1 - EOL prediction is in reference to the remaining insulators which were not changed out during projects in 2013 – 2017.

2 – EOL of Suspension insulators is driven by the hardware corrosion.

2. Purpose

This report outlines the assessed condition of Built Section 1018 and Built Section 1019 which run between Greenbank Substation and Mudgeeraba Substation. The report has been produced to assist in determining an asset management strategy for the line.

3. Scope

The report examines the condition of the transmission line's major component groups, using field data and maintenance records, based upon the asset management guidelines.

The Levels of Corrosion assigned to components are based on the corrosion/deterioration classifications used in Powerlink's Visual Inspection Guides and are summarised below.

Table 3-1: Powerlink Corrosion Grading System

Level of Corrosion	Description
Grade 1 (G1)	New to weathered galvanised steel.
Grade 2 (G2)	Corrosion which represents a loss of greater than 2% but less than 50% of the galvanising layer. Corrosion observed which should continue to be ***Monitored and Reviewed.***
Grade 3 (G3)	Corrosion which 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 which represents the total loss of galvanising and the onset of unprotected carbon steel corrosion.

4. Transmission Line Parameters

4.1 Overview

Built Section 1018 is 65.9km long and consists of 165 steel lattice structures: 52 Tension and 113 Suspension. Built Section 1019 is 66.07km in length and consists of 54 Steel Lattice Tension Towers and 111 Steel Lattice Suspension Towers, totalling 165 steel lattice towers. Both lines are single circuit 275kV feeders running together from Greenbank Substation to Mudgeeraba substation in the southern Gold Coast.

The structure design type utilised for suspension structures on both lines is an S2S2 type. Due to a restricted climbing corridor, access to structures must be under outage with a suitable method for earthing conductors from below in order to maintain exclusion zones. This makes many maintenance activities including inspection more complicated and costly. Typical structures are shown in Figure 8 and Figure 9.

As a result of the orientation of the feeders, the distance from the coast varies significantly between the northern and southern ends of the feeders. Coastal winds and salt affect the southern end of the built section particularly. Microenvironments may also be situated throughout these lines as they traverse to the coast through humid forestry with varying elevation.

Figure 7: Geographical Overview of BS1018 & BS1019

The tower geometry is single circuit delta as shown in the photos below.

Figure 8: 1019-STR-3288 - Tension Tower

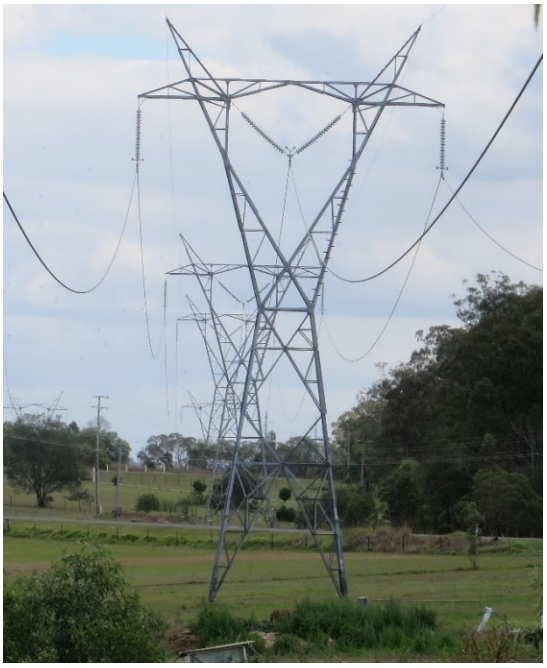


Figure 9: 1018-STR-3052 - Suspension Tower

4.2 Asset Summary Table

Built Section	1018	1019
Commissioning Date	10.01.1975	16.12.1974
Voltage	275kV	275kV
Contract Number	70/18	72/30
No. of Circuits	1	1
Circuits	F835	F836
Route Length (km)	65.9km	66.07 km
No. of Towers	52 Tension 113 Suspension	54 Tension 111 Suspension
Type	Galvanised Steel Lattice Tower	Galvanised Steel Lattice Tower
Foundations	Bored Straight Side / Bored Undercut / Mass Concrete	Bored Straight Side / Bored Undercut / Mass Concrete
Conductor	ACSR/I Martin 54/4.02/19/2.41 'Special' ACSR/GZ 42/2.72/19/2.59 (SPN 100 – 102) AAAC/1120 Sulphur (SPN 216 – 218) 1 Sub-Conductor /Phase (except spans 100A and 100B)	ACSR/I Martin 54/4.02/19/2.41 AAAC/1120 Sulphur (SPN 031 – 033) 'Special' ACSR/GZ 42/2.72/19/2.59 (SPN 095 – 097) 1 Sub-Conductor /Phase (except spans 100A and 100B)
Sub-Conductor /Phase	1	1
Conductor Line Clamps	AGSU and compression tubes	AGSU and Compression Tubes
Conductor Vibration Dampers	Stockbridge	Stockbridge
No. of OHEW	2	2
Earthwire	SC/GZI/I_19/2.03 SC/GZ/I_19/2.59 (SPN 100 – 102) AACSR/AC Volley Ball 8/3.6/7/2 (SPN 216-218)	SC/GZI/I_19/2.03 SC/GZ/I_19/2.59 (SPN 095 – 097) SC/AC Hitachi 19/2.59 (SPN 182 – 198)
OHEW Line Clamps	Twin Grips and gimbal	Twin Grips and trunion
OHEW Vibration Dampers	Spiral	Spiral
No. of OPGW	0	0
AVG Easement width	60m	60m

4.2.1 Insulators BS1018

Table 4-1: BS1018 Insulator Age and Type

Insulator Function	Structures	Material	Rating	Type	Discs	Installed
Suspension	8	Porcelain	160kN	Fog	19	1994 - 95
	8	Porcelain	160kN	Fog	17	1994 - 95
	38	Porcelain	125kN	Fog	17	1995 - 96
	38	Porcelain	125kN	Fog	19	1995 - 96
	23	Porcelain	125kN	Fog	17	2010 - 11
	23	Porcelain	125kN	Fog	19	2010 - 11
	44	Porcelain	125kN	Fog	17	2013 - 14
	44	Porcelain	125kN	Fog	19	2013 - 14
Bridging	3	Porcelain	125kN	Fog	17	1970
	14	Porcelain	125kN	Fog	19	1970
	1	Porcelain	125kN	Fog	17	1972
	8	Porcelain	160kN	Fog	19	1994 - 95
	6	Porcelain	160kN	Fog	17	1994 - 95
	11	Porcelain	125kN	Fog	17	2017
	26	Porcelain	125kN	Fog	19	2017
Tension	20	Porcelain	125kN	Fog	18	1970
	3	Porcelain	160kN	Fog	18	1989
	1	Porcelain	125kN	Fog	18	1989
	1	Porcelain	125kN	Fog	18	2000
	10	Porcelain	125kN	Fog	19	2017

4.2.2 Insulators BS1019

Table 4-2: BS1019 Insulator Age and Type

Insulator Function	Structures	Material	Rating	Type	Discs	Installed
Suspension	24	Porcelain	125kN	Fog	17	2005
	23	Porcelain	125kN	Fog	19	2005
	73	Porcelain	125kN	Fog	17	2010
	73	Porcelain	125kN	Fog	19	2010
	14	Porcelain	125kN	Fog	17	2013/14
	14	Porcelain	125kN	Fog	19	2013/14
Bridging	1	Porcelain	125kN	Fog	17	1972
	1	Porcelain	125kN	Fog	19	1972
	1	Porcelain	125kN	Fog	17	2012
	15	Porcelain	125kN	Fog	17	2017
	50	Porcelain	125kN	Fog	19	2017
Tension	44	Porcelain	125kN	Fog	18	1972
	1	Porcelain	125kN	Fog	18	2000
	23	Porcelain	125kN	Fog	19	2005
	10	Porcelain	125kN	Fog	19	2017

5. Location and Environment

5.1 General Location

The transmission line is located in Southern Brisbane and extends to the southern end of the Gold Coast. The built sections cover the distance between Greenbank and Mudgeeraba substations. Parts of these transmission lines traverse residential areas and there are multiple road crossings, both major motorways and minor roads. There are also 2 rail crossings, one at the Northern end of the line and the other at the Southern end of the line. The lines run is close proximity to a large number of dwellings, with some unapproved construction and encroachment within the easement corridor.

Figure 10: Residences close to BS1018 and 1019

Figure 11: Recreation areas near BS1018 and 1019

Figure 12: BS1018 and 1019 M1 Motorway crossing near Mudgeeraba Substation

5.2 Atmospheric Corrosion

Built Sections 1018 and 1019 are located approximately 5.8km from the coast at the nearest point (Mudgeeraba) and up to 40km from the coast at Greenbank Substation at the Northern end of the line. These Built Sections experience an average rainfall of between 610mm and 725mm with a mean annual humidity of approximately 65%.

The atmospheric corrosion environment has been classified as C3 according to Australian Standards which is a mild corrosive environment with low exposure to industry. A section of the lines is elevated and is exposed to salt laden winds which has resulted in this section being classified as C4 which is a moderate corrosion environment typical in areas of increased vegetation within and adjacent to the easement.

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 BS1018 and BS1019 are, at the time of assessment, exhibiting low to mid-level grade 2 corrosion across both fasteners and structure members. Occasional bolts have progressed to grade 3 with as yet only occasional grade 4 corrosion. 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.

Table 5-1: Estimated Service based on Corrosion Environment

Component	Minimum coating thickness µm	Estimated life to First Service in Years *(First Appearance of Grade 2)*
Bolts & nuts	45	(C2,C3,C4,C5) 64, 22, 11, 5
Members ≤ 6mm	70	(C2,C3,C4,C5) 100, 33, 17, 8
Members > 6mm	85	(C2,C3,C4,C5) 121, 40, 20, 10

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

6.1 Summary of BS 1018 Health Indices

The condition data detailed in the sections below has been summarised in Figure 13 which is a graph of available health indices for the major components of BS1018.

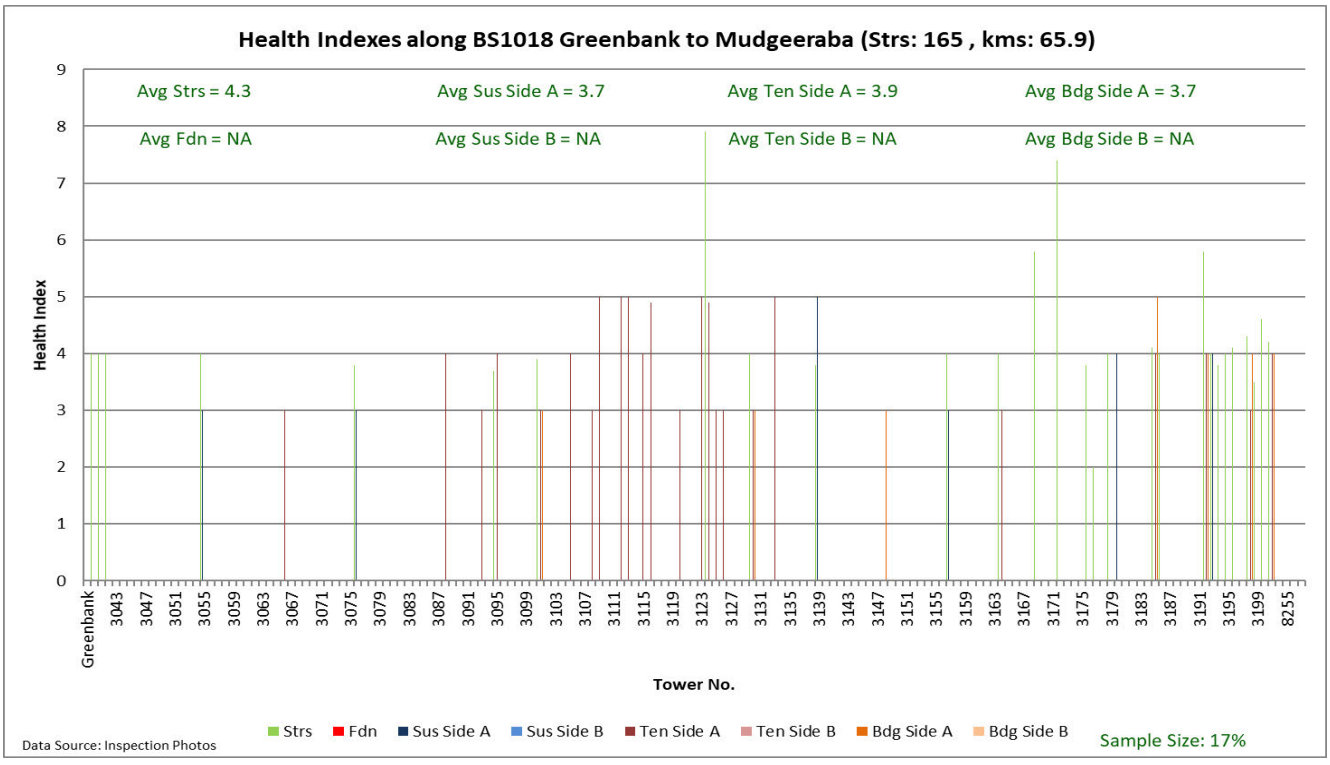


Figure 13: Graph of BS1018 Health Indices

Appendix 7.1 has two graphs depicting the number of notifications relating to corrosion. These graphs indicate higher levels of G3 and G4 corrosion towards the southern end of the lines and as such, there is a correlation

between the notification graphs and the health index graph above, which shows slightly higher percentages of corrosion (and higher health indices) towards the southern end.

The following work order costs presented in Figure 14 show that on average, $339,330 p.a. is spent on maintenance across 165 structures, equating to $2,057 per structure, per year.

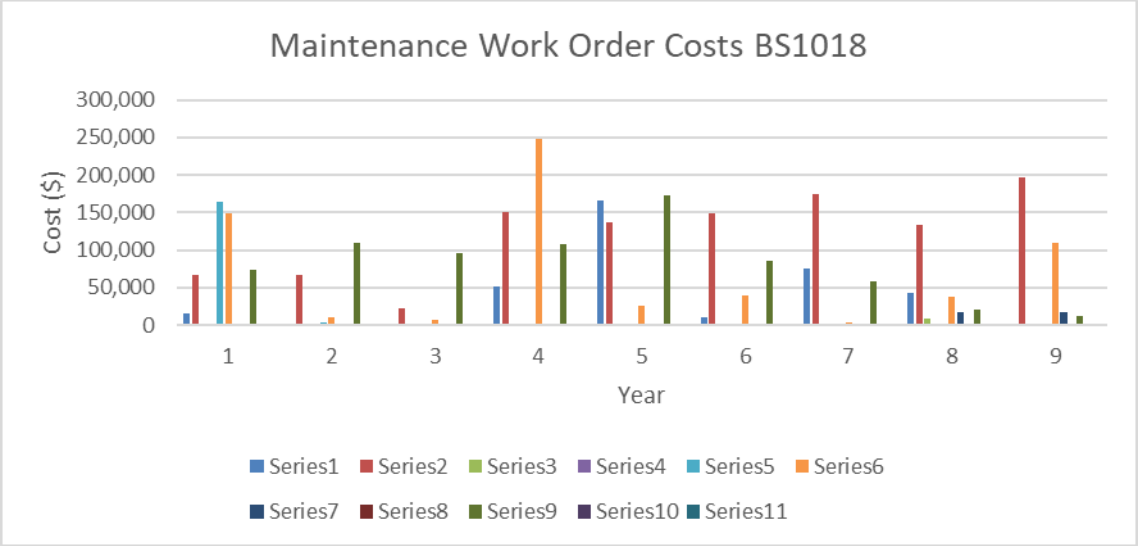


Figure 14: Maintenance WO Costs BS1018

6.2 Summary of BS 1019 Health Indices

The condition data detailed in the below sections has been summarised in Figure 15 which is a graph of available health indices for major components of BS1019.

