East Coast Area Strategic Plan
System Capacity Planning Project
Aurora Energy

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5	20 May 2010	Final Issue	NJG	JLB/BK	MSH	MSH

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Appendix D

Glossary

Executive summary

The long term plan for East Coast recommends the establishment of substations at Swansea and Ross. Two alternative development paths are discussed in the plan, with the extension of the 110 kV network and 110/22 kV substations compared with the establishment of a 66 kV subtransmission network and 66/22 kV zone substations. NPV analysis indicates that the costs are equivalent within the margin of error of the study, however the 66 kV development option is ultimately recommended as it is considered the technically superior option.

The ten year plan for East Coast recommends the installation of a second transformer at Avoca substation to provide firm capacity, as well as projects to reinforce the 22 kV networks into the Ross, Swansea and St Helens areas. The plan discusses the potential to build certain 22 kV feeders at 66 kV to facilitate the future establishment of 66/22 kV zone substations.

The five year plan for East Coast examines the distribution networks of the three terminal substations in the area. No distribution feeder works have been identified in the five year plan for East Coast.

This report is part of a series covering the eleven planning areas in the state of Tasmania. References are made in this report to others in the series which cover adjacent planning areas. An overarching summary document was compiled to highlight the important outcomes and recommendations from each area in the study.

Report Reference	Planning Area
0	System capacity planning project summary
1	Tamar area strategic plan
2	North Coast area strategic plan
3	North West area strategic plan
4	Hobart West area strategic plan
5	Hobart East area strategic plan
6	South area strategic plan
7	Sorell area strategic plan
8	**East Coast area strategic plan**
9	North East area strategic plan
10	Central area strategic plan
11	West Coast area strategic plan

1. Introduction

Aurora Energy (Aurora) engaged Aurecon (formerly Connell Wagner) to undertake a network system capacity planning study covering the eleven planning areas in the state of Tasmania. A report will be produced for each of the eleven planning areas and will include a long term strategic plan, a ten year plan and a five year plan.

Each area report contains a summary of the planning area, describing the geographical region encompassed, the existing electrical infrastructure and the local council plans as well as Aurora and Transend's committed and proposed works for the area. A load forecast is then presented, with a discussion of the magnitude and location of expected load growth, followed by a discussion of the resulting limitations at each substation. The long term strategic plan, ten year plan and five year plan are then presented.

1.1 Background

Aurora is the distribution network service provider of mainland Tasmania, supplying more than 1 GW peak load through its high voltage network in 2008. Transend is the transmission network service provider of Tasmania.

The Aurora HV distribution system consists mainly of 22 and 11 kV feeders, with the connection point generally on the load side of the feeder circuit breakers at Transend's terminal substations. Aurora also owns several 33/11 kV zone substations and 33 kV feeders, which are supplied by Transend's 110/33 kV substations.

This report has been prepared for Aurora and its intent is to review Aurora's short and long term network requirements, however it is understood that Transend is impacted by the recommendations contained within. Therefore all efforts have been made to perform the study in consultation with Transend, and consideration has been given to Transend's future vision and network security standards.

1.2 Methodology

The methodology used to carry out the planning study is outlined below.

To begin with, data was reviewed for each of the planning areas including:

- Annual planning reports from Transend and Aurora
- Known developments and constraints
- The existing network configuration (using Webmap)
- Load models and load transfer capacity
- Transformer refurbishment program (Aurora)
- Schematics of Aurora and Transend substations
- Joint planning studies and regulatory test reports
- Council plans and residential strategies for all of the Tasmanian councils (where available)

The load model for each planning area was then refined into smaller growth areas, with each area allocated medium or high growth based on land availability, council plans for the area and information from Aurora on growth hot spots and point loads. This process resulted in a load forecast for each planning area which fell between the medium and high growth forecasts provided by Aurora, with load growth biased towards those areas (and hence substations) where high growth is expected. This forecast is considered the high growth forecast for this study, with the medium and low forecasts being those provided by Aurora.

For the purposes of the long term strategic plan and ten year plan it was decided to use the high growth forecast to determine the timing of limitations. This conservative approach was taken to ensure that Aurora is prepared should a higher than expected forecast eventuate. The five year plan is intended to be used by Aurora for its short-term planning, including regulatory submission for relevant projects, and therefore needs to be as accurate as possible. As a result, the five year plan uses the medium growth forecast to determine the timing of limitations.

The long term strategic plan was produced by projecting the high growth load forecast out to the year 2050 and performing a high level review of the resulting limitations. Substation capacity and condition were the primary limitations considered at this stage, as distribution network limitations are difficult to forecast and can largely be addressed independently of major substation projects. The introduction of new voltage levels and phasing out of non-standard voltage levels were examined at this time. The recommendations considered to address the resulting limitations included load transfers, transformer refurbishment or replacement to increase capacity, installation of additional transformers and switchgear and the establishment of new substations.

The recommended projects which fell within the period from 2012 to 2022 were then examined in greater detail in the ten year plan. An options analysis was undertaken by comparing the technical and financial implications of the recommended option against several other feasible options. The project drivers were also examined in greater detail, with distribution network limitations such as feeder loading and reliability considered at this stage.

The five year plan focused on the distribution works required within the period from 2012 to 2017. An analysis of each of the existing and new substations was completed to determine feeder limitations in the five year period. The medium growth substation forecast provided by Aurora was combined with historical feeder loading data from 2009 to produce a five year forecast for all distribution feeders in the Aurora network. A number of projects were proposed which included works as part of the substation projects identified in the ten year plan and new projects based on the analysis of feeder loading. A brief justification for the new feeder projects has been included and DINIS studies were completed as applicable. A section has been included to discuss the ultimate configuration of the substation areas and the impact on the ultimate plan by any works completed in the five year period.

For each area, a report was compiled including the long term strategic plan, ten year plan and five year plan. An overarching summary document was compiled to highlight the important outcomes and recommendations from each area in the study.

1.3 Assumptions

A list of some of the general assumptions made for the study is outlined below.

- Direct connected customers were not included in the original load models. However, where the direct connected load affects the substation, an estimated block load has been incorporated into the substation load to determine the capacity limitation.
- The UES 2008 forecast has been used for all load models. The high and medium growth rates for smaller areas in the substation supply areas have been assumed based on existing feeder configuration, land availability, council plans for the area and information from Aurora on growth hot spots and point loads.
- Draft historical feeder loadings were used for the long term strategic and ten year plans. Revised feeder loadings were provided prior to the commencement of the five year plan and the new figures were incorporated to ensure feeder limitations were accurately determined.
- All committed proposed projects up to 2012 are assumed to be completed for this study
- The assumed substation limitation is load above firm capacity
- Transformer asset life as advised by Aurora is 40 years for zone substations and 45 years for terminal substations. For the purpose of this report, it is assumed that actual transformer life is extended by approximately 5 years due to the regular condition assessments and transformer loading under normal conditions.

- The four-hour emergency ratings for transformers is based on 1.2 x normal capacity. It has been assumed that remote switching can be completed within four hours.
- Substation general arrangements were not available during the study and it has been assumed that there is space for the proposed upgrades outlined in the long term strategic plan
- The long term strategy does not take into account individual distribution feeder capacity or voltage drop. This has been further reviewed in the five year plan.
- ESI regulations have been taken into consideration where applicable
- Basic costing was provided by Aurora and Transend and any additional assumptions made are shown in Appendix A
- An NPV analysis has been completed for each of the ten year proposed projects. It should be noted that a cost benefit analysis has not been undertaken
- Demand side initiatives have not been considered in this study. Any feasible demand side initiatives that are identified as part of a separate review will in some cases defer or alleviate identified capital expenditure. The focus of this review is to identify network constraints and determine appropriate network solutions.

2. Area background

The East Coast planning area covers the east coast of Tasmania, from Orford in the South to Ansons Bay in the north. It also encompasses the inland towns of Avoca and Campbell Town. Figure 2-1 provides a geographic view of the area under study.

Figure 2-1 East Coast planning area geographic view

The East Coast is considered a medium growth area, recording growth rates of 1-2% pa for the past three years.

In general the area has a low population density, containing a mixture of low level farming and coastal tourist towns. In particular, the Northern coastal areas are experiencing localised areas of significant residential development.

The coastal area is prone to wind and storm damage and is considered high fire danger, which can cause supply reliability issues.

2.1 Existing infrastructure

The substations within the East Coast planning area are listed in Table 2-1.

Table 2-1 Terminal substations in the East Coast planning area

Substation	Number of Transformers	Transformer MVA	Transformer Primary Voltage	Transformer Secondary Voltage	Number of Feeders
Avoca	1	10 MVA	110 kV	22 kV	4 distribution
St Marys	2	10 MVA	110 kV	22 kV	4 distribution
Triabunna	2	25 MVA	110 kV	22 kV	3 distribution (one dedicated customer)

As outlined above, distribution within this planning area is at 22 kV.

2.2 Council areas and restrictions

The East Coast planning area includes the Break O'Day and Glamorgan-Spring Bay councils.

Break O'Day Council

The major load areas within the Break O'Day council are the towns of St Marys and St Helens, with the council area having a total population of approximately 6,500.

The major industries in the area are tourism, agriculture, forestry, aquaculture and mining.

Vision East Consultation Report 2009 indicates that development will be focussed on the key towns of St Helens and St Marys (within township bounds).

Glamorgan-Spring Bay Council

The predominant industries within this council area are aquaculture and fishing, forestry, agriculture and tourism.

The population of the council area is approximately 4,500.

Vision East Consultation Report 2009 states that the towns of Triabunna, Bicheno and Swansea are appropriate for future growth and development.

2.3 Approved and proposed works

The following approved projects have been identified in the Aurora program of works. For the purpose of this report, it is assumed that these projects will be commissioned by 2012.

Distribution feeder works

- Reliability (TRIP) programs (including Loop Automation) to be undertaken in the Coles Bay and Bicheno areas in 2010/11
- High voltage feeder reinforcement in the St Marys and Bicheno areas in 2009/10

The following proposed projects has been identified in the 2009 Transend Annual Planning Report.

St Marys terminal substation upgrade

The load on St Marys terminal substation currently exceeds firm capacity. This project upgrades the existing 2 x 10 MVA 110/22 kV transformers to 2 x 25 MVA units in 2013.

St Helens 22 kV connection point

Avoca and St Marys terminal substations are currently supplied radially by a single 110 kV teed feeder from Palmerston terminal substation. As a result, a single fault on this feeder will result in a loss of supply to Avoca and St Marys substations with no alternative source of supply.

To address this limitation, Transend are proposing additional 110 kV injection into the area. The first stage of works is a proposed new substation in the St Helens area supplied at 110 kV from Derby terminal substation, with 110 kV supply continuing to St Marys from St Helens terminal substation in a subsequent stage. The tentative timing from the Transend APR for this project is 2017.

3. Load forecast

Avoca, St Marys and Triabunna substations have median growth rates of approximately 2.2%, 0.9% and 1.0% respectively.

While Avoca substation has experienced continued load growth over the past several years, due to the rural nature of the load, significant growth above this rate is considered unlikely. St Marys and Triabunna substations on the other hand supply coastal towns including Scamander, Bicheno and Swansea which are seen as attractive tourist and holiday destinations with the potential for higher growth.

As a result, to produce a conservative load forecast medium growth has been applied at Avoca whereas high growth has been applied at St Marys and Triabunna substations.

The resulting 40 year load forecast and firm ratings for the substations of the East Coast planning area are provided below.

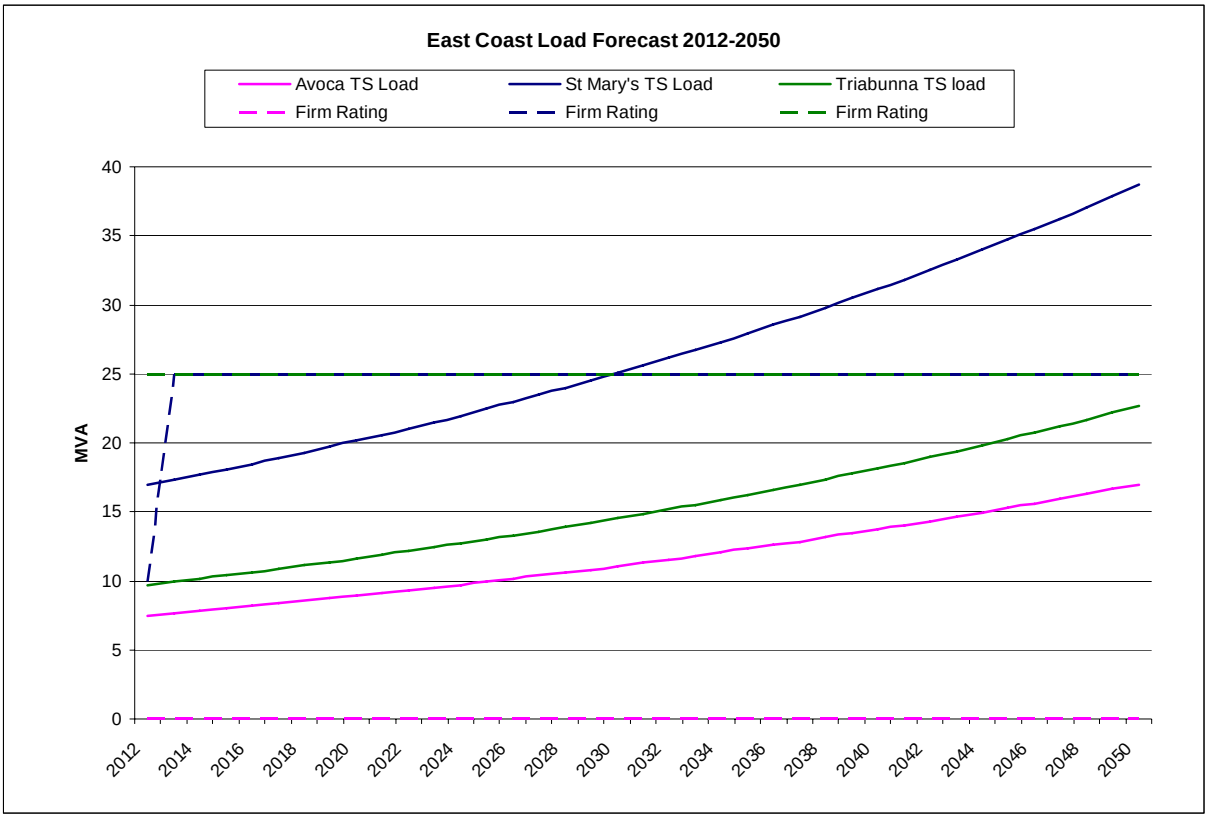


Figure 3-1 East Coast existing load forecast 2012-2050

Figure 3-2 provides a geographic view of the resulting load distribution in 2012 and 2050. The areas in which high growth has been applied are indicated with red borders.

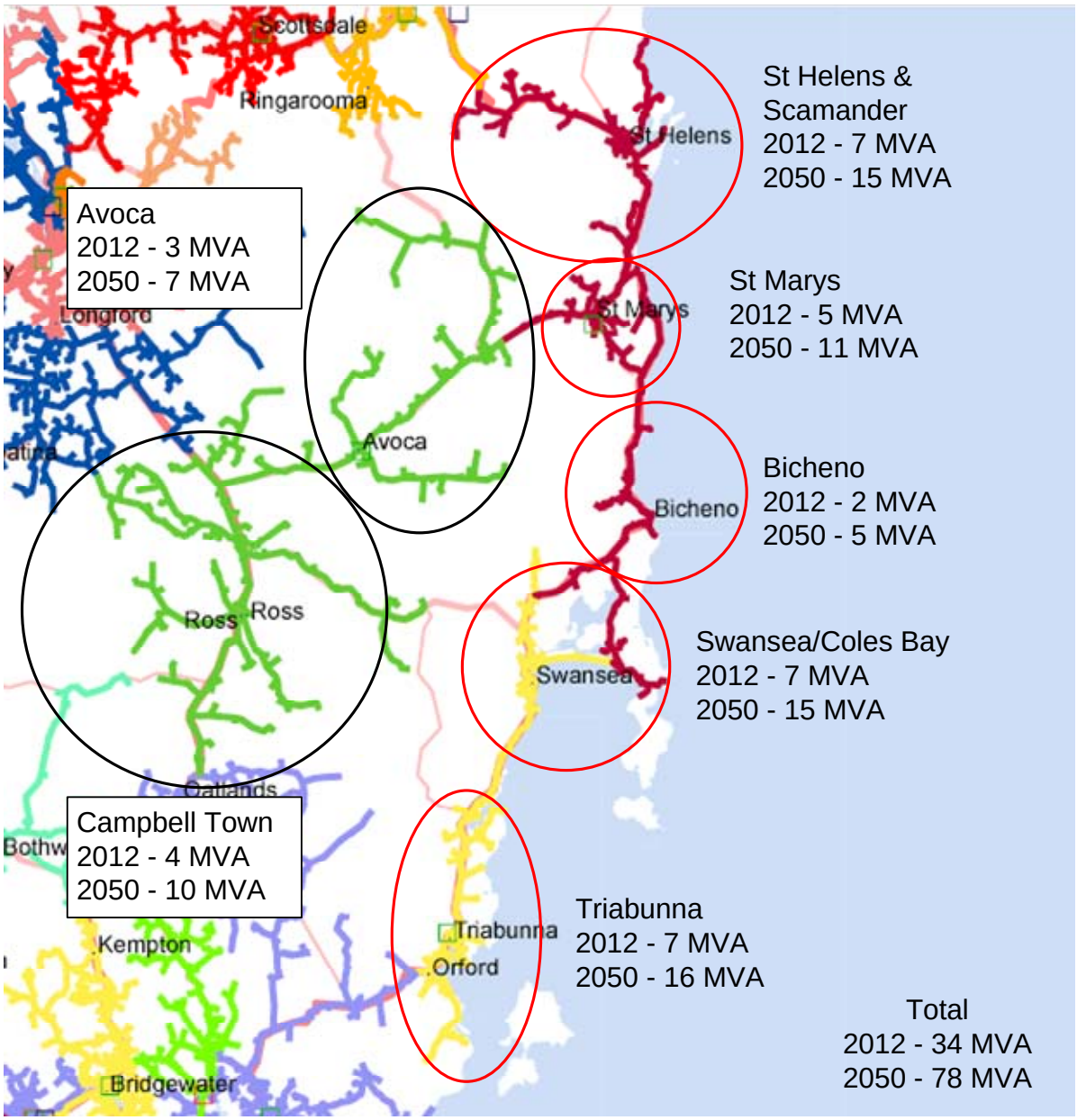


Figure 3-2 East Coast geographic load forecast 2012-2050

4. Limitations

4.1 Avoca terminal substation

Avoca terminal substation is equipped with 1 x 10 MVA 110/22 kV transformer, resulting in no firm capacity.

The transformer at Avoca substation was installed in 1997.

4.2 St Marys terminal substation

St Marys terminal substation is equipped with 2 x 10 MVA 110/22 kV transformers, resulting in a firm capacity of 10 MVA.

The load at St Marys currently exceeds substation firm capacity by approximately 8 MVA, however the installation of 2 x 25 MVA transformers by Transend in 2013 addresses this limitation until approximately 2030.

4.3 Triabunna terminal substation

Triabunna terminal substation is equipped with 2 x 25 MVA 110/22 kV transformers, resulting in a firm capacity of 25 MVA.

The load at Triabunna substation is forecast to reach approximately 23 MVA in 2050 under the high growth forecast.

The transformers at Triabunna were installed in 2006.

4.4 Palmerston-Avoca 110 kV transmission line

The Palmerston-Avoca 110 kV transmission line has a summer rating of 39 MVA and supplies Avoca and St Marys terminal substations. The combined summer load at the Avoca and St Mary substations is forecast to exceed this rating in approximately 2040. The ESI limitation of 300 MWh is currently exceeded for the loss of the Palmerston-Avoca line.

Taking supply from a single transmission line exposes Avoca and St Marys to the risk of loss of supply in the event of a transmission line fault, and makes maintenance or replacement of the line very difficult. There is not sufficient transfer capacity to transfer load to adjacent substations in the event of a 110 kV feeder fault.

4.5 Lindisfarne-Triabunna 110 kV transmission line

The Lindisfarne-Triabunna 110 kV transmission line has a winter rating of 36 MVA and supplies only Triabunna terminal substation. The load at Triabunna substation is not forecast to exceed this rating within the period of study. The ESI limitation of 300 MWh is currently exceeded for the loss of the Lindisfarne-Triabunna line.

Taking supply from a single transmission line exposes Triabunna to the risk of loss of supply in the event of a feeder fault, and makes maintenance or replacement of the line very difficult. There is not sufficient transfer capacity to transfer load to adjacent substations in the event of a 110 kV feeder fault.

5. Planning philosophy

The East Coast planning area consists of inland areas of rural low-density load, such as the townships of Avoca, Campbell Town and Ross, as well as pockets of medium-density coastal load in townships of St Helens, St Marys, Bicheno, Coles Bay, Swansea and Triabunna.

The Campbell Town and Ross area is currently supplied from a single feeder from Avoca (50 km backbone to Ross), with the load forecast increasing from 5.5 MVA in 2012 to 12.5 MVA in 2050. This is expected to be able to be relieved somewhat by Palmerston feeder 51003 in 2017, however Ross is an even greater distance from Palmerston substation so this is not considered a long-term solution. The Oatlands area to the south of Ross is supplied by a 60 km feeder from Sorell and has a forecast load of 2.5 MVA in 2012 increasing to 6 MVA in 2050, though a second feeder into Oatlands area is proposed in the Hobart-East report to defer voltage and reliability limitations in the area. There is also the potential for future irrigation pumping load in the areas around Ross and Avoca. It is considered likely that a substation will ultimately be required to relieve the feeder limitations into the Campbell Town, Ross and Oatlands area. Ross is considered an ideal location being roughly in the centre of load for the area and being remote enough from Avoca and Palmerston to create transfer capacity between the substations. Due to the high cost of substation establishment it is proposed to relieve limitations initially by reinforcement of the distribution network.

Similarly, the Swansea, Bicheno and Coles Bay area is currently supplied by a 60 km feeder from St Marys and a 60 km feeder from Triabunna. The load in the area is forecast to increase from 9 MVA in 2012 to 20 MVA in 2050. The coastal nature of these feeders also makes them prone to faults during the frequent storms in the area. It is considered likely that a substation will also be required in the Swansea area, however 22 kV reinforcement from Avoca is proposed to defer the substation for as long as possible.

The St Helens area is currently supplied by a 30 km feeder from St Marys and a 60 km feeder from Derby substation. Scamander, to the south of St Helens, also has a dedicated 15 km feeder from St Marys. Load at St Helens and Scamander is forecast to increase from 7 MVA in 2012 to 15 MVA in 2050. While a substation may be required ultimately in the St Helens area, it is expected that extending the existing Scamander feeder north to St Helens and establishing additional 22 kV support to Scamander can defer this requirement for the scope of the study.

As per the Sorell planning area, the introduction of a 66 kV voltage level has been considered for the East Coast planning area due to the distance of the proposed substations from the existing 110 kV transmission network. An alternative to the Transend proposal for a 110 kV single circuit from Derby to St Marys has also been investigated. All three options are discussed in the long term strategy.

6. Long term strategy

Two paths of development have been considered to address the forecast limitations in the East Coast planning area. Both options assume the closure of the 110 kV ring from Derby to St Marys proceeds in 2017, as described in the Transend Annual Planning Report 2009. These options are similar, in that they propose substation establishment at the same locations and timings, the difference being that option 1 proposes zone substations supplied from an Avoca 66 kV injection point whereas option 2 proposes 110/22 kV substations. Both options also propose stages of 22 kV feeder works to defer substation establishment, with sections of feeder being constructed at 66 kV in option 1.

A third option was considered as an alternative to Transend's proposal to construct a new single circuit 110 kV line from Derby to St Marys. This option involves the installation of a new double circuit line from Palmerston to Avoca, with Avoca established as a 66 kV injection point and St Marys substation converted to a 66/22 kV zone substation. While the option is competitive on cost, it is unlikely to be considered a feasible option for the following reasons:

- It does not facilitate the establishment of future wind farm and hot rocks generation capability to the north and east of Derby
- The conversion of St Marys to a zone substation would require the transfer of assets from Transend to Aurora which may be politically complicated
- The option relies heavily on the 22 kV network to provide backup to substations which are run above firm capacity

As a consequence, the option is not discussed any further in this report, however it is included as option 3 in the NPV analysis for the East Coast in Appendix B, and a schematic showing the proposed staging and cost is included in Appendix C. Transend are in the process of performing a more detailed analysis on the proposed Derby to St Marys 110 kV line. Should the analysis determine that such a route is significantly more expensive or difficult than expected, the option may be considered as an alternative.

