2018-22
POWERLINK QUEENSLAND REVENUE PROPOSAL

APPENDIX 5.10 - PUBLIC

Powerlink Queensland Asset Management Plan (Volume 2 - Asset Investment Outlook)

Delivering better value

ASSET MANAGEMENT PLAN 2015

Volume 2 – Asset Investment Outlook

Prepared by: Strategy and Planning
Investment and Planning
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DISCLAIMER

This Asset Management Plan has been produced to provide general information about the development of Powerlink's network and is a summary of the best view of asset investment strategies at the time of writing. In many cases, the projects listed in the Asset Management Plan have been selected from a large number of future scenarios and are the result of preliminary investigations.

As well as the need for future analysis to evaluate system and asset conditions and alternatives, there are processes described in the National Electricity Rules that need to be followed before projects can be approved. It is possible that projects listed here may change in scope or timing, be replaced by other projects or deemed unnecessary. Business decisions and actions should not be made solely on the basis of information contained here. The Asset Management Plan does not replace any current business or approval processes.

Risk costs continue to be enhanced and at this stage should not be used to solely prioritise projects or prioritise projects between asset classes as currently not all risks have been modelled which leads to some risk costs being understated. Similarly some asset risks are based on desktop analysis at an asset fleet level rather than based on individual asset condition, depending on the timing of the anticipated investment need.

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APPROVALS

Status	Name	Position	Signature	Date
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Endorsed	[redacted]	Network Integration Manager		
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ABBREVIATIONS

AMP	Asset Management Plan
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
TAPR	Transmission Annual Planning Report
BCS	Business Continuity Site
CVT	Capacitor Voltage Transformer
DC	Direct Current
DWDM	Dense Wavelength Division Multiplexing
EMF	Electric and Magnetic Field
EMS	Energy Management System
EOL	End of Life
FNQ	Far North Queensland
GIS	Gas Insulated Substation
GOC	Government Owned Corporation
IEC	International Electro technical Commission
iPASS	Intelligent Plug and Switch System
kV	Kilovolt
LNG	Liquefied Natural Gas
MVAr	Megavolt Ampere Reactive
NEFR	National Electricity Forecasting Report
NEL	National Electricity Law
NEM	National Electricity Market
NER	National Electricity Rules
OPGW	Optical Ground Wire
OSS	Operational Support System
OTN	Operational Telephone Network
PV	Photovoltaic
QNI	Queensland to New South Wales Interconnector
RIT-T	Regulatory Investment Test for Transmission
SCADA	Supervisory control and data acquisition
SDH	Synchronous Digital Hierarchy
SDM	Substation design standard
SVC	Static VAr Compensator
TNSP	Transmission Network Service Provider

1. INTRODUCTION

This volume of the Asset Management Plan provides an overview of the forecast asset reinvestment needs required over the 10 year outlook period.

2. INVESTMENT OUTLOOK

2.1 General

Excluding the demand growth driven by liquefied natural gas (LNG) development in the Surat Basin, forecast for both energy and maximum demand across the balance of the Queensland transmission network over the 10 year outlook period remains relatively flat.

An amended planning standard for the transmission network also came into effect on 1 July 2014, allowing the network to be planned and developed with up to 50MW or 600MWhr at risk of being interrupted during a single network contingency. This provides more flexibility in cost effective development of network and non-network solutions to meet future demand requirements.

The combined effect of the above have caused a significant reduction in demand driven investment over the 10 year outlook period of the Asset Management Plan (AMP), which has had the effect of reducing Powerlink's overall outlook of capital investment compared to previous years.

The Queensland transmission network experienced significant growth in the period from the 1960s to the 1980s. The capital expenditure needed to manage the emerging risks related to this asset base which is now reaching end of technical or economic life represents the majority of Powerlink's program of work over the 10 year outlook period.

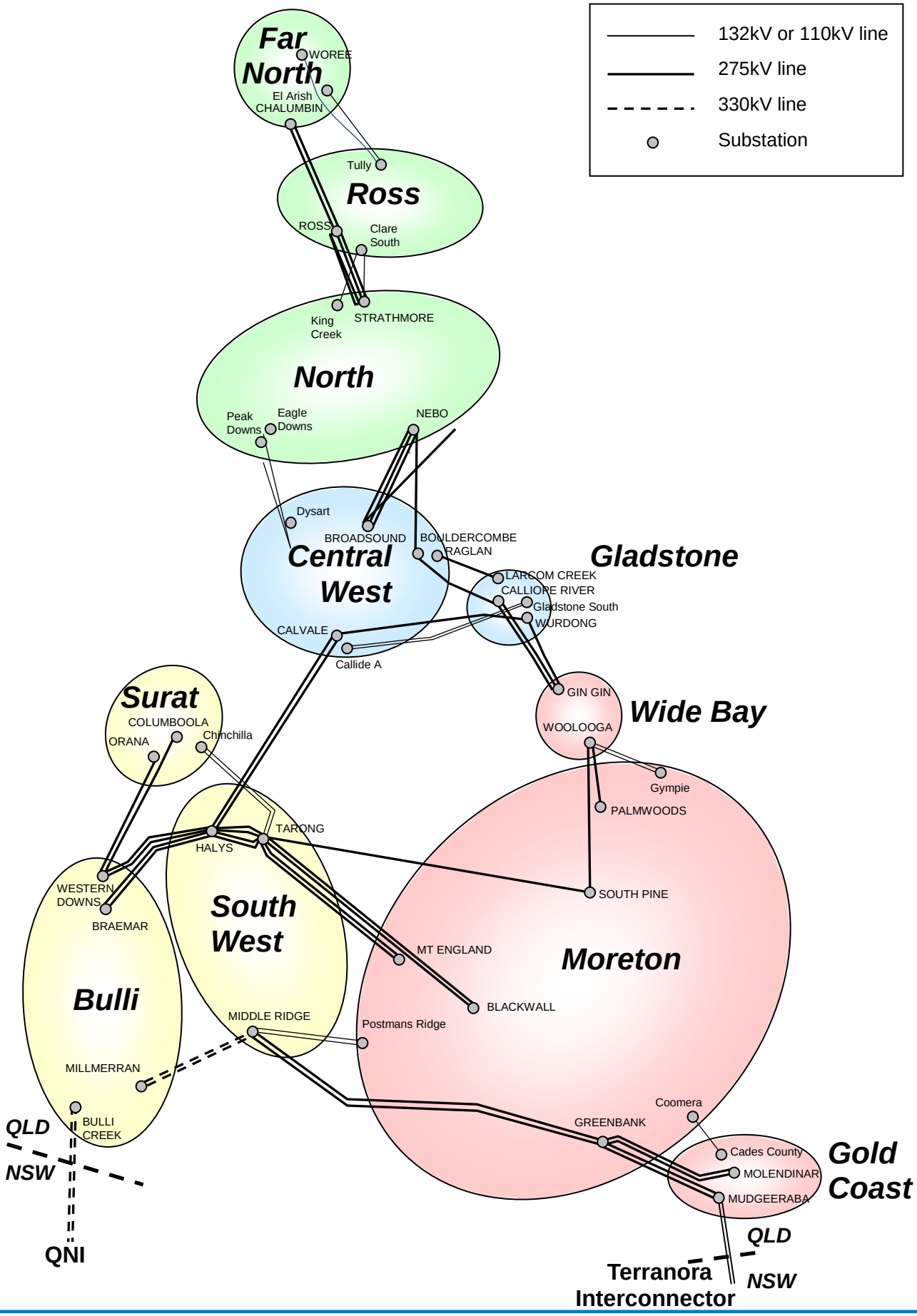
2.2 Zone Definitions

The investment outlooks described within this section have been described according to the different zones across the Powerlink network to provide clarity with the grouping of projects as follows:

Zone	Area covered
Far North	North of Tully, including Chalumbin
Ross	North of Proserpine and Collinsville, excluding the Far North zone
North	North of Broadsound and Dysart, excluding the Far North and Ross zones
Central West	South of Nebo, Peak Downs and Mt McLaren, and north of Gin Gin, but excluding the Gladstone zone
Gladstone	South of Raglan, north of Gin Gin and east of Calvale
Wide Bay	Gin Gin, Teebar Creek and Woolooga 275kV substation loads, excluding Gympie
Surat	West of Western Downs and south of Moura, excluding the Bulli zone
Bulli	Goondiwindi (Waggamba) load and the 275/330kV network south of Kogan Creek and west of Millmerran
South West	Tarong and Middle Ridge load areas west of Postmans Ridge, excluding the Bulli zone
Moreton	South of Woolooga and east of Middle Ridge, but excluding the Gold Coast zone
Gold Coast	East of Greenbank, south of Coomera to the Queensland/New South Wales border

These zones correspond to the definitions used within the Powerlink Transmission Annual Planning Report (TAPR), which is published annually by 30 June (refer to Figure 2.1).

Figure 2.1 Powerlink zone definitions



2.3 Area Plans

Considerable emphasis is given to ensuring that asset reinvestment is not just on a like for like basis. Network planning studies have focused on evaluating the enduring need for existing assets in the context of a subdued demand growth outlook and the potential for network reconfiguration coupled with alternative non-network solutions. The outcomes of these planning studies are captured through Area Plans.

2.4 NCIPAP

The AER's Service Target Performance Incentive Scheme (STPIS) is designed to incentivise electricity transmission network service providers (TNSPs) to maintain a high level of service performance for the benefit of National Electricity Market (NEM) participants and electricity end users[1]. Under Version 5 of the STPIS, the Network Capability Component (NCC) is designed to incentivise Transmission Network Service Providers (TNSPs) to deliver benefits of improved network capability from existing network assets to benefit customers and wholesale market outcomes when most needed. The NCC facilitates improvements in the capability of transmission assets through operational expenditure and minor capital expenditure on a TNSPs network which results in:

- improved capability of those elements of the transmission network most important to determining spot prices, or
- improved capability of the transmission system at times when Transmission Network Users place greatest value on the reliability of the transmission system.

The NCC has encouraged Powerlink to further examine its network to identify suitable low cost, one-off operational and capital expenditure projects that are expected to improve the capability of its transmission network.

Powerlink has identified the following 3 NCIPAP projects against the NCC criteria and objective of the STPIS:

- Increase Design Temperature of Bouldercombe to Raglan and Larcom Creek to Calliope River 275kV transmission lines
- Greenbank System Integrity Protection Scheme (SIPS)
- Load Model Enhancement and Validation (Brisbane CBD and neighbouring bulk supply point and a major regional centre in Far North Queensland)

These projects have been noted within the AMP to provide a holistic view of projects proposed for implementation within Powerlink's high voltage transmission network.

2.5 Management of Corrosion Levels

With over 22,500 galvanised steel lattice structures, many approaching or just passed 50 years of age, the impending challenge of managing corrosion levels in Powerlink's fleet of transmission line structures is likely to be a significant one over the next 10 years. For example in corrosion region C (C3) where almost 75% of Powerlink structures reside equates to approximately 16,500 structures. If an average of 1100 bolts per tower is assumed this equates to over 18 million bolts in region C.

