Tamar Area Strategic Plan
System Capacity Planning Project
Aurora Energy

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Executive summary

The long term plan for Tamar recommends the continuation of the existing philosophy of 110 kV transmission network with 110/22 kV terminal stations. Terminal substation establishment has been recommended near existing 110 kV overhead lines and at existing sites where available. It is proposed that the existing 110 kV ring around Launceston be maintained with a CBD substation to supply the large load centre inside the ring and additional terminal substations to be placed around the outside of the ring to support the load centres developing to the north, south and west of the city.

The ten year plan for Tamar recommends the establishment of new terminal substations at Westbury and Longford. These substations will supply the fast growing areas of Westbury, Deloraine, Longford, Perth, Evandale and the Launceston airport. The Deloraine area is currently situated in the North Coast planning area and will be transferred to the Tamar area with the establishment of the Westbury substation.

The five year plan for Tamar details the distribution works required for the six existing and two new substations in the Tamar area. This includes information on the installation of the new St Leonards and Westbury substations and the effect on the surrounding substations.

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 five 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 Tamar are covers the surrounding areas of Launceston north to George Town.

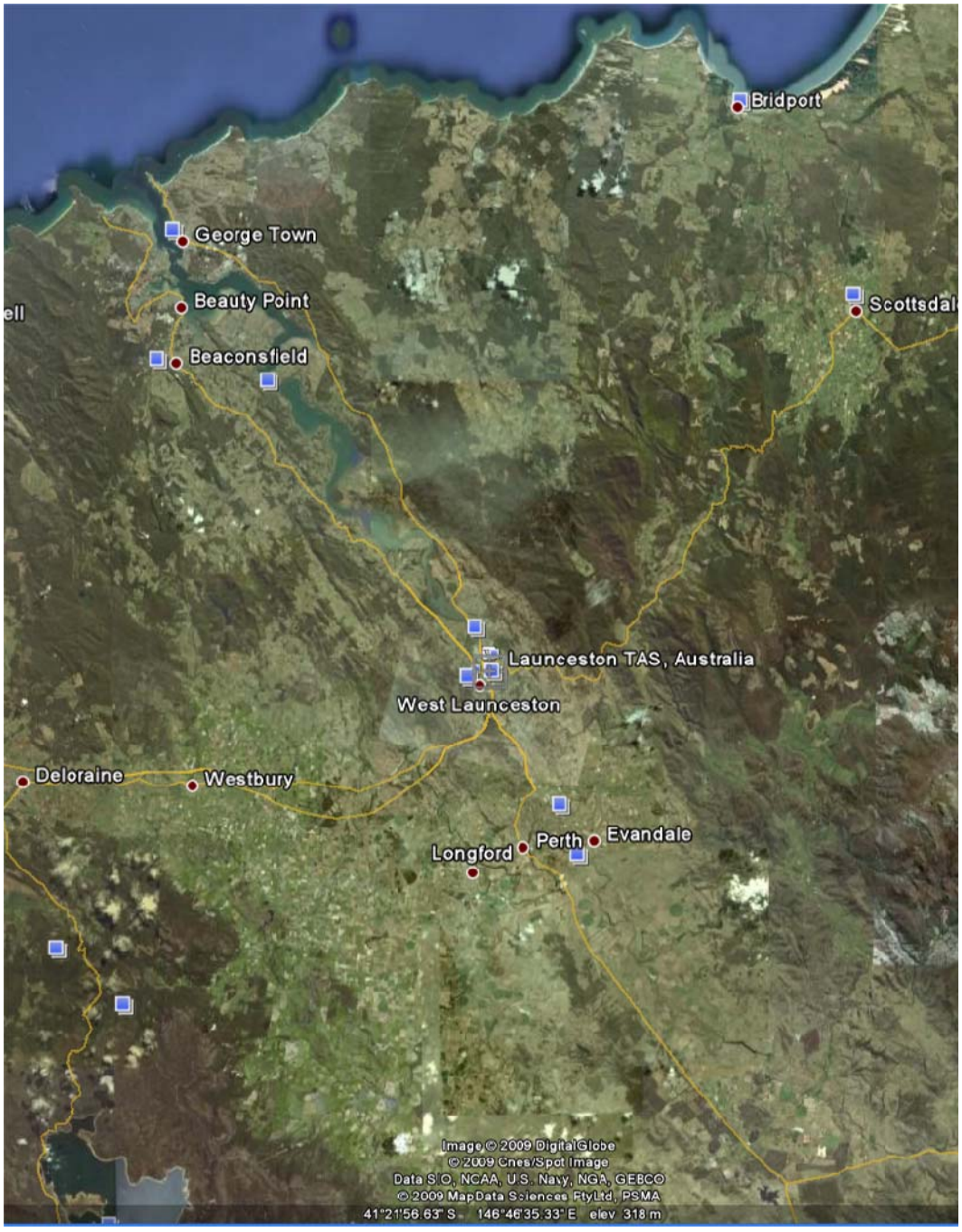

Figure 2-1 Tamar supply area

Launceston has seen a consistent growth in the CBD and surrounding areas. There is strong commercial growth in the CBD and south of Launceston towards the airport and increasing industrial developments west in Westbury and in the industrial town of George Town.