It should be noted that the projects proposed in this section will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 M (RIT-D) or $5 M (RIT-T).

6.1 Proposed projects

6.1.1 Install 2nd transformer at Avoca terminal substation

Avoca terminal substation is equipped with a single 10 MVA 110/22 kV transformer, resulting in no firm capacity. The load at Avoca is forecast to reach 17 MVA by 2050, so 2 x 25 MVA transformers will ultimately be required.

The existing transformer was installed in 1997 and is a standard Transend 10/17/25 MVA unit without radiator fans installed. Thus the installation of four fans can increase capacity to 25 MVA.

Therefore it is proposed that a new 25 MVA transformer be installed at Avoca as soon as practical (currently planned for 2014 by Transend). The existing 10 MVA unit may have radiator fans installed at the same time, or this could be deferred until 2026 when load at Avoca is forecast to exceed 10 MVA.

The existing transformer is predicted to reach nominal end of life in 2047. However replacement can be deferred until justified by condition assessment, since load is not forecast to exceed firm capacity beyond 2050.

This project is discussed in more detail in the ten year plan.

6.1.2 Establish 110 kV transmission line from Derby to St Marys

To address the N-1 limitations on the 110 kV network to Avoca, St Marys and Derby substations, it is proposed that a single circuit 110 kV feeder be installed from Derby to St Marys substations (approximately 65 km). This project would address the lack of firm capacity to Avoca, St Marys and Derby substations for 110 kV feeder contingencies.

The timing of the project would be driven by the ESI requirement of no more than 300 MWh of unsupplied energy for a single contingency. Transend have indicated that this requirement is not met as of 2009, and have advised a tentative timing of 2017 for this project.

6.1.3 Extend Avoca 22 kV feeder 56001 to Swansea

St Marys 22 kV feeder 57004 and Triabunna 22 kV feeder 43507 currently supply the Bicheno, Swansea and Coles Bay areas. These areas are currently experiencing reliability issues with the current round of reliability works in the area expected to relieve the limitations until approximately 2020.

To address these limitations, it is proposed to extend existing Avoca feeder 56001 along Old Coach Road (approximately 15 km) to provide a third supply into the Swansea area in 2020. The new section of 22 kV feeder could be built at 66 kV if it is determined that the 66 kV option is likely to be pursued.

It should be noted that the proposed commissioning date of 2020 is based on the advice from Aurora that the current round of reliability works will defer reliability limitations by approximately ten years. Timing should be re-evaluated closer to the date.

This project is discussed in more detail in the ten year plan.

6.1.4 Extend St Marys 22 kV feeder 57003 to St Helens

St Marys 22 kV feeder 57006 supplies north to the Scamander, Beaumaris and St Helens areas. The St Helens area is currently experiencing reliability issues, with the current round of reliability works in the area expected to relieve these limitations until approximately 2020.

To address these limitations it is proposed to extend existing St Marys feeder 57003, which currently supplies north to Scamander and Beaumaris, further north (approximately 11 km) to take some St Helens load in 2020.

It should be noted that the proposed commissioning date of 2020 is based on the advice from Aurora that the current round of reliability works will defer reliability limitations by approximately ten years. Timing should be re-evaluated closer to the date.

This project is discussed in more detail in the ten year plan.

6.1.5 Load transfers from Avoca to Palmerston

Avoca 22 kV feeder 56004 supplies to the Avoca, Campbell Town and Ross areas and is currently experiencing reliability issues. The current round of reliability works in the area is expected to relieve these limitations until approximately 2020.

Palmerston 22 kV feeder 51003 is also experiencing reliability issues. It is expected that the establishment of Westbury substation in 2017 and Longford substation in 2021 will address the limitations on 51003. This would enable the feeder to supply further towards Campbell Town, thus deloading 56004 and improving reliability in the area.

A new 5 km section of 22 kV feeder could subsequently be installed between Ross and Campbell Town to establish a second supply into Ross.

6.1.6 Establish Swansea substation

The load at St Marys substation is forecast to exceed firm capacity in 2035.

At that time there is forecast to be approximately 15 MVA of load in the Swansea area, supplied by three long 22 kV feeders from Avoca, St Marys and Triabunna which are expected to be experiencing reliability issues.

To address these limitations, it is proposed to establish a new substation in the Swansea area with 2 x 25 MVA transformers. The substation would deload Avoca, St Marys and Triabunna substations as well as addressing the reliability issues on the 22 kV feeders into the Swansea area.

66 kV option

Under the 66 kV development path Swansea would be established as a 66/22 kV substation, supplied by a new 66 kV circuit from Avoca (approximately 60 km). At the same time a 110/66 kV substation would be established at Avoca. To defer costs it is proposed to install a single 110/66 kV transformer at Avoca and single circuit to Swansea initially, with the second transformer to follow on establishment of the future Ross zone substation.

It should be noted that if the Avoca site is not suitable for the establishment of 66 kV injection, an alternative may be to establish a new site along the 110 kV Palmerston to Avoca line. The intersection of the Esk Hwy and Midland Hwy would be a possible location as this would provide an alternate route to Swansea via Lake Leake Rd while shortening the future 66 kV feeder to Ross. However this is not the preferred option as it increases the length of the Swansea feeder, and this route does not provide the opportunity to energise at 22 kV initially to support Swansea.

110 kV option

Under the 110 kV development path Swansea would be established as a 110/22 kV substation, supplied by a new 110 kV circuit from Avoca (approximately 50 km).

6.1.7 Establish Ross substation

The load at St Marys substation is again forecast to exceed firm capacity in 2045.

At that time there is forecast to be approximately 8 MVA of load in Ross and Campbell town supplied from two 50 km feeders from Avoca and Palmerston. At the same time there is a forecast load of 6-7 MVA in the Oatlands area, supplied by two 60 km feeders from Sorell and an 80 km feeder from Meadowbank. This quantity of load at the end of such long 22 kV feeders is expected to result in reliability issues.

To address these limitations, it is proposed to establish a new substation in the Ross area with 2 x 25 MVA transformers. The substation would deload Sorell, Meadowbank, Palmerston and Avoca and address the reliability issues on the 22 kV feeders into the Ross and Oatlands areas.

66 kV option

Under the 66 kV development path, Ross would be established as a 66/22 kV substation, supplied by a new 66 kV circuit from Avoca (approximately 40 km). The second 110/66 kV transformer would be installed at Avoca at this time.

110 kV option

Under the 110 kV development path, Ross would be established as a 110/22 kV substation, supplied by teeing off the existing Palmerston-Avoca 110 kV circuit (approximately 20 km).

6.2 Summary of proposed works

A summary of the proposed works from 2012 to 2050 in the East Coast planning area is outlined in Table 6-1

Table 6-1 East Coast project summary

Year	Proposed Project	Proposed Outcomes
2014	Install 2nd transformer at Avoca terminal substation	Provide firm capacity at Avoca substation
2017	Establish 110 kV transmission line from Derby to St Marys	Address 110 kV N-1 limitations
2020	Extend Avoca 22 kV feeder 56001 to Swansea	Address reliability and capacity limitations on St Marys feeder 57004 and Triabunna feeder 45307
2020	Extend St Marys 22 kV feeder 57003 to St Helens	Address reliability and capacity limitations on St Marys feeder 57006
2020	Load transfers from Avoca to Palmerston	Address reliability and capacity limitations on Avoca feeder 56004
2026	Install fans on Avoca transformer	Increase firm capacity at Avoca substation
2035	Establish Swansea substation	Address capacity limitation at St Marys and 22 kV feeder reliability and capacity in the Swansea, Bicheno and Coles Bay areas
2045	Establish Ross substation	Address capacity limitation at St Marys and 22 kV feeder reliability and capacity in the Campbell Town, Ross and Oatlands areas
2047	Replace Avoca 110/22 kV transformer	Replace ageing transformer

The resulting load forecast curves are given in Figure 6-1.

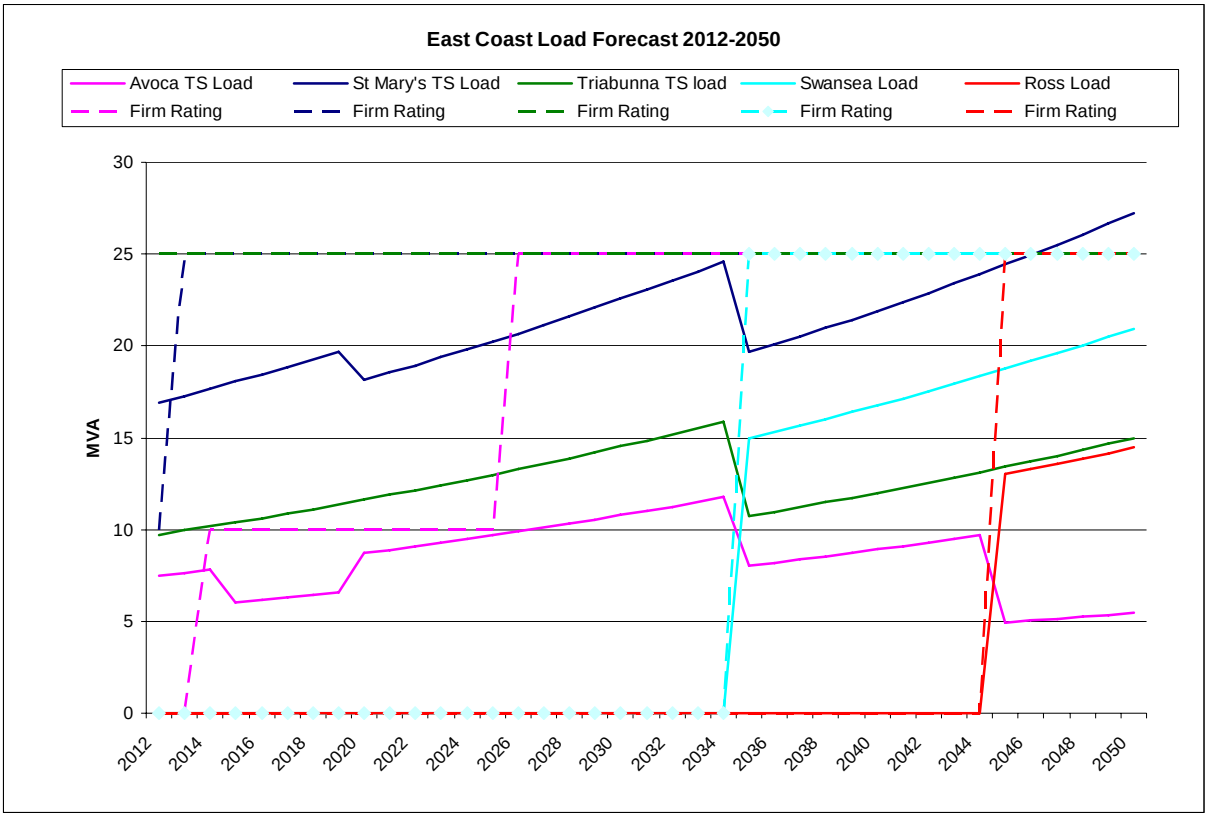


Figure 6-1 East Coast proposed load forecast 2012-2050

A technical comparison of the 110 kV and 66 kV options is given in Table 6-2.

Table 6-2 Technical comparison of options

Option	Advantages	Disadvantages
66 kV option	• Flexibility to establish zone substations in areas of high load growth • 66 kV circuits are smaller and may be run on wooden poles, thus have less community impact • Ability to stage 66 kV feeders by energising at 22 kV initially • Aurora have ownership of 22 kV CBs, which simplifies operation of the distribution network	• 66 kV is a non-standard voltage level in Tasmania at present (although expected at Roseberry in the near future) • Requires the establishment of a 110/66 kV substation at Avoca
110 kV option	• Consistent with the Transend 40 year plan • Lower losses than the 66 kV option	

A cost comparison of the 110 kV and 66 kV options is given in Table 6-3.

Table 6-3 Cost comparison of options

Option	Initial Capital Cost	Total Capital Cost	Net Present Value
66 kV option	5.0	112.8	44.2
110 kV option	5.0	123.1	47.5

As outlined above, the 66 kV option has a lower net present value, however the difference between the options is within the margin of error of the estimate. Details of the NPV analysis are given in Appendix B.

Schematic diagrams of the proposed ultimate 66 kV and 110 kV configurations are given in Figure 6-2 and Figure 6-3 respectively. Schematic diagrams showing the proposed staging for each option is given in Appendix C.

Based on the technical and cost comparisons, the 66 kV development path is considered the superior option. Since the first stage of works involving the 66 kV voltage level is not proposed until around 2035, the decision to commit to this development path need not be made in the short-term. However there is the potential for future 22 kV feeders, such as the proposed feeder from Avoca to Swansea in 2020, to be built at 66 kV to facilitate the future establishment of 66/22 kV zone substations. It would be ideal for Aurora to be committed to a development path prior to these works to ensure that the most efficient staging of network augmentation can be achieved.

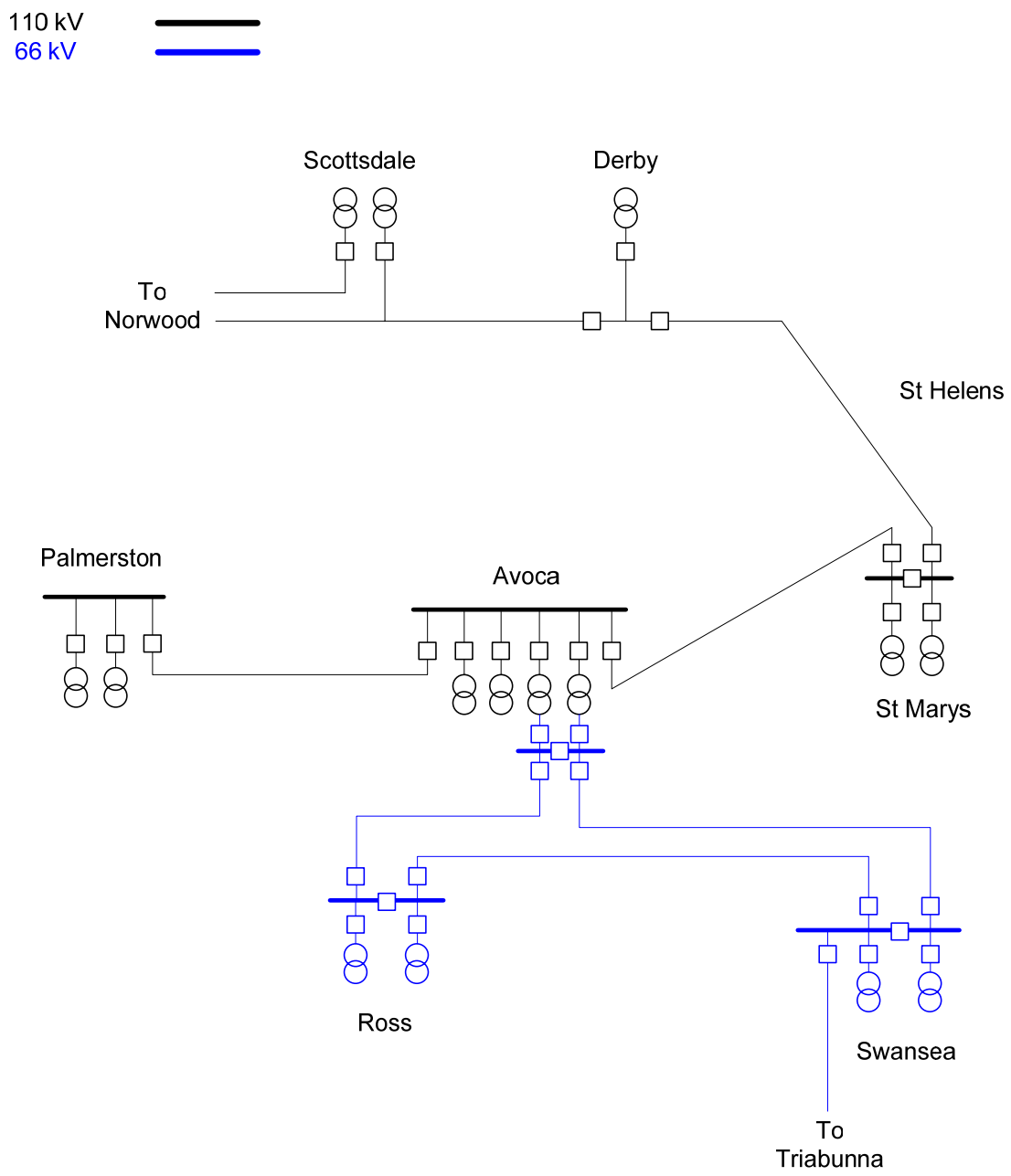


Figure 6-2 Proposed ultimate schematic diagram for the East Coast 66 kV option

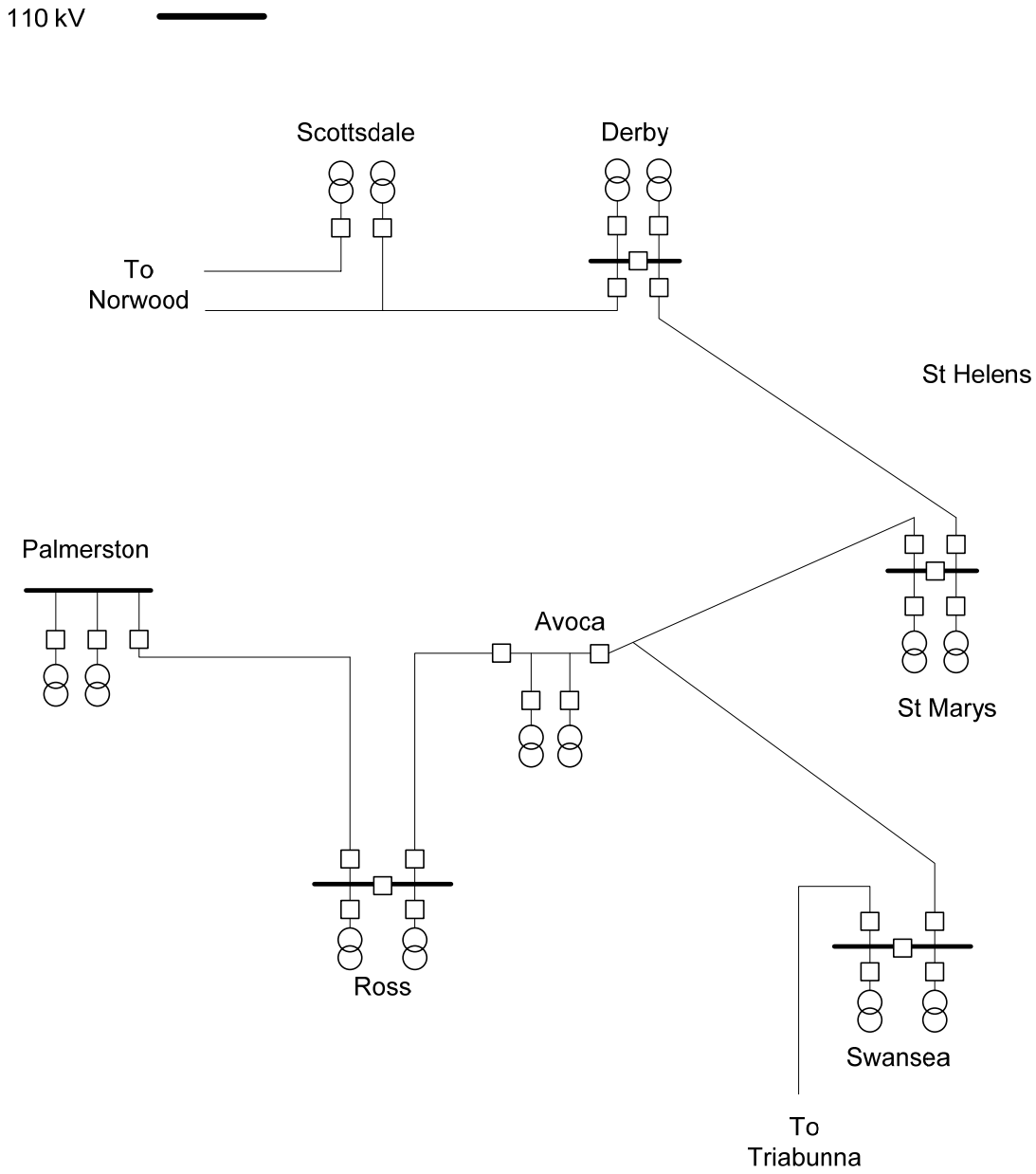


Figure 6-3 Proposed ultimate schematic diagram for the East Coast 110 kV option

7. Ten year plan

The ten year plan for the East Coast is mainly concerned with reinforcement of the 22 kV network to address reliability limitations in St Helens and Swansea. The plan also recommends the installation of a second 110/22 kV transformer at Avoca in 2014 to provide firm capacity.

It should be noted that while each proposed project has undergone a thorough high level analysis, these projects will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 million (RIT-D) or $5 million (RIT-T).

7.1 Proposed projects

7.1.1 Install 2nd transformer at Avoca terminal substation

Limitations

Avoca terminal substation is equipped with 1 x 10 MVA 110/22 kV transformer providing no firm capacity. The transformer was installed in 1997 which implies a nominal end of life in 2047. It is a standard Transend transformer without radiator fans installed, so installation of fans would increase capacity to 25 MVA.

The ten year load forecast for Avoca terminal substation is outlined in Figure 7-1.

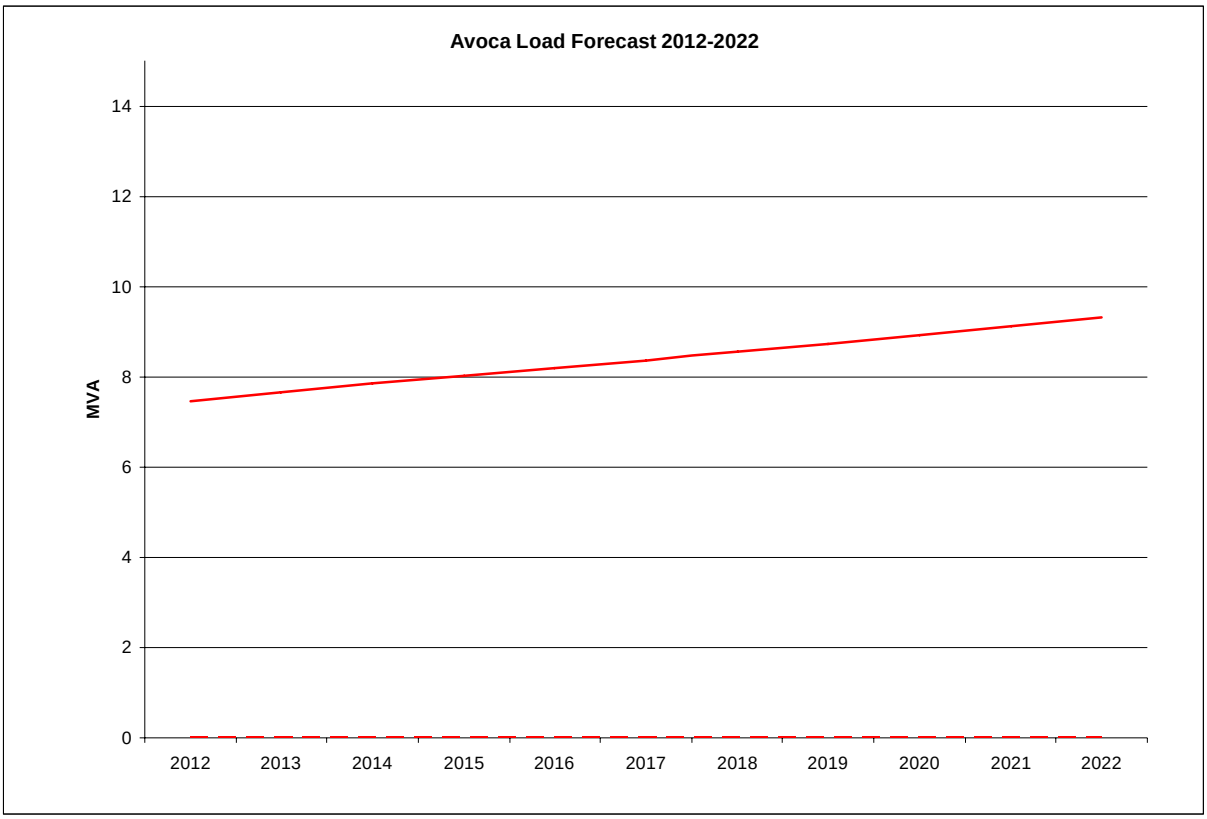


Figure 7-1 Avoca existing load forecast 2012-2022

As outlined above, the load at Avoca is forecast to increase from approximately 7.5 MVA in 2012, to approximately 9.5 MVA in 2022. Aurora has indicated that there is approximately 3 MVA transfer capacity from Avoca to St Marys substation in 2012, resulting in 4.5 MVA (peak) of unsupplied load for a transformer contingency at Avoca. This corresponds to greater than 300 MWh of unsupplied load for a single credible contingency, contravening the ESI regulations.