Rates of corrosion vary between bolts and the small and large tower members due to the differing thickness of zinc on each component, their position and orientation on the structure, and many environmental and climatic factors. Galvanising thickness is dependent on the size and mass of the component, with larger members attracting higher levels of protective zinc. In region C, the corrosion rate is based on a loss of galvanising of between 0.7 and 2.1µm per year, and loss of steel between 25 and 50µm per year. Grade G3 corrosion, (a loss of galvanising surface area of between 50 and 100%) of bolts is a leading indicator of corrosion, and is taken as a fore-warning that remedial action may be required in the near future. Powerlink performs condition assessments to categorise the extent of bolt

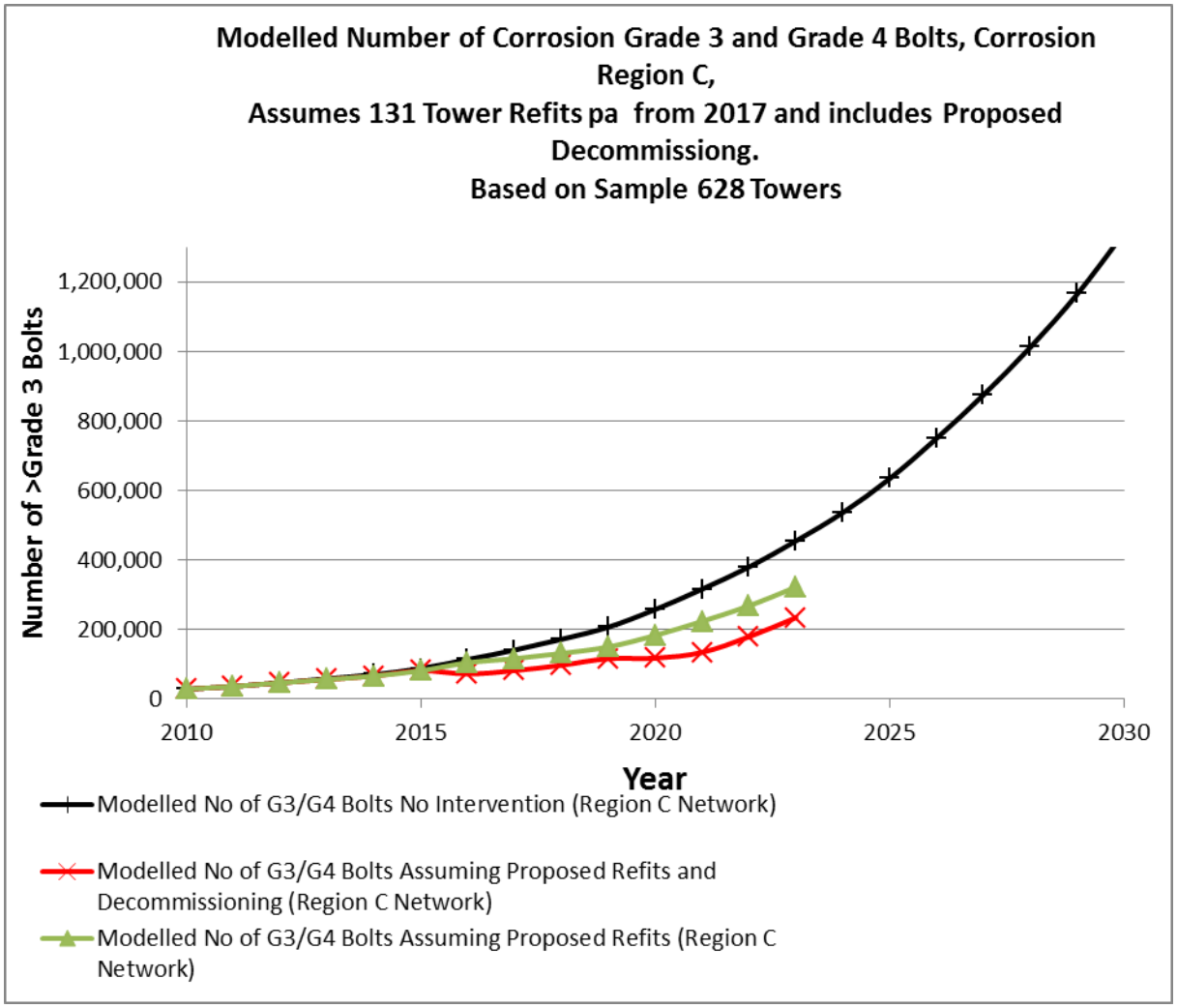
[1] *FINAL Electricity transmission network service provider, STPIS Version 5 (*corrected), AER, October 2015.

and member corrosion on major tower sub-systems, such as tower legs, cross-arms, and the superstructure.

Figure 2.2 shows a projection of the quantity of grade 3+ bolts in the Powerlink network in region C until 2030. It is based on the bolt corrosion levels of 628 sample towers, adjusted according to the sample tower age and projected in line with the average region C corrosion rates. The projected trend in Figure 2.2 is sufficiently accurate to demonstrate the accelerated grade G3 and G4 corrosion doubling effect for towers between 45 and 55 years old in addition to the high rate of population increase for towers of this age over the next 15 years.

The model indicates that if no corrective intervention is taken (black), the number of bolts exceeding grade G3 corrosion will increase substantially in the next decade. Figure 2.2 also shows the predicted reduction in the number of bolts that exceed grade G3 corrosion on various built sections undergoing refit as a result of planned Capital Projects (green) and proposed decommissioning of lines (red).

Figure 2.2: Projected Number of Greater than Grade 3 Bolts in Corrosion Region C Built Sections: No Intervention (Black), Including Refit CPs (Green), and Including Refit CPs and Decommissioning (Red).



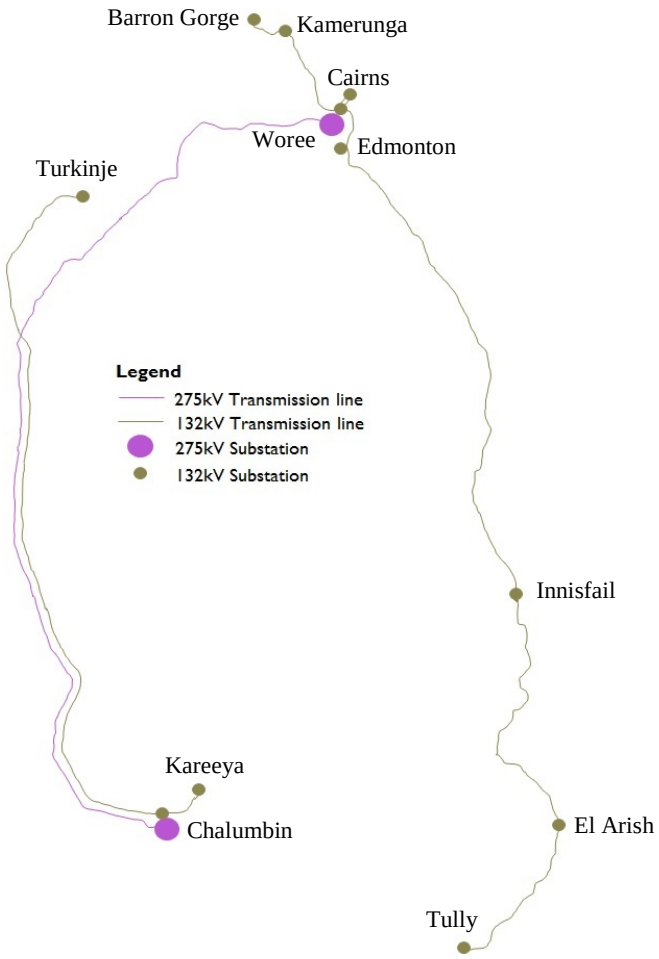
2.6 Investment Outlook

2.6.1 Far North

Existing network

The Far North zone is supplied by a 275kV transmission network with major injection points at the Ross, Chalumbin and Woree substations into the 132kV transmission network. This 132kV network supplies the Ergon distribution network in the surrounding areas of Ingham, Cardwell, Tully, Innisfail, Turkinje and Cairns, and connection to the hydro power stations at Barron Gorge and Kareeya (refer to Figure 2.3).

Figure 2.3 Far North zone transmission network



Network limitations

There are no network limitations forecast to occur in the Far North zone within the 10 year outlook period.

Transmission lines

Environment

Transmission lines in the Far North zone operate in an environmentally sensitive world heritage area in the Wet Tropics with extremely high humidity conditions impacting on the life of galvanised components.

Woree to Cairns 132kV transmission line

The 132kV transmission line was constructed in the late 1950s to supply the Cairns area. Line refit works are currently underway to address the extent of corrosion observed during Powerlink's condition assessment which is expected to extend the life of the transmission line for a further 20 years.

Woree to Edmonton 132kV transmission line

The 132kV transmission line was constructed in the late 1990s and forms part of the 132kV coastal supply to Cairns and Edmonton substation. A portion of the transmission line traverses the environmental sensitive Wet Tropics region. There is an ongoing need to maintain the transmission line in-service and it is highly unlikely that Powerlink will be able to obtain additional easements through this particularly corrosive environment near the Marine Park for future line replacement works. Early life tower painting works are currently underway to address corrosion observed during Powerlink's condition assessment which is expected to delay the effects of further corrosion beyond the 10 year outlook period.

Woree to Kamerunga 132kV transmission line

The 132kV transmission line was constructed in the early 1960s and provides connection to the Barron Gorge Power Station as well as 22kV supply to the Ergon network at Kamerunga Substation. Remedial works are currently underway to address the condition issues associated with transmission line components observed during Powerlink's condition assessment to ensure the existing transmission line reaches the end of its technical or economic life requires that Powerlink consider options for line refit works just beyond the 10 year outlook period.

Chalumbin to Woree 275kV transmission line

The 275kV transmission line from Chalumbin to Woree was constructed in the late 1990s, and is the high voltage supply into Far North Queensland. A portion of the transmission line traverses the environmentally sensitive Wet Tropics region. There is an ongoing need to maintain the transmission line in-service and it is highly unlikely that Powerlink will be able to obtain additional easements through this environmentally sensitive world heritage area. The current strategy is to monitor the condition of this asset and undertake further analysis of the transmission line. Based on the outcomes of this analysis, Powerlink will consider either line refit or early life tower painting works to manage the effects of corrosion.

Barron Gorge to Kamerunga 132kV transmission line

The 132kV transmission line was constructed in the early 1960s, and provides connection to the Barron Gorge Power Station at Kamerunga substation. The extent of corrosion observed during Powerlink's condition assessment requires that Powerlink consider repainting tower steelwork within the next five years to extend the technical and economic life of the transmission line.

Kareeya to Chalumbin 132kV transmission line

The 132kV transmission line was constructed in the mid-1980s and provides connection to the Kareeya Power Station from the Chalumbin Substation. The extent of corrosion observed during Powerlink's condition assessment, and the inherent constraints of working within the Wet Tropics Management Authority area, requires that Powerlink consider refit options within the next five years to extend the technical and economic life of the transmission line.

Substations

Powerlink's routine program of condition assessments has identified transformer, primary plant and secondary systems assets within the Far North zone with emerging risks that are likely to require reinvestment within the 10 year outlook period. The majority of these assets have a continued network requirement to meet mandated reliability of supply obligations under medium economic growth load forecast projections.

The related condition based investment needs requires Powerlink to consider reinvestment options at Kamerunga substation within the next five years. A transformer replacement at Cairns substation and condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Tully,
- Barron Gorge,
- Cairns,
- Edmonton,
- Turkinje,
- Ingham South,
- Chalumbin

Due to relatively flat forecast load growth within the Cairns area, Powerlink is likely to not replace one of the existing 132/22kV transformers at Cairns substation once the unit reaches the end of its technical or economic life towards the end of the outlook period. A detailed assessment will be undertaken closer to the need timing.

Other transmission investment works required

Insulator and hardware replacement works are currently underway between Woree and Kamerunga. Additional works being considered in the zone in the outlook period include [redacted] a microwave replacement for Barron Gorge-Wright's Lookout and revenue metering replacement at Cardwell.

Related Customer Projects

Subject to customer commitment, Ergon Energy have indicated there may be a requirement for the construction of additional 132kV Feeder Bays at Kamerunga to meet potential load growth in the Cairns northern beaches area toward the end of the outlook period.

2.6.2 Ross zone

Existing network

The 132kV network between Collinsville and Tully was developed in the 1950s, 1960s and 1970s to supply mining, heavy commercial and residential loads. The 275kV network within the zone was developed more than a decade later to reinforce supply into far north Queensland (refer to Figure 2.4).