The distribution network is under pressure due to consistent load growth and the wood heater buyback scheme.

2.1 Existing infrastructure

There are six Transend terminal substations supplying the Tamar area.

Table 2-1 Tamar terminal substations

Terminal substation	Number of transformers	Rating of each transformer	Transformer primary voltage	Secondary voltage	Number of distribution feeders
George Town	2	48 MVA	110 kV	22 kV	10
Hadspen	2	50 MVA	110 kV	22 kV	10
Mowbray	2	50 MVA	110 kV	22 kV	10
Norwood	2	50 MVA	110 kV	22 kV	8
Palmerston	2	25 MVA	110 kV	22 kV	3
Trevallyn	3	50 MVA	110 kV	22 kV	17

2.2 Council areas and restrictions

The Tamar area covers four council areas; George Town, West Tamar, Meander Valley and Launceston. Each council has its own planning schemes and strategic plans for their area.

George Town

The George Town Council has a strategic plan document for 2007-2012. This document outlines the key areas affecting the municipality and the strategies to reinforce the direction of the council. The priorities of the George Town council include the six key areas of governance, corporate, planning and development, environment and heritage, infrastructure and community.

The George Town draft planning scheme is currently available for public comment. The planning scheme outlines a number of different zones and the development that is allowed in each zone. These intents will be taken into account in the development of the strategic plan for the Tamar.

West Tamar

The West Tamar Council has a strategic plan document for 2009-2014. This document outlines the key areas affecting the municipality and the strategies to reinforce the direction of the council. The priorities of the West Tamar council include the five key objectives of community, economic and regional development, environment, infrastructure and organisation.

The West Tamar planning scheme was published in 2006. The planning scheme outlines a number of different zones and the development that is allowed in each zone. These intents will be taken into account in the development of the strategic plan for the Tamar.

Meander Valley

The Meander Valley Council has a strategic plan document for 2004-2014. This document outlines the main objectives of the council. The priorities of the Meander Valley council include natural and built environment, economic growth, creative community learning, heath and well being, working together and infrastructure and services.

The Meander Valley planning scheme was originally published in 2007. The planning scheme outlines a number of different zones and the development that is allowed in each zone. These intents will be taken into account in the development of the strategic plans for Tamar and the North Coast. The document also outlines strategies for individual areas.

- Deloraine – develop industrial development in the East Goderich/Lake highway precinct and the Butter Factory site on mole Creek Road
- Westbury – develop industrial development in the vicinity of Tasmanian Alkaloids off Birralee Road, promote low density residential development
- Prospect Vale – encourage commercial uses and restrict industrial, key area for residential growth
- Blackstone Heights – will not be promoted for residential development
- Hadspen – significant growth area between Meander Valley Road and the South Esk River
- Mole Creek – promote future incremental residential growth
- Chudleigh/ Meander/Elizabeth Town – low density residential development
- Bracknell/Kimberley/Exton/Hagley – not promoted for future growth

Launceston

The Launceston City Council has a strategic plan document for 2008-2013. This document outlines the key areas affecting the municipality and the strategies to reinforce the direction of the council. The priorities of the Launceston City council include the five key objectives of natural environment, built environment, social and economic environment, cultural environment and governance services.

The Launceston City Council Vision 2020 document was published in 2006. This document outlines the vision for Launceston from both the council and the community.

The Launceston draft residential strategy provides a way forward for housing development in Launceston for the next 20 years. The goals in this strategy have been developed to be consistent with the outcomes required from Vision 2020. The strategy states that 'There is evidence of growing markets for smaller houses, renovation of inner city houses, and new flats and apartments in inner areas, along with significant growth in retirement village and residential aged care facilities.' The strategy discusses the issues faced by town planners and the proposed future housing demand for Launceston. The strategy discusses the transition of existing commercial areas in the CBD to higher density residential/mixed use. There are a number of areas in Launceston that have known constraints for development of higher density areas. This includes park areas, 100 year flood levels, land stability issues and heritage and scenic protected areas. These constraints, when combined with the 'walkability' principle, combine to show areas that are available for higher density development. Most land considered suitable for residential development in Launceston would need to be re-zoned for development to proceed.