The Palmerston-Avoca 110 kV transmission line is a single circuit which supplies Avoca and St Marys terminal substations. A fault on this line would result in approximately 24 MVA of peak load interrupted in 2012, and well in excess of the 300 MWh allowed by the ESI regulations for a single credible contingency. It is assumed for the purposes of this study that the proposed Transend project for a 110 kV circuit from Derby to St Marys will proceed as soon as possible (tentatively proposed for 2017), thus providing N-1 security for the 110 kV network to Avoca and St Marys.

Option 1 (recommended option) – Install 2nd transformer at Avoca terminal substation

This option involves the installation of a 2nd 110/22 kV transformer at Avoca in 2014. The transformer may be installed without radiator fans initially, but space should be allowed for the future installation of fans on both transformers.

While the second transformer is required as soon as possible to meet the ESI regulations, the Transend program of works indicates a commissioning date of August 2014 so this is considered the earliest date for practical completion.

Option 2 – Reinforce 22 kV network to Avoca

This option involves the reinforcement of the 22 kV network from St Marys to Avoca in 2014. The project to deload Palmerston feeder 51003 is expected to create transfer capacity between the substations, however it is unlikely to be able to pickup the load in Avoca township due to the distance from Palmerston.

It is expected that by reconductoring the existing sections of 19/.064 Cu on St Marys feeder 57005 and Avoca feeder 56003 (approximately 15 km), an additional 3-4 MVA of transfer capacity may be established, thus deferring the requirement for the second transformer at Avoca until around 2020.

Technical comparison

Table 7-1 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Install 2nd transformer at Avoca terminal substation	Increases firm capacity at Avoca by 10 MVA Better reliability since there is no loss of load for a transformer fault	
2	Reinforce 22 kV network to Avoca	Improves 22 kV transfer capacity between Avoca and St Marys	Does not increase firm capacity in the area Requires significant 22 kV feeder augmentation

The above technical comparison of options indicates that option 1 provides the best technical solution.

Cost comparison

Table 7-2 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	5.0	5.0	3.9
2	1.5	6.5	3.8

The above cost comparison of options indicates that the options are equal within the margin of error of the analysis. Details of the NPV analysis are given in Appendix B.

Recommended option

Based on the technical and cost comparison, option 1 is considered the preferred option to address the forecast limitations.

The scope of works at Avoca substation includes:

- Installation of 1 x 25 MVA 110/22 kV transformer
- Installation of 1 x 110 kV CB
- Installation of 22 kV bus with transformer CB and bus section CB
- Connect existing two 22 kV feeder CBs to the new 22 kV bus

The resulting load forecast is given in Figure 7-2.

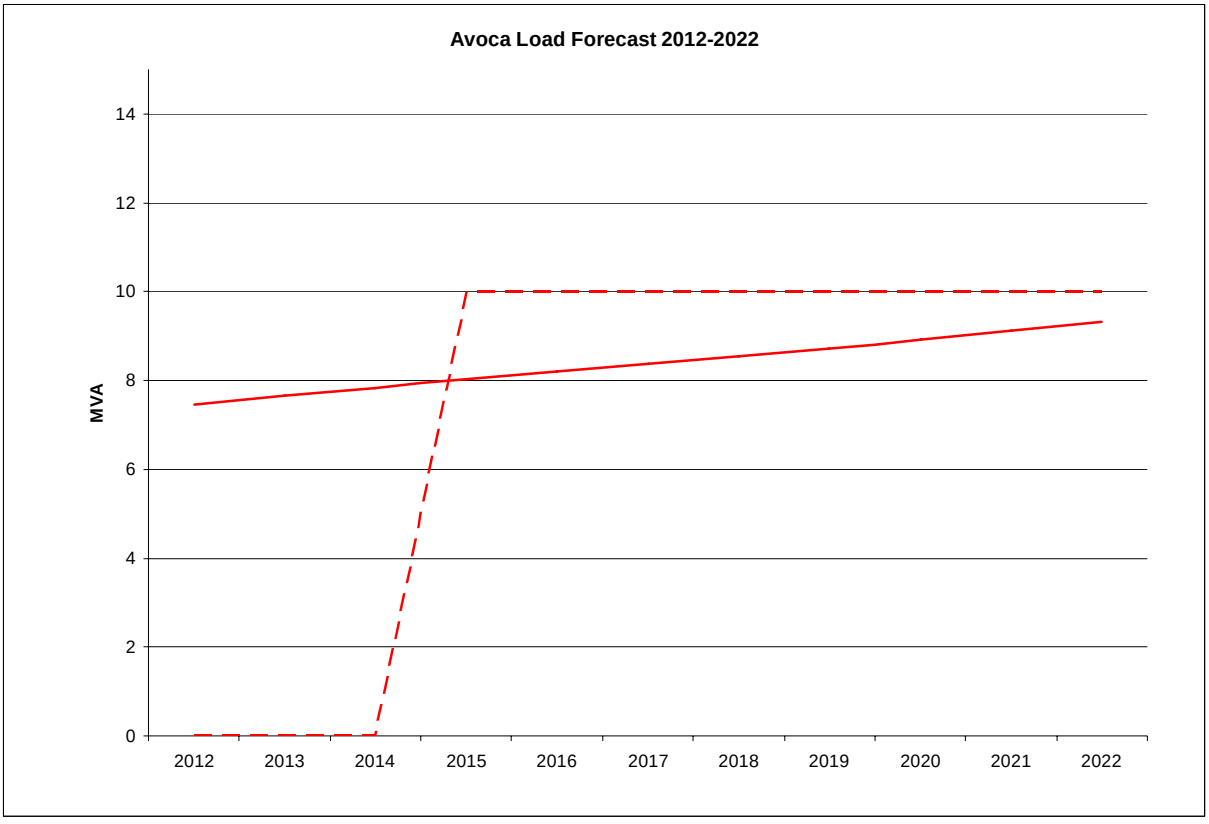


Figure 7-2 Avoca proposed load forecast 2012-2022

As outlined above, following the proposed project the load at Avoca is below firm capacity for the period of study.

7.1.2 Extend 22 kV feeder 56001 from Avoca to Swansea

Limitations

St Marys 22 kV feeder 57004 and Triabunna 22 kV feeder 43507 currently supply the Bicheno, Swansea and Coles Bay areas. The load on 57004 is forecast to increase from 5.9 MVA to 7.1 MVA between 2012 and 2022. The load on 43507 is forecast to increase from 4.2 MVA to 5 MVA between 2012 and 2022. It should be noted that these loads include a block load of approximately 2 MVA, split evenly across the two feeders, to represent the resort development in Coles Bay. Both feeders also currently experience peak loading during the winter months, and this is expected to continue.

Feeders 57004 and 43507 are both long coastal feeders (approximately 60 km) which are vulnerable to faults during the frequent stormy weather in the area.

The Swansea and Coles Bay area is currently experiencing reliability issues. The current round of reliability works in the area is expected to relieve these limitations until approximately 2020.

A geographic diagram of the area under study is given in Figure 7-3.

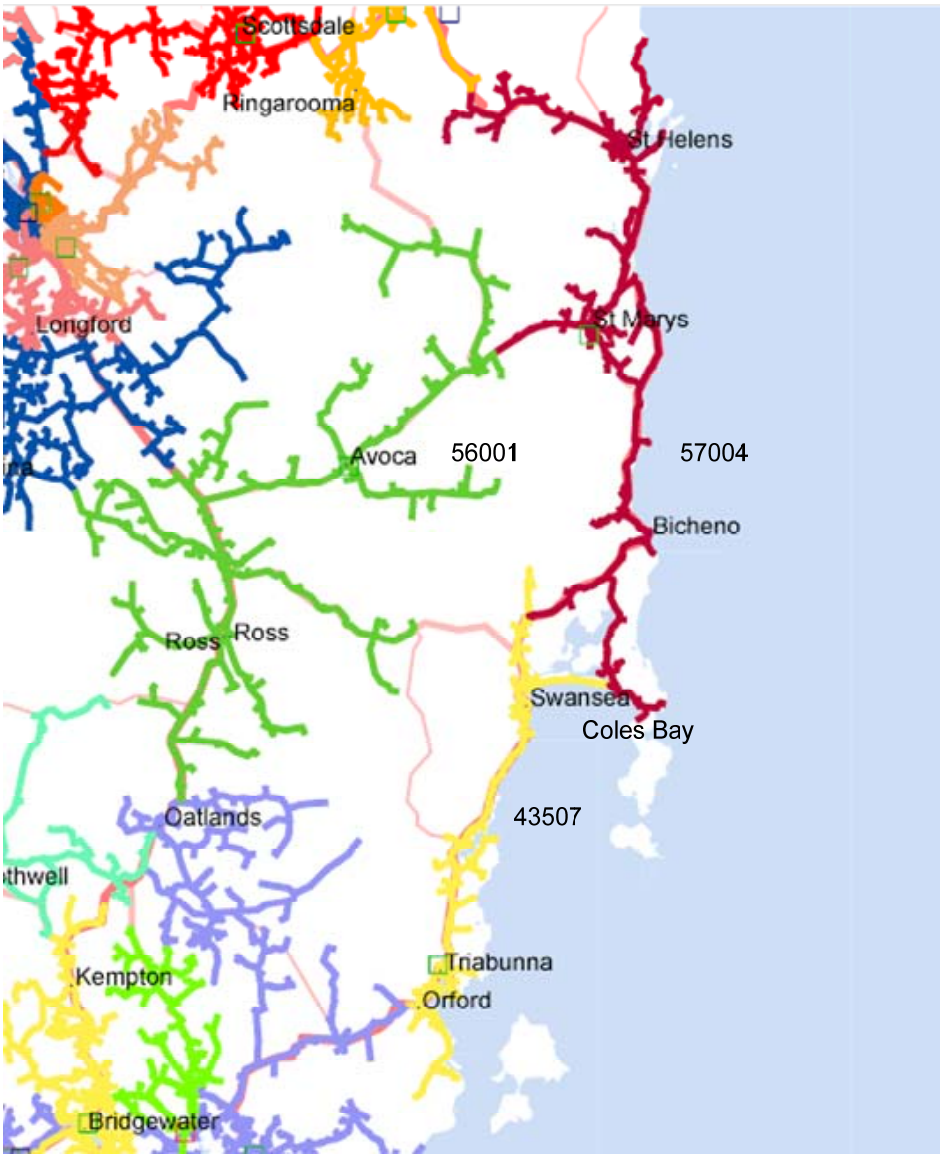


Figure 7-3 Bicheno, Swansea and Coles Bay feeders existing geographic diagram

Option 1 (recommended option) – Extend 22 kV feeder 56001 from Avoca to Swansea

This option involves the extension of existing Avoca feeder 56001 along Old Coach Rd to Cranbrook (approximately 15 km) in 2020, thus deloading feeders 57004 and 43507. The resulting feeder would contain sections of 7/.134 AAC and 7/.064 Cu conductor, providing a feeder winter day rating of 4.7 MVA. Reconductoring these sections (approximately 20 km) to 19/3.25 AAC would increase the rating to 12.4 MVA (limited by the remaining sections of 7/.173 AAC).

Option 2 – Establish new 22 kV feeder from St Marys

This option involves the establishment of a new 22 kV feeder from St Marys (approximately 40 km) to split existing feeder 57004 in 2020. The new feeder would follow the same coastal route as 57004, and would split 57004 in the vicinity of Bicheno.

The feeder would be terminated on an existing spare 22 kV CB at St Marys.

Option 3 – Establish new 22 kV feeder from Triabunna

This option involves the establishment of a new 22 kV feeder from Triabunna (approximately 50 km) to split existing feeder 43507 in 2020. The new feeder would follow the same coastal route as 45307, and would split 45307 in the vicinity of Swansea.

The existing 22 kV bus at Triabunna would be extended with a new 22 kV CB as part of this option.

Technical comparison

Table 7-3 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Extend 22 kV feeder 56001 from Avoca to Swansea	• Shortest 22 kV feeder run (utilises existing feeder) • Uncongested feeder route • Results in three sources of supply to the Swansea and Coles Bay area • Defers the firm capacity limitation at St Marys substation • Decreases load on the radial Avoca-St Marys and Lindisfarne-Triabunna 110 kV transmission lines	• Brings forward the firm capacity limitation at Avoca substation
2	Establish new 22 kV feeder from St Marys	• Allows ties between new and existing feeders along entire feeder route, making the supply more tolerant to 22 kV feeder faults • New feeder installation may be staged, with load progressively transferred from the existing feeder to the new feeder	• New feeder must share same route as existing

Option	Description	Advantages	Disadvantages
3	Establish new 22 kV feeder from Triabunna	• Allows ties between new and existing feeders along entire feeder route, making the supply more tolerant to 22 kV feeder faults • New feeder installation may be staged, with load progressively transferred from the existing feeder to the new feeder	• New feeder must share same route as existing

The above technical comparison of options indicates that option 1 provides the best technical solution.

Cost comparison

Table 7-4 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	3.5	3.5	1.8
2	4.0	4.0	2.1
3	5.1	5.1	2.7

The above cost comparison of options indicates that option 1 provides the lowest cost solution. Details of the NPV analysis are given in Appendix B.

Recommended option

Based on the technical and cost comparison, option 1 is considered the preferred option to address the forecast limitations.

The scope of works includes:

- Establish a new section of 22 kV 19/3.25 AAC feeder from the end of existing feeder 56001 to the spur of 43507 on Old Coach Rd (approximately 15 km). Consideration should be given to fire-proofing of this new section of feeder since the area is known to be vulnerable to bush fires.
- Reconductor the 7/.064 Cu section of 43507 on Old Coach Rd to the Tasman Highway with 19/3.25 AAC (approximately 8 km)
- Reconductor the 7/.134 AAC section of 46001 from Avoca substation along Royal George Rd to 19/3.25 AAC (approximately 12 km)

As a result, Avoca feeder 56001 will have a winter day capacity of 12.4 MVA and will deload St Marys feeder 57004 and Triabunna feeder 43507. The feeder winter day rating can be increased to 15.8 MVA by reconductoring the remaining 6 km section of 7/.173 AAC with 19/3.25 AAC. The quantity of load transfers and any requirement for voltage regulators will be determined in a more detailed study closer to the requirement date.

Consideration should be given to fireproofing the new sections of feeder as the area is notorious for being susceptible to bush fires. Building the new sections at 66 kV should also be considered, if the 66 kV development path is chosen for the East Coast planning area.

The resulting geographic diagram is given in Figure 7-4.

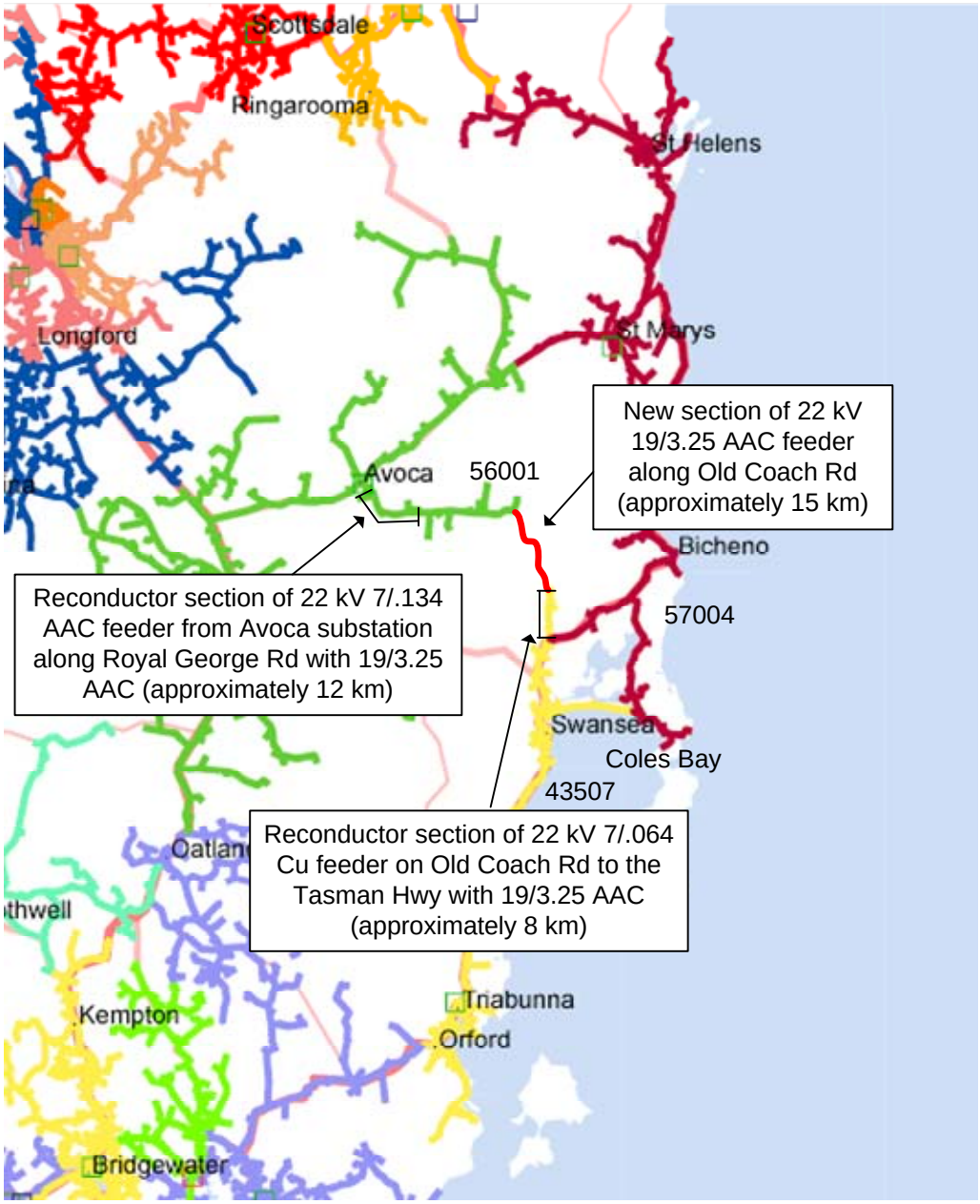


Figure 7-4 Avoca feeder 56001 extension proposed geographic diagram

7.1.3 Extend 22 kV feeder 57003 from St Marys to St Helens

Limitations

St Marys 22 kV feeder 57006 currently supplies to the St Marys, Scamander, Beaumaris and St Helens areas. The load on 57006 is forecast to increase from 7.9 MVA to 9.8 MVA between 2012 and 2022. The St Helens area is currently experiencing reliability issues, with the current round of reliability works in the area expected to relieve these limitations until approximately 2020.

St Marys 22 kV feeder 57003 currently supplies to the St Marys, Scamander and Beaumaris areas. The load on 57003 is forecast to increase from 1.1 MVA to 1.3 MVA between 2012 and 2022.

A geographic diagram of the area under study is given in Figure 7-5.

Figure 7-5 St Marys feeders 57003 and 57006 existing geographic diagram

Option 1 (recommended option) – Extend 22 kV feeder 57003 from St Marys to St Helens

This option involves the extension of existing St Marys feeder 57003 along the Tasman Highway to St Helens (approximately 11 km) in 2020. The resulting feeder would contain sections of 7/.134, 7/3.75 and 6/1/.144 AAC conductor, and 7/.064 Cu conductor, providing a feeder winter day rating of 4.7 MVA. Reconductoring these sections (approximately 12 km) with 19/3.25 AAC would increase the rating to 13.3 MVA (limited by the 185 mm² Al cable in Scamander).

Option 2 – Establish St Helens terminal substation

This option involves the establishment of a new terminal substation in St Helens in 2020. This option assumes that the 110 kV ring from Derby to St Marys, as proposed by Transend for 2017, has been completed and thus only 25 km of 110 kV feeder works are required as part of the option.

Option 3 – Establish new feeder from Derby to St Helens

This option involves the establishment of a new 22 kV feeder from Derby substation to deload St Marys feeder 57006 in 2020. The feeder would follow the same route as existing feeder 55002 from Derby (approximately 35 km).

Technical comparison

Table 7-5 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Extend 22 kV feeder 57003 from St Marys to St Helens	• Shorter 22 kV feeder run than option 3 • Optimally utilises existing assets • Defers requirement for new St Helens terminal substation	• New feeder must share same route as existing
2	Establish St Helens terminal substation	• Shorter 22 kV feeders than options 1 and 3, resulting in the best reliability	• Requires land acquisition for new substation site
3	Establish new feeder from Derby to St Helens	• Defers requirement for new St Helens terminal substation	• New feeder must share same route as existing

The above technical comparison of options indicates that option 1 provides the best technical solution.

Cost comparison

Table 7-6 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	2.3	19.8	4.9
2	17.5	17.5	9.2
3	3.5	21.0	5.6

The above cost comparison of options indicates that option 1 provides the lowest cost solution. Details of the NPV analysis are given in Appendix B.

Recommended option

Based on the technical and cost comparison, option 1 is considered the preferred option to address the forecast limitations.

The scope of works includes:

- Establish a new section of 22 kV 19/3.25 AAC feeder from the end of existing feeder 57003, along the Tasman Hwy to split 57006 in the vicinity of Falmouth St (approximately 11 km)
- Reconductor the 7/.134, 7/3.75 and 6/1/.144 AAC conductor, and 7/.064 Cu conductor sections of 57003, beginning on Esk Main Rd and continuing along the Tasman Hwy to Scamandar, with 19/3.25 AAC (approximately 12 km)

As a result, St Marys feeder 57003 would have a winter day capacity of 13.3 MVA (limited by the 185mm2 cable at Scamander) and would deload St Marys feeder 57006.

The quantity of load transfers and any requirement for voltage regulators would be determined in a more detailed study closer to the requirement date.

The resulting geographic diagram is given in Figure 7-6.