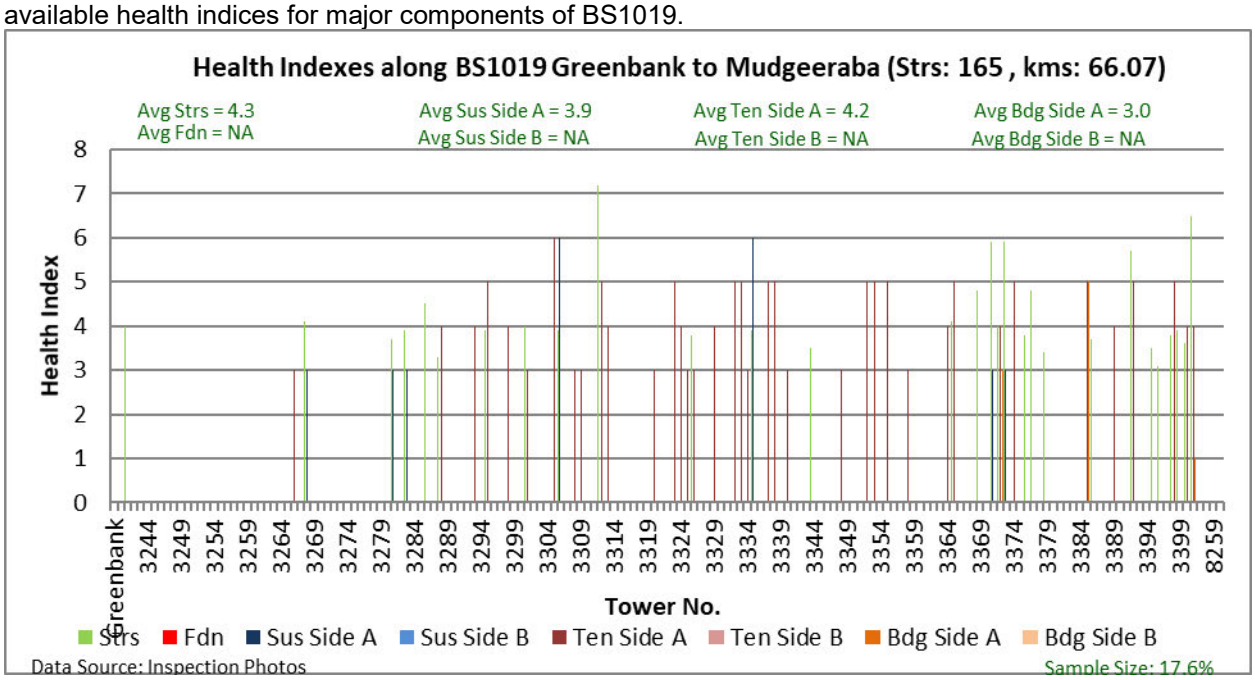


Figure 15: Graph of BS1019 Health Indices

Appendix 7.2 has two graphs depicting the number of notifications relating to corrosion. These graphs indicate higher levels of G3 and G4 corrosion towards the southern end of the lines and as such, there is a correlation between the notification graphs and the health index graph above, which shows slightly higher percentages of corrosion (and higher health indices) towards the southern end.

The following work order costs presented in Figure 16 show that on average $262,045 p.a. is spent on maintenance across 165 structures, equating to $1,588 per structure per year.

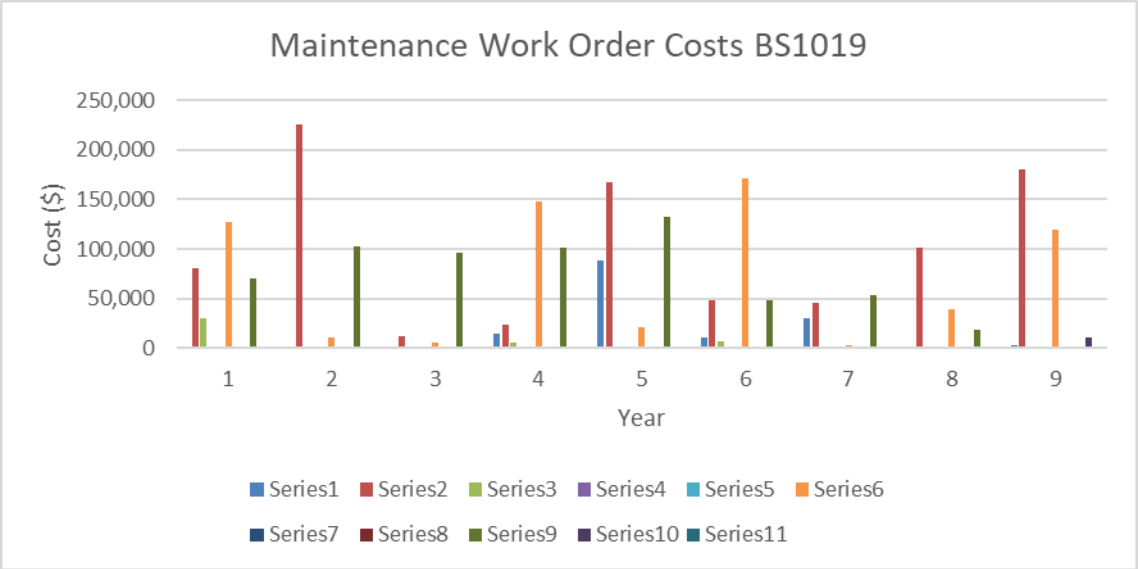


Figure 16: Maintenance WO BS1019

6.3 Structure Condition BS1018 by Zone

Table 6-1 below summarises the average condition of structure zones. Based on direct visual and photographic assessment, the estimated remaining service life has also been provided for the built section. It is noted that this assumes 10% exceedance across the line, i.e. 90% of structures will have a lower health Index while 10% will exceed this value. Using this method, it is estimated that a Built Section Health Index of 7 will be exceeded in just over 5 years (2025), and a Health Index of 8 will be reached in 2029.

Average Observed Corrosion Grades are based upon Powerlink Visual Inspection Guides, as applied by field crews or to photographic evidence. The measurement document data is contained in and extracted from SAP.

Table 6-1: SAP MD Data BS1018

Structure Zone	Average Level of Corrosion (%)				Sample Size	Installed Year	Health Index (90%)	Estimated Years until HI of 7
Structure								
Foundations	G1	G2	G3	G4		1975	6.3	2
Legs	97.1	2.4	0.4	0.1	17			
Structure Overall	G1	G2	G3	G4	28	1975	5.8	5
Fasteners	87	11.3	1.7	0	26			
Members	95.4	4.6	0	0	26			
Climbing Aids	G1	G2	G3	G4				
Fasteners	89.6	9	2	0	21			
Tower Base	G1	G2	G3	G4				
Fasteners	96.1	3.3	0.4	0.2	24			
Members	97.8	2.2	0	0	24			
Tower Body	G1	G2	G3	G4				
Fasteners	85.1	12.9	2	0	25			
Members	93.2	6.8	0	0	25			
Superstructure	G1	G2	G3	G4				
Fasteners	81.5	16.2	2.3	0	22			
Members	94.3	5.7	0	0	22			
Cross Arms	G1	G2	G3	G4				
Fasteners	83.7	13.7	2.4	0.2	24			
Members	94.8	5.2	0	0	24			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	84	13.2	2.8	0	18			
EW Peak	G1	G2	G3	G4	24			
Fasteners	74.8	22.5	2.7	0	12			
Members	91.7	8.3	0	0	15			
	Min	Max	Avg					
Structure Earthing Resistance	0.35	300	33.1		159			

Table 6-2: Structure Zone Condition Summary BS1018

Structure Zone	Comment
Foundation	Structures utilise a standard steel reinforced concrete foundation. Overall the foundations are in good condition, however there are a small percentage of structures with foundation interface corrosion (0.4% G3, 0.1% G4). At the time of this Condition Assessment maintenance work is being carried out to rectify existing notifications relating to interface corrosion.
Climbing Aids	Steps bolts are in good condition with generally G2 corrosion observed, and G3 on 2% of step bolts on sampled structures. Additionally while this is not a safety issue, it is noted that step bolts do not meet our current standards for climbing aids, which incorporate a climbing attachment point.
Tower Base	Members in good condition with low levels of G2, which is expected for structures of this age. The nuts and bolts of this structure zone are experiencing G2 corrosion at low levels with 0.4% of sampled structures at G3 and 0.2% at G4. These results are expected for structures of this age. Corrosion levels are generally higher at the southern end of the feeder.
Tower Body	Most of the tower body bolts are still in G1 condition with 12.9% G2 and 2% G3. Members are predominately G1 with G2 corrosion developing on some members which is expected for structures of this age. Corrosion levels are generally higher at the southern end of the feeder.
Superstructure	Members are in good condition with typically low levels of G2 corrosion. 2.3% of nuts and bolts are corrosion grade 3. Corrosion levels are generally higher at the southern end of the feeder.
Cross Arms	Similar condition to that of the Superstructure, showing low levels of G2 corrosion over members. Nuts and bolts are showing 2% G3 and 0.2% G4 corrosion. Corrosion levels are generally higher at the southern end of the feeder.
Conductor Attachment	Attachment plates are in good condition with only 3% G3 corrosion on nuts and bolts.
Earthwire Peak	Similar condition to that of the Superstructure, with occasional G3 bolts. Much of the assessment has been from ground level, therefore this is not a comprehensive overview of EW peaks. Corrosion levels are generally higher at the southern end of the feeder.
Anti-climbing Barrier	These towers have the standard barb wire installed, no issues found in condition.

Figure 17: 1018-STR-3192 Interface Corrosion

Figure 18 below is a frequency distribution of structure health indices based on the sample of data.

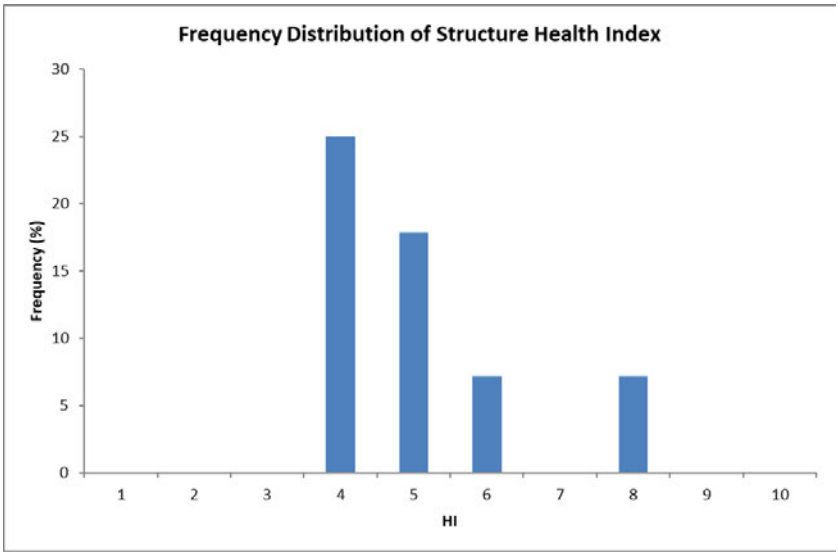


Figure 18: Frequency Distribution of Structure Health Indices BS1018

Figure 19 below is a graph of structure corrosion along the built section based on the sample of data. A slight trend of increased corrosion towards the southern end of the line is emerging.

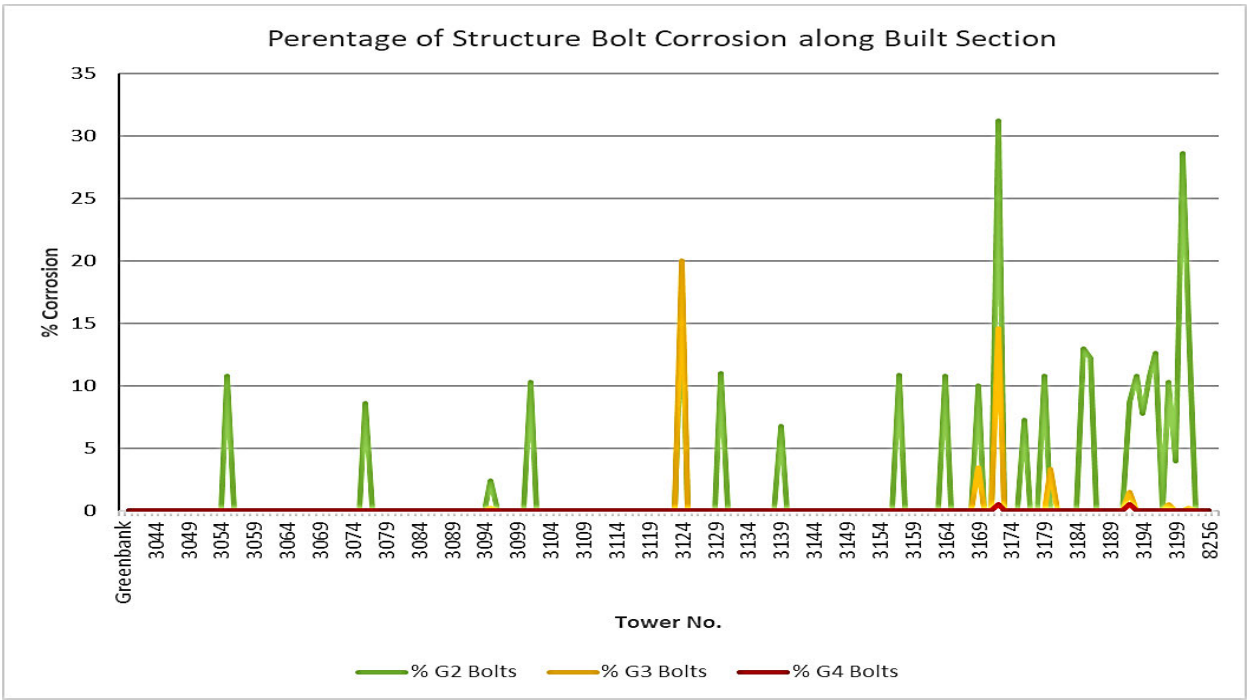


Figure 19: BS1018 Structure Bolt Corrosion as Percentage

Figure 20 below is the projection of average level of corrosion on the entire built section based on the sample of data.