Network limitations

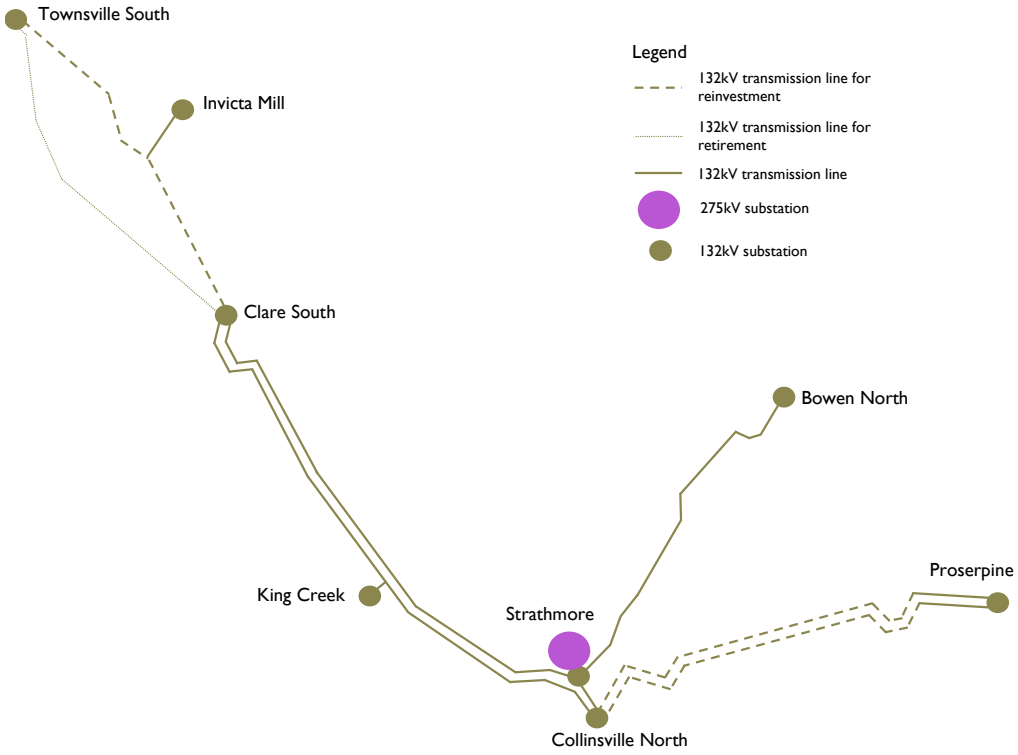
There are no network limitations forecast to occur in the Ross zone within the 10 year outlook period.

Transmission Lines

Environment

Transmission lines in the Ross zone operate in a varied environment, with the coastal circuits exposed to higher, accelerated rates of structural corrosion compared to the inland circuits due to exposure to high salt laden winds.

Figure 2.4 Ross zone transmission network



Townsville South to Clare South 132kV transmission lines

The two 132kV single circuit transmission lines between Townsville South and Clare South substations were constructed in the 1960s on separate coastal and inland alignments, and are now experiencing condition related issues. As a result of subsequent 275kV and 132kV network developments within the area, network capability studies have indicated that it may be possible to retire the inland circuit from service and meet minimum mandated reliability of supply obligations, provided voltage stability issues within the area are addressed. The condition driven risks of the remaining coastal circuit requires that Powerlink consider options for line refit works within the next five years to extend the technical and economic life of the transmission line.

The installation of a 132kV 30MVAr capacitor bank at Proserpine substation within the next five years is a cost effective network option that assists with maintaining satisfactory voltage levels within the area, in particular within the Proserpine area. Powerlink will undertake a Non-Network Feasibility Study to assess the technical and economic viability of a potential non-network solution closer to the need timing.

Collinsville/Strathmore to Clare South 132kV transmission lines

The 132kV double circuit transmission lines between Collinsville and Clare South substations was constructed in the 1960s and is now experiencing condition related issues. Powerlink is expecting to replace insulators within the next five years and consider options for line refit works within the next five to 10 years to extend the technical and economic life of the transmission line.

Garbutt to Allan Sherriff 132kV transmission lines

The two 132kV double circuit transmission lines between Garbutt and Alan Sherriff substations were built in the late 1950s and early 1960s, and the subsequent deviation of the landing span in the mid-2000s. A replacement project is currently underway to address the condition issues associated with transmission line observed during Powerlink's condition assessment. This work includes the recovery of the northern section of the transmission line.

Ross to Dan Gleeson 132kV transmission line

The 132kV transmission traverses both the Ross and North zones and was constructed in the 1970s. Routine inspections have identified that the condition of the asset requires that Powerlink consider options for line refit works within the next five to 10 years.

Asset retirement

Townsville South - Clare South inland transmission line

Although the inland circuit has experienced lower rates of structural corrosion compared to the coastal circuit, it is not economically feasible to retain this circuit due to the degrading condition of the existing grillage foundations. As a result, Powerlink may decommission the inland transmission line at the end of its technical life expected towards the beginning of the five to 10 year outlook period.

Dan Gleeson - Alan Sherriff 132kV transmission line

It is not economically feasible to retain this circuit due to the degrading condition of the existing grillage foundations. Powerlink may retire this transmission line at the end of its technical life expected within the next five years.

Substations

Powerlink's routine program of condition assessments has identified transformer, primary plant and secondary systems assets within the Ross zone with emerging risks that are likely to require reinvestment within the 10 year outlook period.

Network capability studies confirm that there is a continued need for the majority of these assets under medium economic growth load projections to meet mandated reliability of supply standards. Subject to the outcome of a Non-Network Feasibility Study to be undertaken in 2016, it is proposed to replace the existing transformers at Garbutt substation and relocate a system spare transformer at Townsville Port (East) substation within the next five years. Powerlink is also proposing to replace the transformer at Tully towards the end of the 10 year outlook period.

Primary plant replacements at Ross and Newlands substations are proposed towards the end of the 10 year outlook period.

A secondary systems replacement project at Ross substation is currently underway. Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Dan Gleeson
- Alan Sherriff

Other transmission investment works required

Additional works to be considered in the zone include replacement of the Townsville South - Clare South Communication Path and insulator and hardware replacement between Collinsville and Strathmore within the next five years.

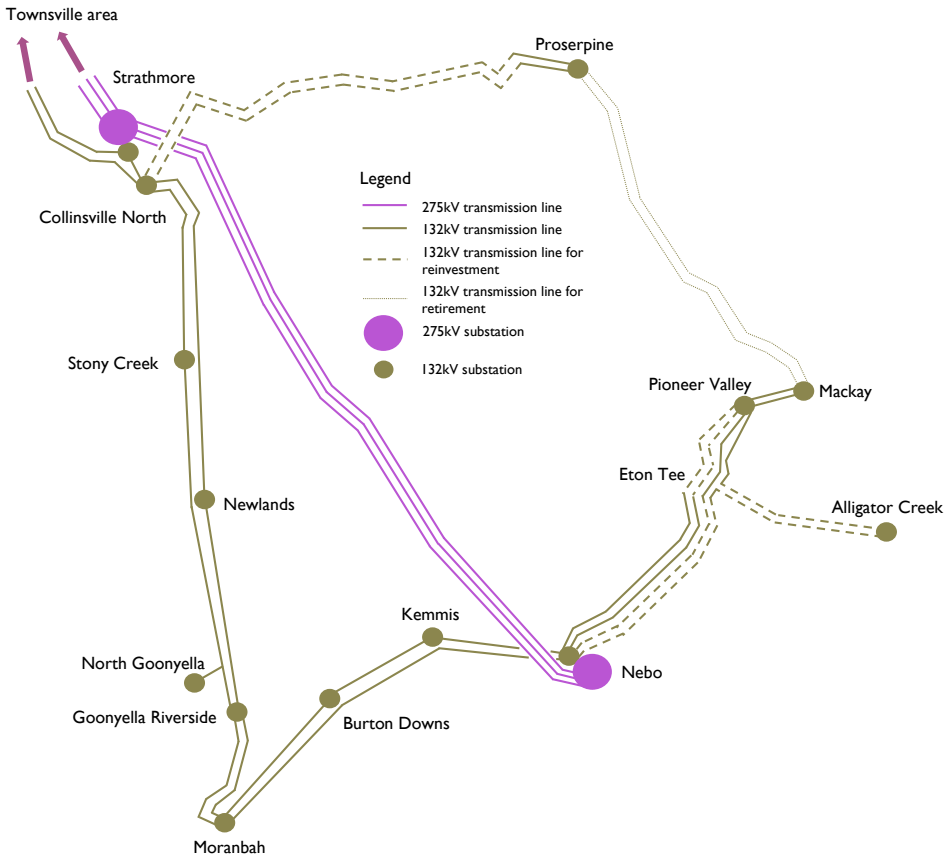
2.6.3 North zone

Existing network

The central to north Queensland 275kV corridor was originally established in the early 1980's and was subsequently reinforced from 2007 and there are now three 275kV circuits between Nebo and Strathmore substations.

A 132kV sub-transmission network connects inland and coastal areas to supply regional centres and infrastructure including mining loads, coal haulage and ports associated with the Bowen Basin coal deposits (refer to Figure 2.5).

Figure 2.5 North zone transmission network



Network limitations

There are no network limitations forecast to occur in the North zone within the 10 year outlook period. However, demand in the Proserpine area has the potential to exceed the transmission capability depending on how the Proserpine and Bowen Basin area loads develop.

Depending on the magnitude and location of additional load which may occur, a feasible network solution may involve the installation of a 132kV capacitor bank at Proserpine Substation. A Feasibility Study will also be undertaken to test the viability of a non-network solution should this load eventuate.

Transmission Lines

Collinsville to Proserpine 132kV transmission line

The 132kV transmission line was constructed in the1960s and supplies Proserpine Substation and the Whitsunday region. Following the retirement of the Proserpine to Mackay transmission line by 2017/18, it will be the only 132kV transmission line supply into the region. A project to replace the most critical coastal spans on the transmission line has recently been completed. A condition assessment identified levels of corrosion on the remaining inland structures requiring line refit works within the next five year years and a committed project is underway.

Eton Tee to Pioneer Valley 132kV transmission line

The 132kV transmission line was constructed in 1977 and runs parallel to and approximately 20km inland from the coast. Routine inspections have identified that the transmission line's corrosion is similar to other transmission lines in the area and likely to require investment in around 10 years. Planning studies have also identified a potential opportunity to rationalise the network by retiring these feeders. Further detailed studies and condition assessments are required to determine the optimal strategy to address condition related issues.

Eton Tee to Alligator Creek 132kV transmission line

The 132kV transmission line was constructed in the early 1980's and there is an ongoing need for this asset to supply critical port and coal haulage infrastructure associated with the Mackay ports. The line is in close proximity to the coast and is exposed to highly corrosive, salt laden winds. The profile of corrosion observed along the feeder requires Powerlink to consider options for line refit or rebuild within the next five years.

Eton Tee to Nebo 132kV transmission line

The 132kV transmission line traverses west over the Eton Range and was constructed in 1977. Routine inspections have provided evidence that the condition of the asset located on the coastal side of the range has experienced accelerated corrosion when compared with the inland portion of the transmission line. Further analysis is required to evaluate the optimum strategy to address condition related issues, which are most likely to involve refit or replacement beyond the 10 year outlook period.

Asset retirement

Glenella to Proserpine 132kV transmission line

The 132kV transmission between Mackay and Proserpine was constructed in 1967. Routine inspections have provided evidence that the condition of the asset has experienced severe corrosion. A project is currently underway to remove the section of the line between Glenella and Proserpine.

Substations

Powerlink's routine program of condition assessments has identified transformer, SVC, primary plant and secondary systems assets within the North zone with emerging risks that are likely to require reinvestment within the outlook period. Network capability studies confirm these substation assets are required to provide ongoing reliable supply and power station connection within the zone.

Projects are currently underway for the replacement of Mackay and Nebo substations (including a secondary systems and transformer replacement at Nebo). Other condition based investment needs in the North zone include transformer replacements at Ingham South, Nebo and Kemmis substations, and SVC replacements at Nebo, Moranbah and Dysart within the 10 year outlook period.