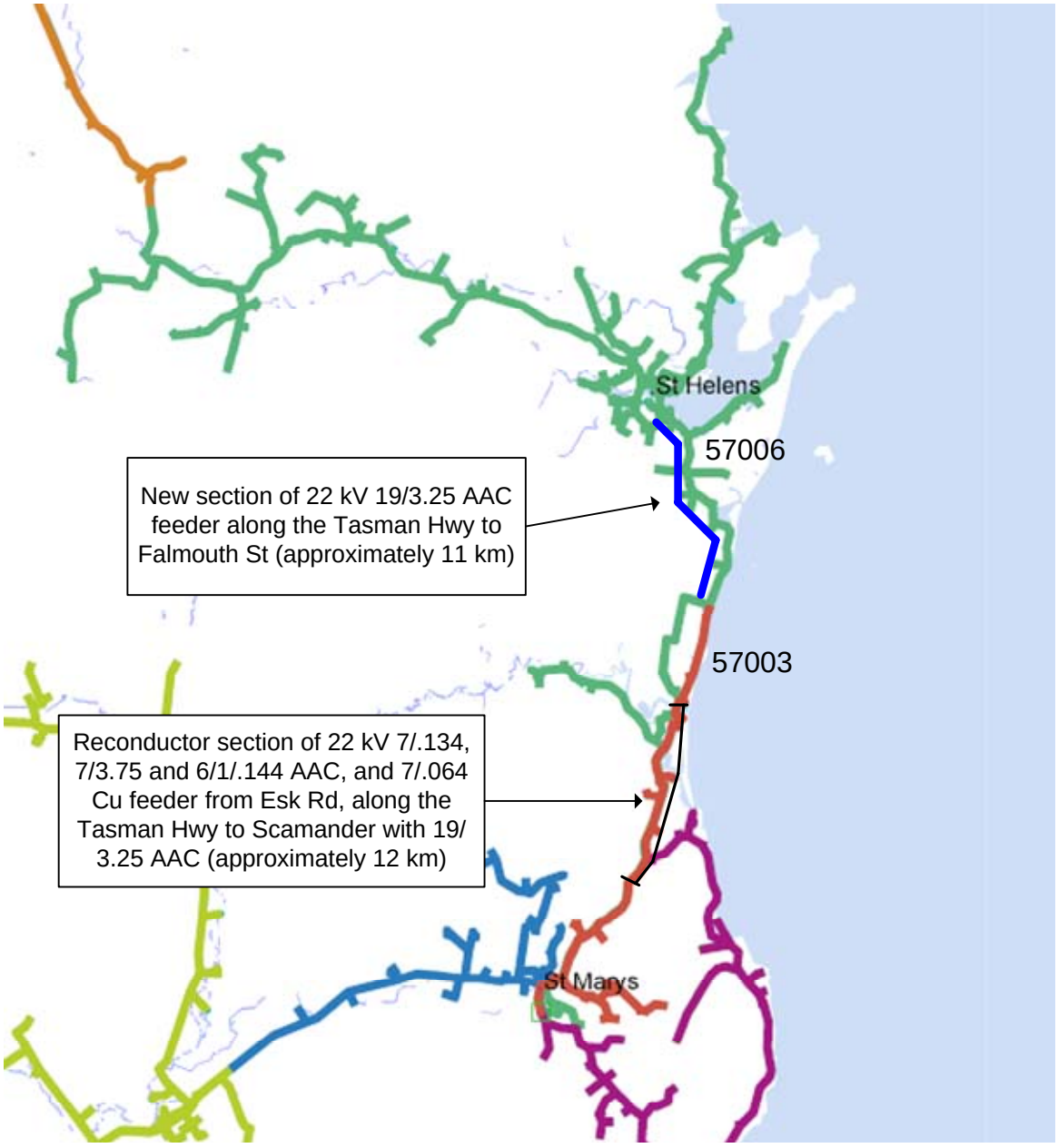


Figure 7-6 St Marys feeder 57003 extension proposed geographic diagram

7.2 Summary of proposed works

The proposed works from 2012 to 2022 in the East Coast planning area are listed in Table 6-1.

Table 7-7 East Coast project summary

Year	Proposed Project	Proposed Outcomes
2014	Install 2nd transformer at Avoca terminal substation	Provide firm capacity at Avoca substation
2020	Extend 22 kV feeder 56001 from Avoca to Swansea	Address reliability and capacity limitations on St Marys feeder 57004 and Triabunna feeder 45307
2020	Extend 22 kV feeder 57003 from St Marys to St Helens	Address reliability and capacity limitations on St Marys feeder 57006

8. Five year plan

A five year plan for each of the substations in the East Coast area is outlined below.

It should be noted that while each proposed project has undergone a thorough high level analysis, these projects will require further detailed analysis to confirm their economic and technical feasibility. A regulatory investment test will also be required for those projects where the augmentation component exceeds $1 million (RIT-D) or $5 million (RIT-T).

8.1 St Marys substation

St Marys terminal substation supplies the East coast townships of St Marys, St Helens, Bicheno and Swansea as well as inland to Fingal.

8.1.1 Limitations

Using the medium growth forecast, St Marys substation load is forecast to grow from 16 MVA in 2012 to 17 MVA in 2017, with the substation firm capacity increasing from 10 MVA to 25 MVA with the replacement of the transformers by Transend in 2013. It should be noted that this forecast includes a 1 MVA block load to account for the resort development in Coles Bay prior to 2012. The five year load forecast for St Marys substation is given in Figure 8-1.

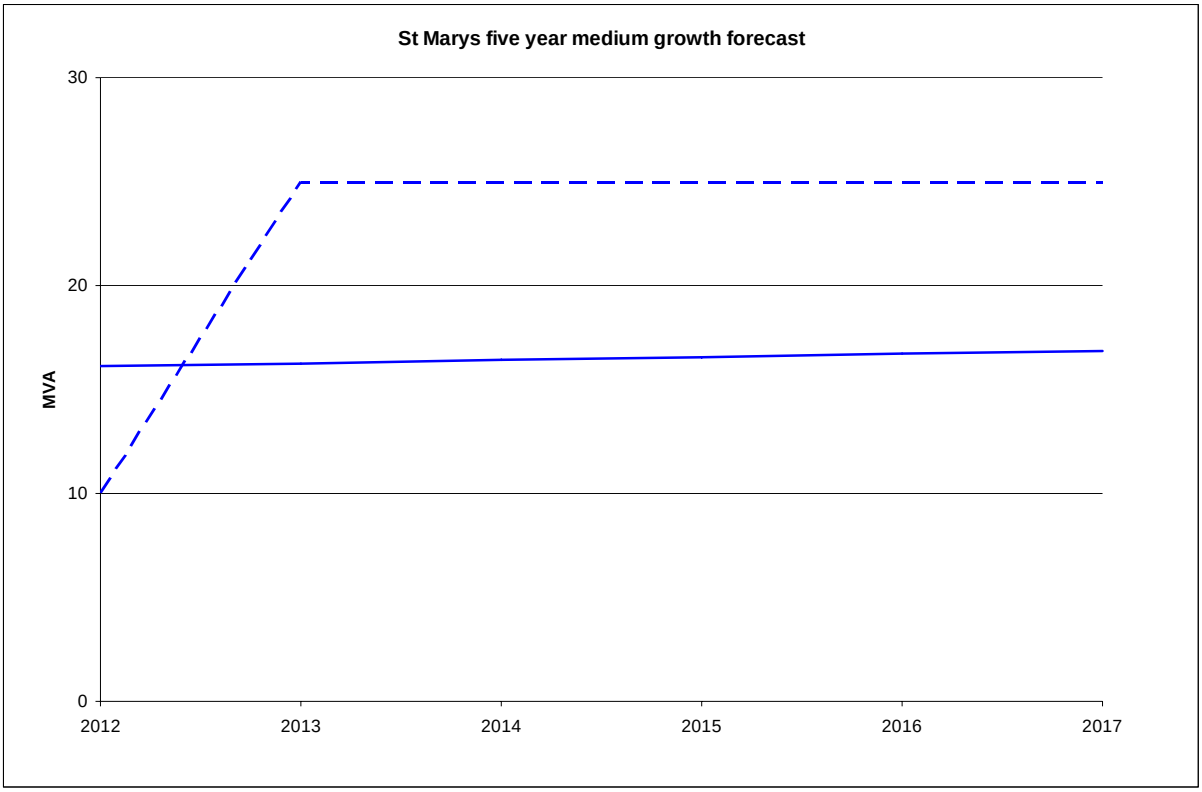


Figure 8-1 St Marys five year medium growth forecast

The 22 kV network from St Marys consists of four distribution feeders and there is a single spare feeder circuit breaker available for future feeders. There is also space for an additional five circuit breakers to be connected to the existing switchgear.

The St Marys supply area and individual feeders are shown in Figure 8-2 and Figure 8-3 below.

Figure 8-2 St Marys 22 kV supply area

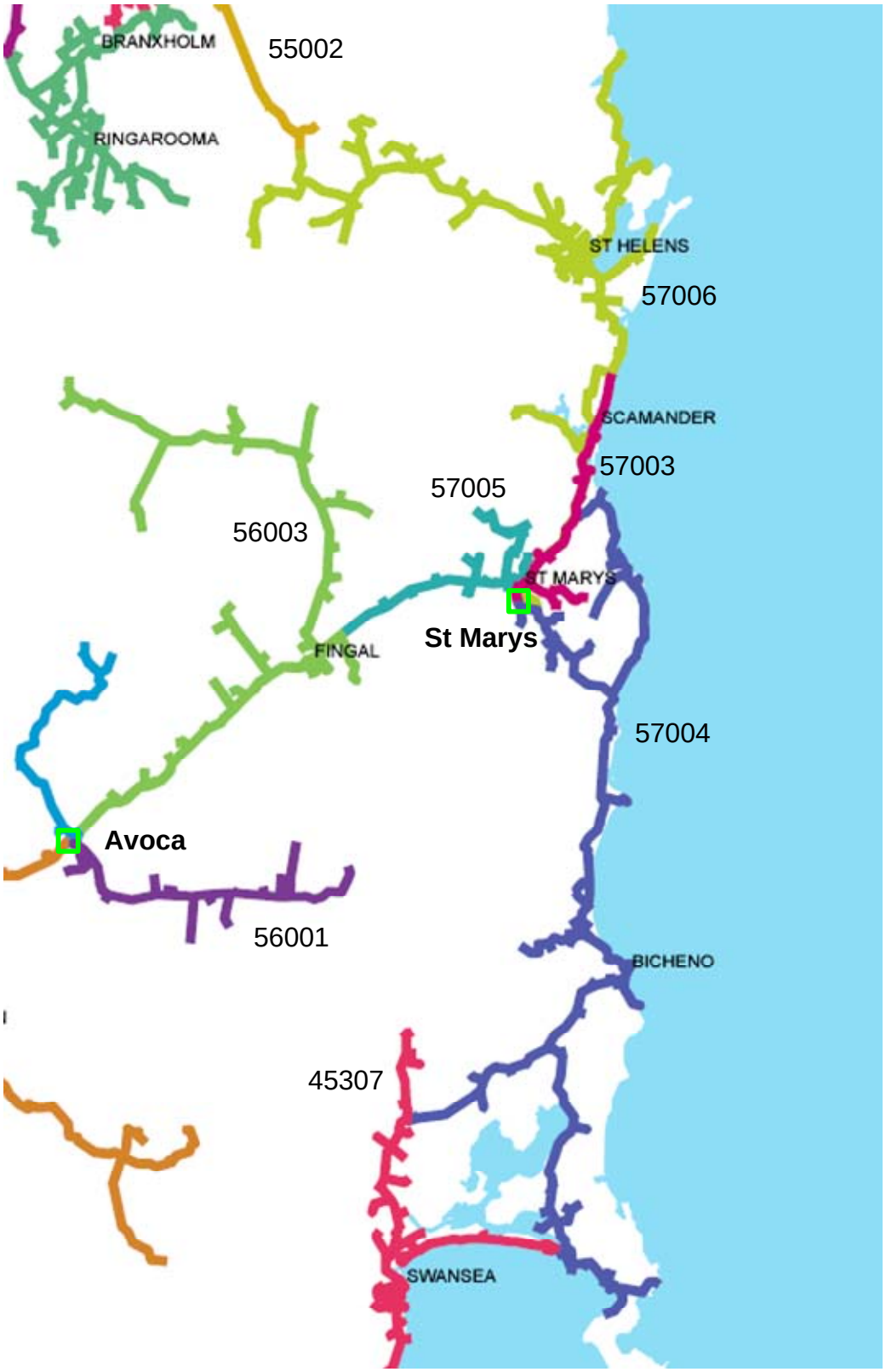


Figure 8-3 St Marys 22 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the historical 2009 feeder peak loads. The feeder forecast is outlined in Table 8-1.

Table 8-1 St Marys substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
57003	1.1	1.1	1.1	1.1	1.1	1.1
57004	6.4	6.4	6.5	6.5	6.6	6.6
57005	1.3	1.3	1.3	1.3	1.3	1.4
57006	7.1	7.2	7.3	7.3	7.4	7.5

As outlined above, there are no feeders that exceed the feeder planning rating of 10 MVA within the period of study. It should be noted that the above load forecast includes a block load of 1 MVA on feeder 57004 to account for the Coles Bay resort development prior to 2012.

The available transfer capacity from St Marys substation to Derby substation is outlined in Table 8-2.

Table 8-2 St Marys substation transfer capability

Substation	Feeder	2012 Transfer (MVA)	2013 Transfer (MVA)	2014 Transfer (MVA)	2015 Transfer (MVA)	2016 Transfer (MVA)	2017 Transfer (MVA)
Derby		2.7	2.7	2.7	2.7	2.7	2.7
Total transfers	**-**	**2.7**	**2.7**	**2.7**	**2.7**	**2.7**	**2.7**

As outlined above, there is only a small amount of transfer capacity away from St Marys for the period of study.

8.1.2 Proposed projects

There are no projects proposed in the St Marys supply area in the five year plan.

8.1.3 Ultimate configuration

Substation

St Marys is expected to remain a two 110/22 kV transformer substation up to 2050. The transformers at St Marys are not predicted to require replacement on condition grounds prior to 2050 as they are being replaced in 2013. However, the switchgear may need to be extended in order to establish future 22 kV feeders out of the substation.

Feeders

As discussed above, there are no feeder limitations at St Marys up to 2017.

It is expected that the feeders to St Helens (57006) and Swansea (57004) will require support for reliability and capacity limitations in the near term. Projects have been proposed to address these limitations in the ten year plan, including the extension of 57003 into St Helens, and the extension of Avoca feeder 56001 to Swansea. Tentative timing of 2020 has been proposed for these projects, however the actual timing is dependent on load growth and reliability requirements in these areas.

The long term plan proposes the establishment of a substation in the Swansea area. It is expected that the existing feeders from Triabunna and St Marys, as well as the proposed new feeder from Avoca, will provide adequate supply to the area until the substation is required (proposed for 2035 in the long term plan).

A substation in the St Helens area is also a possibility prior to 2050, however it is expected that this area can adequately be supplied from St Marys with new feeders if necessary.

8.2 Avoca substation

Avoca terminal substation supplies the eastern Tasmanian townships of Avoca, Fingal, Campbell Town and Ross.

8.2.1 Limitations

Using the medium growth forecast, Avoca substation load is forecast to grow from 7.5 MVA in 2012 to 8.5 MVA in 2017, with no substation firm capacity. The five year load forecast for Avoca substation is given in Figure 8-4.

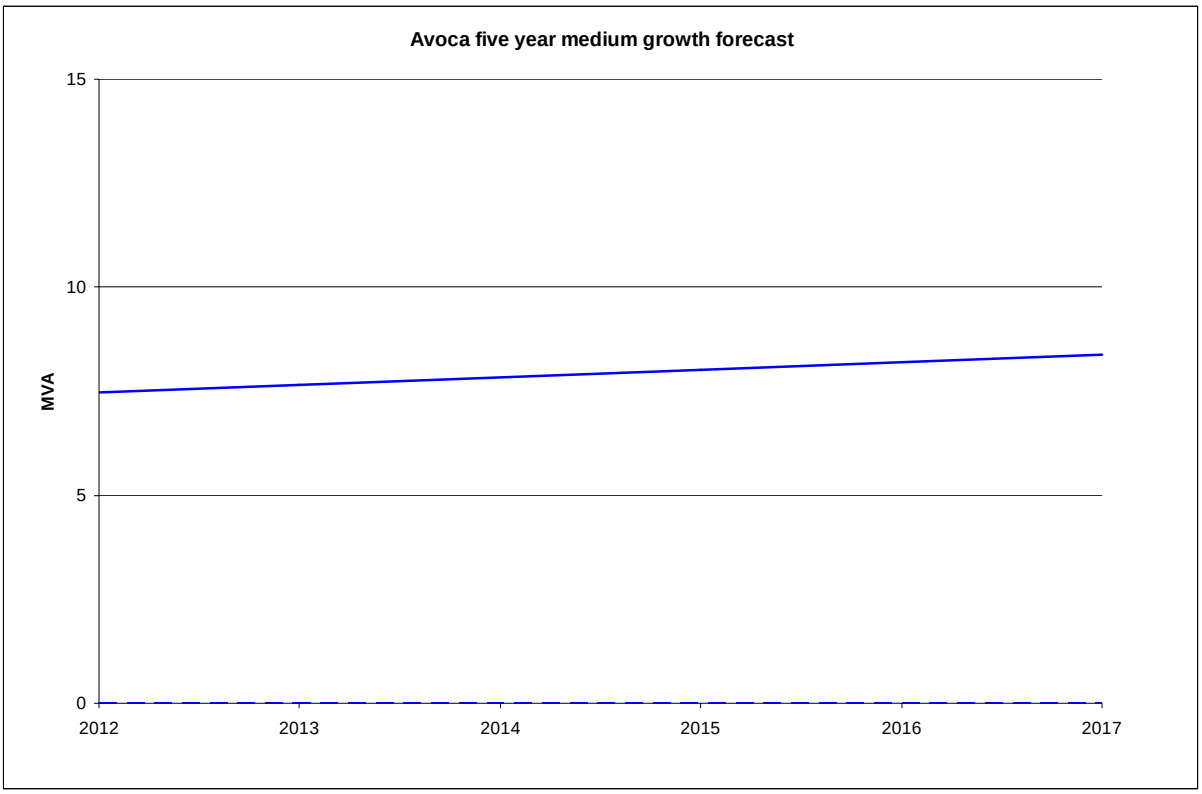


Figure 8-4 Avoca five year medium growth forecast

The 22 kV network from Avoca consists of four distribution feeders and there are no spare feeder circuit breakers available for future feeders.

The Avoca supply area and individual feeders are shown in Figure 8-5 and Figure 8-6 below.

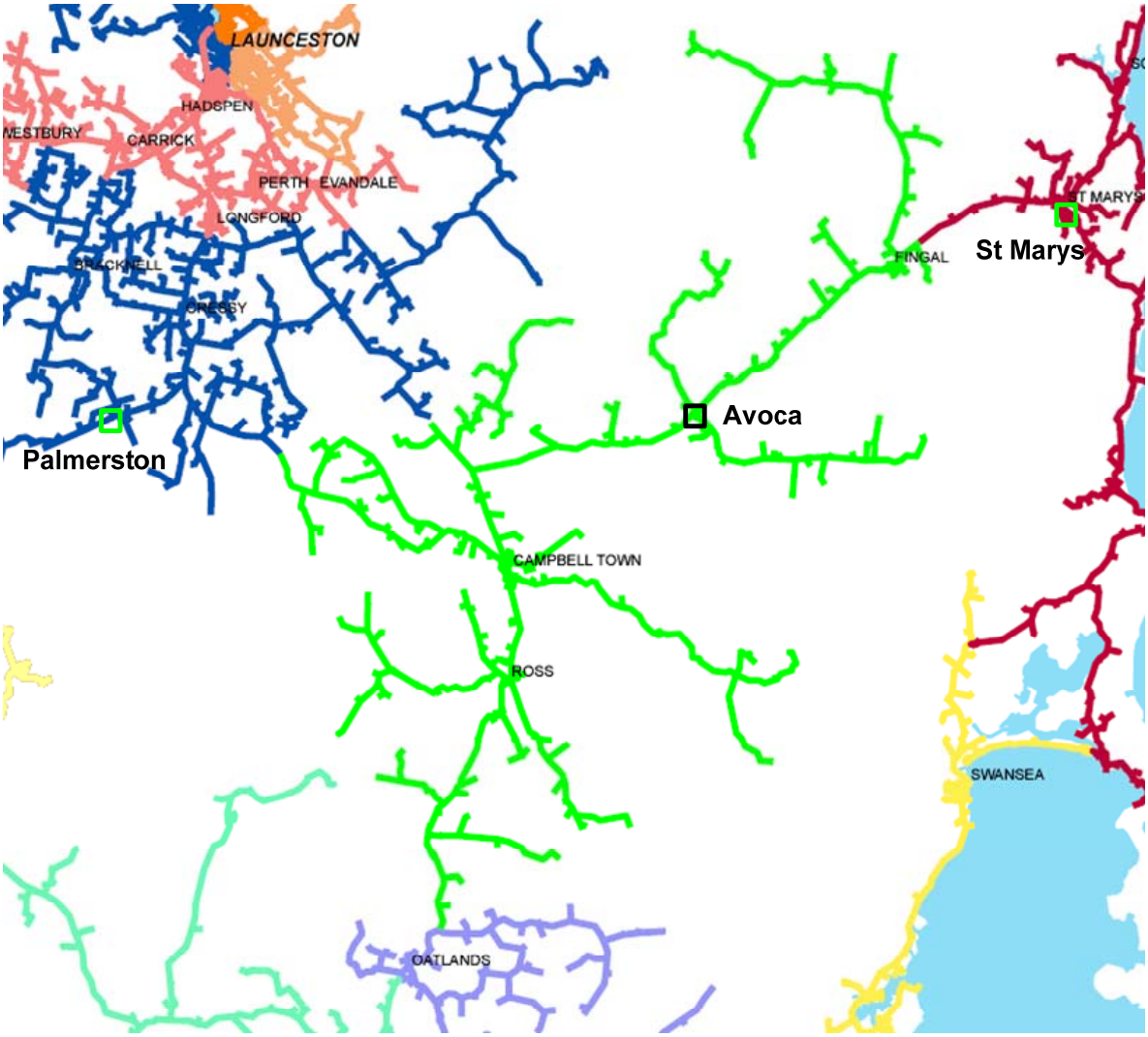


Figure 8-5 Avoca 22 kV supply area

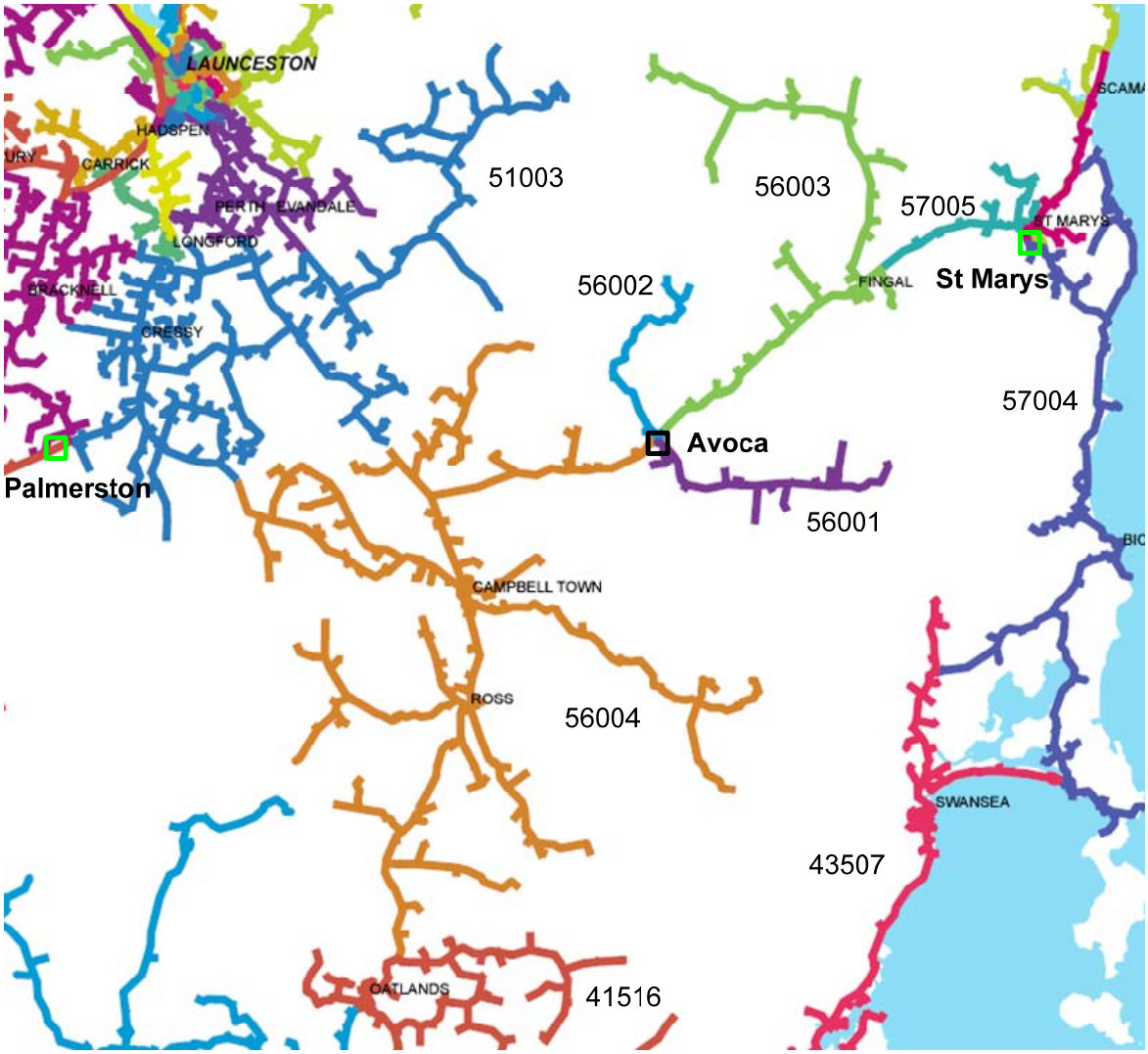


Figure 8-6 Avoca 22 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the 2009 historical feeder peak loads. The feeder forecast is outlined in Table 8-3.