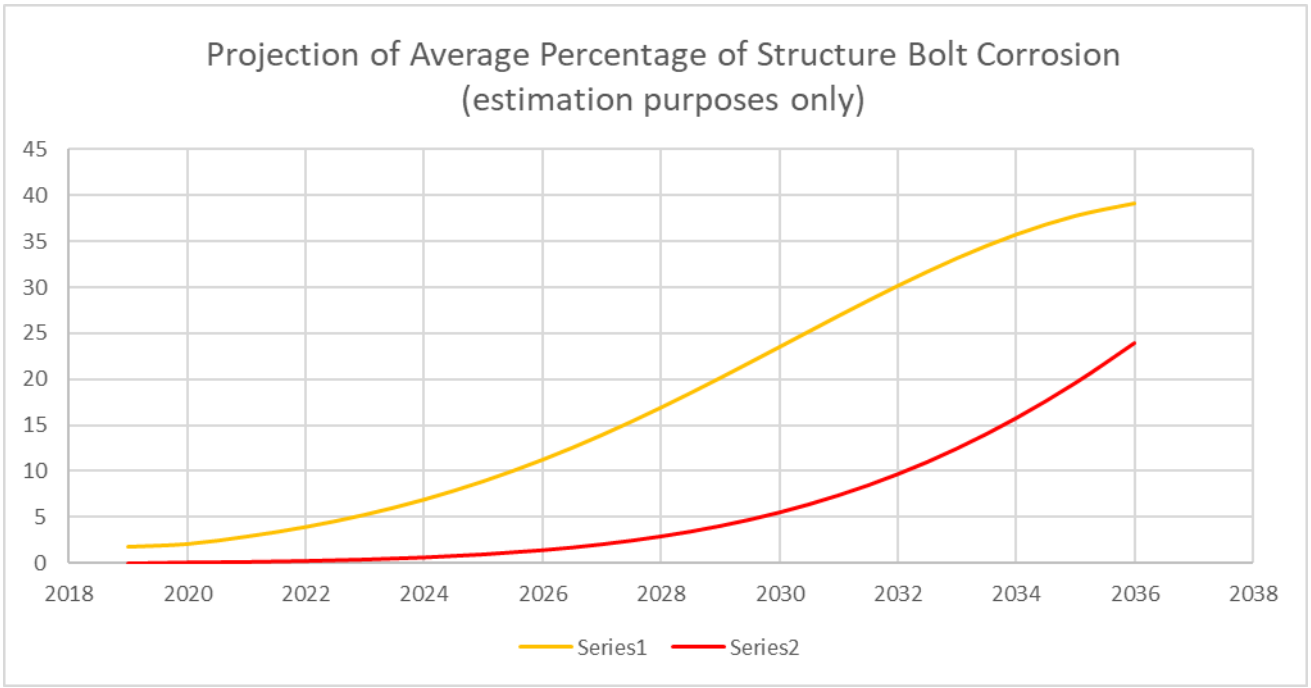


Figure 20: Corrosion Percentage Projection BS1018

6.4 Structure Condition BS1019 by Zone

Table 6-3 below summarises the average condition of BS1019 structure zones. Based on direct visual and photographic assessment, the estimated remaining service life has also been provided for the Built Section. It is noted that this assumes 10% exceedance across the line, i.e. 90% of structures will have a lower health Index while 10% will exceed this value. Using this method, it is estimated that a Built Section Health Index of 7 will be exceeded in 5 years (2025), and a Health Index of 8 will be reached in 2029.

Average Observed Corrosion Grades are based upon Powerlink Visual Inspection Guides, as applied by field crews or to photographic evidence. The measurement document data is contained in and extracted from SAP.

Table 6-3: SAP Structure MD Data BS1019

Structure Zone	Average Level of Corrosion (%)				Sample Size	Installed Year	Health Index (90%)	Estimated Years until HI of 7
Structure								
Foundations	G1	G2	G3	G4		1974	4.5	11
Legs	96.8	3	0.2	0	13			
Structure Overall	G1	G2	G3	G4	29	1974	5.6	5
Fasteners	85.9	13.2	0.8	0.1	29			
Members	93.8	6.2	0	0	29			
Climbing Aids	G1	G2	G3	G4				
Fasteners	86	14	0	0	24			
Tower Base	G1	G2	G3	G4				
Fasteners	88.5	11.5	0	0	26			
Members	93.1	6.9	0	0	26			
Tower Body	G1	G2	G3	G4				
Fasteners	80.5	18.1	1.3	0.1	24			
Members	92.3	7.7	0	0	24			
Superstructure	G1	G2	G3	G4				
Fasteners	86.6	12.3	1.1	0	22			
Members	95.9	4.1	0	0	22			
Cross Arms	G1	G2	G3	G4				
Fasteners	83.4	15.5	1.1	0	28			
Members	93.6	6.4	0	0	28			
Conductor Attachment Plate	G1	G2	G3	G4				
Fasteners	84.6	13.5	1.9	0	27			
EW Peak	G1	G2	G3	G4	26			
Fasteners	42.1	57.9	0	0	12			
Members	53.3	46.7	0	0	12			
	Min	Max	Avg					
Structure Earthing Resistance	0.1	34.95	4.1		70			

Table 6-4: Structure Zone Condition Summary BS1019

Structure Zone	Comment
Foundation	Structures utilise a standard steel reinforced concrete foundation. Overall the foundations are in good condition, however there are a small percentage of structures with G3 foundation interface corrosion. At the time of this Condition Assessment maintenance work is being carried out to rectify existing notifications relating to interface corrosion.
Climbing Aids	Steps bolts are in good condition with some G2 corrosion observed. Additionally while this is not a safety issue, it is noted that the step bolts do not meet our current standards for climbing aids, which incorporate a climbing attachment point.
Tower Base	Members in good condition showing low levels of G2. The nuts and bolts of this structure zone are exhibiting G2 corrosion at low levels. These results are expected for structures of this age. Corrosion levels are generally higher at the southern end of the feeder.
Tower Body	Most of the tower body bolts are still in G1 or G2 condition with low levels of G3 and very low levels (<1) G4. Members are predominately G1 with G2 corrosion developing in isolated situations. Corrosion levels are generally higher at the southern end of the feeder.
Superstructure	Members are in good condition showing low levels of G2 corrosion. Higher levels of G2 are found on bolts and currently 1% of nuts and bolts are at G3 level. Corrosion levels are generally higher at the southern end of the feeder.
Cross Arms	Similar condition to that of the Superstructure, showing low levels of G2 corrosion over members. Nuts and bolts are showing 1% G3, with more widespread G2. Corrosion levels are generally higher at the southern end of the feeder.
Cond. Attachment	Attachment plates are in good condition with only 2% G3 corrosion on nuts and bolts.
Earthwire Peak	Similar condition to that of the Superstructure showing G2 corrosion. Much of the assessment has been from ground level, therefore this is not a comprehensive overview of EW peak. Corrosion levels are generally higher at the southern end of the feeder.
Anti-climbing Barrier	These towers have the standard barb wire installed: no systemic condition issues were identified.

Figure 21: 1019-STR-3401 Interface Corrosion

Figure 22 below is a frequency distribution of structure health index based on the sample of data.

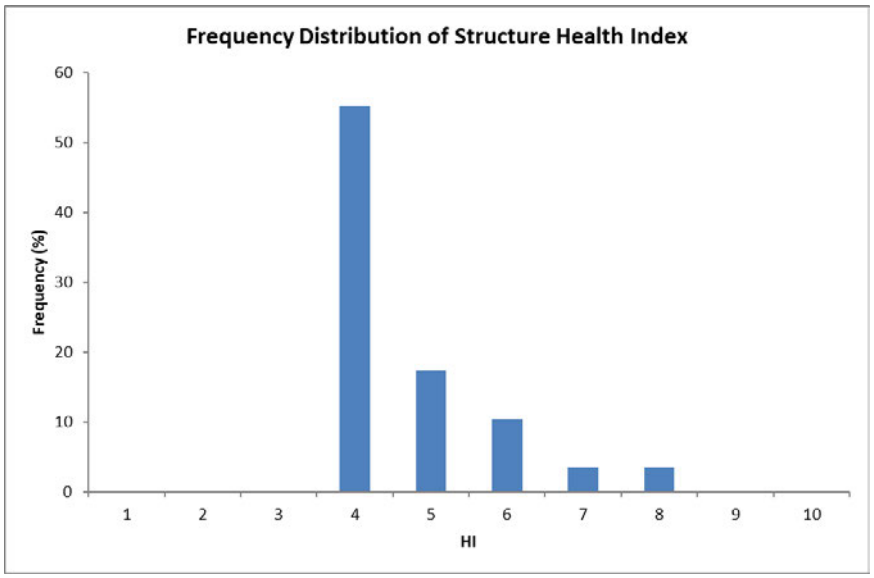


Figure 22: Frequency Distribution of Structure Health Indices BS1019

Figure 23 below is a graph of structure corrosion along Built Section 1019 based on the sample of data. As with its sister line BS1018, slightly elevated corrosion levels have been observed at the southern (Mudgeeraba) end.

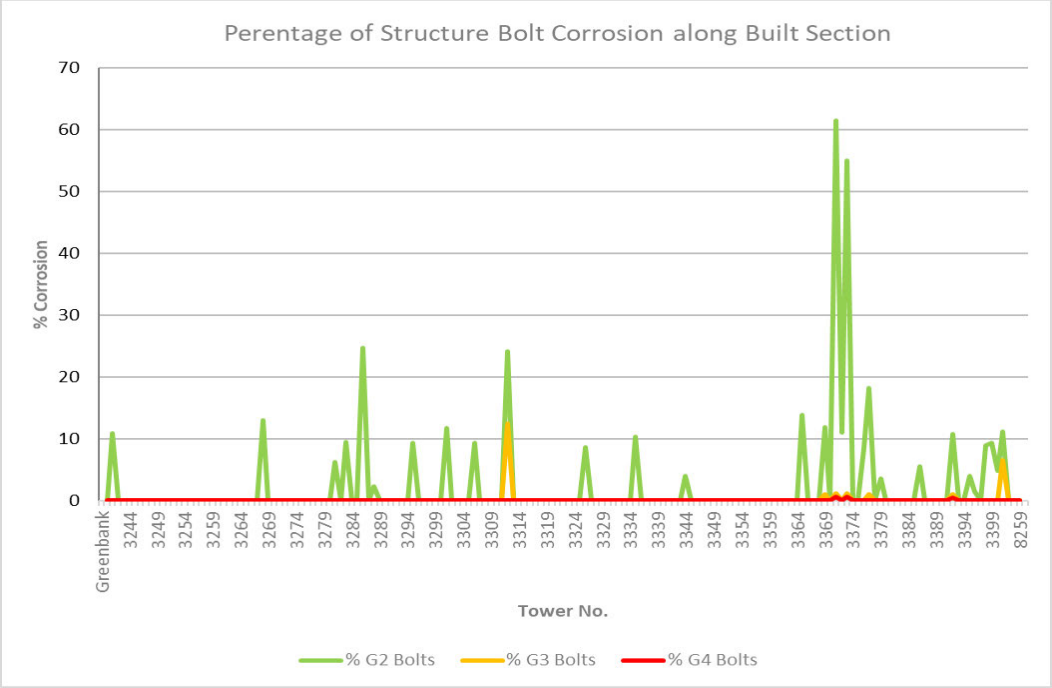


Figure 23: BS1019 Structure Bolt Corrosion as Percentage

Figure 24 below is the projection of average level of corrosion on the entire built section based on the sample of data.

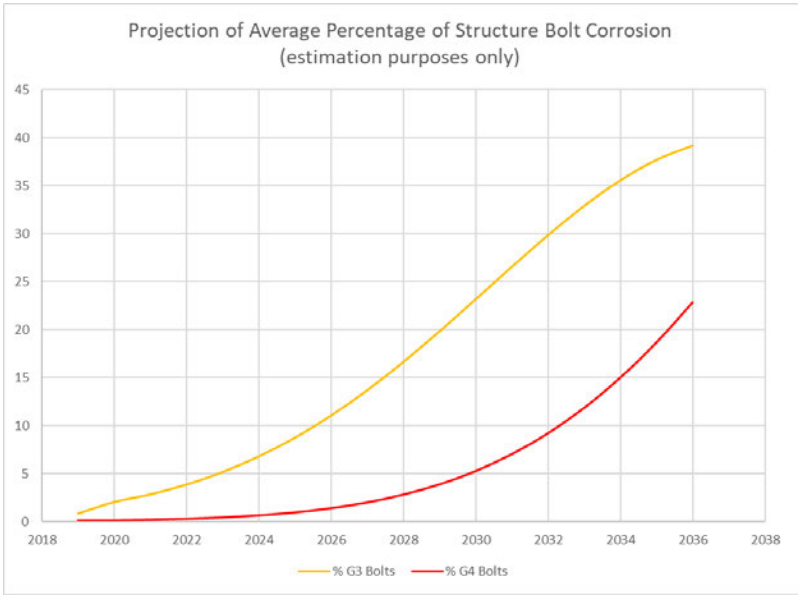


Figure 24: Corrosion Percentage Projection BS1019

6.5 Insulators and Hardware BS1018

Please refer to Table 6-5 for details of BS1018 insulator ages and types. Due to the very wide range of ages and types of BS1018 insulators there also significant variation in condition, and some specific issues have been identified.

The condition of the BS1018 insulators has been summarised by functional type in Table 6-5.

Table 6-5: Insulator and Hardware Condition Summary BS1018

Insulator String Function	Comment
Suspension	Suspension insulators are non-original, with an install date range from 1994 to 2008. Generally all are in fair condition with low levels of corrosion observed, the only exception being staining on the first 4 – 6 discs from the live end on suspension V-strings. This requires further investigation but is not currently a significant defect. The main issue with suspension insulators is hardware, as this was not replaced when new discs were installed. As such hardware is now a mix of G2 and G3.
Tension	In 2017 replacement of high risk tension strings over major roads prior to the Gold Coast Commonwealth Games was carried out under OR.02120. Other tension strings were inspected and found to typically be grade 2 or low grade 3. These are likely to require replacement within the 2020s. As with suspension insulators, all hardware is original and has low to medium levels of corrosion.
Bridging	Also under OR.02120, most BS 1018 bridging strings were replaced in 2017 prior to the Gold Coast Commonwealth Games. Those original bridging insulators that remain are typically G2 and G3 and will require replacement in the medium term. Bridging insulator hardware is original, and will require replacement due to corrosion in the late 2020s.

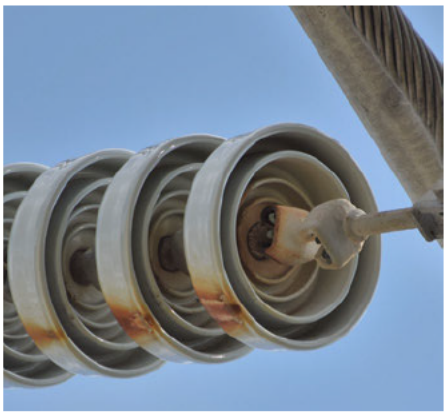


Figure 25: 1018-STR-3199 Suspension V-String Insulator Corrosion

Figure 26: 1018-STR-3112 Tension Insulator Corrosion

6.6 Insulators and Hardware BS1019

Please refer to Table 6-6 for details of BS1019 insulator ages and types. Due to the very wide range of ages and types of BS1019 insulators there also significant variation in condition, and some specific issues have been identified.