Secondary systems replacement projects for Pioneer Valley and Strathmore (IPASS) substations are in progress. Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- North Goonyella
- Strathmore
- Moranbah
- Kemmis.

Other transmission investment works required

Additional works being considered in the zone in the 10 year outlook period include Synchronous Digital Hierarchy (SDH) rationalisation for the North region and revenue metering replacement at Collinsville Substation. Other works being considered include insulator and hardware replacement between Moranbah and Nebo.

2.6.4 Central West and Gladstone zones

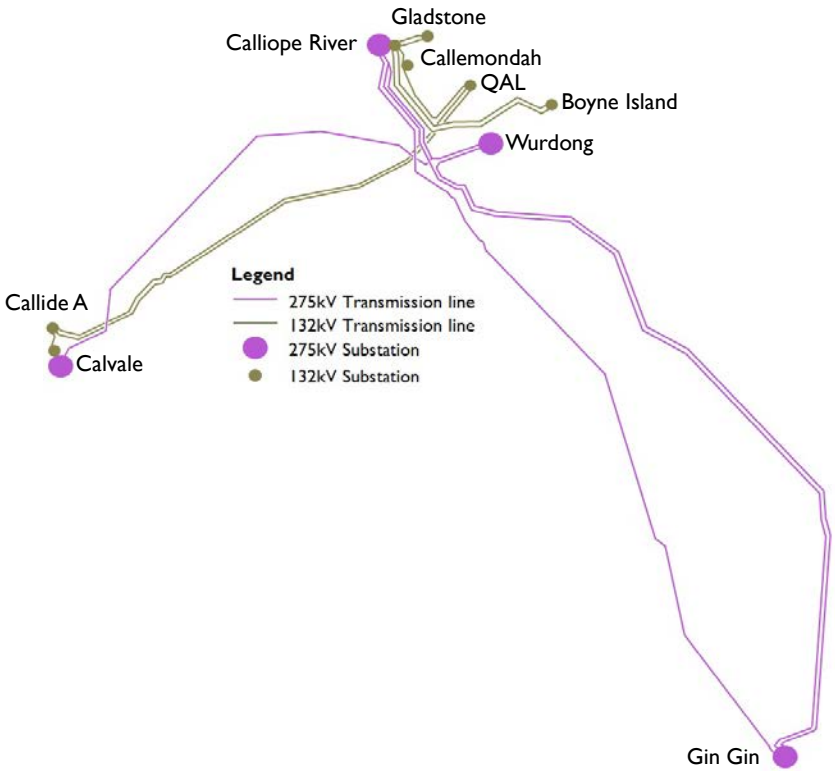
Existing network

The Central West 132kV network was developed between the mid-1960s to late 1970s to meet the evolving requirements of mining activity in the Southern Bowen Basin. The 132kV injection points for the network are taken from Calvale and Lilyvale 275kV substations. The network is located approximately 150km from the coast in a drier environment making infrastructure less susceptible to corrosion. As a result transmission lines and substations in this region have met (and in many instances exceeded) their anticipated nominal life, but are expected to require reinvestment in the future.

The Gladstone 275kV network was initially developed in the 1970s with the Gladstone Power Station and has evolved over time with the addition of the Wurdong Substation and 275kV supply into the Boyne Island smelter in the early 1990s. The 132kV injection point for Gladstone is the Calliope River Substation.

The Gladstone Region also contains parts of Powerlink's 275kV Central to Southern Queensland (CQ-SQ) transmission corridor. The south-east section of the corridor was constructed in the 1970s and 1980s. The 275kV lines at the northern end of the CQ-SQ coastal corridor (near Calliope River) are currently tracking to higher rate of corrosion and it is expected that the risks associated with these lines may exceed acceptable levels within the next five to 10 years. This higher rate of corrosion is due to the proximity to the coast and exposure to salt laden coastal winds. The Calliope River to Wurdong line also traverses two tidal crossings and operates in a heavily polluted industrial area (refer to Figure 2.6).

Figure 2.6 Calliope River to Wurdong transmission network



Network limitations

There are no network limitations forecast to occur in the Central West or Gladstone zones within the 10 year outlook period.

Transmission lines

Egans Hill to Rockhampton 132kV transmission line

The 132kV transmission line was constructed in the early 1960s and there is an ongoing need for this asset to supply the Rockhampton region. A condition assessment has identified levels of structural corrosion requiring action. Depending on easement constraints, this may require line refit works within the next five years, or a rebuild within the 10 year outlook period.

Callide A to Moura 132kV transmission line

The 132kV transmission line was constructed in the early 1960s and there is an ongoing need for this asset to supply the Biloela and Moura regions. Condition assessment indicates reinforcement may be required to maintain foundation integrity due to the expected degraded condition of the grillage foundations. Repair of grillage foundation combined with a refit of the above ground tower structure is considered uneconomic in comparison to a replacement of the transmission line. Therefore, it is expected that a line rebuild may be required within the 10 year outlook period.

Calliope River to Boyne Island 132kV transmission line

The Calliope River to Boyne Island 132kV transmission line was constructed in the early 1980s and there is an ongoing need for this asset to supply Boyne Island Smelter. Condition assessment indicates high levels of structural corrosion and reinforcement may be required to maintain foundation integrity of some towers. Options being considered include selective tower replacement and partial refit of the remaining towers as required in the short term. These works are expected to extend the life of the transmission line beyond the 10 year outlook period and will require further detailed condition assessment.

Calliope River to Gin Gin 275kV transmission line

The Calliope River to Gin Gin 275kV transmission line which was constructed in the early 1970s is approximately 135kms in length and traverses both the Gladstone and Wide Bay zones. Routine inspections have provided evidence that due to the extent of corrosion observed the asset may reach end of life within the next five to ten years. Powerlink's preferred strategy is to undertake targeted maintenance within the next five years, followed by a 15km partial rebuild within the 10 year outlook period. This strategy defers any potential future large reinvestments beyond the 10 year outlook period and provides flexibility to further consider the disconnection of the remaining 121kms of transmission line within the 10 year outlook period as the range of future potential investment options further develops.

Asset retirement

An option is being considered to disconnect the Callide A - Gladstone South 132kV circuit within the next five years and to undertake decommissioning works in the following five years.

Substations

Powerlink's routine program of condition assessments has identified transformers, primary plant and secondary systems assets within the Central West and Gladstone zone with emerging risks that are likely to require reinvestment within the 10 year outlook period. Planning analysis indicates the possibility of optimising the number of transformers within the zone particularly at Lilyvale substation. The analysis also confirms the balance of substation assets are required to provide ongoing reliable supply.

Projects are currently underway for the replacement of the Rockhampton, Blackwater, and Moura Substations. Dysart substation replacement as well as primary plant replacement at Lilyvale and Bouldercombe substations has been identified within the next five years.

With the latest forecast demand, planning analysis has indicated that rationalisation of the network through the installation of a second transformer at Calvale, and bypassing Callide A substation is a more economical alternative compared to rebuilding Callide A substation on a like for like basis.

Condition based transformer replacements will be considered at the following substations within the next 10 year outlook period:

- Dysart
- Blackwater
- Bouldercombe
- Lilyvale.

A secondary systems replacement project at Baralaba substation is currently in progress. Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Biloela
- Blackwater
- Calvale
- Wurdong
- Egans Hill
- Stanwell
- Boyne Island
- Gladstone South
- QAL West.

Other transmission investment works required

Additional works being considered in the zone in the 10 year outlook period include Gladstone South to Boyne Island microwave replacement, Synchronous Digital Hierarchy (SDH) rationalisation for the Central Region, minor works at Callemondah, and Calvale to Halys Polymer Insulators Replacement which traverses the Central West and South West zones.

2.6.5 Wide Bay zone

Existing network

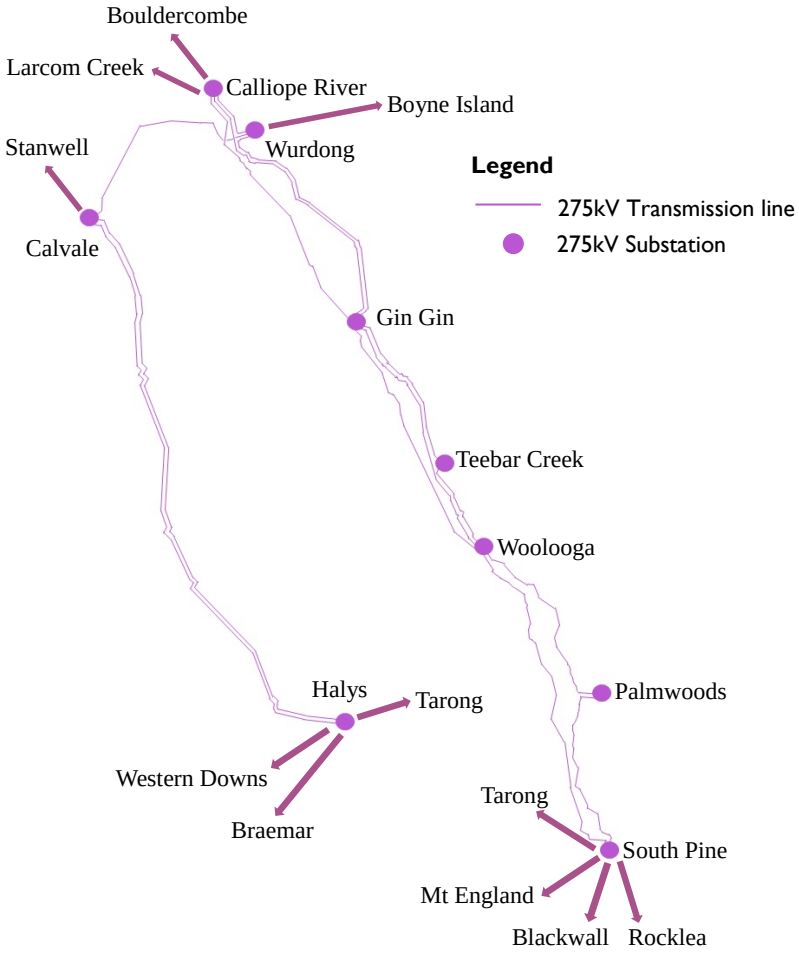
The Wide Bay zone supplies loads in the Maryborough and Wide Bay region and also contains the south-eastern part of Powerlink's Central to Southern Queensland (CQ-SQ) transmission corridor. Initial condition assessments identified the 275kV transmission lines between South Pine to Woolooga and Palmwoods to South Pine are tracking to a higher rate of corrosion and may exceed acceptable risk levels in the next five years. The higher rate of corrosion is due to a localised wet weather environment in the hinterland regions of Mapleton and Maleny.

With the current demand forecast and the connection of additional generation in southern Queensland at Braemar 1, Braemar 2, Darling Downs and Kogan Creek power stations, the reliance on the CQ-SQ corridor to deliver efficient market outcomes and reliability of supply to south Queensland is forecast to remain at current levels. As a result, it is likely that it will be economic and prudent for some level of reconfiguration of the CQ-SQ coastal corridor, including the potential disconnection of some assets.

Powerlink's current strategy is to take an incremental approach utilising increased targeted maintenance as a preferred short term solution to permit greater operational flexibility and maintain transfer capability. This strategy has the benefit of deferring a considerable amount of capital investment beyond the 10 year outlook period, maintains the flexibility of adopting a range of future potential investment options and provides an opportunity to further monitor, quantify and assess the prevailing market requirements.

As potential reinvestment options may impose varying degrees of market impact, a Regulatory Investment Test for Transmission (RIT-T) will be undertaken to identify the preferred option and ensure the appropriate reinvestment is implemented at the appropriate time.

Figure 2.7 CQ-SQ transmission corridor



Network limitations

There are no network limitations forecast to occur in the Wide Bay zone or CQ-SQ transmission corridor within the 10 year outlook period.