Table 8-3 Avoca substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
56001	0.2	0.2	0.2	0.2	0.2	0.2
56002	0.0	0.0	0.0	0.0	0.0	0.0
56003	3.5	3.6	3.7	3.7	3.8	3.9
56004	5.3	5.4	5.6	5.7	5.8	6.0

As outlined above, there are no feeders that exceed the feeder planning rating of 10 MVA within the period of study.

The available transfer capacity from Avoca substation to St Marys substation is outlined in Table 8-4.

Table 8-4 Avoca substation transfer capability

Substation	Feeder	2012 Transfer (MVA)	2013 Transfer (MVA)	2014 Transfer (MVA)	2015 Transfer (MVA)	2016 Transfer (MVA)	2017 Transfer (MVA)
St Marys		3.5	3.5	3.5	3.5	3.4	3.4
Total transfers	-	3.5	3.5	3.5	3.5	3.4	3.4

As outlined above, there is only a small amount of transfer capacity away from Avoca for the period of study.

8.2.2 Proposed projects

Install second 110/22 kV transformer at Avoca

For information on the options analysis and justification for this project please refer to the ten year plan in Section 7.1.1. The impact on the distribution network is the installation of a new 22 kV switchboard which would allow the establishment of future 22 kV feeders.

The resulting Avoca five year load forecast is shown in Figure 8-7.

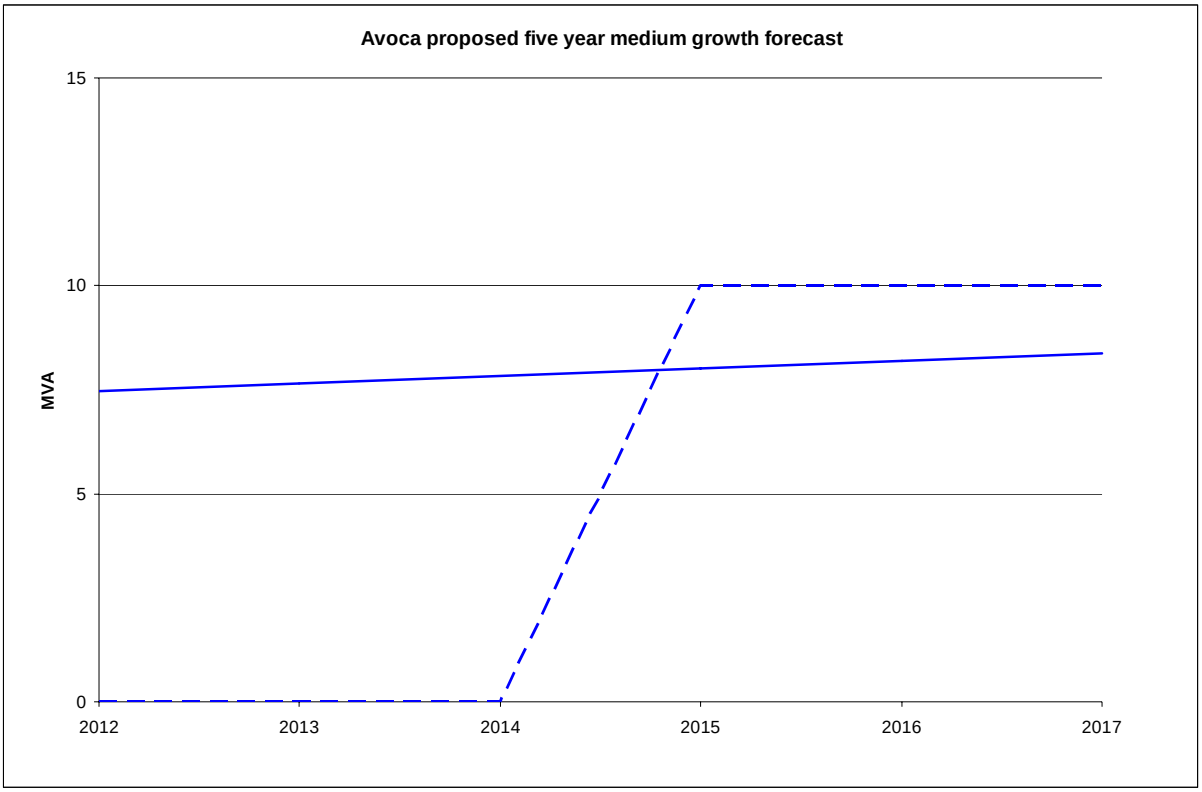


Figure 8-7 Avoca proposed five year medium growth forecast

As outlined above, Avoca firm capacity is increased above firm capacity in 2015.

8.2.3 Ultimate configuration

Substation

Avoca is expected to be a two 110/22 kV transformer substation up to 2050. The existing 110/22 kV 10 MVA transformer was installed in 1997 so is predicted to be end of life around 2047. It is expected that radiator fans will be required on the existing transformer, though this may be deferred until the load at Avoca exceeds 10 MVA (forecast for 2026).

The long term plan discusses the option of establishing Avoca as a 66 kV injection point, which would require the installation of a 110 kV bus, two 110/66 kV transformers and 66 kV switchgear. The first substation works involving the introduction of a 66 kV system are expected to be required around 2035, should the 66 kV option be pursued.

Feeders

As discussed above, there are no feeder limitations at Avoca up to 2017.

Feeder 56004 to Ross and Campbell Town will require support for reliability and capacity limitations in the near term. It is expected that Palmerston feeder 51003 will be significantly deloaded by the establishment of Westbury and Longford substations proposed for 2017 and 2021 respectively. At this time it is proposed that load be transferred from 56004 to 51003 to ease the reliability issues in the Ross and Campbell Town areas. Subsequent reinforcement to the area could be accomplished by running a 5 km section of 22 kV feeder to create a second backbone between Ross and Campbell Town, and hence a second supply into Ross.

As discussed in the long term and ten year plans, it is also proposed to reinforce the Swansea area from Avoca by extending lightly loaded feeder 56001 in 2020. There is the potential to build this feeder at 66 kV to simplify the future supply of a 66/22 kV zone substation in the Swansea area, should the 66 kV option be pursued.

The long term plan proposes the establishment of substations in the Ross and Swansea areas. It is expected that the above feeder reinforcement would provide adequate supply to these areas until the substation is required (proposed for 2035 and 2045 in the long term plan for Swansea and Ross respectively).

8.3 Triabunna substation

Triabunna terminal substation supplies the east coast townships of Triabunna, Orford, Pontypool and Swansea.

8.3.1 Limitations

Using the medium growth forecast, Triabunna distribution substation load is forecast to grow from 9.3 MVA in 2012 to 9.8 MVA in 2017, well below the substation firm capacity of 25 MVA. The five year load forecast for Triabunna substation is given in Figure 8-8.

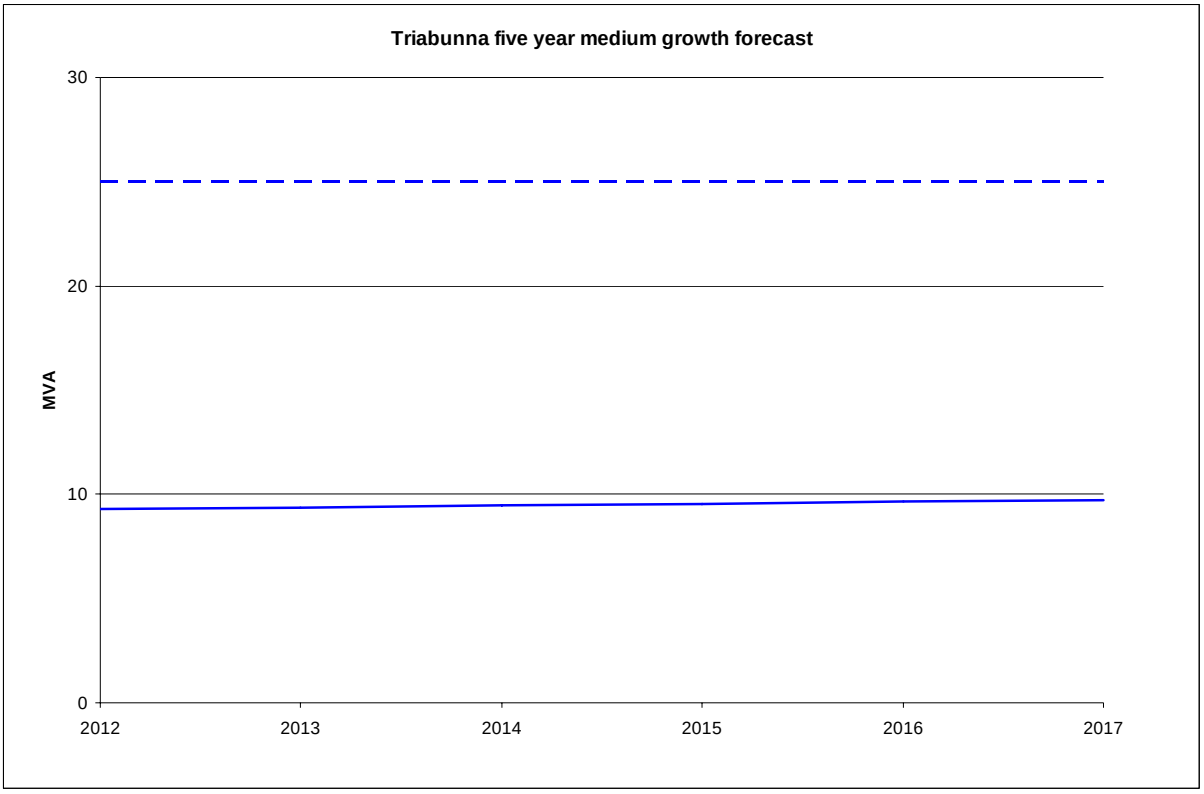


Figure 8-8 Triabunna five year medium growth forecast

The 22 kV network from Triabunna consists of three distribution feeders and there are no spare feeder circuit breakers available for future feeders.

The Triabunna supply area and individual feeders are shown in Figure 8-9 and Figure 8-10 below.

Figure 8-9 Triabunna 22 kV supply area

Figure 8-10 Triabunna 22 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the 2009 historical feeder peak loads. The feeder forecast is outlined in Table 8-5.

Table 8-5 Triabunna substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
43505	5.1	5.2	5.2	5.3	5.3	5.4
43506	3.2	3.3	3.3	3.3	3.4	3.4
43507	3.9	3.9	4.0	4.0	4.1	4.1

As outlined above, there are no feeders that exceed the feeder planning rating of 10 MVA within the period of study. It should be noted that feeder 43505 is a dedicated supply to the Triabunna Woodchip Mill.

There is no available transfer capacity from Triabunna substation to adjacent substations.

8.3.2 Proposed projects

There are no projects proposed in the Triabunna supply area in the five year plan.

8.3.3 Ultimate configuration

Substation

Triabunna is expected to remain a two 110/22 kV transformer substation up to 2050. The transformers at Triabunna are not expected to require replacement on condition grounds prior to 2050, however the switchgear may need to be extended in order to establish future 22 kV feeders out of the substation.

The Sorell report long term plan discussed the potential to convert Triabunna to a 66/22 kV zone substation beyond 2050, should the 66 kV option be pursued.

Feeders

As discussed above, there are no feeder limitations at Triabunna up to 2017.

Feeder 45307 to Swansea will require support for reliability and capacity limitations in the near term. A project to extend Avoca feeder 56001 to Swansea has been proposed to address this limitation in the ten year plan. Tentative timing of 2020 has been proposed, however the actual timing is dependent on load growth and reliability requirements in the Swansea area.

The long term plan proposes the establishment of a substation in the Swansea area. It is expected that the existing feeders from Triabunna and St Marys, as well as the proposed new feeder from Avoca, will provide adequate supply to the area until the substation is required (proposed for 2035 in the long term plan).

Appendix A
Estimating data

Appendix A

The following tables list the standard feeder and substation costs used for this report.

Voltage	Feeder Type	Cost ($k/km)			Source
		Rural	Urban	High Density Urban	
110 kV	Overhead single circuit	450	-	-	Transend (advised $400-500k)
110 kV	Over head single circuit (double circuit construction)	500	-	-	Transend (advised $400-500)
110 kV	Overhead double circuit	550	-	-	Transend (advised $500-600k)
66 kV	Overhead single circuit	250	-	-	Aurora
66 kV	Overhead double circuit	330	-	-	Aurecon assumption
66 kV	Overbuild of existing 22 kV	180	290	360	Aurecon assumption
33 kV	Underground single circuit	250	300	500	Aurora
33 kV	Underground double circuit	420	500	750	Aurora
33 kV	Overhead single circuit	150	200	300	Aurora
22 kV	Overhead single circuit	100	150	200	Aurora
22 kV	Underground single circuit	220	270	470	Aurora
22 kV	Underground double circuit	360	440	690	Aurora
11 kV	Overhead single circuit	100	150	200	Aurora
11 kV	Underground single circuit	220	270	470	Aurora
11 kV	Underground double circuit	360	440	690	Aurora

Component	Cost ($k)	Source
110/22/11 kV terminal substation	17,500	Transend (advised $15-20M)
110/22/11 kV terminal substation (single 25 MVA transformer)	9,000	Transend (advised $8-10M)
Install 3rd 110/22/11 kV transformer at existing site	7,000	Transend (advised $6-8M)
Install 3rd 33/11 kV transformer at existing site	3,000	Aurecon assumption
Replace 2 x 110/22/11 kV 60 MVA transformers	6,000	Aurecon assumption based Transend projects in APR
Replace 2 x 110/22/11 kV 25 MVA transformers	5,000	Aurecon assumption based Transend projects in APR
Establish 110/33 kV substation at existing site	13,500	Transend (advised $12-15M)
Establish 110/66 kV substation at existing site	14,000	Aurecon assumption
66/22 kV zone substation	9,000	Aurora
33/11 kV zone substation	7,000	Aurora
33 kV switchboard (5 CBs in existing building)	500	Aurecon assumption
11 kV switchboard (8 CBs in existing building)	300	Aurecon assumption

Appendix B
NPV analysis

Appendix B

The following table lists the NPV analyses attached in this section of the report.

NPV	Project	Section reference
1	East Coast 66 kV vs 110 kV	6.2
2	Install 2nd transformer at Avoca terminal substation	7.1.1
3	Extend 22 kV feeder 56001 from Avoca to Swansea	7.1.2
4	Extend 22 kV feeder 57003 from St. Marys to St. Helens	7.1.3

East Coast 66 kV vs 110 kV NPV analysis

Base Year

2010

OPTION 1

Close 110 kV ring Derby-St Marys and establish 66 kV injection at Avoca

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2013	2012	2014	Avoca and St Marys exceed firm capacity	Upgrade St Marys transformers: - 2 x 25 MVA 110/22 kV transformers Split Palmerston feeder 51003 (common)	$5,000	$4.24	$4.12	$4.01	$4.48	$4.40	$4.32	$4.01	$3.87	$3.72
2015	2014	2016	Avoca and St Marys exceed firm capacity	Install 2nd transformer at Avoca: - 1x10 MVA 110/22 kV transformer	$5,000	$3.80	$3.63	$3.46	$4.01	$3.87	$3.72	$3.60	$3.40	$3.21
2015	2014	2016	Ross 22 kV feeder limitations	Split Palmerston feeder 3	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2017	2016	2018	110 kV network N-1	Establish 110 kV SCCT Derby-St Marys: - 65 km 110 kV SCCT - 2 x 110 kV feeder CBs at Derby - 110 kV bus at St Marys Reconductor Palmerston-Avoca SCCT 110kV	$40,500	$27.58	$25.82	$24.19	$29.14	$27.54	$26.04	$26.11	$24.22	$22.47
2020	2018	2022	St Helens 22 kV feeder limitations	Extend 22 kV feeder 57003 from St Marys: - 11 km new 22 kV SCCT overhead - 12 km reconductor 7/.134, 7/3.75, 6/1/.144 AAC and 7/.064 Cu to 19/3.25 AAC	$2,300	$1.33	$1.21	$1.10	$1.48	$1.38	$1.28	$1.19	$1.06	$0.95
2020	2018	2022	Swansea 22 kV feeder limitations	Extend 22 kV feeder from Avoca to Swansea: - 15 km new 22 kV SCCT overhead (built at 66kV) - 20 km reconductor 7/.134 AAC and 7/.064 Cu to 19/3.25 AAC	$5,750	$3.32	$3.02	$2.75	$3.71	$3.44	$3.19	$2.98	$2.66	$2.38
2035	2030	2040	Swansea 22 kV feeder limitations	Establish Avoca 66 kV injection: - 1 x 110/66 kV transformers - 66 kV bus	$8,000	$2.03	$1.60	$1.27	$2.67	$2.21	$1.83	$1.54	$1.16	$0.88
2035	2030	2040	Swansea 22 kV feeder limitations	Establish Swansea zone substation: - 2 x 66/22 kV 25 MVA transformer - 1 x 22 kV switchboard - 45 km 66 kV SCCT	$20,250	$5.14	$4.06	$3.21	$6.76	$5.60	$4.64	$3.90	$2.94	$2.22
2045	2035	2055	Oatlands/Ross feeder limitations	Establish Ross zone substation: - Install second 110/66 kV transformer at Avoca - 2 x 66/22 kV 25 MVA transformer - 1 x 22 kV switchboard - 40 km 66 kV SCCT	$26,000	$3.81	$2.74	$1.98	$6.60	$5.21	$4.13	$2.20	$1.44	$0.95
					Total	**$51.25**	**$46.21**	**$41.98**	**$58.85**	**$53.64**	**$49.15**	**$45.54**	**$40.75**	**$36.79**

Base Year
2010

OPTION 2
Close 110 kV ring Derby-St Marys and extend 110 kV network

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2013	2012	2014	Avoca and St Marys exceed firm capacity	Upgrade St Marys transformers: - 2 x 25 MVA 110/22 kV transformers Split Palmerston feeder 51003 (common)	$5,000	$4.24	$4.12	$4.01	$4.48	$4.40	$4.32	$4.01	$3.87	$3.72
2015	2014	2016	Avoca and St Marys exceed firm capacity	Install 2nd transformer at Avoca: - 1x10 MVA 110/22 kV transformer	$5,000	$3.80	$3.63	$3.46	$4.01	$3.87	$3.72	$3.60	$3.40	$3.21
2015	2014	2016	Ross 22 kV feeder limitations	Split Palmerston feeder 3	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2017	2016	2018	110 kV network N-1	Establish 110 kV SCCT Derby-St Marys: - 65 km 110 kV SCCT - 2 x 110 kV feeder CBs at Derby - 110 kV bus at St Marys Reconductor Palmerston-Avoca SCCT 110kV	$40,500	$27.58	$25.82	$24.19	$29.14	$27.54	$26.04	$26.11	$24.22	$22.47
2020	2018	2022	St Helens 22 kV feeder limitations	Extend 22 kV feeder 57003 from St Marys: - 11 km new 22 kV SCCT overhead - 12 km reconductor 7/.134, 7/3.75, 6/1/.144 AAC and 7/.064 Cu to 19/3.25 AAC	$2,300	$1.33	$1.21	$1.10	$1.48	$1.38	$1.28	$1.19	$1.06	$0.95
2020	2018	2022	Swansea 22 kV feeder limitations	Extend 22 kV feeder from Avoca to Swansea: - 15 km new 22 kV SCCT overhead - 20 km reconductor 7/.134 AAC and 7/.064 Cu to 19/3.25 AAC	$3,500	$2.02	$1.84	$1.68	$2.26	$2.09	$1.94	$1.81	$1.62	$1.45
2035	2030	2040	Swansea 22 kV feeder limitations	Establish Swansea terminal substation: - 2 x 25 MVA transformers - 22 kV bus - 50 km 110 kV SCCT from Avoca	$40,000	$10.15	$8.02	$6.35	$13.35	$11.06	$9.17	$7.71	$5.81	$4.39
2045	2035	2055	Oatlands/Ross feeder limitations	Establish Ross terminal substation: - Install 110 kV feeder CB at Avoca - 2 x 25 MVA transformers - 22 kV bus - 20 km 110 kV SCCT tee off Avoca-Palmerston	$26,800	$3.93	$2.82	$2.04	$6.80	$5.37	$4.25	$2.27	$1.49	$0.98
					Total	**$53.05**	**$47.46**	**$42.82**	**$61.52**	**$55.70**	**$50.73**	**$46.71**	**$41.46**	**$37.18**

Base Year
2010

OPTION 3
DCCT 110 kV Palmerston-Avoca and establish 66 kV injection at Avoca

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2013	2012	2014	Avoca and St Marys exceed firm capacity	Install 2nd transformer at Avoca: - 1x10 MVA 110/22 kV transformer Extend 22 kV feeder from Avoca to Swansea: - 15 km new 22 kV SCCT overhead (built at 66 kV) - 20 km reconductor 7/.134 AAC and 7/.064 Cu to 19/3.25 AAC Split Palmerston feeder 51003 (common)	$10,750	$9.12	$8.86	$8.62	$9.63	$9.45	$9.28	$8.63	$8.31	$8.01
2015	2014	2016	Ross 22 kV feeder limitations	Split Palmerston feeder 3	$0	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2017	2016	2018	110 kV network N-1	Establish DCCT 110 kV from Palmerston to Avoca: - 65 km 110 kV DCCT - 110 kV bus at Avoca - Terminate old 110 kV feeder as 22 kV tie Palmerston to Avoca Establish 66 kV SCCT Avoca to St Marys, energised at 22 kV - 50 km 66 kV SCCT	$46,000	$31.33	$29.33	$27.48	$33.10	$31.28	$29.57	$29.66	$27.50	$25.53
2020	2018	2022	St Helens 22 kV feeder limitations	Extend 22 kV feeder 57003 from St Marys: - 11 km new 22 kV SCCT overhead - 12 km reconductor 7/.134, 7/3.75, 6/1/.144 AAC and 7/.064 Cu to 19/3.25 AAC	$2,300	$1.33	$1.21	$1.10	$1.48	$1.38	$1.28	$1.19	$1.06	$0.95
2025	2020	2030	Avoca firm capacity and St Marys ESI 25MW limitation (limitation date is flexible…)	Establish Avoca 66 kV injection: - 1 x 110/66 kV transformer, no 66 kV switchgear initially Install 66/22 kV transformer at St Marys supplied from 66 kV feeder. Existing 110/22 kV transformers paralleled: - 1 x 66/22 kV transformer - Parallel 110/22 kV transformers onto single incomer and split bus	$12,000	$5.27	$4.57	$3.98	$6.93	$6.31	$5.75	$4.01	$3.32	$2.75
2035	2030	2040	St Marys 110/22 kV transformers end of life	Install 2nd 66/22 kV transformer at St Marys: - 1 x 66/22 kV transformer, supplied from old 110 kV line Install 2nd 110/66 kV transformer and 66 kV bus at Avoca: - 1 x 60 MVA 110/66 kV transformer - 1 x 66 kV bus	$11,000	$2.79	$2.20	$1.75	$3.67	$3.04	$2.52	$2.12	$1.60	$1.21
2035	2030	2040	Swansea 22 kV feeder limitations	Establish Swansea zone substation: - 2 x 66/22 kV 25 MVA transformer - 1 x 22 kV switchboard - 60 km 66 kV SCCT	$20,250	$5.14	$4.06	$3.21	$6.76	$5.60	$4.64	$3.90	$2.94	$2.22
2050	2040	2060	Oatlands/Ross feeder limitations	Establish Ross zone substation: - 2 x 66/22 kV 25 MVA transformer - 1 x 22 kV switchboard - 66 kV SCCT 20km (connected to old 110 kV)	$14,000	$1.56	$1.07	$0.74	$2.70	$2.03	$1.54	$0.90	$0.56	$0.35
					Total	**$56.53**	**$51.31**	**$46.87**	**$64.27**	**$59.09**	**$54.58**	**$50.41**	**$45.30**	**$41.02**