The condition of the BS1019 insulators has been summarised by functional type in Table 6-6

Table 6-6: Insulator and Hardware Condition Summary BS1019

Insulator String Function	Comment
Suspension	Suspension insulators are non-original, with an install date range from 1994 to 2008. Generally all are in fair condition with low levels of corrosion observed, the only exception being staining on the first 4 – 6 discs from the live end on suspension V-strings. This requires further investigation but is not currently a significant defect The main issue with suspension insulators is hardware, as this was not replaced when new discs were installed. As such, hardware is now a mix of G2 and G3.
Tension	In 2017 replacement of high risk tension strings over major roads prior to the Gold Coast Commonwealth Games was carried out under OR.02120. Other tension strings were inspected and found to typically be grade 2 or low grade 3. These are likely to require replacement within the 2020s. As with suspension insulators, all hardware is original and has low to medium levels of corrosion.
Bridging	Also under OR.02120, all BS 1019 bridging strings were replaced in 2017 prior to the Gold Coast Commonwealth Games. Bridging insulator hardware is original, and will require replacement due to corrosion in the 2020s.

Figure 27: 1019-STR-3372 Tension String

6.7 Conductor and Conductor Hardware BS1018

The transmission line is strung with ACSR/I Martin 54/4.02/19/2.41 conductor, containing aluminium conductor with steel reinforced strands.

No issues have been identified with the conductor and it is estimated to last 80 years in this environment.

Table 6-7: Conductor and Conductor Hardware EOL BS1018

Component	Installation Year	Comment	Estimated Remaining Service Life (years)
Conductor	1975	No visible deterioration	35
Conductor Dampers	1998		35
Conductor Spacers	NA		
Conductor Mid-Span Joints	1975	Limited information – no known issues.	

6.8 Conductor and Conductor Hardware BS1019

The transmission line is strung with ACSR/I Martin 54/4.02/19/2.41 conductor, containing aluminium conductor with steel reinforced strands.

No issues have been identified with the conductor and it is estimated to last 80 years in this environment.

Table 6-8: Conductor and Conductor EOL BS1019

Component	Installation Year	Comment	Estimated Remaining Service Life (years)
Conductor	1974	No visible deterioration	34
Conductor Dampers	2013		35
Conductor Spacers	NA		
Conductor Mid-Span Joints	1974	Limited information – no known issues.	

6.9 Earthwire Hardware BS1018

Table 6-11 below summarises the average condition of each earthwire or OPGW. Based on visual assessment and past experience the estimated remaining service life has also been provided.

Corrosion Grades are based upon Powerlink Visual Inspection Guides, as applied by field crews or to photographic evidence. The measurement document data is extracted from SAP.

Table 6-9: SAP Earthwire MD Data BS1018

Component	Average Level of Corrosion (%)								Sample Size	Installed Year	Health Index (90%)	Estimated Years until HI of 7
OHEW - Side A										1975	4	14
OHEW	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	61.5	0	0	0	0	0	13			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	69.2	30.8	0	0	0	0	13			
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	7.7	0	61.5	30.8	0	0	0	0	13			
Suspension Clamp	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	76.9	23.1	0	0	0	0	13			
OHEW - Side B										1975	4	14
OHEW	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	69.2	0	0	0	0	0	13			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	69.2	30.8	0	0	0	0	13			
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	76.9	23.1	0	0	0	0	13			
Suspension Clamp	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	76.9	23.1	0	0	0	0	13			

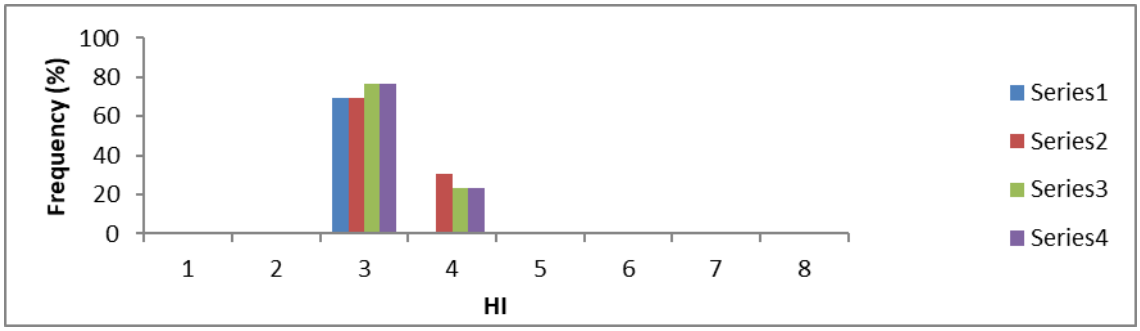


Figure 28: Frequency Distribution of Health Indices OHEW - Side A

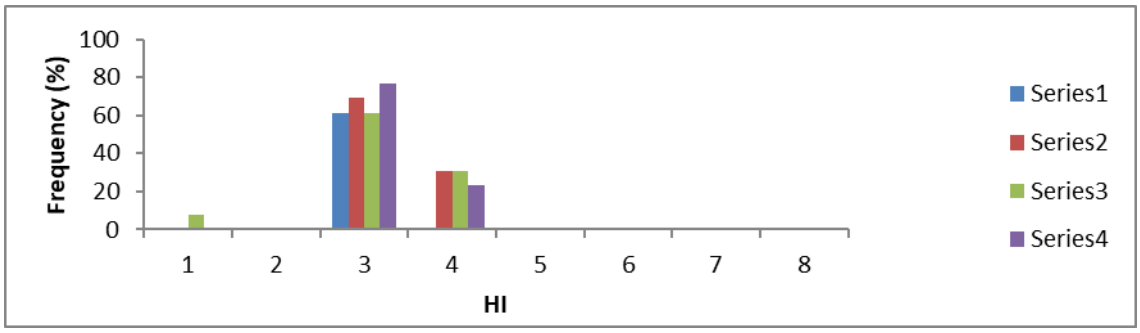


Figure 29: Frequency Distribution of Health Indices OHEW - Side B

Component		Installation Date	Comment	Estimated Remaining Service Life (years)
Earthwire		1975	Low Grade 2	10-15
Earthwire Hardware		1975	Mid-Grade 2	7-12
Earthwire Dampers		1975		7-12
OPGW		N/A		
OPGW Hardware		N/A		
OPGW Dampers		N/A		

Table 6-10: OHEW and OHEW Hardware EOL BS1018

6.10 Earthwire Hardware BS1019

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

Corrosion Grades are based upon Powerlink Visual Inspection Guides, as applied by field crews or to photographic evidence. The measurement document data is extracted from SAP.

Table 6-11: SAP OHEW MD Data BS1019

Component	Average Level of Corrosion (%)								Sample Size	Installed Year	Health Index (90%)	Estimated Years until HI of 7
OHEW - Side A										1974	5	8
OHEW	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	62.5	0	0	0	0	0	8			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	75	12.5	12.5	0	0	0	8			
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	37.5	0	50	12.5	0	0	0	0	8			
Suspension Clamp	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	75	12.5	12.5	0	0	0	8			
OHEW - Side B										1974	5	8
OHEW	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	62.5	0	0	0	0	0	8			
Hardware	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	75	12.5	12.5	0	0	0	8			
Deadend	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	25	0	62.5	12.5	0	0	0	0	8			
Suspension Clamp	Nil	G1	G2L	G2H	G3L	G3H	G4L	G4H				
	0	0	75	12.5	12.5	0	0	0	8			

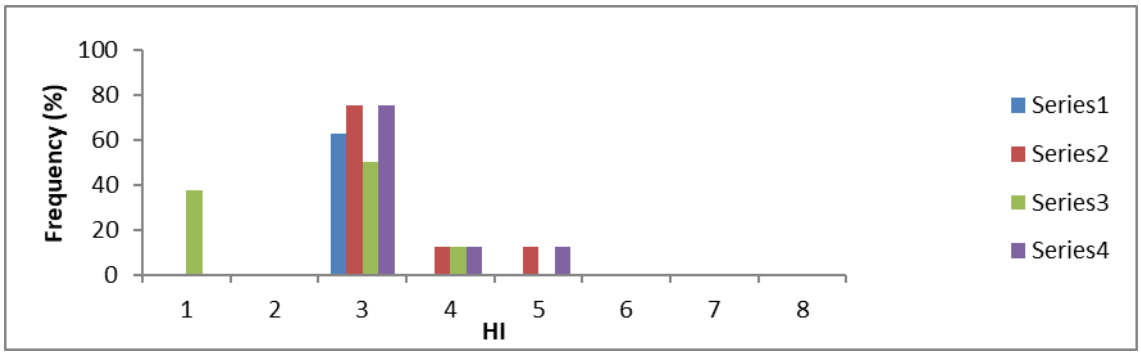


Figure 30: Frequency distribution of Health Indices OHEW - Side A

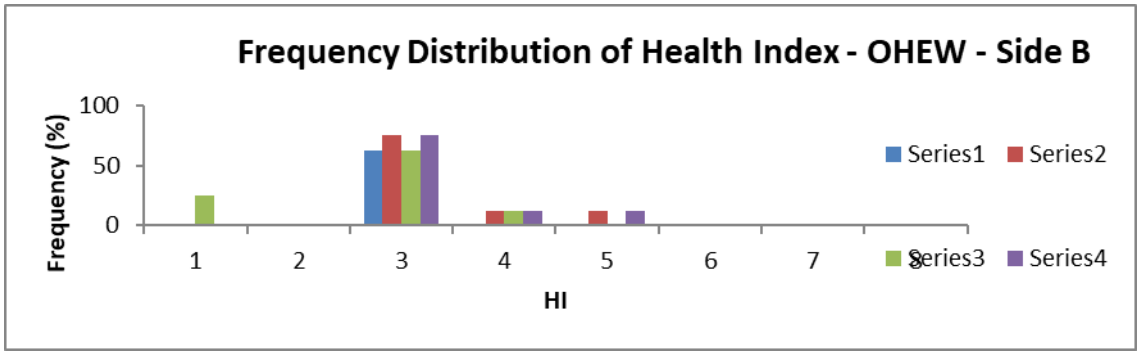


Figure 31: Frequency Distribution of Health Indices OHEW - Side B

Table 6-12: OHEW and OHEW Hardware EOL BS1019

Component	Installation Date	Comment	Estimated Remaining Service Life (years)
Earthwire	1974	Low Grade 2	10-15
Earthwire Hardware	1974	Mid-Grade 2	7-12
Earthwire Dampers	1974		7-12
OPGW	N/A		
OPGW Hardware	N/A		
OPGW Dampers	N/A		

6.11 Earthing

Generally the earthing falls below satisfactory standards, with a number of earth strap and earth bonding issues. Resistance measurements dating from 2012 are on average high: up to 154 ohms. Inside 2.5km of the terminal substations, only 5% of readings lie within the 0 – 5Ω range and 70% lie between 6 and 30Ω. 25% of readings close to substations are over 30 Ohms.

Outside a 2.5km distance from substations, 30% of readings lie within the 0 – 10Ω range and 66% are between 11 and 30Ω. Only 3% are over 30 Ohms.

Table 6-13: Earthing component EOL

Component	Installation Date	Corrosion Grade/Comment	Estimated Remaining Service Life (years)
Earthing (BS1018)	1975	30 instances of broken or worn earth straps.	Some rectification required
Earthing (BS1019)	1974	41 instances of broken or worn earth straps.	Some rectification required