Transmission lines

Woolooga to Palmwoods 275kV transmission line

The Woolooga to Palmwoods 275kV transmission line was constructed in the mid-1970s and traverses both the Wide Bay and Moreton zones. Taking into consideration the range of future potential development options for the CQ-SQ transmission corridor, there is an enduring need for this asset. Routine inspections have provided evidence that due to the extent of corrosion observed the asset may reach end of life within the next ten years and requires reinvestment towards the end of the 10 year outlook period.

Woolooga to South Pine 275kV transmission line

The Woolooga to South Pine 275kV transmission line traverses both the Wide Bay and Moreton zones and was constructed in the 1970s. Condition assessment has identified that the condition of the asset requires that Powerlink consider options for line refit works within the next five years. This aligns with the broader reinvestment options for the CQ-SQ transmission corridor to maintain the transmission configuration over the next five years and closely align with reinvestment decisions of the Woolooga to Palmwoods 275kV transmission line. Powerlink's current preferred option is to utilise targeted maintenance to preserve the condition of the transmission line throughout this 10 year outlook.

Substations

Powerlink's routine program of condition assessments has identified primary plant and secondary systems assets within the Wide Bay zone with emerging risks that are likely to require reinvestment within the 10 year outlook period. Planning analysis confirms these substation assets are required to provide ongoing reliable supply. Gin Gin Substation has been identified as the only substation in the zone to be considered for replacement based on the identified condition issues within the next five years. Woolooga SVC secondary systems may also require condition based replacement towards the end of the 10 year outlook period.

Other transmission investment works required

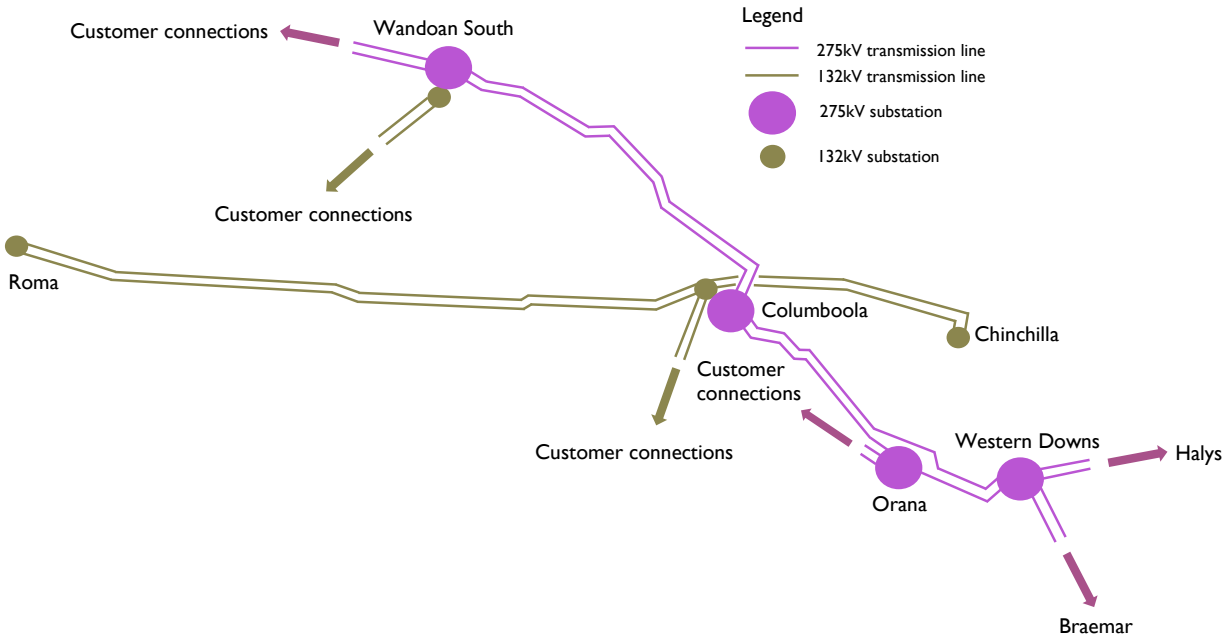
Additional works to be considered in the zone and CQ-SQ transmission corridor in the 10 year outlook period include the replacement of hanger brackets, attachment droppers and selected hardware bridging on the transmission lines from Woolooga to Gin Gin,

2.6.6 Surat zone

Existing network

The Surat Basin zone is defined as the area north west of Western Downs Substation. The area has significant development potential given the vast reserves of gas and coal. Electricity demand in the area is forecast to grow due to new developments of LNG upstream processing facilities by multiple proponents, together with the supporting infrastructure and services (refer to Figure 2.8).

Figure 2.8 Surat Basin north west area transmission network



Network Limitations

There are no network limitations forecast to occur within the Surat zone in the 10 year outlook period.

Reinvestment Requirements

There are no reinvestment requirements within the 10 year outlook period.

2.6.7 Bulli zone

Existing network

The Bulli zone is defined as the area surrounding Goondiwindi and the 275/330kV network south of Kogan Creek and west of Millmerran.

Network Limitations

There are no other network limitations forecast to occur within the Bulli zone in the 10 year outlook period.

Transmission lines

There are no transmission line reinvestments identified in the Bulli zone in the 10 year outlook period.

Substations

Powerlink's routine program of condition assessments has identified primary plant and secondary systems assets within the Bulli zone with emerging risks that are likely to require reinvestment within the 10 year outlook period. Planning analysis confirms these substation assets are required to provide ongoing reliable supply.

A secondary systems (iPASS) replacement project at Braemar Substation is currently in progress. Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Bulli Creek;
- Tangkam

Other Required Transmission Investment

Additional works to be considered in the zone in the 10 year outlook period include the replacement of polymer insulators on the transmission lines from Bulli Creek to the QNI connection point at the New South Wales border.

2.6.8 South West zone

Existing network

The South West zone is defined as the Tarong and Middle Ridge load areas west of Postmans Ridge.

Network Limitations

There are no network limitations forecast to occur within the South West zone in the 10 year outlook period.

Transmission lines

There are no transmission line reinvestments identified in the South West zone in the 10 year outlook period.

Substations

Powerlink's routine program of condition assessments has identified primary plant and secondary systems assets within the South West zone with emerging risks that are likely to require reinvestment within the10 year outlook period.

The existing 275/110kV transformers at Middle Ridge substation, and the 275/66kV transformers at Tarong substation are likely to require refurbishment or replacement within the later part of the 10 year outlook period.

A number of secondary system panels at Chinchilla and Tarong substations may also require refurbishment or replacement within the 10 year outlook period.

Other transmission investment works required

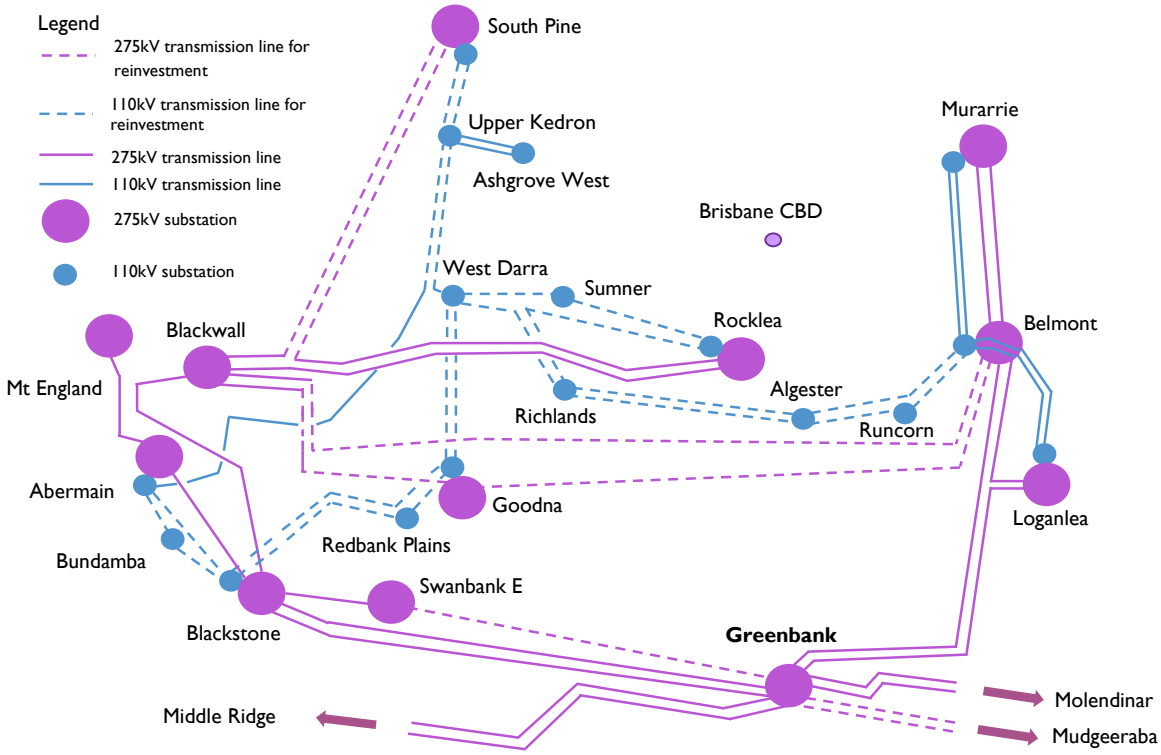
Additional works to be considered in the zone in the 10 year outlook period include remedial works at Tarong substation, tower earthing upgrade, polymer insulators and suspension replacements between Tarong and Mt England substations. Potential telecommunication works within the zone include the provision of underground fibre to Chinchilla.

2.6.9 Moreton zone

Existing network

The Moreton zone includes a mix of 110kV and 275kV transmission network servicing a number of significant load centres in south east Queensland, including the Sunshine Coast, greater Brisbane, Ipswich and northern Gold Coast regions (refer to Figure 2.9).

Figure 2.9 Greater Brisbane transmission network



Future investment needs in the Moreton zone are substantially associated with the condition and performance of 110kV and 275kV assets in the greater Brisbane area.

The 110kV network in the greater Brisbane area was progressively developed between the early 1960s and 1970s, with the 275kV network being developed and reinforced in response to load growth between the early 1970s and 2010. Multiple Powerlink 275/110kV injection points now link with the Energex network to form two 110kV rings supplying the Brisbane CBD.

The establishment of the 275kV network coupled with slowing load growth within the zone has meant that there are potential opportunities for optimising parts of the 275kV and 110kV network which are approaching end of life.

Network limitations

There are no network limitations forecast to occur in the Moreton zone within the 10 year outlook period.

Transmission lines

The 110kV and 275kV transmission lines in the greater Brisbane area are located between 20km and 40km from the coast, traversing a mix of industrial, high density urban and semi-urban areas. Most assets are reasonably protected from the prevailing coastal winds and are exposed to moderate levels of pollution related to the urban environment in which they operate. These assets have over time experienced structural corrosion at similar rates, with end of life for a number of transmission line assets projected within the next 10 year period.

With the forecast relatively flat peak demand, and how the network has been developed over the last 40 years, planning studies have identified a number of 110kV and 275kV transmission line assets that could potentially be retired. Given the uncertainty in future demand growth, Powerlink proposes to investigate low cost maintenance strategies to keep the transmission lines going for a reasonable period. Future decommissioning remains a possibility once demand growth is better understood. This ongoing review, together with further joint planning with Energex, may result in a future investment recommendation that involves retirement of these assets in the 2020s and would involve further external consultation with impacted parties.