Install 2nd transformer at Avoca terminal substation NPV analysis (East Coast area)

Base Year
2010

OPTION 1
Install 2nd transformer at Avoca terminal substation

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2014	2013	2015	Avoca exceeds firm capacity	Install 2nd transformer at Avoca: - 110/22 kV transformer - 1 x 11 kV switchboard - 1 x 110 kV CB	$5,000	$4.01	$3.87	$3.72	$4.24	$4.12	$4.01	$3.80	$3.63	$3.46
					Total	**$4.01**	**$3.87**	**$3.72**	**$4.24**	**$4.12**	**$4.01**	**$3.80**	**$3.63**	**$3.46**

OPTION 2
Reinforce 22 kV network to Avoca

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2014	2013	2015	Avoca exceeds firm capacity	Reinforce 22 kV network to Avoca: - 15 km 22 kV reconductor St Marys-Avoca	$1,500	$1.20	$1.16	$1.12	$1.27	$1.24	$1.20	$1.14	$1.09	$1.04
2020	2019	2021	Avoca exceeds firm capacity	Install 2nd transformer at Avoca: - 110/22 kV transformer - 1 x 11 kV switchboard - 1 x 110 kV CB	$5,000	$2.89	$2.63	$2.39	$3.05	$2.80	$2.58	$2.73	$2.47	$2.22
					Total	**$4.09**	**$3.79**	**$3.51**	**$4.32**	**$4.04**	**$3.78**	**$3.87**	**$3.55**	**$3.26**

Extend 22 kV feeder 56001 from Avoca to Swansea NPV analysis (East Coast area)

Base Year
2010

OPTION 1
Extend 22 kV feeder 56001 from Avoca

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Reliability in Swansea/Coles Bay area	Extend 22 kV feeder from Avoca: - 15 km new 22 kV SCCT overhead - 20 km reconductor 7/.134 AAC and 7/.064 Cu to 19/3.25 AAC	$3,500	$2.02	$1.84	$1.68	$2.14	$1.96	$1.80	$1.91	$1.73	$1.56
					Total	**$2.02**	**$1.84**	**$1.68**	**$2.14**	**$1.96**	**$1.80**	**$1.91**	**$1.73**	**$1.56**

OPTION 2
Establish new 22 kV feeder from St Marys

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Reliability in Swansea/Coles Bay area	Establish 22 kV feeder from St Marys: - 40 km new 22 kV SCCT overhead	$4,000	$2.31	$2.10	$1.92	$2.44	$2.24	$2.06	$2.19	$1.97	$1.78
					Total	**$2.31**	**$2.10**	**$1.92**	**$2.44**	**$2.24**	**$2.06**	**$2.19**	**$1.97**	**$1.78**

OPTION 3
Establish new 22 kV feeder from Triabunna

Development Year			System Limitation	Description of Works	Cost $k	Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low				5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Reliability in Swansea/Coles Bay area	Establish 22 kV feeder from Triabunna: - 50 km new 22 kV SCCT overhead - Install new 22 kV CB	$5,050	$2.92	$2.66	$2.42	$3.08	$2.83	$2.60	$2.76	$2.49	$2.25
					Total	**$2.92**	**$2.66**	**$2.42**	**$3.08**	**$2.83**	**$2.60**	**$2.76**	**$2.49**	**$2.25**

Extend 22 kV feeder 56001 from Avoca NPV analysis (East Coast area)

Base Year
2010

OPTION 1
Extend 22 kV feeder 56001 from Avoca

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	22 kv feeder reliability/capacity in St Helens area	Extend 22 kV feeder 57003 from St Marys: - 11 km new 22 kV SCCT overhead - 12 km reconductor 7/.134, 7/3.75, 6/1/.144 AAC and 7/.064 Cu to 19/3.25 AAC	$2,300	$1.33	$1.21	$1.10	$1.40	$1.29	$1.19	$1.26	$1.13	$1.02
2034	2033	2035	St Marys exceeds firm capacity	Establish St Helens terminal substation: - 2 x 25 MVA transformers - 22 kV switchboard - 3 x 110 kV CBs	$17,500	$4.69	$3.74	$2.99	$4.95	$3.99	$3.22	$4.44	$3.51	$2.78
					Total	**$6.02**	**$4.95**	**$4.09**	**$6.36**	**$5.28**	**$4.40**	**$5.70**	**$4.64**	**$3.80**

OPTION 2
Establish St Helen terminal substation

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	22 kv feeder reliability/capacity in St Helens area	Establish St Helens terminal substation: - 2 x 25 MVA transformers - 22 kV switchboard - 3 x 110 kV CBs	$17,500	$10.11	$9.20	$8.38	$10.68	$9.81	$9.02	$9.57	$8.63	$7.79
					Total	**$10.11**	**$9.20**	**$8.38**	**$10.68**	**$9.81**	**$9.02**	**$9.57**	**$8.63**	**$7.79**

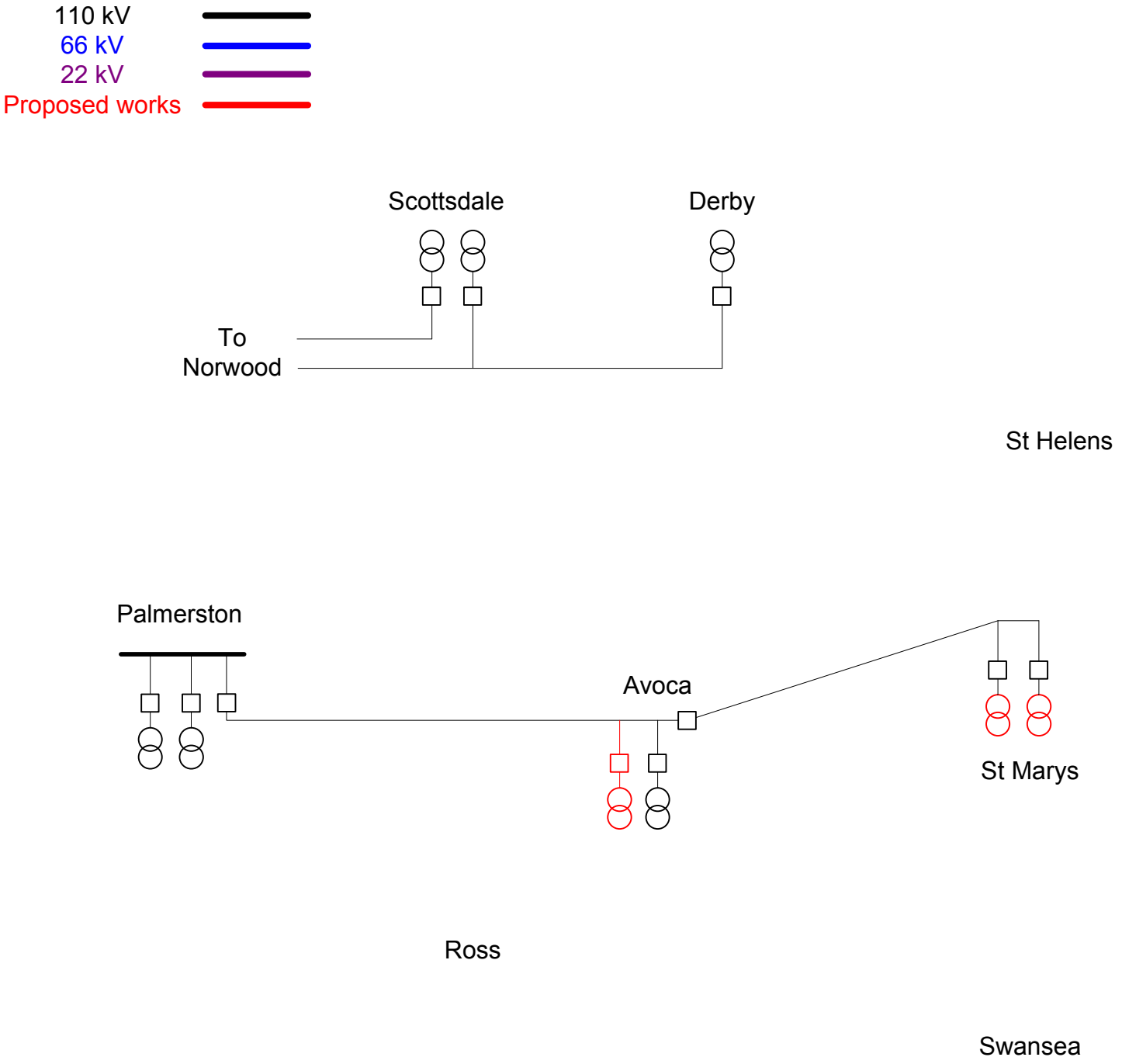
OPTION 3
Establish new 22 kV feeder from Derby

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	22 kv feeder reliability/capacity in St Helens area	Establish new 22 kV feeder from Derby: - 35 km new 22 kV SCCT overhead	$3,500	$2.02	$1.84	$1.68	$2.14	$1.96	$1.80	$1.91	$1.73	$1.56
2034	2033	2035	St Marys exceeds firm capacity	Establish St Helens terminal substation: - 2 x 25 MVA transformers - 22 kV switchboard - 3 x 110 kV CBs	$17,500	$4.69	$3.74	$2.99	$4.95	$3.99	$3.22	$4.44	$3.51	$2.78
					Total	**$6.71**	**$5.58**	**$4.67**	**$7.09**	**$5.95**	**$5.02**	**$6.35**	**$5.23**	**$4.34**

Appendix C
Staging diagrams for East Coast options

Appendix C

Option 1 – Close 110 kV ring Derby-St Marys and establish 66 kV injection at Avoca

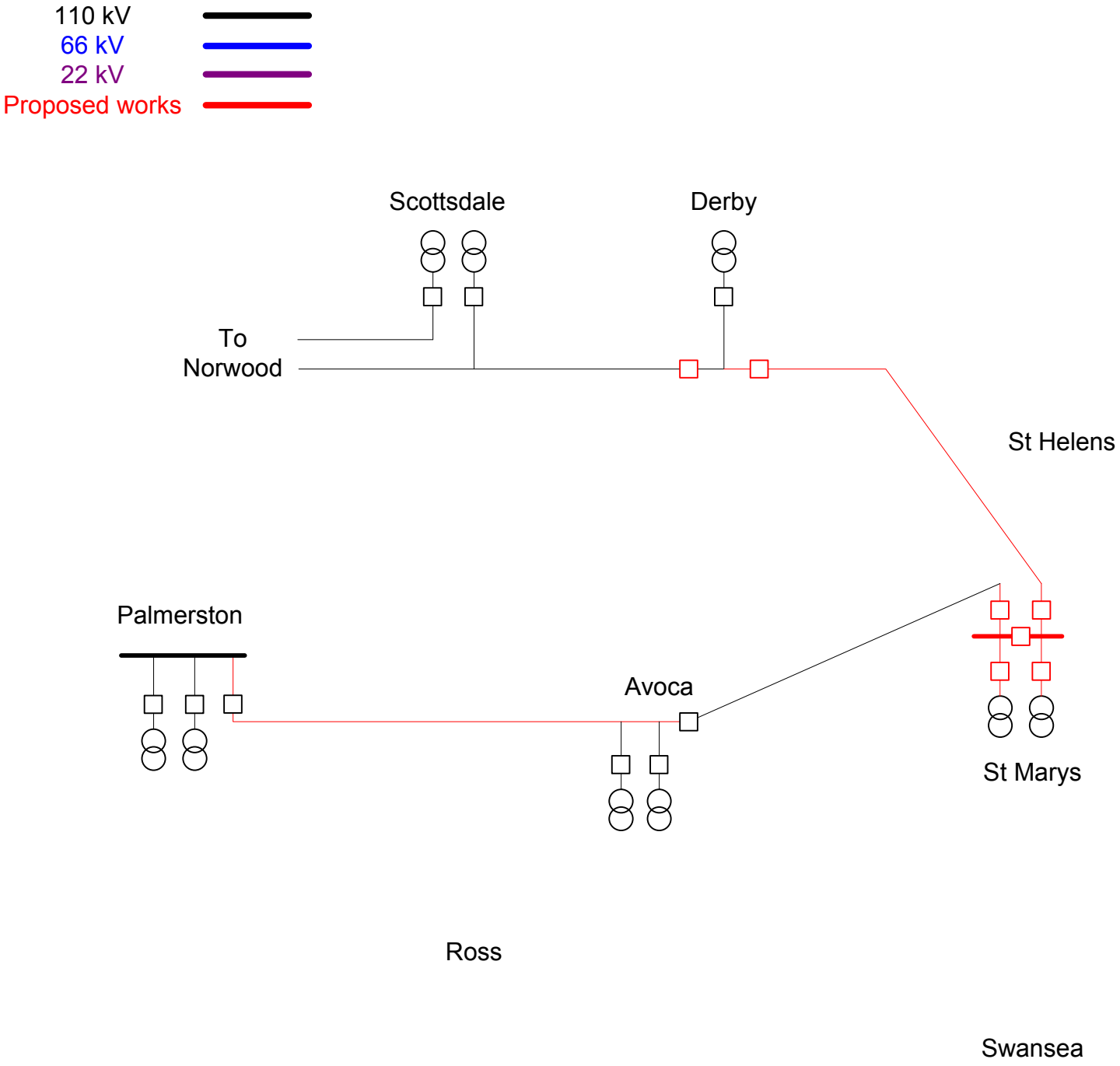


Stage 1 – 2013

Replace St Marys transformers $5M
Assumed Transend timing for this project (can't defer as per the 66 kV option as don't have the 22 kV backup from the 66 kV line installed in stage 2).

Stage 2 – 2015

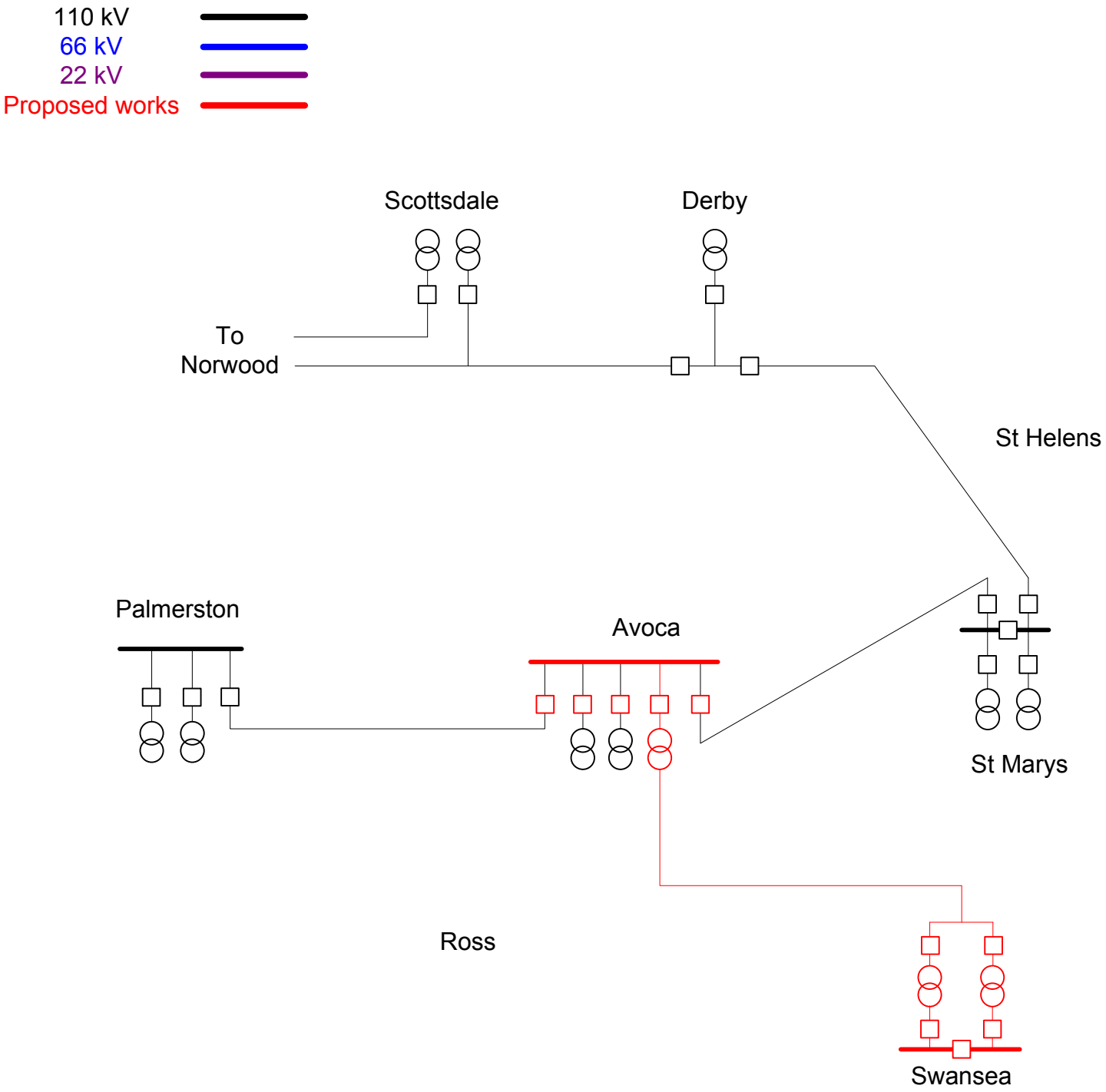
Install 2nd Avoca 110/22 kV transformer $5M
Assumed Transend timing for this project (no potential to defer as per the 66 kV option as don't have 22 kV backup from the old 110 kV line energised at 22 kV).



Stage 3 – 2017

Establish 110 kV SCCT Derby-St Marys $40.5M
- Install 110 kV DCCT 65km
- Install 110 kV bus at St Marys and 110 kV feeder CBs at Derby
- Reconductor Palmerston-Avoca 110 kV SCCT 65km

This project addresses the N-1 limitations on the 110 kV network. 2017 was chosen since this is the date nominated by Transend for closing the 110 kV ring from Derby to St Marys. There is potential to only bring the 110 kV as far as St Helens initially, however the cost of the substation is expected to be higher than extending the 110 kV line.

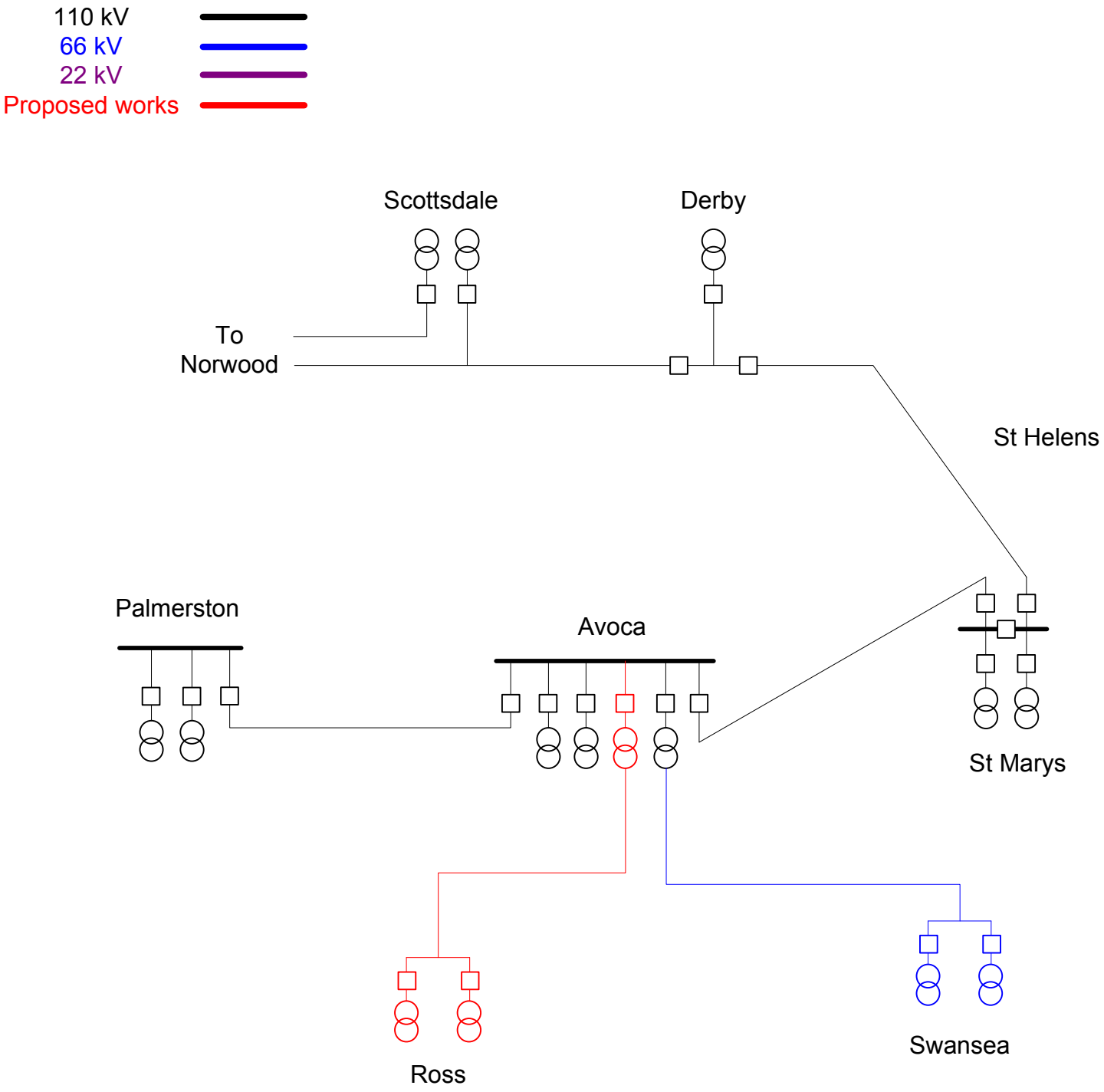


Stage 4 – 2035

Establish 110/66 kV substation at Avoca $8M
- 110 kV bus
- 1 x 110/66 kV 60 MVA transformer

Establish 66/22 kV substation at Swansea $20.25M
- 2 x 66/22 kV 25 MVA transformers
- 22 kV switchgear
- 45km 66 kV SCCT

This project addresses the firm capacity limitation at St Marys and the 22 kV limitations in the Swansea/Bicheno area.