7. Appendices

7.1 SAP Notifications Graph BS1018

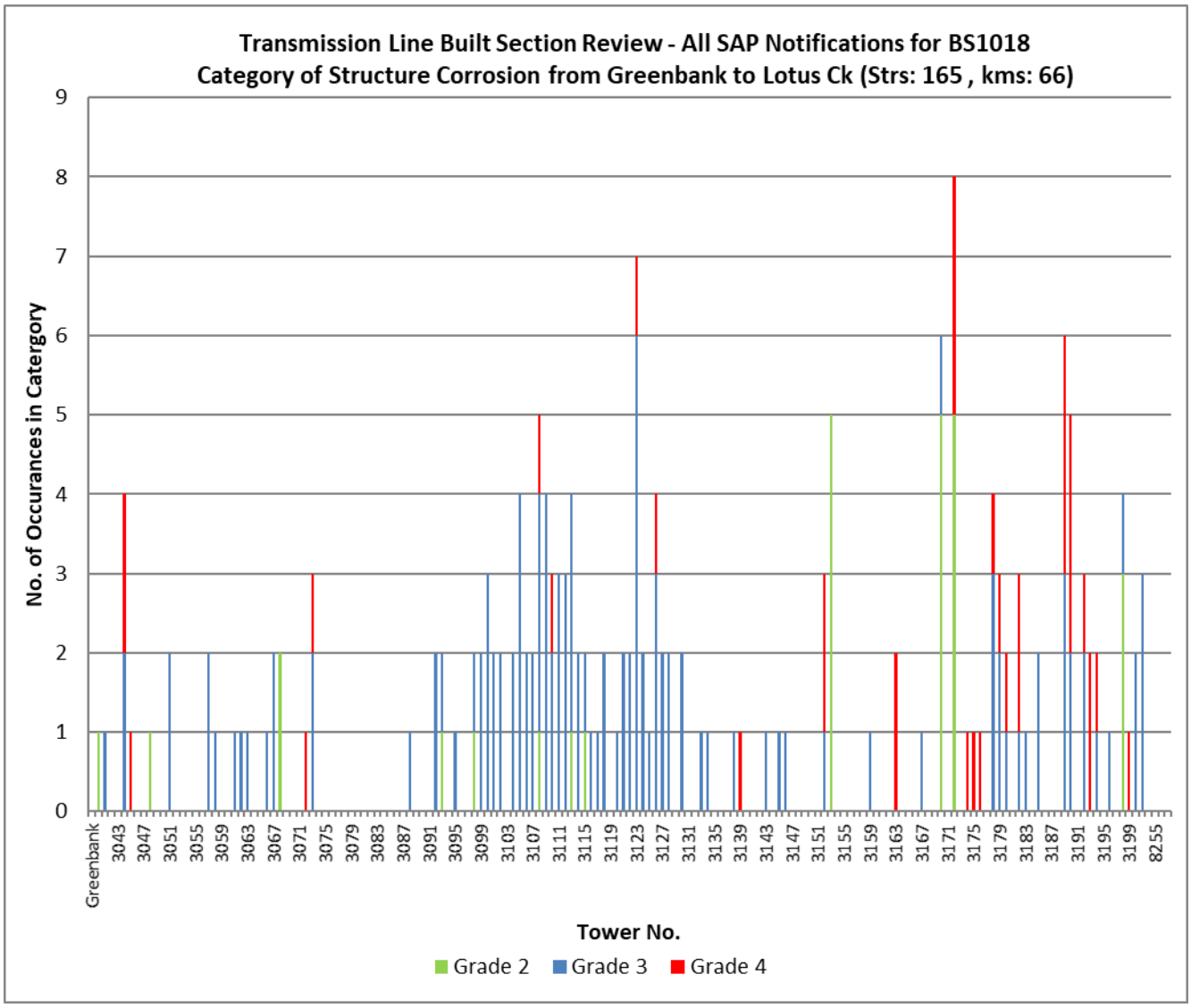


Figure 33: Graph of SAP all Notifications for Corrosion on Structures

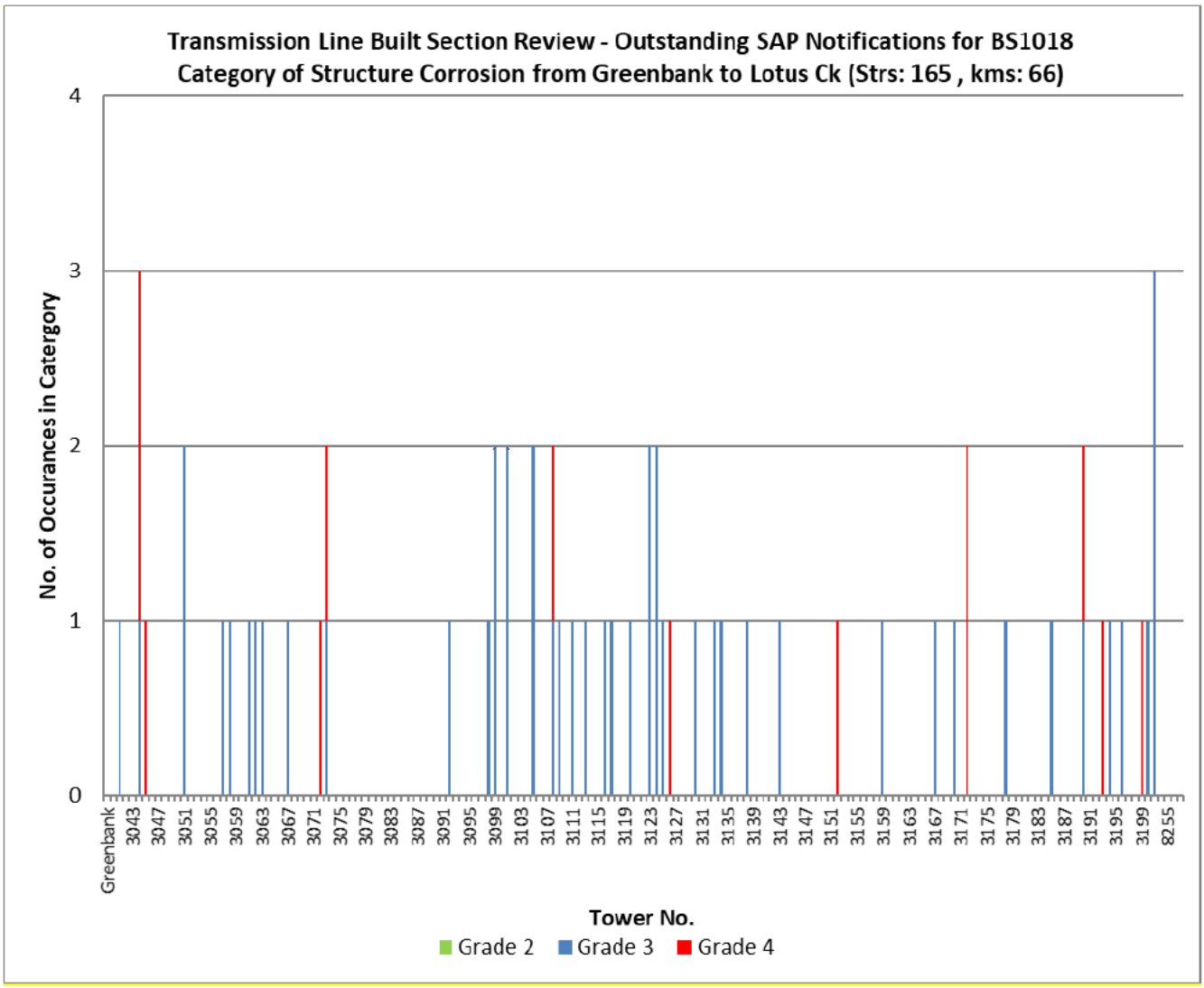


Figure 34: Graph of SAP Outstanding Notifications for Corrosion on Structures

7.2 SAP Notifications Graph BS1019

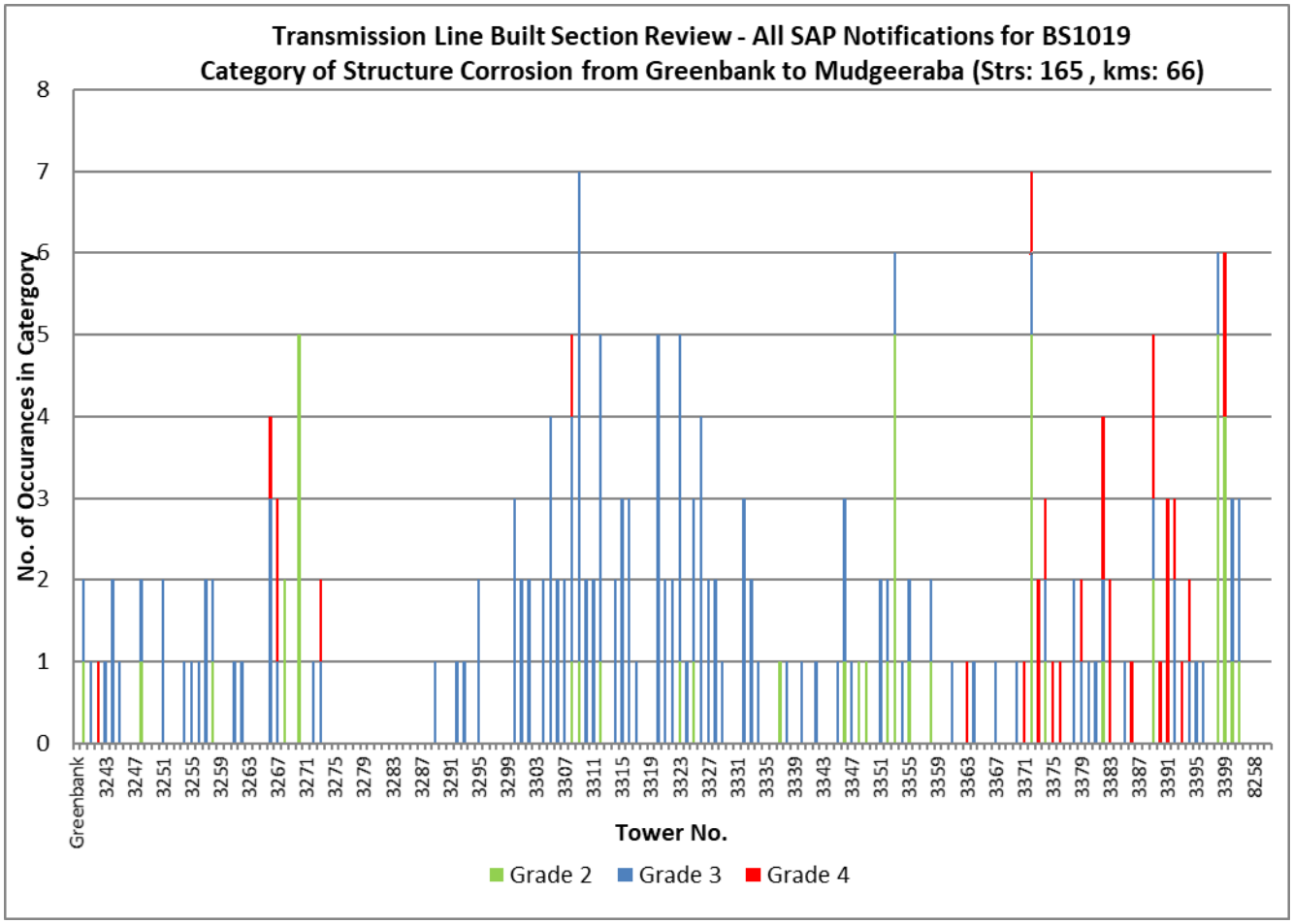


Figure 35: Graph of SAP all Notifications for Corrosion on Structures

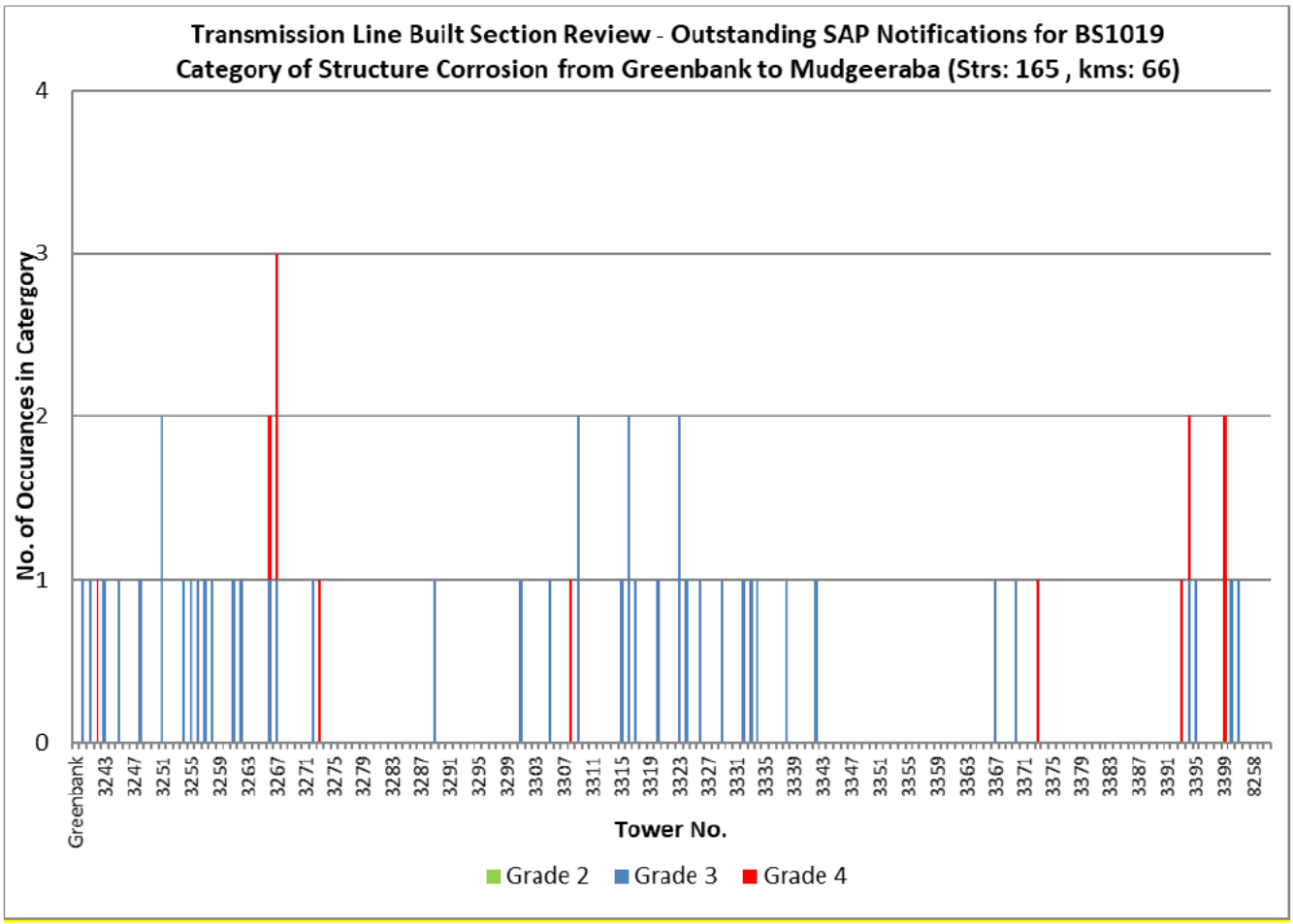
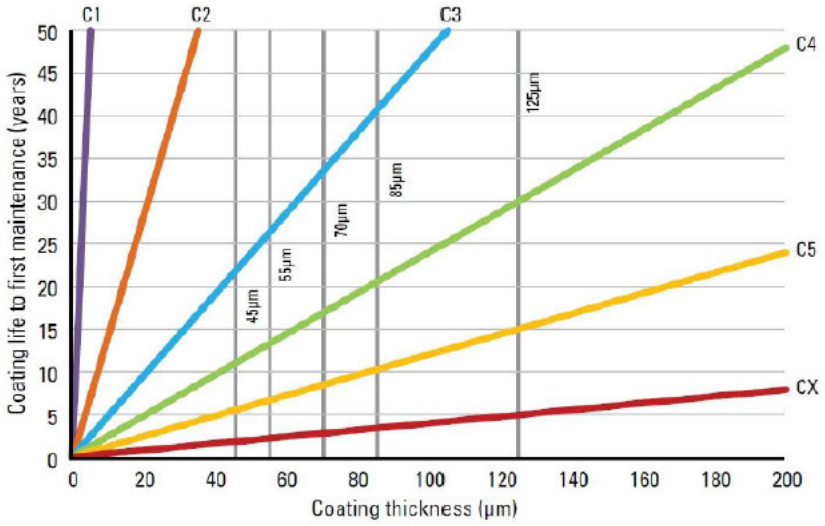


Figure 36: Graph of SAP Outstanding Notifications for Corrosion on Structures

7.3 Estimated Service Life of Galvanised Steel

Corrosivity Category	Corrosivity	Example
C2 (B)	Low	Very mild corrosion environment, such as semi-arid rural environment, with low humidity and rainfall, some rural activity, and/or minor vegetation encroachment into the easement.
C3 (C)	Medium	Mild corrosion environment, such as typical rural areas with moderate humidity and rainfall, average rural activity, and/or moderate vegetation encroachment into the easement.
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.
C5 (E)	Very High	Aggressive corrosion environment and/or close proximity to high salt coastal regions. Average Annual Rainfall may vary. Moderate to dense urbanised area with high public exposure will be included in this category.

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.

Region	Max Rate (µm/year)	Bolts & Nuts (45µm)		Members <= 6mm (70µm)		Members > 6mm (85µm)	
		Min Years	Max Years	Min Years	Max Years	Min Years	Max Years
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 37 - Life to First Maintenance of Galvanised Steel – Galvanisers Association of Australia

7.4 Estimated Service Life of Carbon Steel

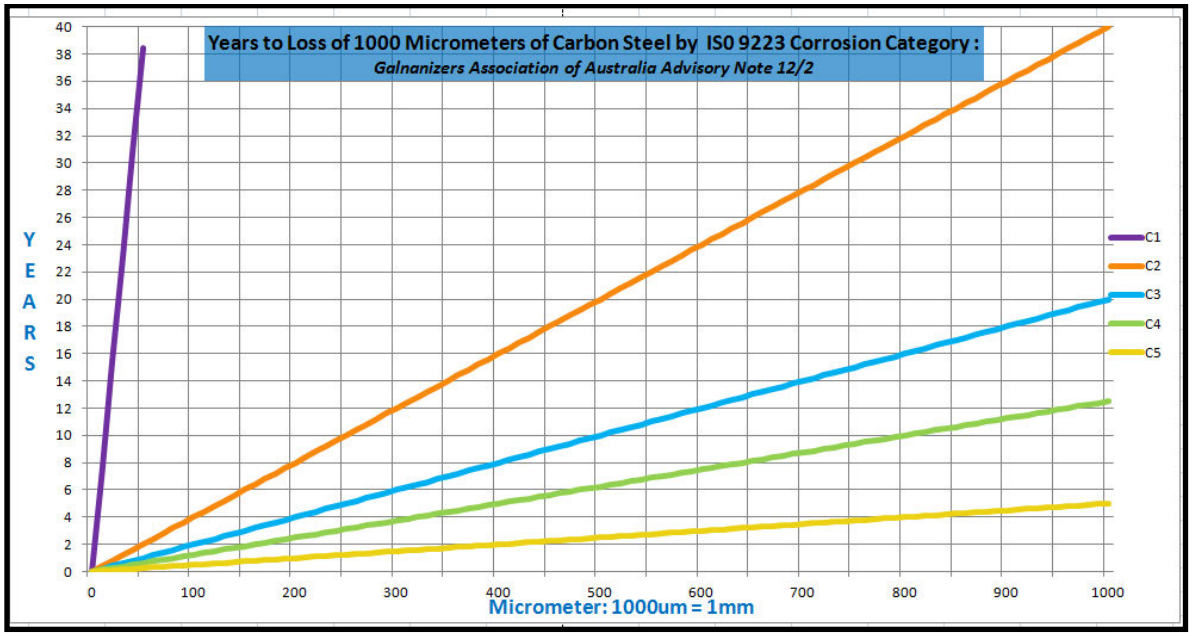


Figure 38 - Rate of Carbon Steel Loss

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

7.5 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.
- AS/NZS 2312-2002 – Guide to the protection of structural steel against atmospheric corrosion by the use of protective coatings

Built Section Configuration

- SAP Reports

Condition Assessment Data

- M Drive Photos
- SAP IK17 Measurement Documents
- Notifications and Work Orders

Planning Statement	**9/10/2020**
Title	CP.02415 Greenbank – Mudgeeraba 275kV TL Refit - Planning Statement [1]
Zone	Gold Coast
Need Driver	Condition assessment of the Greenbank – Mudgeeraba 275kV Transmission Lines January 2020. Recommended refurbishment by June 2028 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.
Pre-requisites	None

Executive Summary

The Greenbank – Mudgeeraba 275kV TL was commissioned in the mid-1970s to supply a growing demand in the Gold Coast area.