Line refit works are currently underway between Sumner Tee to Richlands, and Algester to Belmont. For the balance of transmission line assets with an enduring need, Powerlink is proposing a program of line refit work to manage the risks associated with these assets remaining in service. Line refit works to be considered in the 10 year outlook period include:

- Richlands to Algester 110kV
- West Darra to Sumner 110kV
- Rocklea to Sumner 110kV
- South Pine to Upper Kedron 110kV
- Swanbank to Redbank Plains to West Darra 110kV
- Bergins Hill to Karana Downs 275kV
- Blackstone to Abermain 110kV
- Karana Downs to South Pine 275kV
- Bergins Hill to Goodna to Belmont 275kV
- West Darra to Upper Kedron 110kV

A replacement of the underground transmission cable between Upper Kedron and Ashgrove West substations may be required towards the end of the 10 year outlook period.

Substations

Powerlink's routine program of condition assessments has identified transformers, primary plant and secondary systems assets within the Moreton zone with emerging risks that are likely to require

reinvestment within the 10 year outlook period. Planning analysis confirms the majority of these assets are required to provide ongoing reliable supply to the Moreton zone.

Related investment needs identified include Ashgrove West Substation replacement and Palmwoods and Redbank Plains Substations primary plant replacement. Other condition based investment needs to be considered in the Moreton zone include transformer replacements at the following substations within the 10 year outlook period:

- Redbank Plains transformer 1T and 2T; and
- South Pine No.5

Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Mt England
- Blackwall
- Rocklea
- Tennyson
- Upper Kedron
- Abermain
- Belmont
- Murarrie
- Palmwoods

Asset retirements

The following asset retirements are being considered towards the end of the 10 year outlook period:

- Swanbank to Karana 275kV transmission line
- Belmont 275/110kV transformer 2T and 3T
- Loganlea 110/33kV transformer 2T

Other transmission investment works required

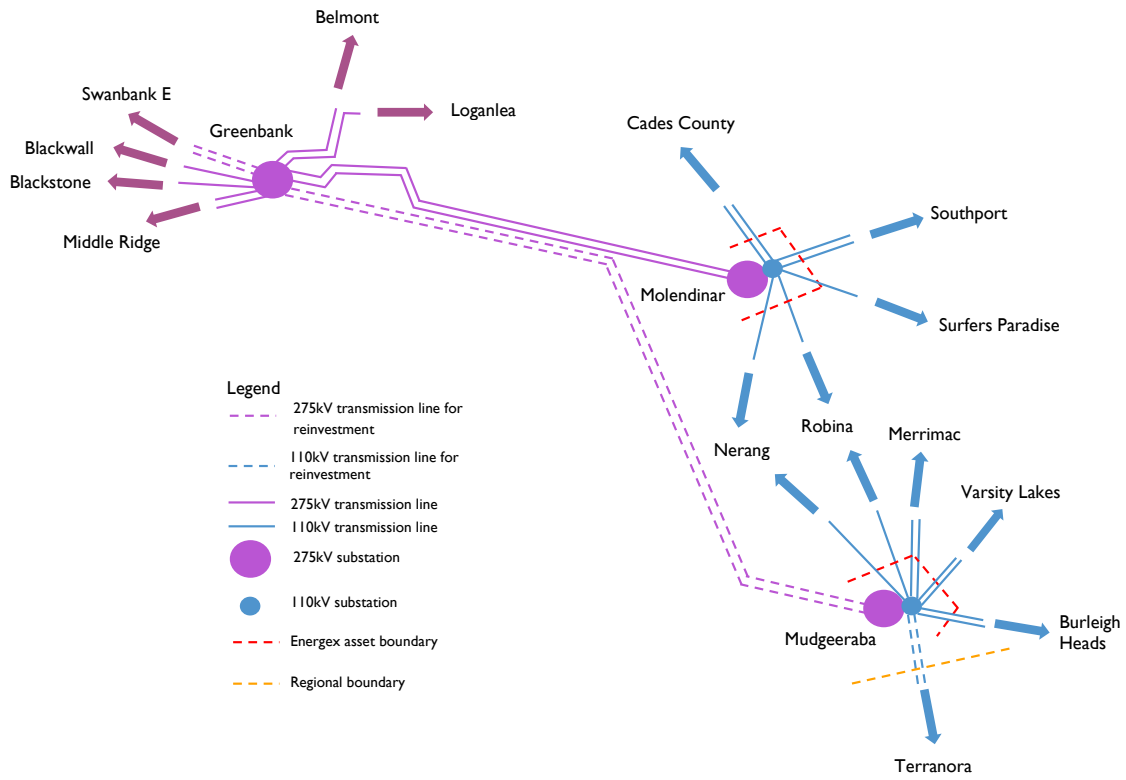
Additional works to be considered in the zone in the 10 year outlook period include insulator replacements on the transmission lines from South Pine to Tarong and Mt England to Tarong as well as tension insulator and hardware replacement works from South Pine to Palmwoods.

2.6.10 Gold Coast zone

Existing network

The Gold Coast zone includes the area east of Greenbank and south of Coomera to the Queensland/New South Wales border. Powerlink's transmission system in the Gold Coast was originally constructed in the 1970s and 1980s. The Molendinar and Mudgeeraba substations are the two major injection points into the area via a double circuit 275kV transmission line between Greenbank to Molendinar, and two single circuit 275kV transmission lines between Greenbank to Mudgeeraba substations (refer to Figure 2.10).

Figure 2.10 Gold Coast zone transmission network



Network limitations

There are no network limitations forecast to occur in the Gold Coast zone within the 10 year outlook period.

Transmission lines

Greenbank to Mudgeeraba 275kV transmission lines

The two 275kV transmission lines were constructed in the mid-1970s and are exposed to high rates of corrosion due to proximity to the coast and the prevailing salt laden coastal winds. The extent of corrosion observed during condition assessments requires that Powerlink consider options for line refit or replacement of these lines within the 10 year outlook period. Network capability studies confirm that these assets are required to provide ongoing reliable supply to into Mudgeeraba. Powerlink is considering an option to replace selective insulators on the Mudgeeraba to Greenbank transmission line in the short term, followed by line refit works within the 10 year outlook period.

Mudgeeraba to Terranora 110kV transmission lines

The 110kV line was constructed in the mid-1970s and forms an essential part of the interconnection between Powerlink and Essential Energy's network in northern New South Wales (NSW), with 13km of the transmission line owned by Powerlink. The transmission line operates in a metropolitan/semi-coastal environment with moderate rates of atmospheric pollution, impacting on the life of its galvanised components and is subject to prevailing salt laden coastal winds. Essential Energy is currently undertaking works to upgrade and extend the life of their portion of the transmission line. Planning analysis confirms these assets are required to provide ongoing reliable supply. Based on Powerlink's condition assessment, line refit or full replacement of the 13km transmission line section is being considered within the 10 year outlook period. Reinvestment works may be required to replace selective insulators on the Mudgeeraba to Terranora transmission line in the short term, followed by line refit works within the 10 year outlook period.

Substations

Powerlink's routine program of condition assessments has identified transformers, primary plant and secondary systems assets within the Gold Coast zone with emerging risks that are likely to require reinvestment within the 10 year outlook period. Network capability studies confirm that these assets are required to provide ongoing reliable supply to the Moreton zone.

Related investment needs identified include Mudgeeraba 110kV substation rebuild and Mudgeeraba 275/110kV No.2 Transformer may require replacement within the next five years.

Condition based secondary systems replacements will be considered at the following substations within the 10 year outlook:

- Mudgeeraba 275kV;
- Mudgeeraba 110kV; and
- Molendinar.

Asset retirements

The following asset retirement is being considered in the 10 year outlook period:

- Mudgeeraba 275/110kV Transformer 3T.

Other transmission investment works required

[redacted]

2.6.11 Telecommunications

Powerlink's telecommunications network has experienced significant growth over the past 10 to 15 years which may require reinvestment decisions to manage the emerging risks related to obsolescence of these assets due to lack of manufacturer support, declining spares and compatibility with modern telecoms technologies. As such the majority of Powerlink's expected program of works for the telecommunication network over the next 10 year outlook period will be related to reinvestment or decommissioning of these assets.

3. CAPITAL PROJECTS

Under the current demand growth forecast, reinvestment in the transmission network to manage identified risks associated with the end of life assets will form the majority of Powerlink's capital expenditure program of work in the 10 year outlook period.

It is useful to consider similar assets when assessing their ability to deliver transmission services. For the Asset Management Plan Powerlink uses seven major types:

- Overhead Transmission Lines (L) or Built Sections (BS)
- Transformers (T)
- Substations (S)
- Secondary Systems (SS)
- Secondary Systems Aux (SS-A)
- Telecommunications (TC)
- Operational technology (OT).

Figure 3.1 shows the indicative aggregated replacement capital project spend on an annual basis for the 10 year outlook of the Asset Management Plan. The indicative date reflects the timing where the cost of asset reinvestment is commensurate with the asset risk cost.

Note in calculating the indicative timing not all risks have been included in the quantifications. Similarly some of the risks are based on a desktop analysis. However, the risk does provide a measure of the relativity of priority between projects of the same asset class. The timing of actual investments will be refined at the time of the investment decision based on further specific asset information, and considering the overall portfolio of work. When considering all factors, it is likely the completion times will vary from the initial projections.

Figure 3.1 includes a number of projects which have currently been approved, and are under construction and have projected spend within the 2016-25 period. These expenditures are based on actual projected project timings and annual spends. For other projects which are not approved, no spend profiling has been performed and the entire project spend is assumed to occur in the year they are delivered in Figure 3.1.

Note that the year shown represents financial years starting from the first month. Hence, 2017 represents the 2017/18 financial year.