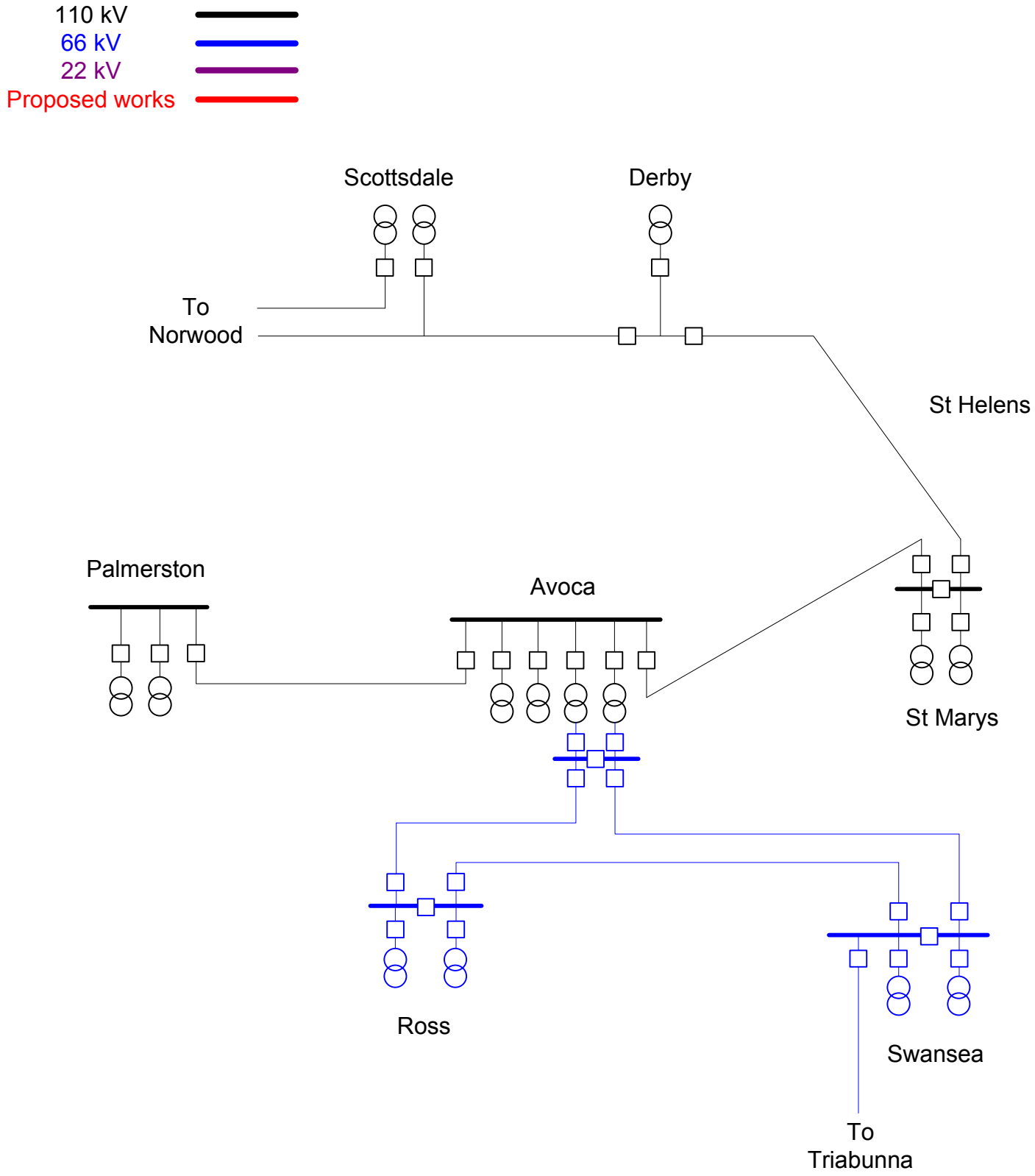


Stage 5 – 2045

Install second 110/66 kV transformer at Avoca $7M
- 1 x 110/66 kV 60 MVA transformer

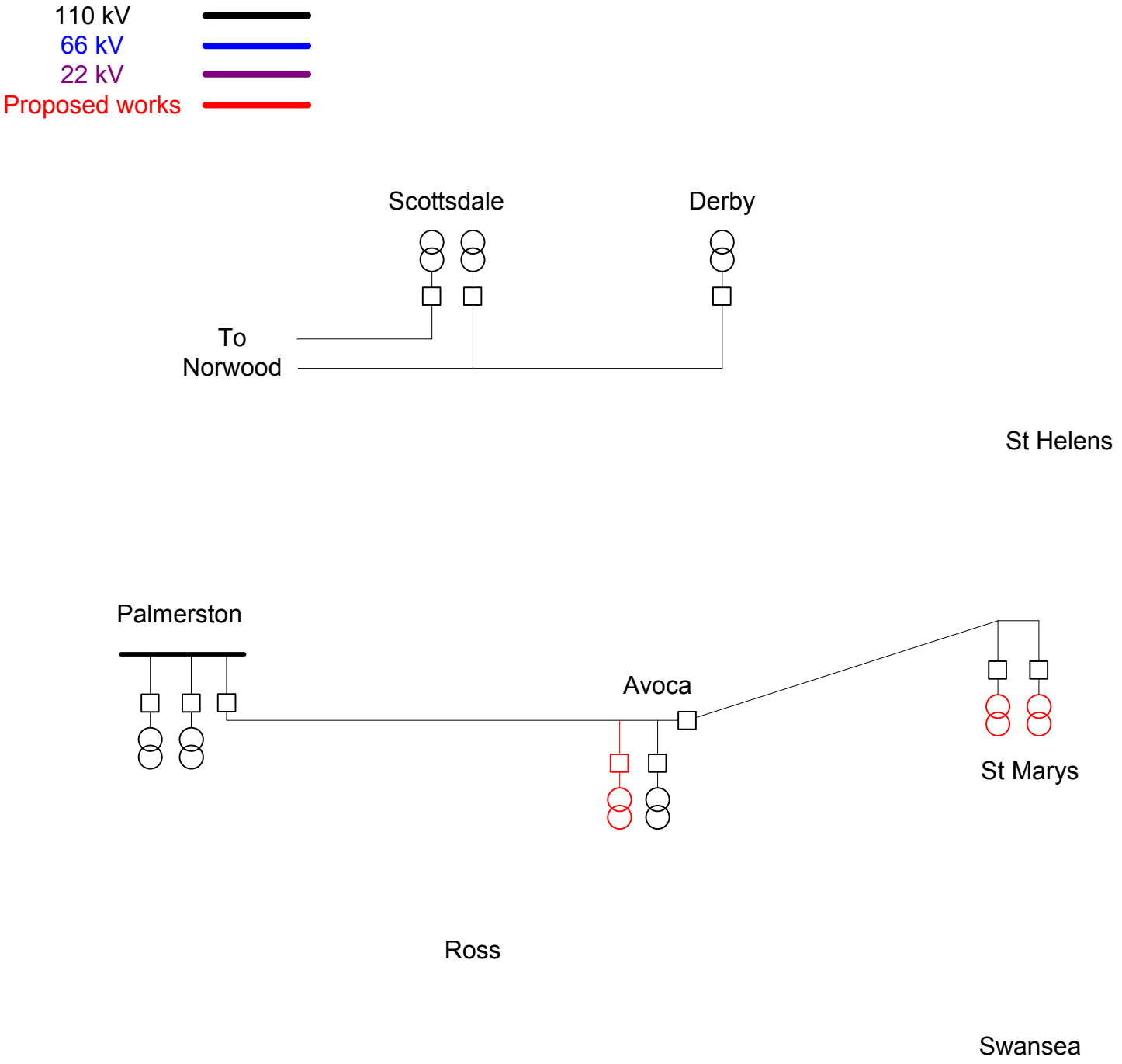
Establish 66/22 kV substation at Ross $19M
- 2 x 66/22 kV 25 MVA transformers
- 22 kV switchgear
- 40km 66 kV SCCT

The timing of this project would be driven by 22 kV feeder limitations in the Ross and Oatlands area


110 kV
66 kV
22 kV
Proposed works
Scottsdale
Derby
To
Norwood
St Helens
Palmerston
Avoca
St Marys
Ross
Swansea
To
Triabunna

Ultimate

Option 2 – Close 110 kV ring Derby-St Marys and extend 110 kV network

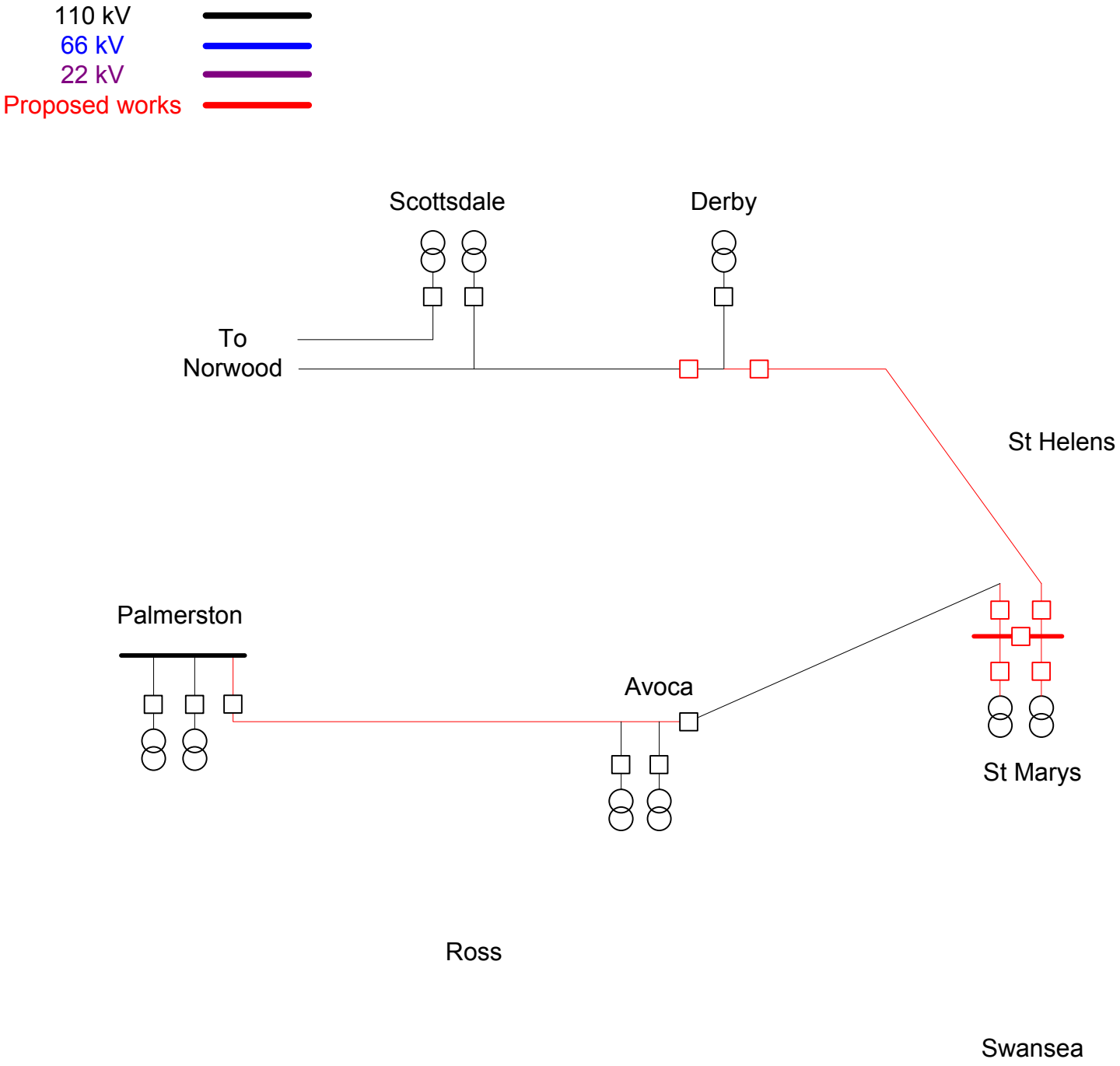


Stage 1 – 2013

Replace St Marys transformers $5M
Assumed Transend timing for this project (can't defer as per the 66 kV option as don't have the 22 kV backup from the 66 kV line installed in stage 2).

Stage 2 – 2015

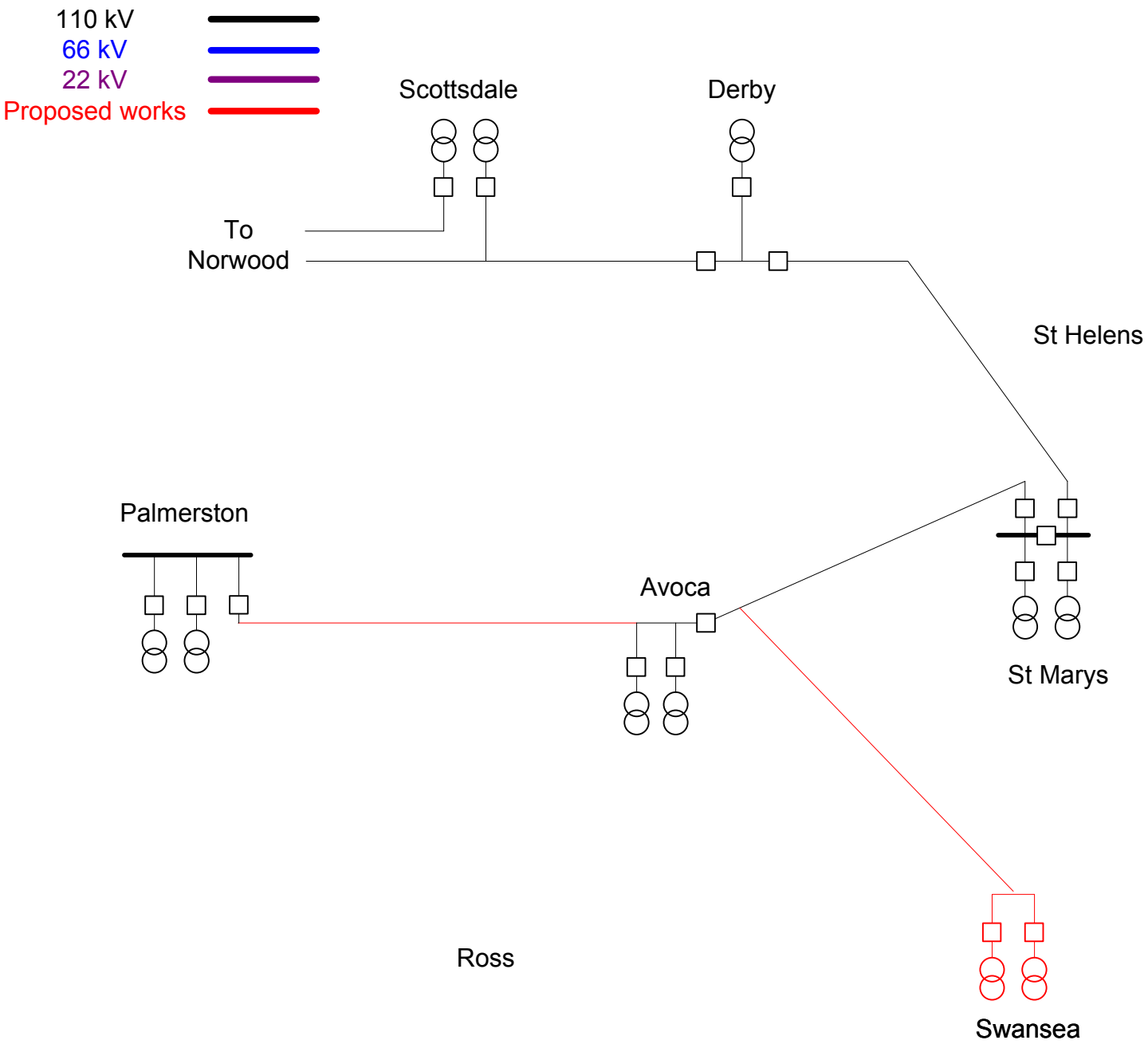
Install 2nd Avoca 110/22 kV transformer $5M
Assumed Transend timing for this project (no potential to defer as per the 66 kV option as don't have 22 kV backup from the old 110 kV line energised at 22 kV).



Stage 3 – 2017

Establish 110 kV SCCT Derby-St Marys $40.5M
- Install 110 kV DCCT 65km
- Install 110 kV bus at St Marys and 110 kV feeder CBs at Derby
- Reconductor Palmerston-Avoca 110 kV SCCT 65km

This project addresses the N-1 limitations on the 110 kV network. 2017 was chosen since this is the date nominated by Transend for closing the 110 kV ring from Derby to St Marys. There is potential to only bring the 110 kV as far as St Helens initially, however the cost of the substation is expected to be higher than extending the 110 kV line.



Stage 4 – 2020

Reinforce St Marys-St Helens 22 kV network $2.3M
This project addresses the forecast 22 kV feeder limitations in the St Helens area.

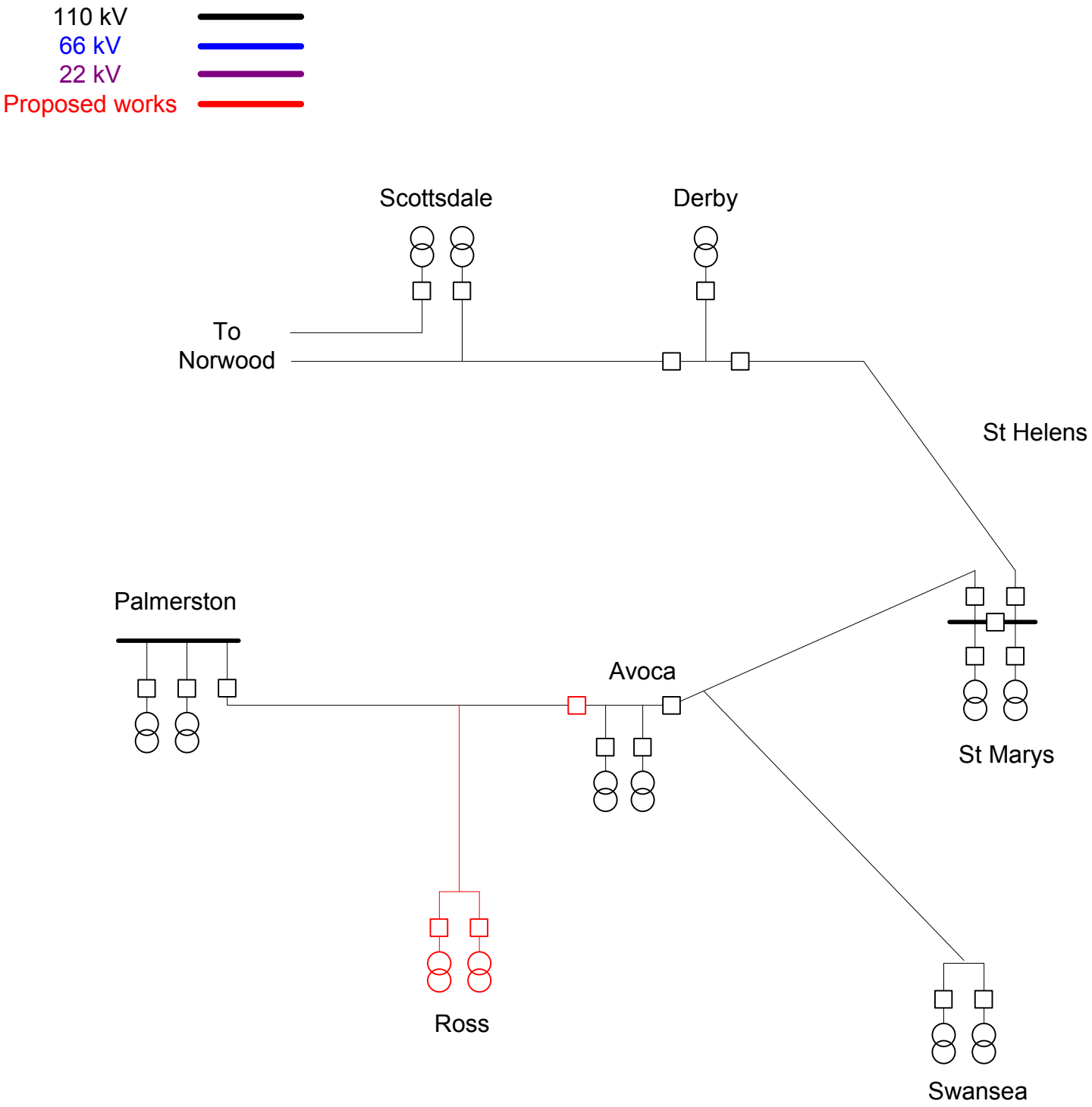
Stage 5 – 2020

22 kV augmentation Avoca to Swansea $3.5M
This project addresses 22 kV feeder limitations in the Swansea area.

Stage 6 – 2035

Establish Swansea terminal substation $40M
- 2 x 25 MVA transformers
- 110 kV SCCT 50km

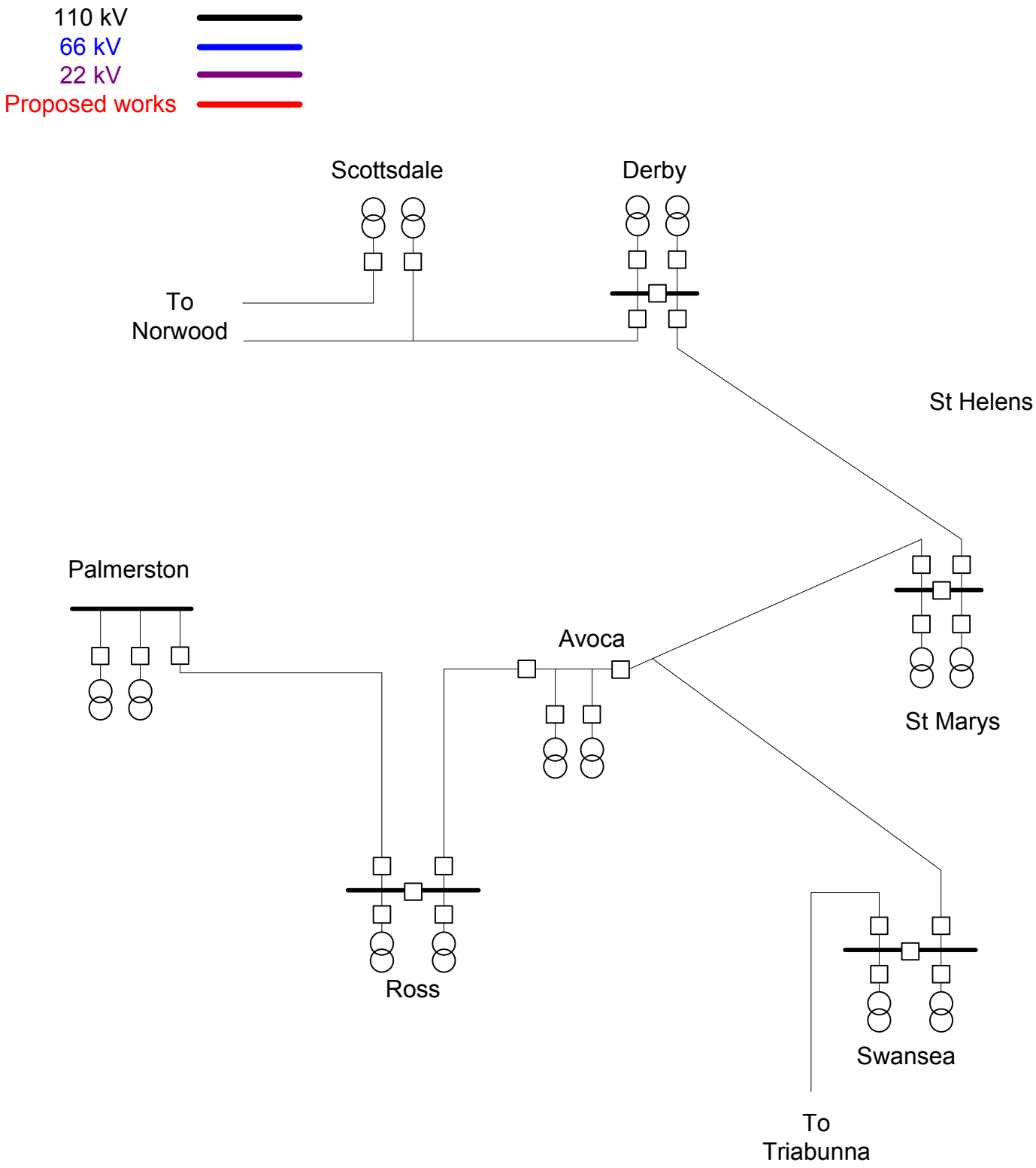
This project addresses the firm capacity limitation at St Marys and the 22 kV limitations in the Swansea/Bicheno area.