A recent condition assessment report has recommended replacement of selected structural members, attachment hardware and climbing step bolts, as well the lines overhead earth wires, along with the repainting of approximately 15% of structures by 2028, ensuring ongoing compliance with Powerlink's Electricity Act, Electrical Safety Act and Electricity Safety Regulation obligations

Energy Queensland forecasts have confirmed there is an enduring need to maintain electricity supply into the local Gold Coast area. Removal of the Greenbank – Mudgeeraba 275kV TL to address emerging condition risks would result in Powerlink breaching its N-1-50MW/600MWh reliability obligations.

The preferred network solution for Powerlink to continue to meet its statutory obligations is to refurbish the line by June 2028.

[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)

1. Contents

2. Introduction

The Greenbank to Mudgeeraba feeders consist of two single circuit 275kV transmission lines, constructed in the mid-1970s. Each feeder comprises approx. 50 tension and 115 suspension structures. The lines are an essential component of the transmission network supplying the southern Gold Coast area and form part of the grid section supplying Northern NSW. The lines have an electrical capacity sufficient to meet long term requirements.

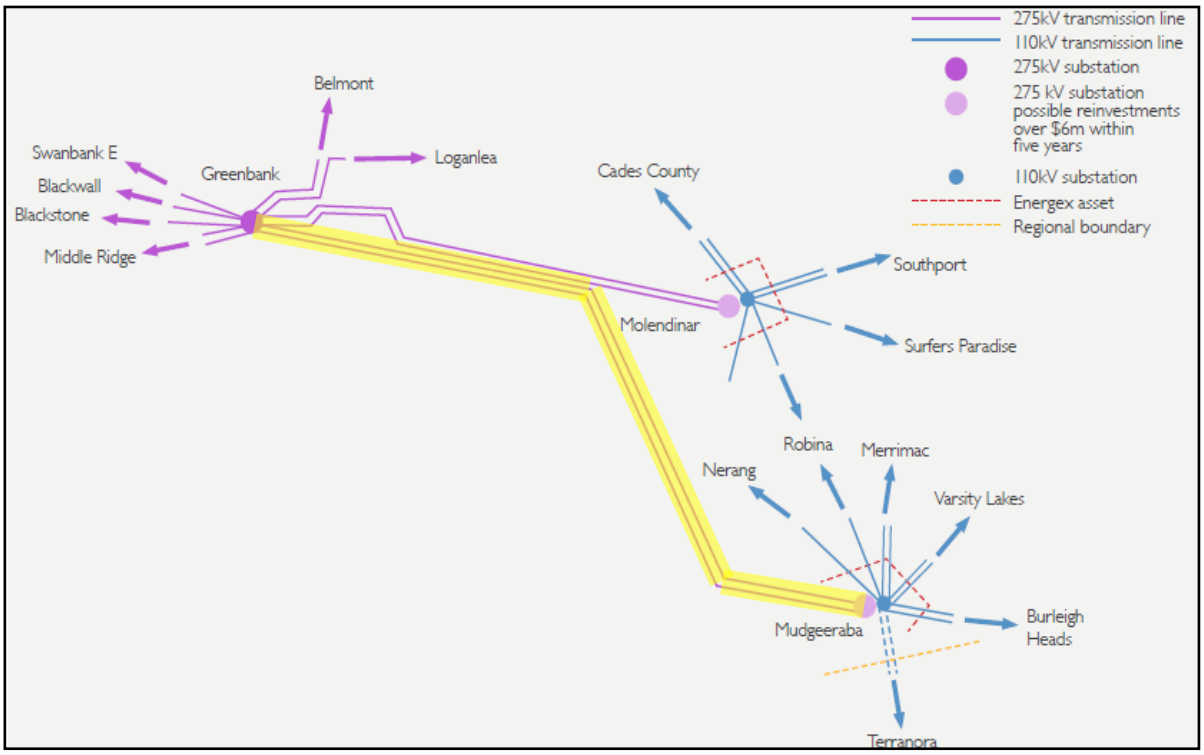


Figure 1 – Greenbank – Mudgeeraba 275kV Transmission Line – Gold Coast

A Condition Assessment of the lines in January 2020 recommending refurbishment by June 2028 to ensure ongoing compliance with statutory safety obligations and reliability of supply standards.

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 Greenbank to Mudgeeraba feeders

3. Gold Coast Demand Forecast

H004 Mudgeeraba Substation was established in the early 1970s to service growing demand in the Southern Gold Coast area. Along with Molendinar substation, it is now a significant 275/110kV transmission substation in the Gold Coast network.

The 110kV network between Molendinar to Mudgeeraba links the coastal bulk supply points at Southport, Surfers Paradise and Broadbeach via an underground cable network and an inland overhead 110kV network supplies Robina and Nerang Substations. This network is owned and operated by Energy Queensland.

In addition to these loads in Queensland, Mudgeeraba supplies two circuits to Terranora in NSW – supplying both local load, and the Directlink (Terranora) Interconnector.

Figure 2 is the duration curve for the 110kV loads connected to Mudgeeraba and Molendinar.

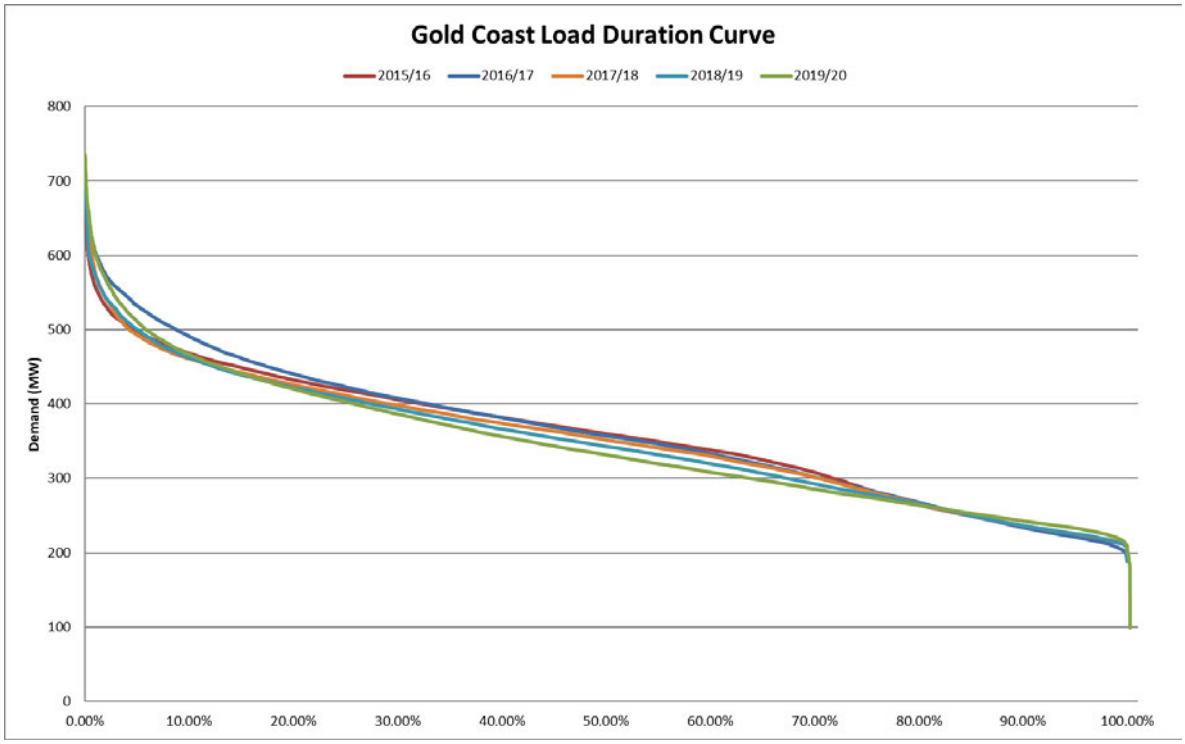


Figure 2 – Gold Coast110kV Load Duration Curve

Historical maximum demand information has been plotted with forecasted maximum demand in Figure 3. Over the next 10 years, the maximum demand is forecast to remain fairly constant.

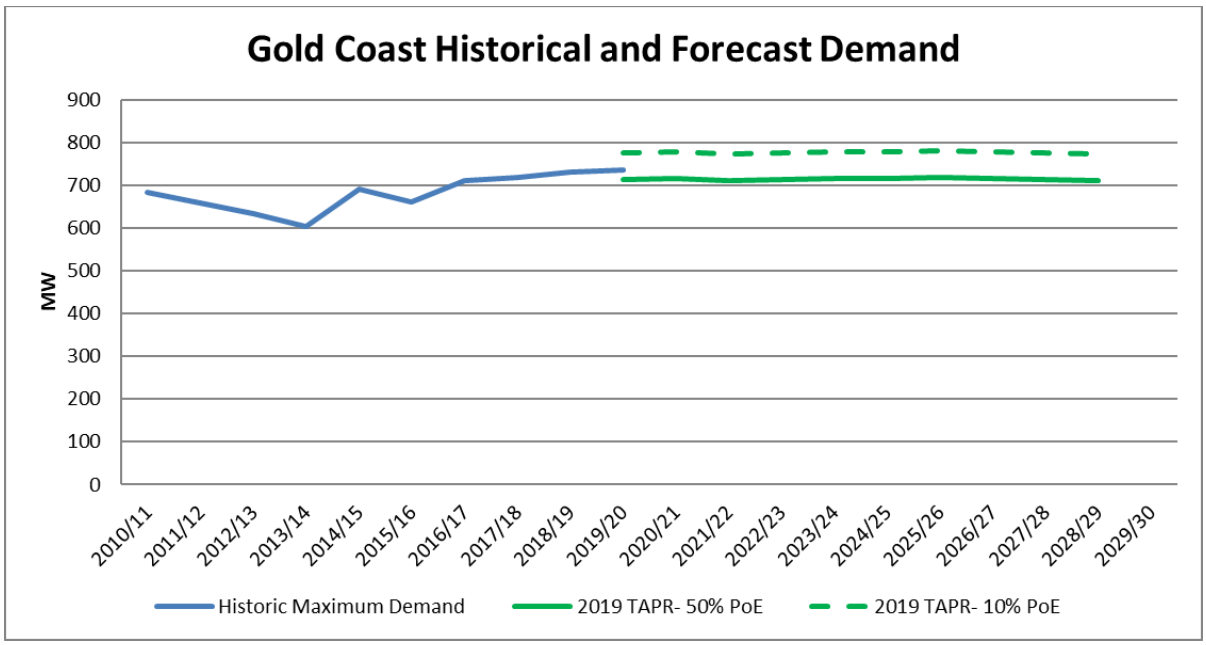


Figure 3 Gold Coast 110kV Maximum Demand

4. Statement of Investment Need

Energy Queensland forecasts have confirmed there is an enduring need to maintain electricity supply into the local Gold Coast area.

The removal of the Greenbank to Mudgeeraba transmission lines to address emerging condition-based safety issues would have a major impact on loads in the Southern Gold Coast area and violate Powerlink's N-1-50MW/600MWh reliability obligations.

Powerlink must therefore preserve the functionality of the Greenbank to Mudgeeraba Transmission Lines to ensure ongoing compliance with its Transmission Authority reliability obligations for the supply of electricity to the southern Gold Coast area.

5. Network Risk

The table below presents the load at risk as well as the energy at risk for loads connected to the Gold Coast region. The loss of a single Greenbank to Mudgeeraba transmission line would lower the maximum supportable load in the Gold Coast region. When the Gold Coast demand is high, the network would have to be radialised to keep the system secure. This would immediately leave large load centres at risk for the next contingency.

The subsequent loss of the remaining Greenbank to Mudgeeraba transmission line, a Greenbank to Molendinar transmission line, or a Molendinar 275/110kV transformer would result in loss of supply under these high demand conditions.

Table 2 – Gold Coast 110kV Load at Risk

At Risk	Contingency	Metric	2026
Mudgeeraba, Burleigh, Varsity Lakes and Terranora	Both Greenbank to Mudgeeraba 275kV Feeders (835 & 836)	Max (MW)	263
		Average (MW)	8
		24h Energy Unserved Max (MWh)	2603
		24h Energy Unserved Average (MWh)	182
Broadbeach, Merrimac, Surfers Paradise, Robina, Nerang, Southport, Molendinar and Cades County	Greenbank to Mudgeeraba 275kV Feeder (835 or 836) + Greenbank to Molendinar 275kV Feeder (8824 or 8825)	Max (MW)	282
		Average (MW)	9
		24h Energy Unserved Max (MWh)	3024
		24h Energy Unserved Average (MWh)	206
	Greenbank to Mudgeeraba 275kV Feeder (835 or 836) + Molendinar 275/110kV Transformer	Max (MW)	282
		Average (MW)	9
		24h Energy Unserved Max (MWh)	3024
		24h Energy Unserved Average (MWh)	206

6. Non Network Options

Potential non-network solutions for the 275kV Transmission Lines would need to provide generation output in excess of 282MW and up to 3024MWh of energy each day.

7. Network Options

7.1 Preferred Option

Planning recommends refurbishment of the lines by June 2028.

Further details of the condition assessment for the transmission lines can be found in Reference 1.

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.

1.1.1 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 System Standards of the National Electricity Rules and its Transmission Authority.

1.1.2 Rebuild

Rebuilding new 275kV feeders from Greenbank – Mudgeeraba would have an extended life, and could provide extra capacity to the region. NPV analysis of initial concept estimates indicates that the most economical way to address the condition risks of feeders 835 and 836 is to refit rather than rebuild.

8. Recommendations

There is an investment need to maintain the functionality of the Greenbank to Mudgeeraba Transmission Lines for Powerlink to continue to meet its reliability of supply obligations.