Figure 3.1 – Reinvestment Capital Projects – "Indicative" Timings

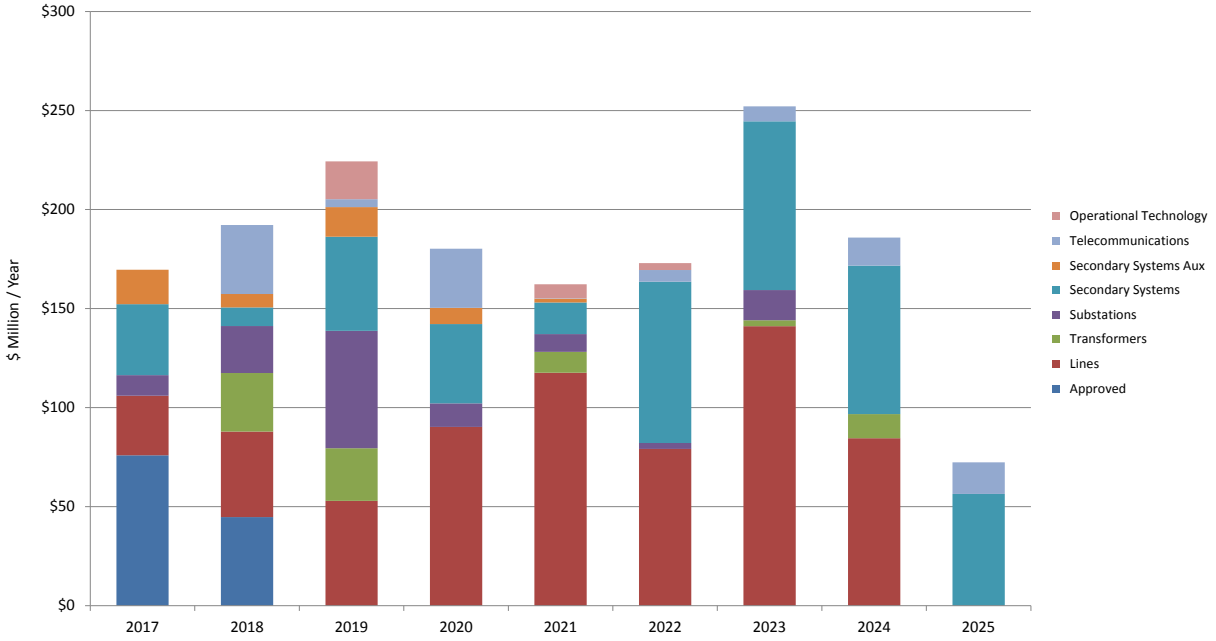


Table 3.1 – Asset Management Plan Capital Project List >$5m

Project No.	Project Description	Category	Status	Indicative Timing	Indicative Project Cost
CP.01091	Garbutt - Alan Sherriff Line Refit	L	A	2017	$8m
CP.01654	Algester - Runcorn 110kV Line Refit (1043,1473)	L	A	2017	$4m
CP.01655	Runcorn - Belmont 110kV Line Refit (1007)	L	A	2017	$6m
CP.PROV	Calliope River - Boyne Island Line Refit (1112)	L	U	2017	$9m
CP.PROV	Woolooga - South Pine 275kV Modified Refit (1020)	L	U	2017	$18m
CP.01158	Egans Hill - Rockhampton Line Refit (1154)	L	U	2018	$6m
CP.02629	Alligator Creek - Eton 132kV Line Refit (1205)	L	U	2018	$12m
CP.02019	Townsville South - Clare South 132kV Line Refit (1209)	L	U	2018	$20m
CP.PROV	Mudgeeraba to STR-1731 (NSW Boarder Terranora) Line Refit (1009)	L	U	2018	$5m
CP.02507	Collinsville - Proserpine 132kV Line Refit (1202,1240)	L	U	2019	$27m
CP.PROV	Greenbank - Mudgeeraba 275kV Line Refit (1019)	L	U	2019	$27m
CP.02415	Greenbank - Mudgeeraba 275kV Line Refit (1018)	L	U	2020	$27m
CP.01647	Biloela - Moura 132kV Line Replacement (1110)	L	U	2020	$37m
CP.01649	Callide - Biloela 132kV T/L Replacement (1157)	L	U	2020	$20m
CP.02533	South Pine - Upper Kedron 110kV Line Refit (1000)	L	U	2021	$6m
CP.01648	Swanbank-Redbank Plains-West Darra 110kV Line Refit (1004,1474,1042)	L	U	2021	$9m
CP.02532	Bergins Hill-Goodna-Belmont 275kV Line Refit (1015,1068,1475)	L	U	2021	$30m
CP.PROV	Calliope River - Gin Gin 275kV Rebuild (First 15km)	L	U	2021	$14m

Project No.	Project Description	Category	Status	Indicative Timing	Indicative Project Cost
	(1122)				
CP.PROV	Calliope River - Wurdong Tee 275kV Rebuild (1125)	L	U	2021	$14m
CP.PROV	Gin Gin - Woolooga 275kV Modified Refit (1025)	L	U	2021	$18m
CP.02565	Karana Downs to South Pine 275kV Line Refit (1047)	L	U	2021	$24m
CP.02189	West Darra - Upper Kedron 110kV Line Refit (1036, 1037)	L	U	2022	$14m
CP.02508	West Darra - Sumner 110kV Line Refit (1038)	L	U	2022	$7m
CP.02509	Rocklea - Sumner 110kV BS1039 Line Refit (1039)	L	U	2022	$8m
CP.02304	Collinsville/Strathmore to Clare 132kV Line Refit (1215,1260)	L	U	2022	$45m
CP.PROV	Wurdong Tee - Gin Gin 275kV Rebuild (1124)	L	U	2023	$124m
CP.01822	Upper Kedron to Ashgrove West Cable Replacement	L	U	2023	$15m
CP.PROV	Woolooga - Palmwoods 275kV Rebuild (1048)	L	U	2024	$85m
CP.01543	Mudgeeraba 275/110kV No.2 Transformer Replacement	T	A	2017	$9m
CP.02516	Garbutt 132/66kV Transformers Replacement	T	U	2018	$7m
CP.PROV	Calvale 2nd 275/132kV Transformer	T	U	2018	$20m
CP.02463	Dysart 132/66kV Transformers Replacement	T	U	2019	$9m
CP.02462	Ingham South No.1 & 2 Transformers Replacement	T	U	2019	$7m
CP.02356	Lilyvale 132/66kV Transformer Replacement	T	U	2019	$9m
CP.02371	Bouldercombe Transformer 1T 2T Replacement	T	U	2021	$7m
CP.02584	Tarong 275/66/11kV Transformers Replacement	T	U	2024	$6m
CP.01549	Moura Primary Plant Replacement (T027)	S	A	2016	$24m
CP.01128	Mackay Substation Replacement (T038)	S	A	2017	$15m
CP.01666	Dysart Substation Rebuild (T035)	S	U	2017	$11m
CP.02351	Nebo Primary Plant Replacement (H011)	S	A	2018	$12m
CP.01710	Gin Gin Substation Rebuild (H006)	S	U	2018	$24m
CP.02350	Bouldercombe Primary Plant Replacement (H010)	S	U	2019	$23m
CP.02355	Ashgrove West Substation Rebuild (T030)	S	U	2019	$12m
CP.02617	Kamerunga Substation Rebuild (T053)	S	U	2019	$22m
CP.02340	Lilyvale Primary Plant Replacement Drivers 5-10 (H015)	S	U	2020	$8m
CP.PROV	Townsville South Primary Plant Replacement (T056)	S	U	2021	$9m
CP.PROV	Ross Primary Plant Replacement (H013)	S	U	2023	$15m
CP.01161	Rocklea Secondary Systems Replacement	SS	A	2016	$17m
CP.01918	Strathmore iPASS Secondary Systems Replacement	SS	A	2017	$6m

Project No.	Project Description	Category	Status	Indicative Timing	Indicative Project Cost
CP.01443	Tennyson Secondary Systems Replacement	SS	A	2017	$6m
CP.01151	Calvale & Callide B Secondary Systems Replacement (H024 and H030)	SS	A	2017	$16m
CP.01457	Baralaba Secondary Systems Replacement	SS	A	2017	$6m
CP.01679	Mudgeeraba 110kV Rebuild & 110kV Secondary Systems Replacement	SS	A	2017	$14m
CP.02272	Mudgeeraba 275kV Secondary Systems Replacement	SS	U	2021	$11m
CP.01148	Wurdong Secondary Systems Replacement (H040)	SS	U	2017	$16m
CP.02531	Boyne Island Secondary Systems Replacement (H008)	SS	U	2017	$6m
CP.01016	Nebo Secondary Systems Replacement	SS	A	2018	$12m
CP.01179	Turkinje Secondary Systems Replacement (T055)	SS	A	2018	$8m
CP.01293	Ross Secondary Systems Replacement	SS	A	2018	$9m
CP.01640	Dan Gleeson Secondary Systems Replacement (T092)	SS	U	2019	$8m
CP.02319	Belmont 275kV Secondary Systems Replacement (H003)	SS	U	2019	$22m
CP.02153	Tangkam Secondary Systems Replacement (T147)	SS	U	2019	$9m
CP.PROV	Townsville South Secondary Systems Replacement Stage 1 (T056)	SS	U	2019	$9m
CP.01635	Abermain Secondary Systems Replacement (T136)	SS	U	2020	$20m
CP.02303	Palmwoods 275kV Secondary Systems Replacement (H009)	SS	U	2020	$9m
CP.PROV	Woree Secondary Systems Replacement Stage 1 (H039)	SS	U	2020	$11m
CP.PROV	Strathmore 275kV and 132kV Partial AIS Secondary Systems Replacement	SS	U	2021	$5m
CP.PROV	Gladstone South Secondary Systems Replacement (T152)	SS	U	2022	$21m
CP.PROV	Mt England Secondary Systems Replacement Stage 1 (H012)	SS	U	2022	$5m
CP.PROV	Kemmis Secondary Systems Replacement (T067)	SS	U	2022	$9m
CP.PROV	QAL West Secondary Systems Replacement (T153)	SS	U	2022	$6m
CP.01999	Tarong Secondary Systems Replacement Stage 2 (H018)	SS	U	2022	$11m
CP.PROV	South Pine, Nebo, Moranbah and Dysart SVC Refurbishments	SS	U	2022	$20m
CP.PROV	Cairns Secondary Systems Replacement (T051)	SS	U	2023	$9m
CP.PROV	Innisfail Secondary Systems Replacement (T050)	SS	U	2023	$9m
CP.PROV	Murarrie 110kV Secondary Systems Replacement (H021)	SS	U	2023	$27m
CP.PROV	Mollendinar Secondary Systems Replacement (Stage 1)	SS	U	2023	$17m
CP.PROV	C50 RTUs Replacement (due to Obsolescence) Stage 1	SS	U	2023	$25m

Project No.	Project Description	Category	Status	Indicative Timing	Indicative Project Cost
CP.PROV	Alan Sherriff Secondary Systems Replacement (T150)	SS	U	2024	$12m
CP.PROV	Middle Ridge Secondary Systems Replacement (H014)	SS	U	2024	$46m
CP.PROV	Chalumbin Secondary Systems Replacement Stage 2 (H032)	SS	U	2024	$7m
CP.PROV	Biloela Secondary Systems Replacement (T026)	SS	U	2025	$8m
CP.PROV	Edmonton Secondary Systems Replacement (T129)	SS	U	2025	$8m
CP.PROV	Strathmore SVC Secondary Systems Replacement	SS	U	2025	$6m
CP.PROV	C50 RTUs Replacement (due to Obsolescence) Stage 2	SS	U	2025	$25m
CP.PROV	Woolooga SVC Secondary System Replacement	SS	U	2025	$7m
CP.02321	Woree SVC Secondary Systems Replacement	SS	U	2022	$5m
CP.02512	SCADA and OpsWAN Network Rationalization (Stage 1)	SS-A	U	2017	$8m
CP.02326	Accurate Fault Location System Stage 3	SS-A	U	2019	$7m
CP.02296	PDH Mux Replacement	TC	U	2018	$35m
CP.02269	DWDM Replacement	TC	U	2020	$30m
CP.02265	SDH Replacement/Rationalisation Northern Region	TC	U	2022	$6m
CP.02650	SDH Replacement/Rationalisation Central Region	TC	U	2023	$7m
CP.PRDT023	SDH Replacement/Rationalisation Southern Region	TC	U	2024	$13m
CP.TELC007	MPLS Replacement	TC	U	2025	$16m
CP.02364	EMS Replacement Program	OT	U	2019	$19m

Note: - A- Approved, U-Unallocated
L – Line, T – Transformer, SS – Secondary Systems, SS-A – non bay related Secondary Systems, TC – Telecommunications.

Notes

- A number of line replacement projects may have associated easement clearance or easement acquisition projects. These have not been included in the capital expenditure list.
- [redacted]

4. OPERATIONAL PROJECTS

Powerlink's operating expenditure includes maintenance, maintenance support, network operations, asset management and corporate support, insurances and Operational Refurbishment (OR) projects to retain assets in a suitable condition to ensure reliability and security of supply to customers. When this is no longer prudent, the replacement of the asset is addressed through capital expenditure. Without appropriate levels of operating expenditure, reliability will start to decline and ultimately lead to inefficiencies (and higher costs) as more reactive approaches to maintenance are adopted.

The operational refurbishment needs are identified and managed in groups according to asset classes. It is useful to consider assets by type when assessing their ability to deliver transmission services as they have similar age, condition or obsolescence drivers. The operational refurbishment needs are therefore identified and managed in groups according to asset classes.