Stage 7 – 2045

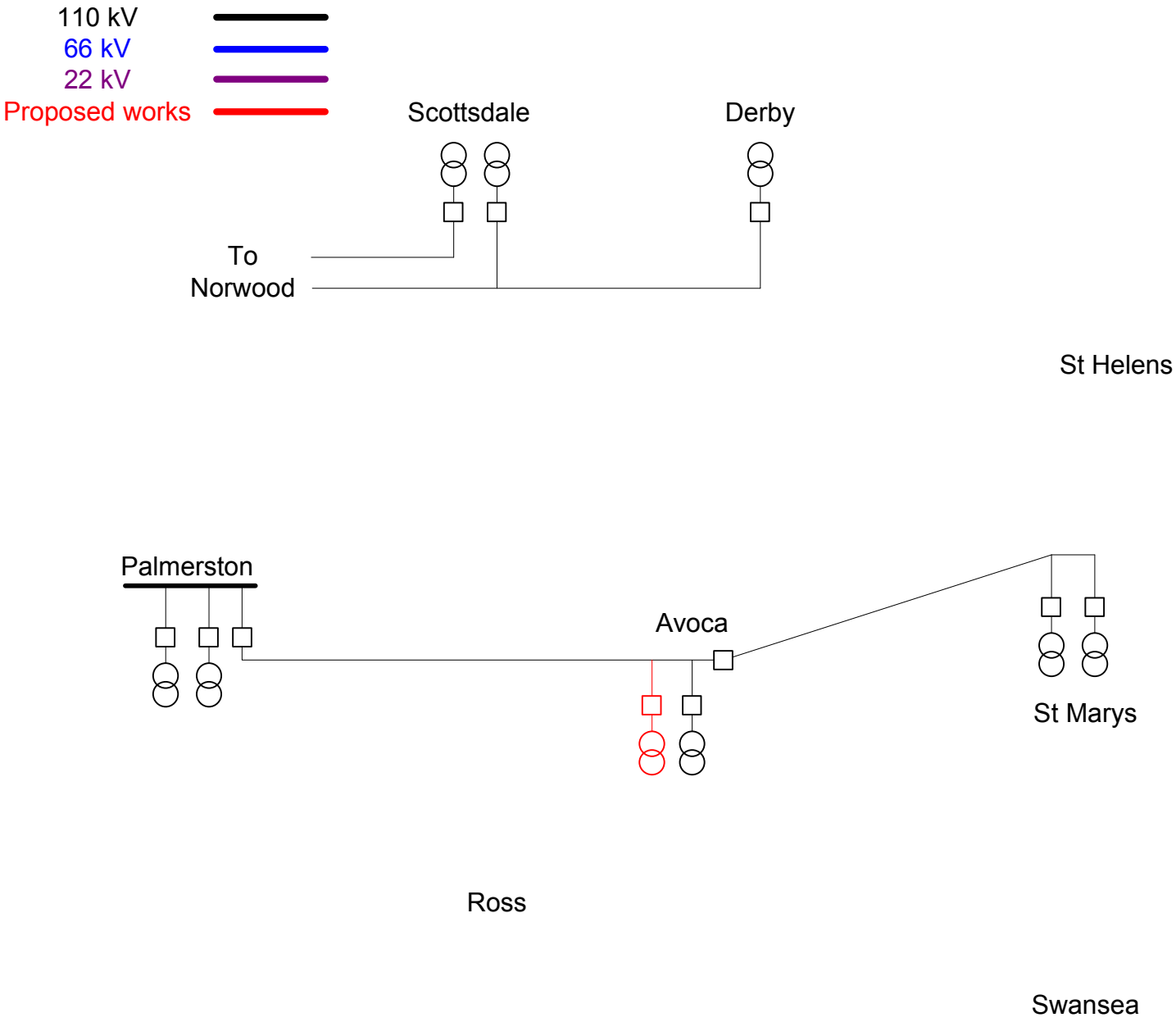
Establish 110/22 kV substation at Ross $27M
- 2 x 25 MVA transformers
- 110 kV SCCT 20km

The timing of this project would be driven by 22 kV feeder limitations in the Ross and Oatlands area


110 kV
66 kV
22 kV
Proposed works
Scottsdale
Derby
To
Norwood
St Helens
Palmerston
Avoca
St Marys
Ross
Swansea
To
Triabunna

Ultimate

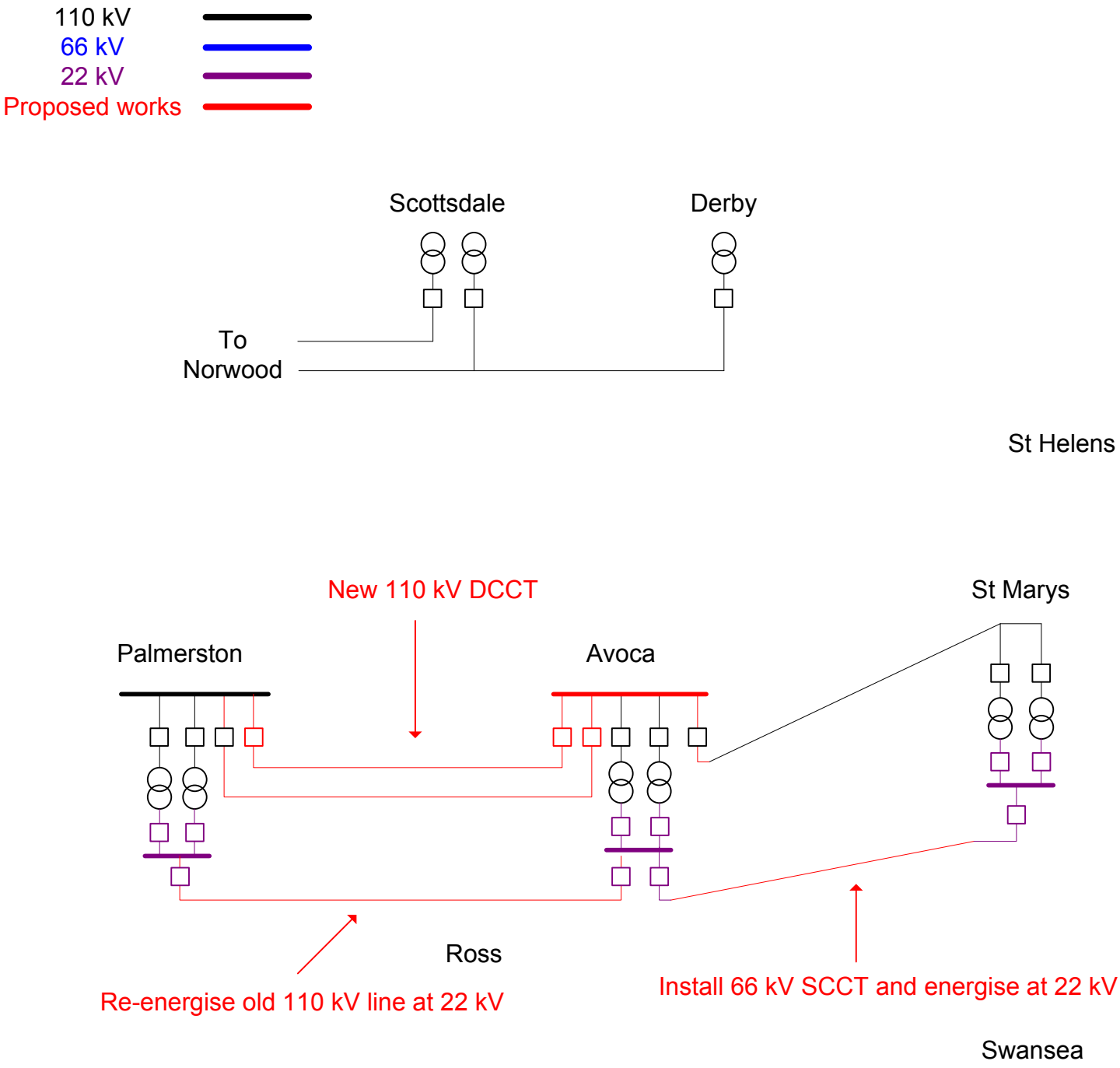
Option 3 – Establish DCCT 110 kV Palmerston-Avoca and establish 66 kV injection at Avoca



Stage 1 – 2013

Install 2nd transformer at Avoca $5M:
This project addresses the firm capacity limitation at Avoca. May be able to avoid this if there is enough transfer capacity away from Avoca after splitting Palmerston feeder 3. If not, potential to reinforce Avoca-St Marys 22 kV network to gain transfer capacity.

22 kV augmentation Avoca to Swansea $5M ($3.5M if built at 22 kV)
This project addresses the firm capacity limitation at St Marys by providing transfer capacity away from St Marys. The new sections of line would be built at 66 kV to facilitate the future establishment of a 66/22 kV zone substation at Swansea. This project also addresses the expected 22 kV feeder limitations in the Swansea area in 2020.



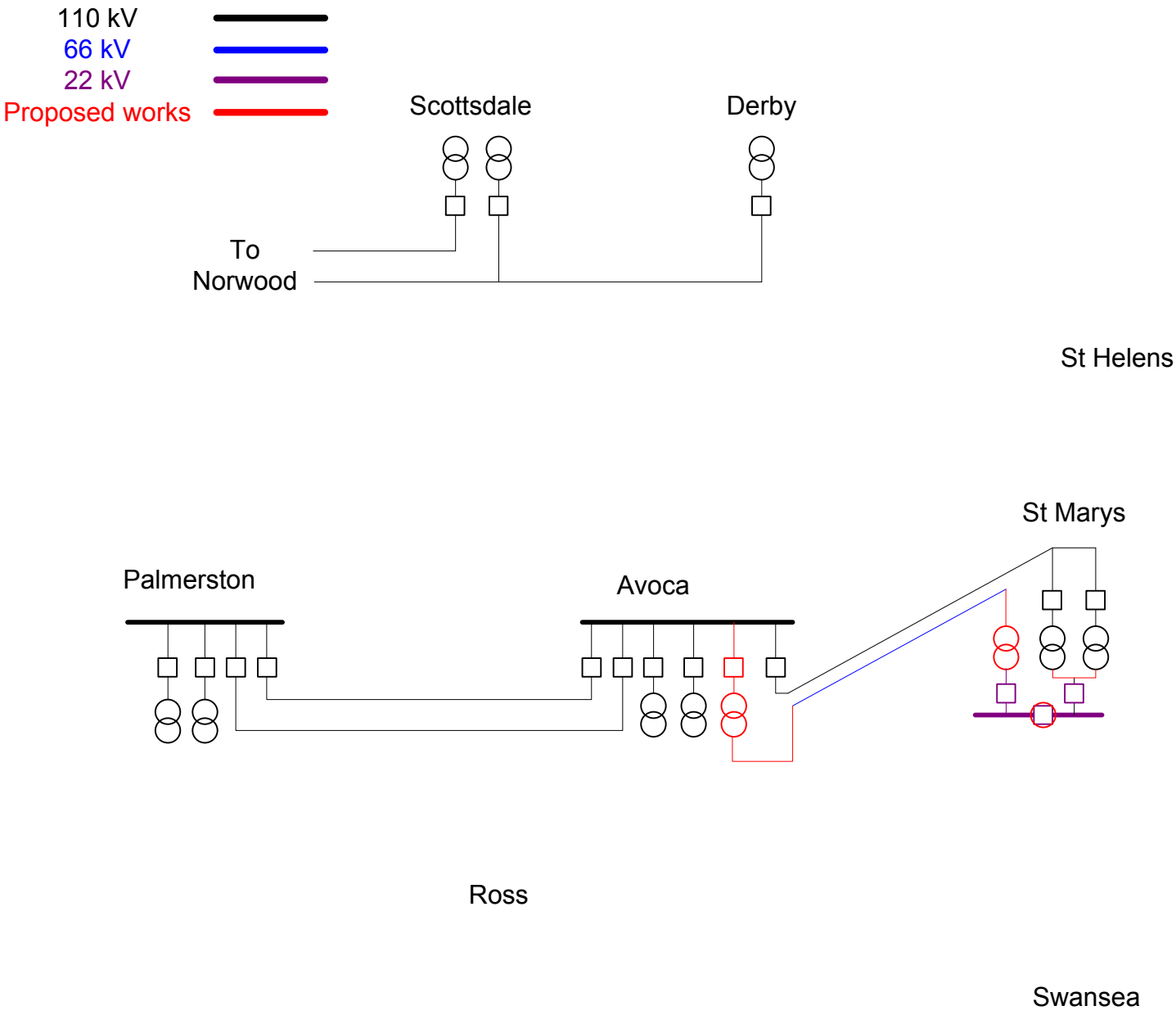
Stage 2 – 2017

Establish 110 kV DCCT Palmerston-Avoca $33.5M
- Install 110 kV bus at Avoca
- Install 110 kV feeder bay at Palmerston
- Install 110 kV DCCT Palmerston-Avoca 65 km
- Re-energise old 110 kV line at 22 kV to provide transfer capacity between Palmerston and Avoca

This project addresses the N-1 limitations on the 110 kV network. 2017 was chosen since this is the date nominated by Transend for closing the 110 kV ring from Derby to St Marys.

Establish 66 kV SCCT Avoca-St Marys $12.5M
- Install 66 kV SCCT Avoca-St Marys 50 km

This feeder (energised at 22 kV) provides backup for loss of the 110 kV Avoca-St Marys line or a St Marys transformer.

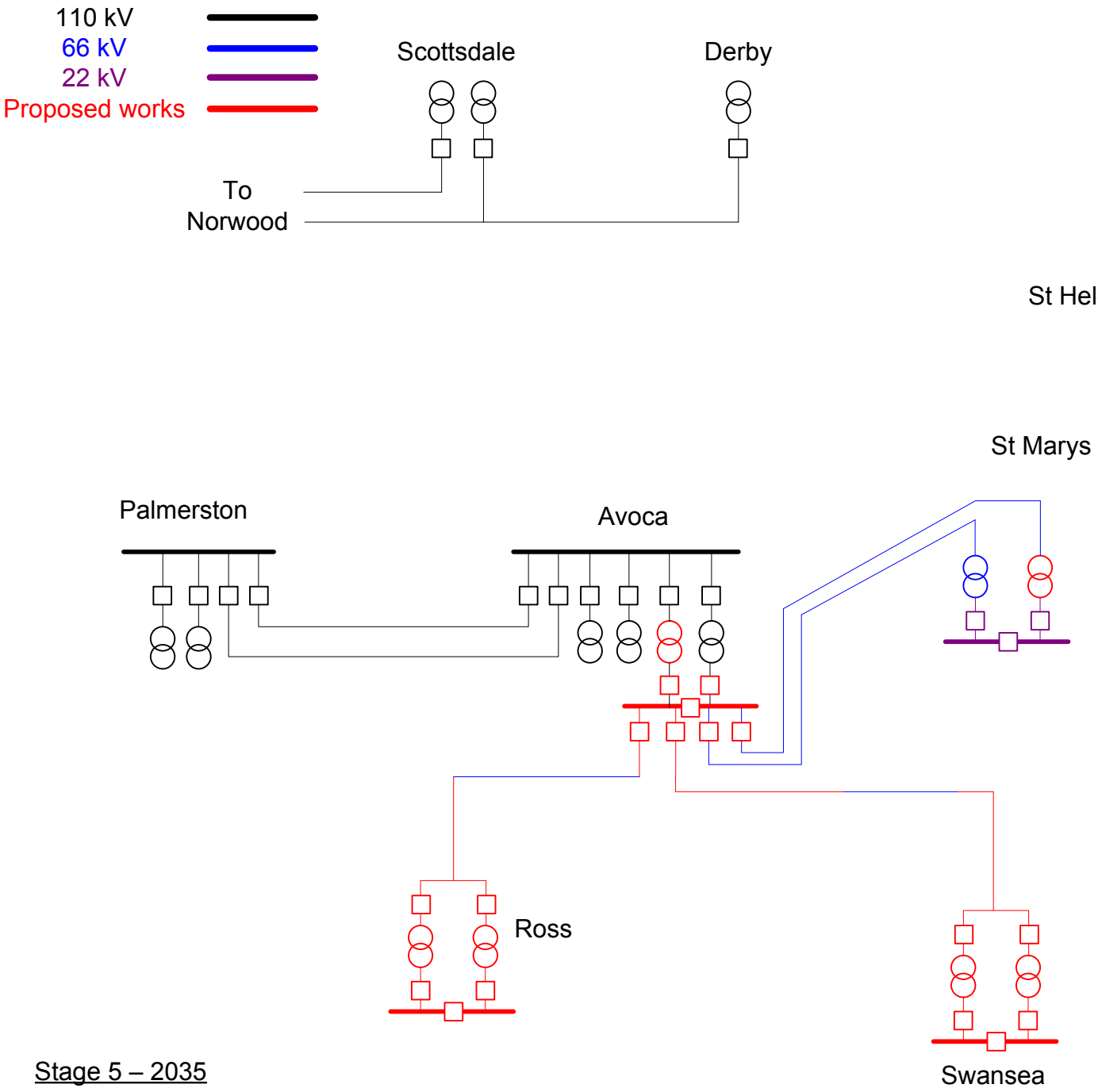


Stage 3 – 2020

Reinforce St Marys-St Helens 22 kV network $2.3M
This project addresses the forecast 22 kV feeder limitations in the St Helens area.

Stage 4 – 2025

Establish Avoca 66 kV injection and St Marys 66/22 kV transformer $12M
This project addresses the firm capacity limitation at St Marys (taking into account the transfer capacity away from St Marys). To reduce costs up front, it is proposed to install a single 110/66 kV transformer at Avoca and a single 66/22 kV transformer at St Marys. The existing 110/22 kV transformers at St Marys could be parallelled onto a single CB.



Stage 5 – 2035

Install 2nd transformers at Avoca and St Marys $11M
This project is driven by the end of life of the St Marys 110/22 kV transformers as well as firm capacity limitation around the same time. The project proposes to install the 2nd transformer and 66 kV switchgear at Avoca, as well as the second 66/22 kV transformer at St Marys. The new St Marys transformer would be supplied by energising the existing 110 kV line at 66 kV.

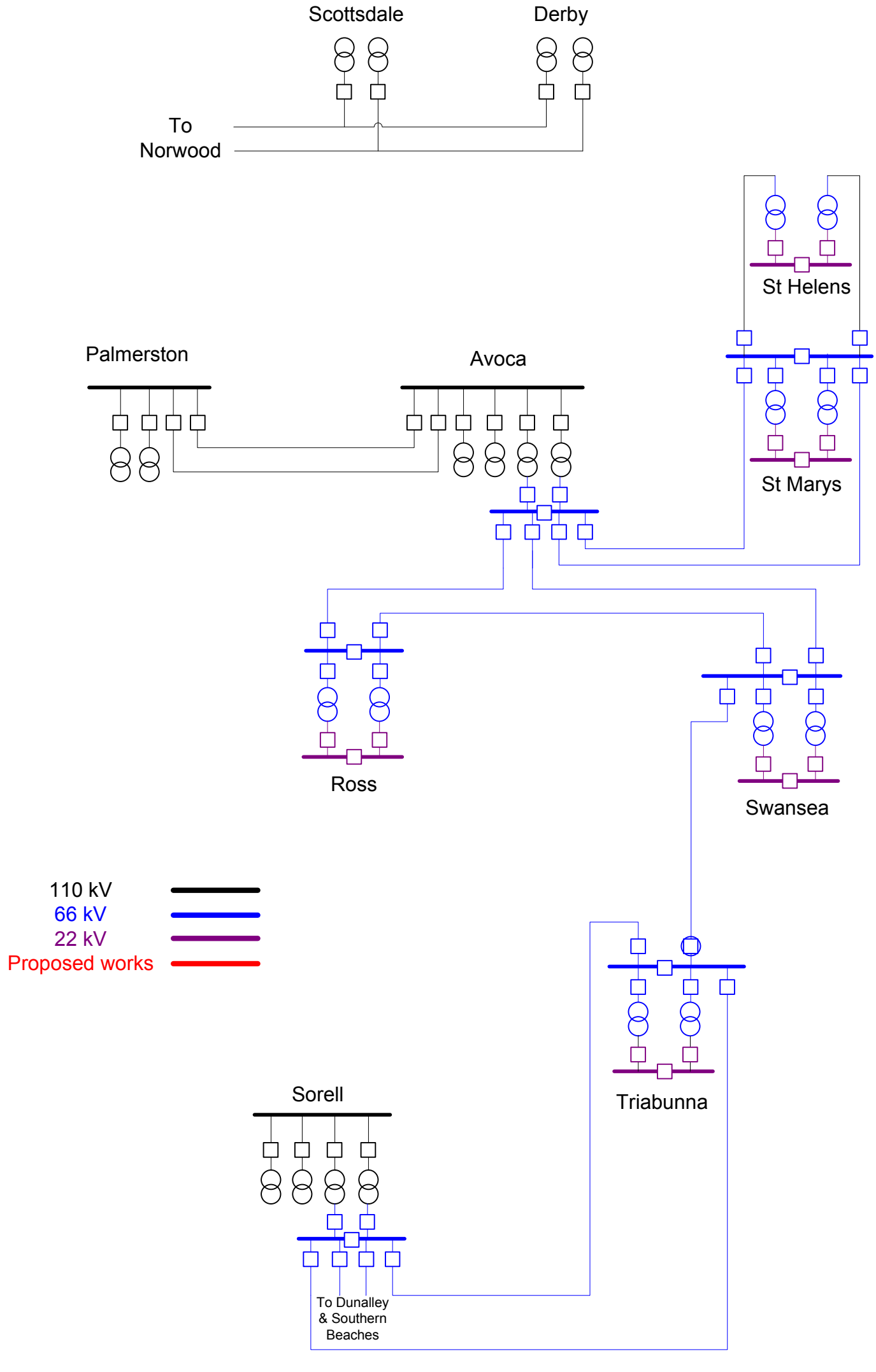
Stage 6 – 2035

Establish 66/22 kV zone substation at Swansea $20M
The timing of this project would be driven by 22 kV feeder limitations in the Swansea and Bicheno area. The Swansea zone substation would be supplied from Avoca by a new 66 kV line, using parts of the 22 kV line which was built at 66 kV in stage 1.

Stage 7 – 2040

Establish 66/22 kV zone substation at Ross $14M
The timing of this project would be driven by 22 kV feeder limitations in the Ross and Oatlands area. The Ross zone substation would be supplied from Avoca using part of the old 110 kV Palmerston-Avoca line.

Ultimate


Scottsdale
Derby
To
Norwood
St Helens
Palmerston
Avoca
St Marys
Ross
Swansea
110 kV
66 kV
22 kV
Proposed works
Triabunna
Sorell
To Dunalley
& Southern
Beaches

Appendix D
Glossary

Appendix D – Glossary of terms

AAC – All Aluminium Conductor

AAAC – All Aluminium Alloy Conductor

ACO – Auto Change-Over

APR – Annual Planning Report

AVR – Automatic Voltage Regulation

CB – Circuit Breaker

CBD – Central Business District

DCCT – Double Circuit

DINIS – Power systems software package used by Aurora for load flow studies.

ESI regulations – Electricity Supply Industry regulations, transmission network performance standards specified by the Tasmanian Department of Energy

ECC – Emergency Cyclic Capacity

FLRS – Feeder Load Reporting System, Aurora database of historical distribution feeder loading.

HV – High Voltage

NCC – Normal Cyclic Capacity

NPV – Net Present Value

PMR – Pole-Mounted Recloser

RIT – Regulatory Investment Test

RMU – Ring Main Unit

SCCT – Single Circuit

TRIP – Targeted Reliability Improvement Project

WACC – Weighted Average Cost of Capital

Webmap – Software package used by Aurora to maintain geographical information about installed assets.

XLPE – Cross Linked Poly Ethylene

Adelaide 61 8 8237 9777
Auckland 64 9 520 6019
Bangkok 66 2 260 4560
Blenheim 64 3 520 6060
Brisbane 61 7 3173 8000
Cairns 61 7 4051 6266
Canberra 61 2 6112 0100
Christchurch 64 3 366 0821
Darwin 61 8 8919 9777
Geraldton 61 8 9964 2764
Gladstone 61 7 4962 0600
Gold Coast 61 7 5591 7775
Hamilton 64 7 834 1565
Hanoi 84 4976 1282
Ho Chi Minh City 84 8 3910 0288
Hong Kong 852 3664 6888
Jakarta 62 21 5140 2470
Karratha 61 8 9185 6344
Kuala Lumpur 60 3 2164 7301
Lithgow 61 2 6351 3750
Mackay 61 7 4951 3500
Maroochydore 61 7 5443 4055
Melbourne 61 3 8683 1333
Mildura 61 3 5022 2766
Morwell 61 3 5116 7205
Nelson 64 3 539 0190
Newcastle 61 2 4941 5415
Paraparaumu 64 4 296 1240
Parramatta 61 2 9890 4100
Perth 61 8 9223 1500
Phnom Penh 855 12 923 248
Port Augusta 61 8 8642 3197
Queenstown 64 3 441 0346
Rangiora 64 3 313 8776
Shanghai 86 21 3313 4750
Singapore 65 6256 6188
Sydney 61 2 9465 5599
Tauranga 64 7 578 6183
Toowoomba 61 7 4632 6249
Townsville 61 7 4772 2858
Traralgon 61 3 5176 0113
Wellington 64 4 472 9589
Whyalla 61 8 8645 5755
Wollongong 61 2 4224 7274

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