It is recommended the lines be refurbished by June 2028 to ensure Powerlink’s ongoing compliance the Electrical Safety Act 2002, Electrical Safety Regulation 2013 and its Transmission Authority.

9. References

1. BS1018 & 1019 Greenbank to Mudgeeraba Line Condition Assessment – Report 2020

2. Transmission Annual Planning Report 2020

3. Asset Planning Criteria Framework

10. Appendix A – Network Risk methodology

Feeders 835 & 836

When the Gold Coast demand exceeds approximately 550MW, then if one of the 275kV feeders from Greenbank to Mudgeeraba (835 or 836) was out of service, the network would have to be radialised to keep the system secure. This would immediately leave large load centres at risk for the next contingency.

Base Case Risk and Maintenance Costs Summary Report

CP.02415 Greenbank to Mudgeeraba T/L Reinvestment

Version Number	Objective ID	Date	Description
1.0	A3429608	16/09/2020	Original document
2.0	A3429608	10/12/2020	Risk models updated with revised methodology to incorporate updated safety risks and optioning.

1 Purpose

The purpose of this model is to quantify base case risk cost profiles and maintenance costs for the two single circuit 275kV transmission lines between Greenbank and Mudgeeraba (built sections 1018 and 1019) which are candidates for reinvestment under CP.02415.

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

2 Topography

The Greenbank to Mudgeeraba 275kV transmission circuit are the primary source of supply to the southern Gold Coast area. The built sections are around 65km in length.

The northern Gold Coast area is supplied by a double circuit transmission line from Greenbank to Molendinar, and there are strong 110kV sub-transmission links between Molendinar and Mudgeeraba substations.

The Greenbank to Mudgeeraba transmission lines transverse residential areas and communities within the Gold Coast hinterland. There are a number of motorway and road crossings along the transmission line route.

Figure 1 – Network Topography

3 Key Assumptions

In calculating the potential unserved energy (USE) arising from a failure of the ageing structures within BS1018 and BS1019, 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 south east Queensland network;
- The Value of Statistical Life (VSL) published within the OBPR guidance note has been used when calculating safety risk cost;
- The 275kV transmission lines from Greenbank to Mudgeeraba supply a mixture of residential, commercial and industrial load types within the greater Gold Coast area, 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 for this project and have been modelled in the analysis.

4.2 Transmission Line Analysis

This section analyses the risks presented by BS1018 and BS1019.

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.

The most significant source of risk cost relates to safety risks due to the proximity to built-up residential areas, and highway and road crossings.

4.2.1 Structures – Risk Cost by Year

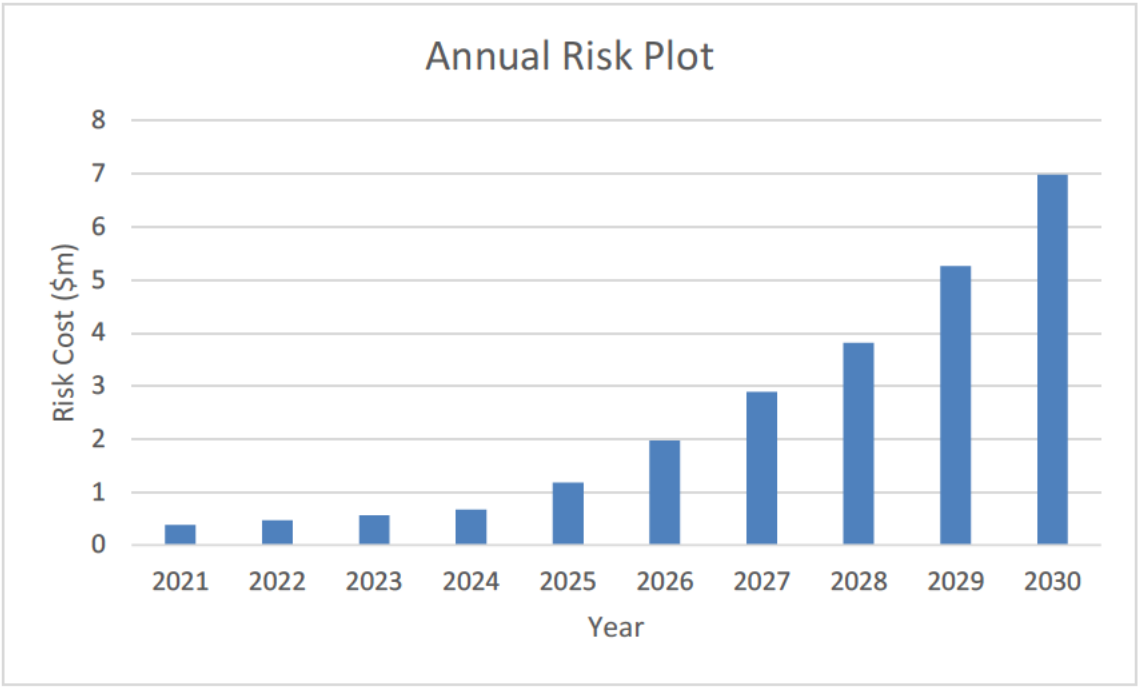


Figure 2 – Risk cost over time (10 years)

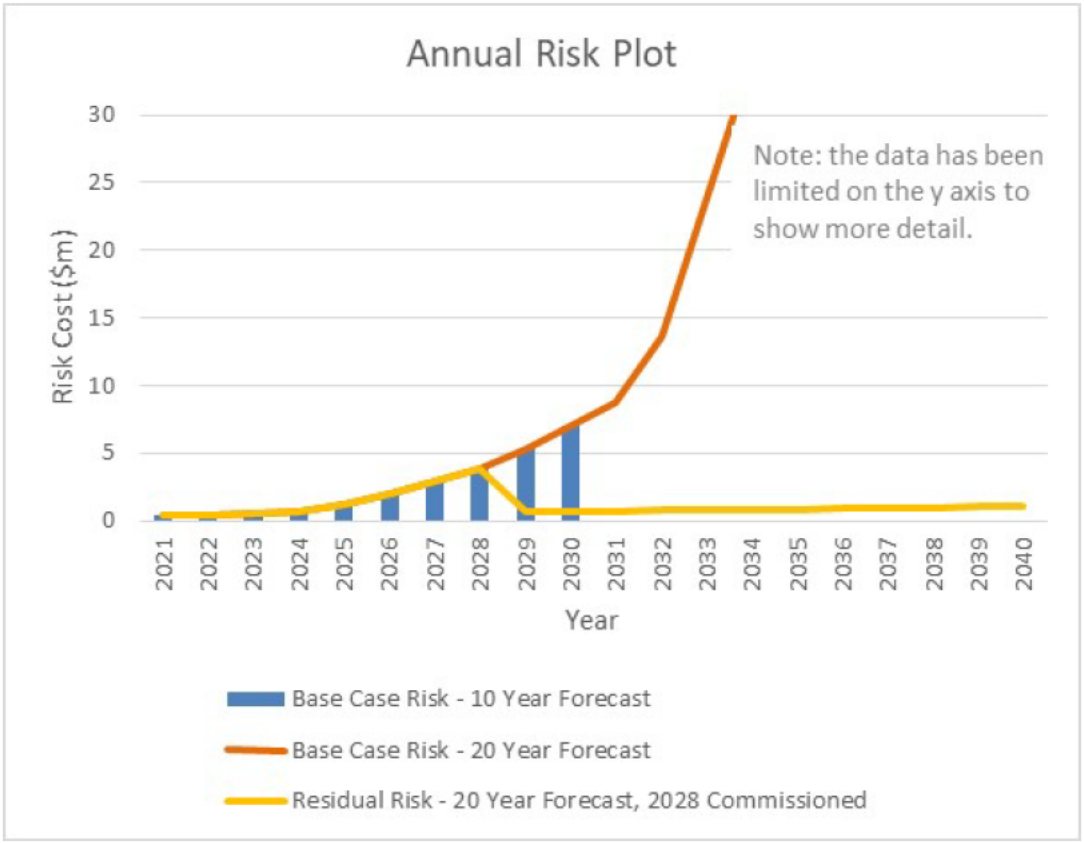


Figure 3 – Risk cost over time

4.2.2 Structures – Risk Breakdown by Risk Category

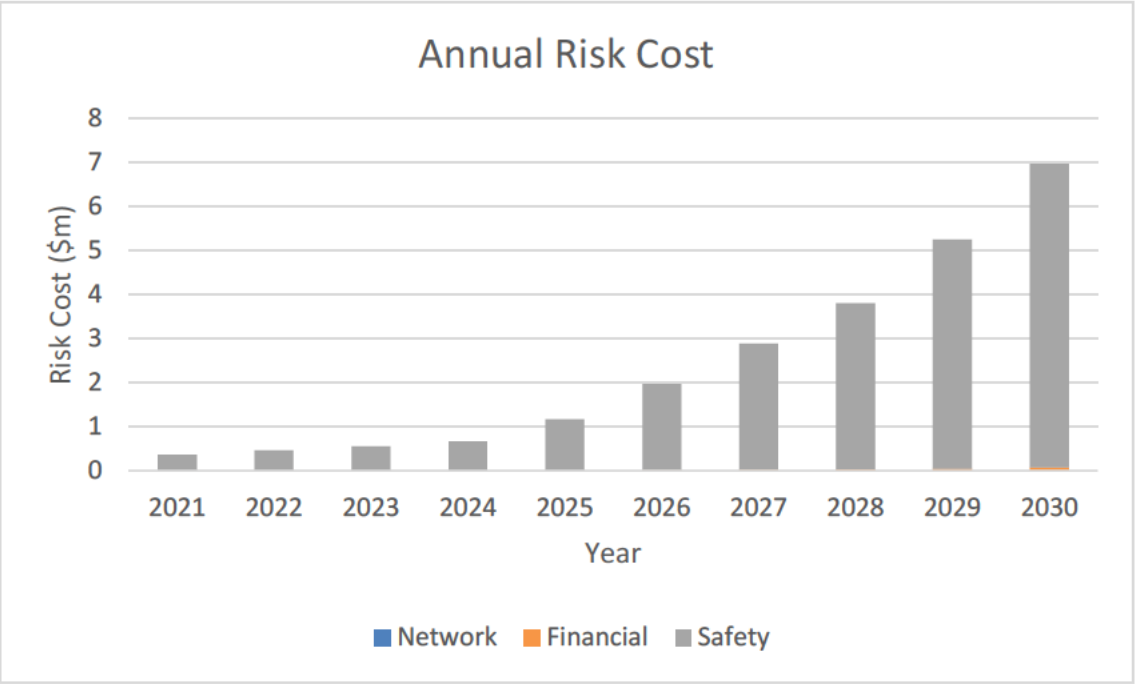


Figure 4 – Structure risk cost by category

Figure 5 –Structure risk cost by category (2028)

4.3 Base case risk statement

The primary source of risks for the BS1018 and BS1019 Greenbank to Mudgeeraba transmission lines are safety risks related to failure of the overhead line structures.

The network risk cost are comparatively small due to the single tower arrangement of the built section, and the strong Energex 110kV sub-transmission network between Molendinar and Mudgeeraba substations which mitigates the impacts of feeder outages.

5 Maintenance costs

Maintenance costs are still being developed. For the purposes of this report, maintenance has been modelled as 0.8% of the project capital cost inflated by 2% annually.

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

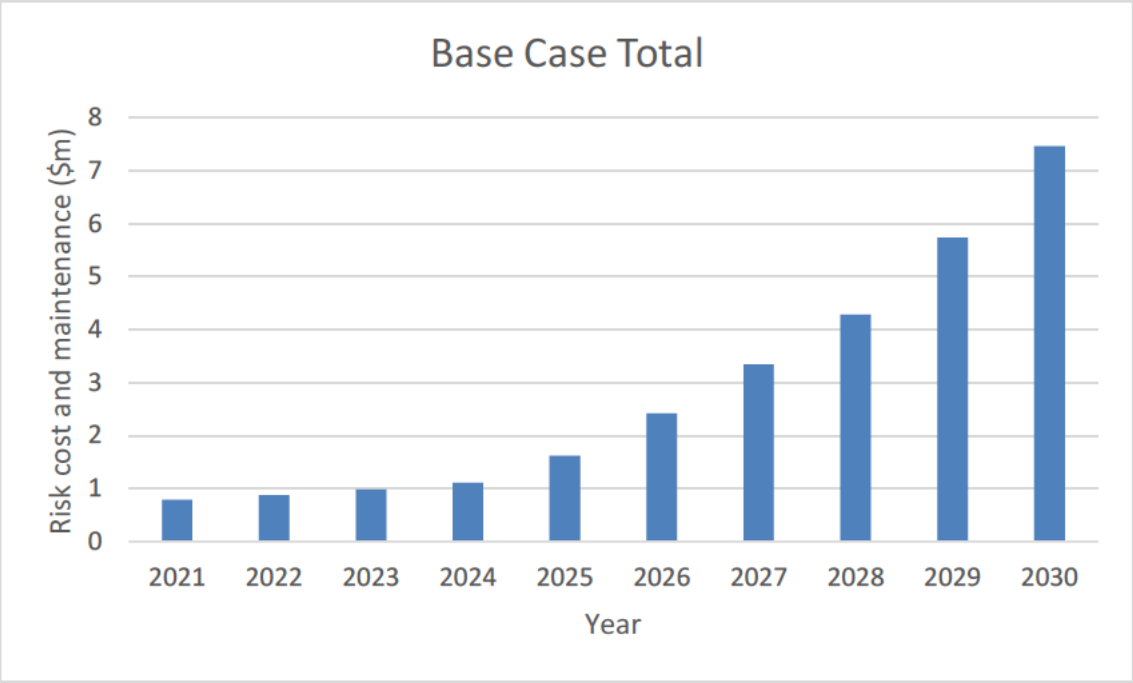


Figure 6 – Base case Total (Risk Cost + Maintenance) 2020 to 2029

6 Input participation

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.

Risk Category	Input	Value	Unit
Network	VCR	40030	$/MWh
	Restoration time	72	hours
Financial	Tower restoration cost	0.6	$m
Safety	VSL	5	$m

Figure 2 – Transmission line risk cost model inputs

A 100% increase in the input values for VCR or tower restoration time has negligible effect on the overall risk.

A 100% increase in the input value for tower restoration cost will result in the overall risk increasing by approximately 2%.

Project Scope Report

CP.02415

Greenbank - Mudgeeraba 275kV TL Refit

Concept – Version 2

Document Control

Change Record

Issue Date	Responsible Person	Objective Document Name	Background
28/02/20	[redacted]	Project Scope Report CP.02415 Greenbank - Mudgeeraba 275kV TL Refit Concept	Preliminary scope
22/09/20	[redacted]	Project Scope Report CP.02415 Greenbank - Mudgeeraba 275kV TL Refit Concept	Removal of climbing bolts and fall arrest brackets, and delay to commissioning

Related Documents

Issue Date	Responsible Person	Objective Document Name

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 circuits between Greenbank and Mudgeeraba comprise two single circuit 275kV transmission lines, feeders 835 and 836 (built sections 1018 and 1019), constructed in the mid-1970s. Each feeder consists of 165 structures comprising approx. 50 tension and 115 suspension structures. The transmission lines are an essential component of the transmission network supplying the southern Gold Coast area and have an electrical capacity which meets long term requirements. The transmission lines have deteriorated due to natural ageing, and the condition of the lines need to be addressed to ensure its long term safety and reliability.