For this purpose, Powerlink uses 5 major types:

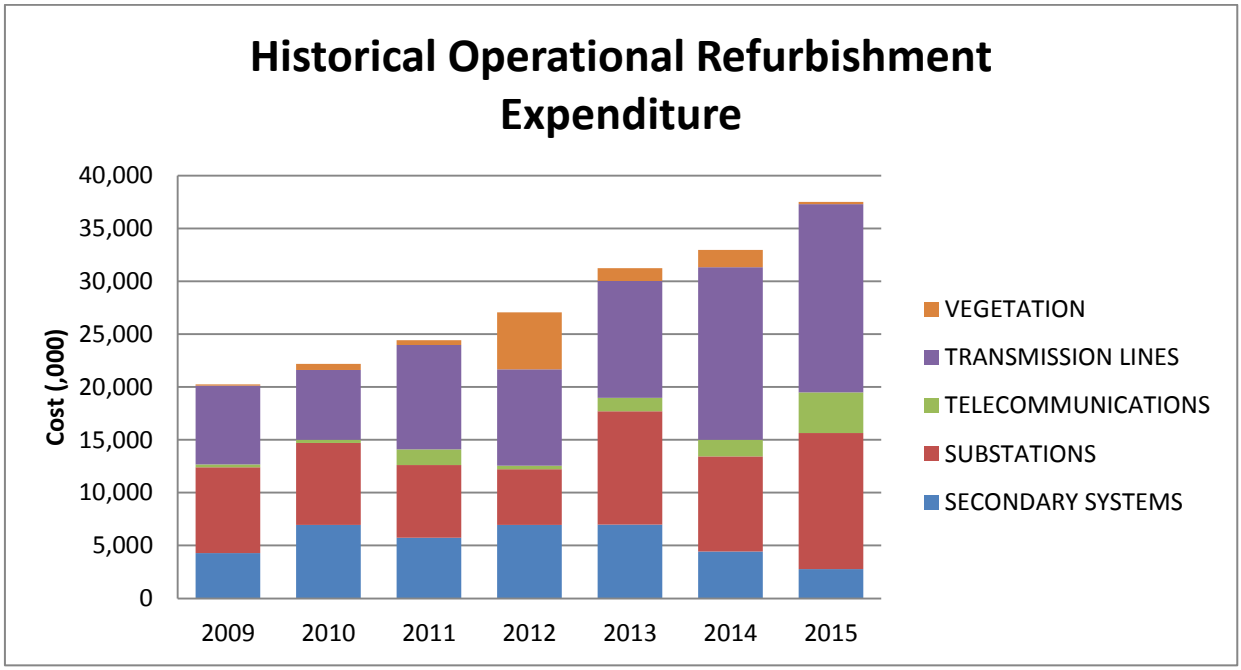
- Secondary Systems;
- Substations (including transformers);
- Telecommunications;
- Transmission Lines (insulators and line other); and
- Land (Vegetation);

Within each asset class, the OR projects and provisions are grouped into sub-categories relating to the type (category) of equipment applicable to the works proposed. The history of OR spend is shown in Table 4.1 and Graph 4.1 below.

Table 4.1 – Actual Operational Refurbishment Expenditure by Asset Type

Nominal- Refurbishment (14/15 ,000)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15
Secondary systems	4,301	6,948	5,731	6,961	6,969	4,446	2,766
Substations	8,109	7,766	6,888	5,249	10,736	8,973	12,868
Telecommunications	277	304	1,479	346	1,257	1,595	3,857
Transmission lines	7,424	6,592	9,877	9,124	11,082	16,316	17,811
Vegetation	136	588	438	5,375	1,196	1,622	203
Total	20,247	22,198	24,413	27,055	31,240	32,952	37,505

Figure 4.1 – Actual Operational Refurbishment Expenditure by Asset Type



OR projects have shorter planning timeframes than asset replacement and augmentation projects. In the short term, the existing need with specific locations and equipment can be identified. This allows an operational refurbishment need to be identified and the development of scopes and estimates. A project management approach is applied to operational refurbishments to ensure delivery effectiveness and cost efficiency.

However, operational refurbishment planning timeframes are less certain in the longer term and this varies between asset types. Where the certainty of specific refurbishment activity on specific assets is not able to be identified, and to reflect required future spends, Powerlink has included provisions within the forecast.

Provisions are forecast projected spends (beyond the short to medium term planning timeframes) based on history and known behaviour of the assets. Annual provisions are calculated by reviewing the historical quantities and out-turn costs of completed projects.

Information from the area plans and forecast capital expenditure projects are taken into account in the development of the forecast OR projects to ensure alignment and no double counting of investment needs. The resulting OR projects / provisions greater than $2M are included in Table 4.2 below.

The forecast operational spend is also shown in Table 4.2 and Graph 4.2 below.

Table 4.2 OR Projects / Provisions >$2M

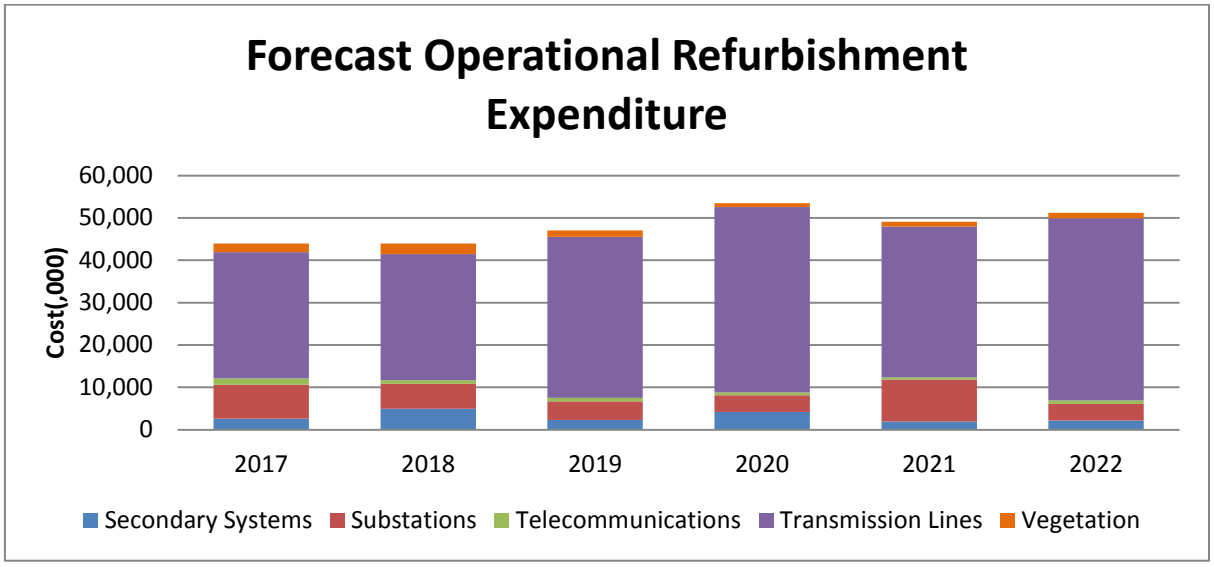
Project No	Description	Status	Indicative Timing	Indicative Project Cost
OR.02017	F857/F858 BS1220 OHEW Replacement Stage 1	U	2017	$4m
OR.02025	Mudgeeraba Primary and Sec Sys Refurbishment	A	2017	$3m
OR.02044	BS1208 BS1247 Moranbah Nebo Insulator Replacement	U	2018	$6m
OR.PROV	BS(s)1400 Tower earthing upgrade	U	2018	$4m
OR.01317	F7113 Baralaba - Blackwater Insulator Replacement	A	2018	$4m
OR.01996	BS1214 F879 Insulator Replacement	U	2018	$4m
OR.PROV	BS(s)1051 (Sth Pine) to (Tarong) Insulator replacement	U	2018	$2m
OR.02041	BS1034/1035 Calvale Halys polymer insulator Replacement Stage 1	U	2019	$8m
OR.PROV	BS(s)1253 OHEW Replacement Stage 1	U	2019	$5m
OR.PROV	BS(s)1253 Foundation Repairs	U	2019	$3m
OR.PROV	BS(s)1182 Broadsound-Lilyvale Insulator Replacement	U	2019	$3m
OR.PROV	BS(s)1153 (Bouldercombe) pass (Egans Hill) Structural Repairs	U	2019	$3m
OR.PROV	BS(s)1253 OHEW Replacement Stage 1	U	2019	$5m
OR.02029	DC System Upgrade - North	U	2019	$3m
OR.PROV	BS(s)1131 (Broadsound) to (Bouldercombe) OHEW Replacement Stage 1	U	2019	$7m
OR.PROV	BS(s)1214 Strathmore to STR-8319 F879R Suspension V-string insulator replacement	U	2019	$4m
ORPROV	F857/F858 BS1220 OHEW Replacement Stage 2	U	2020	$4m
OR.PROV	BS(s)1235 OHEW Replacement	U	2020	$6m

Project No	Description	Status	Indicative Timing	Indicative Project Cost
OR.PROV	BS(s)1420 Bulli Creek to STR-0479 Polymer Insulators Replacement	U	2020	$4m
OR.PROV	BS(s)1400 1027 Tarong to Mt England Polymer Insulators Replacement	U	2020	$3m
OR.PROV	BS(s)1012 Mt England - Tarong polymer insulator replacement	U	2020	$3m
OR.PROV	BS(s)1600 Chalumbin to (Springmount) Polymer Insulators Replacement	U	2020	$2m
OR.PROV	BS(s)1207 1243, 1244, 1245 Nebo to Strathmore Insulators Replacement Stage 1	U	2020	$5m
OR.PROV	Aerial Laser Survey - Northern Region Stage 2	U	2020	$2m
OR.PROV	Aerial Laser Survey - Southern Region Stage 2	U	2021	$3m
OR.PROV	BS(s)1253 OHEW Replacement Stage 2	U	2021	$5m
OR.PROV	Circuit breaker replacements (Provisional)	U	2021	$5m
OR.02075	Siemens Railway SVC Partial Control System Upgrade	U	2021	$4m
OR.PROV	BS1034/1035 Calvale Halys polymer insulator Replacement Stage 2	U	2022	$8m
OR.PROV	BS(s)1213 BS 1213 Susp Insulators and Hardware Replacement	U	2022	$5m
OR.PROV	BS(s)1412 Halys to Braemar Polymer Insulators Replacement	U	2022	$4m
OR.PROV	BS(s)1012 (Tarong) - (MtEngland) Tower earthing upgrade	U	2022	$4m
OR.PROV	BS(s)1235 Replace all Disk Insulators to FOG to Increase High Polution Performanceand h/ware	U	2022	$4m
OR.PROV	BS(s)1140 (Broadsound) to (Stanwell) Suspension Insulators and Hardware Replacement	U	2022	$3m
OR.01918	BS1170 Callemondah-Gladstone Sth Structure Upgrade	U	2022	$3m
OR.PROV	BS(s)1207 1243, 1244, 1245 Nebo to Strathmore Insulators Replacement Stage 2	U	2022	$5m
OR.02030	Calliope Island Towers Refurbishment	U	2022	$2m

Table 4.3 - Forecast Operational Refurbishment Expenditure by Asset Type

Nominal-Refurbishment (14/15 ,000)	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Secondary Systems	2,633	4,971	2,350	4,200	1,900	2,180
Substations	8,003	5,858	4,314	3,910	9,921	3,881
Telecommunications	1,513	836	884	709	560	900
Transmission Lines	29,754	29,816	37,995	43,738	35,588	42,960
Vegetation	2,076	2,443	1,522	922	1,132	1,259
Total OR	**43,978**	**43,925**	**47,065**	**53,480**	**49,101**	**51,180**

Graph 4.2 - Forecast Operational Refurbishment Expenditure by Asset Type



Depending upon the type of asset, a condition assessment and performance appraisal process will be applied to develop an overall strategy for ongoing maintenance, operational refurbishment or asset replacement forecast.

The condition assessment and performance appraisal process for network assets may involve site inspections, analysis of maintenance records, operational performance, engineering data, technical investigations, emerging issues associated with obsolescence and other relevant data to develop a holistic view of the condition of the asset.

This forecast view of OR for later years has been based on provisions and desk top assessments. Actual timing and expected project costs will be confirmed at the time of investment with condition and risk being taken into account to inform priorities.

For example transmission lines show expenditure across the entire planning time frame. This need is primarily driven from the insulator replacement program which requires a number of insulators to be replaced to prevent conductors falling. For insulator replacement there is typically only certainty in the one to two year time frame as the replacement timing is confirmed by the condition of the asset. Provisions for insulator replacement have been included based on a desktop assessment which will be refined closer to the time of investment.