Both transmission lines consist of S2S2 suspension towers, which have a known issue under current standards in respect of safe climbing access. Work is to be commenced to determine a permanent solution to the climbing access constraint, which may be incorporated into the scope of works of this project prior to its approval.

Following additional assessment of condition data, the replacement of step bolts and fall arrest brackets from all towers above the safe climbing limit has been removed from scope, and the commissioning date deferred in line with the structural refit need date (with early staging of insulator replacement and foundation repairs).

The objective of this project is to undertake refit works to extend the reliable life of the transmission lines by June 2028.

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 project consists of selected refit activities along the length of two single circuit 275kV transmission lines, each approximately 65km and comprising 165 structures, including the surface treatment and painting of a small number of towers on each transmission line.

3.1.1. Transmission Line Works – Built Section 1018

Undertake transmission line refit works on built section 1018 as follows.

- Review and upgrade access track as necessary to enable contractor access and works on both built sections.

- Review all tower leg/stub members and encapsulate where the concrete to steel interface is showing signs of corrosion – assume a total of 30 foundations (approx. 5% of total).
- Replace tower nuts and bolts exhibiting grade 3 or grade 4 corrosion – assume a total of 40,000 nuts and bolts (approx. 20% of total).
- Replace tower members exhibiting grade 3 or grade 4 corrosion – assume a total of 160 members (approx. 0.5% of total).
- Undertake surface preparation and paint 30 towers per current Powerlink standards:
  - towers 1018-STR-3109 to 1018-STR-3123 inclusive; and
  - towers 1018-STR-3187 to 1018-STR-3201 inclusive.
- Replace step bolts and fall arrest brackets on all towers up to the safe climbing limit only – assume combined 12,000 (approx. 34% of total).
- Replace signs and anti-climbing barriers where necessary – assume 16 towers (approx. 10% of total).
- Replace two existing overhead earth wires with one OPGW and one OHEW of equivalent and matching rating; review earth peak design and strengthen as required.
- Replace tension, beam and bridging insulators where original (manufactured between 1969 and 1972) – assume 20 towers.
- Replace all insulator hardware and vibration dampers on all towers.
- Undertake earthing tests at all towers where outside of current test date – assume 40 towers (approx. 25% of towers).
- Install grading rings at towers where required – assume 128 towers in urban areas.
- Update SAP records and drawings.

3.1.2. Transmission Line Works – Built Section 1019

Undertake transmission line refit works on built section 1019 as follows.

- Review all tower leg/stub members and encapsulate where the concrete to steel interface is showing signs of corrosion – assume a total of 30 foundations (approx. 5% of total).
- Replace tower nuts and bolts exhibiting grade 3 or grade 4 corrosion – assume a total of 40,000 nuts and bolts (approx. 20% of total).
- Replace tower members exhibiting grade 3 or grade 4 corrosion – assume a total of 160 members (approx. 0.5% of total).
- Undertake surface preparation and paint 30 towers per current Powerlink standards:
  - towers 1019-STR-3309 to 1019-STR-3323 inclusive; and
  - towers 1019-STR-3387 to 1019-STR-3401 inclusive.
- Replace step bolts and fall arrest brackets on all towers up to the safe climbing limit only – assume combined 12,000 (approx. 34% of total).
- Replace signs and anti-climbing barriers where necessary – assume 16 towers (approx. 10% of total).
- Replace two existing overhead earth wires with one OPGW and one OHEW of equivalent and matching rating; review earth peak design and strengthen as required.

- Replace tension, beam and bridging insulators where original (manufactured between 1969 and 1972) – assume 45 towers.
- Replace all insulator hardware and vibration dampers on all towers.
- Undertake earthing tests at all towers where outside of current test date – assume 40 towers (approx. 25% of towers).
- Install grading rings at towers where required – assume 129 towers in urban areas.
- Update SAP records and drawings.

3.1.3. Substation Works

Not applicable

3.1.4. Telecoms Works

Not applicable

3.1.5. 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 available condition information at time of scoping.

4. Project Timing

4.1. Project Approval Date

The anticipated date by which the project will be approved is 30 April 2025.

4.2. Site Access Date

The Greenbank to Mudgeeraba transmission lines are existing Powerlink assets, hence site access for construction activities is immediately available.

4.3. Commissioning Date

The latest date for the commissioning of the new assets included in this scope is 30 June 2028.

The works should be staged such that the replacement of insulators and the review/ rectification tower leg/stub members is completed by December 2026.

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 Investment & Planning.

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

Not applicable

10. Division of Responsibilities

Not applicable

11. Related Projects

No related projects

Concept Estimate for CP.02415 - Greenbank - Mudgeeraba 275kV TL Refit

Record ID	A3328224	
Policy stream	Asset Management	
Authored by	Project Manager	[redacted]
Reviewed by	Team Leader	[redacted]
Approved by	Manager Projects	[redacted]

Contents

1. Executive Summary

The circuits between Greenbank and Mudgeeraba comprise two parallel single circuit 275kV transmission lines, feeders 835 and 836 (Built Sections 1018 and 1019 respectively), constructed in the mid-1970s. Each feeder consists of 165 structures comprising approximately 50 tension and 115 suspension structures.

The transmission lines are an essential component of the transmission network supplying the southern Gold Coast area and have an electrical capacity which meets long term requirements. The transmission lines have deteriorated due to natural ageing, and the condition of the lines need to be addressed to ensure its long term safety and reliability.

The objective of this project is to undertake refit works to extend the reliable life of the transmission lines by June 2028.

Note: Both transmission lines consist of S2S2 type suspension towers, which have a known issue under current standards in respect of safe climbing access. Determining a permanent solution to this climbing access constraint will be undertaken prior to and separate to this project, however, it is possible the resultant solution may form part of the scope of works. Costs for the resultant solution works will not be allowed under this Concept Estimate, but should be considered moving forward under any future estimates and/or proposals for this project.

The alignment of the transmission line/s is as below in Figure 1:

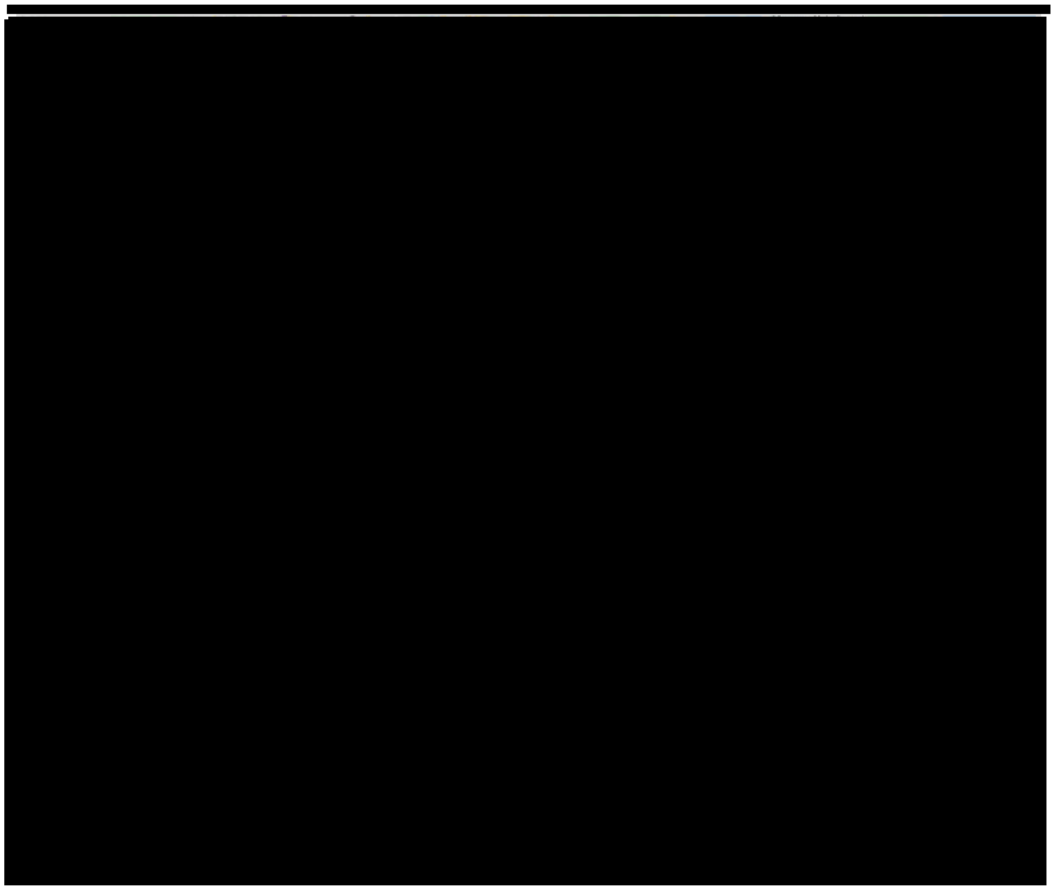


Figure 1

1.1 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		43,892,655	59,388,908
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

1.2 Project Financial Year Cash Flows

	June 2021 Base $	Escalated $
To June 2023	18,722	21,121
To June 2024	14,356	16,859
To June 2025	615,269	752,174
To June 2026	2,807,875	3,573,404
To June 2027	13,657,300	18,093,391
To June 2028	26,779,132	36,931,958
TOTAL	**43,892,655**	**59,388,908**

2. Project and Site Specific Information

2.1 Project Dependencies & Interactions

This Concept Estimate considers only one option, as detailed within the Project Scope Report.

The Project Scope Report identifies there are “No related projects”, however, future considerations should be given to any simultaneous transmission line and/or substation projects that could impact outage availability due to network constraints, as well as resource constraints as a result of simultaneous project scheduling.

2.2 Site Specific Issues

Issues specific to both BS1018 and BS1019 are as follows:

- The lines traverse sections of undulating vegetated terrain, as well as small acreage properties,
- Northern half of lines are within the mapped Red Imported Fire Ant zone,
- The lines have short section of “Slight” UXO risk,
- The northern sections of the lines nominated for blasting and painting works are generally contained to vegetated areas, free of housing and/or other sensitive receptors. The southern sections of the line, however, are within housing, sporting grounds, local roads and the Pacific Motorway.
- There are small sections of Cultural Heritage nominated areas along the alignments, as well as along off-easement access,
- Small sections of the lines traverse the Wickham National Park and Tamborine National Park.

3. Selective Refit of BS1018 and BS1019

3.1 Definition

3.1.1 Scope

Briefly, the project consists of refit works along the two parallel single circuit 275kV transmission lines, (BS1018 and BS1019), by means of nut and bolt, hardware, member, OPGW and OHEW replacement, as well as selective blasting and painting of structures.

Each Built Section is approximately 65km in length, comprising approximately 165 structures, which equals approximately 330 structures in total for the project.

3.1.1.1 Substations Works

Not applicable.

3.1.1.2 Transmission Line Works

Scope of works for both Built Sections, BS1018 and BS1019 includes the following:

- Review and upgrade access tracks as necessary to Powerlink Standards to enable contractor access and works on both built sections,
- Review all tower leg/stub members and encapsulate where the concrete to steel interface is showing signs of corrosion – assume a total of 60 foundations (approx. 5% of total),
- Replace tower nuts and bolts exhibiting grade 3 or grade 4 corrosion – assume a total of 80,000 nuts and bolts (approx. 20% of total),
- Replace tower members exhibiting grade 3 or grade 4 corrosion – assume a total of 320 members (approx. 0.5% of total),

- Undertake surface preparation and paint 60 towers as per current Powerlink standards:
  - towers 1018-STR-3109 to 1018-STR-3123 inclusive,
  - towers 1018-STR-3187 to 1018-STR-3201 inclusive,
  - towers 1019-STR-3309 to 1019-STR-3323 inclusive; and
  - towers 1019-STR-3387 to 1019-STR-3401 inclusive.
- Replace step bolts and fall arrest brackets on all towers up to the safe climbing limit only – assume combined 24,000 (approx. 34% of total),
- Replace signs and anti-climbing barriers – assume 32 towers (approx. 10% of total),
- Replace existing overhead earth wires with one OPGW and one OHEW of equivalent rating on each Built Section, (review earth peak design and strengthen if required, assume 33 structures, or 10%),
- Replace tension, beam and bridging insulators where original (manufactured between 1969 and 1972) – assume 20 towers for BS1018 and 45 towers for BS1019, 65 towers in total,
- Replace all insulator hardware and vibration dampers on all 330 towers,
- Undertake earthing tests at all towers where outside of current test date – assume 80 towers (approx. 25% of towers),
- Install grading rings at towers where required – assume 257 towers, located in urban areas,
- Update SAP records and drawings for all works completed.

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 works required, with the exception of any brake/winch sites for OPGW/OHEW works,
- Signage replacement works is limited to those structures being blasted and painted,
- MSP resources will be sufficient to undertake that component of the works,
- Suitable, extended outages for both Fdr835 and Fdr836 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. fire ants, and/or weeds,
- There may be several delays to the delivery as a result of property owner issues, access constraints, presence of bird nests, possible cultural heritage constraints, under crossings, quality issues, as well re-sequencing of the works.

3.1.3 Scope Exclusions

The below is excluded from the scope of works:

- Connection and/or commissioning of the new OPGW on each Built Section at each remote end,
- Any works associated with the development of, or implementation of a solution to the climbing corridor constraint issue/s, (these works may form part of the scope, as identified in the Project Scope Report, but have not been included for in this Concept Estimate),
- Construction of new access to structures for the works.

3.2 Project Execution

3.2.1 Project Schedule

A High Level Project Schedule should be developed and should address the following project stages:

Task	Target Completion
Project Approval	April 2025
Site Access	March 2026
Transmission Line Works completed – stage 1 (insulators and foundations)	October 2026
Transmission Line Works completed – stage 2 (structural refit and paint)	June 2028
Construction close out	October 2028
Project closure	June 2029

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 both feeders Fdr835 and Fdr836 due to works encroaching with the Exclusion Zones. Such outage/s may constrain the surrounding network, but are to be considered acceptable, allowing the works to proceed.

3.2.3 Project Staging

Review and rectification of foundations and replacement of insulators will be staged ahead of structural refit works per the Project Scope Report version 2.0. Structure earthing will be tested and upgraded as part of this early staging of 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.

Resource availability during the pending execution of this project is unknown, however, it is anticipated that sufficient resources shall be available to suit the project schedule.

3.3 Project Estimate

Estimate Components		Base $	Escalated $
Estimate Class	5		
Estimate Accuracy	+100% / -50%		
Base Estimate		43,892,655	59,388,908
Mitigated Risk	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
TOTAL		[redacted]	[redacted]

3.4 Project Financial Year Cash Flows

	June 2021 Base $	Escalated $
To June 2023	18,722	21,121
To June 2024	14,356	16,859
To June 2025	615,269	752,174
To June 2026	2,807,875	3,573,404
To June 2027	13,657,300	18,093,391
To June 2028	26,779,132	36,931,958
TOTAL	**43,892,655**	**59,388,908**

3.5 Project Asset Classification

Asset Class	Asset Life	Base $	Percentage
Secondary systems	15 years		
Communications	15 years		
Transmission lines refit	35 years	43,892,655	100%
Primary plant	40 years		
Transmission lines	50 years		
TOTAL		**43,892,655**	

4. References

Document name	Version	Date
Project Scope Report	2.0	22/09/2020