The plan identifies suitable growth areas for rural residential development including:

- Expansion of the Los Angelos Rd area, Swan Bay area and the Dilston area east of the old highway
- Expansion of the Relbia Rural Residential zone
- Expansion at Lilydale (water supply limited at present)
- Expansion at White Hills (currently not zoned as rural residential)

2.3 Approved and proposed works

The Tamar area has a number of existing system constraints. The approved projects to be completed by December 2012 are outlined below:

An upgrade to the Mathinna SWER system will be completed in 2010/11 for an estimated cost of $200,000.

St Leonards substation and second 110 kV feeder into Mowbray

The second 110/22 kV transformer has been installed at Mowbray terminal substation. Two 22 kV super feeders from Trevallyn terminal substation currently supply the load that is to be supplied by T2. The new 110 kV feeder will complete the 110 kV ring around the city and will come from Norwood via the new St Leonards terminal substation. The feeder and St Leonards terminal substation are both due to be completed in May 2012.

3. Load forecast

The growth in the Tamar region varies between medium and high growth development. The assumed high growth areas include Legana, Dilston, Rocherlea, Ravenswood, Longford, Westbury, Perth and Evandale. The assumed medium growth areas include Georgetown supply area, Invermay, West Launceston, Launceston CBD and surrounding suburbs, Norwood supply area and Palmerston supply area.

The resulting 38 year load forecast and firm ratings for the Tamar area substations are provided below.

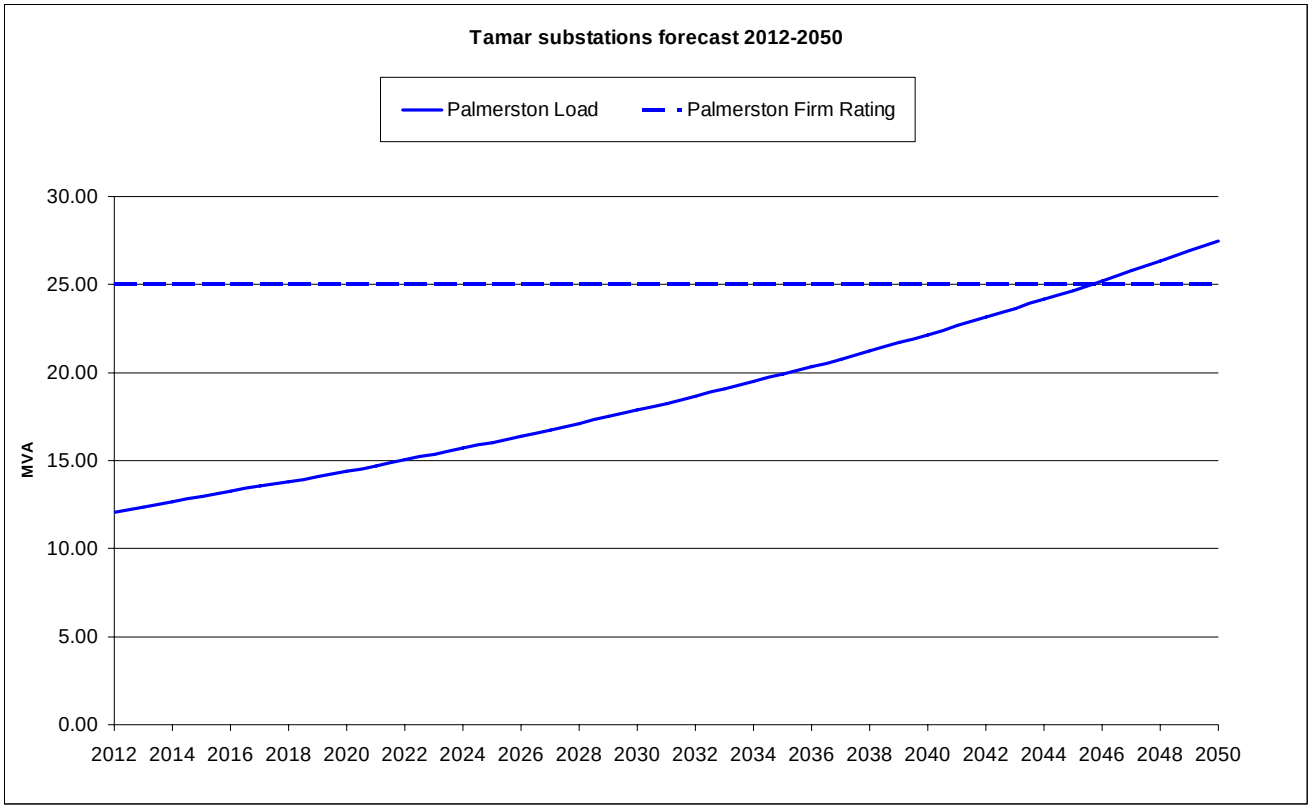

Figure 3-1 Substation load forecast for the Palmerston area

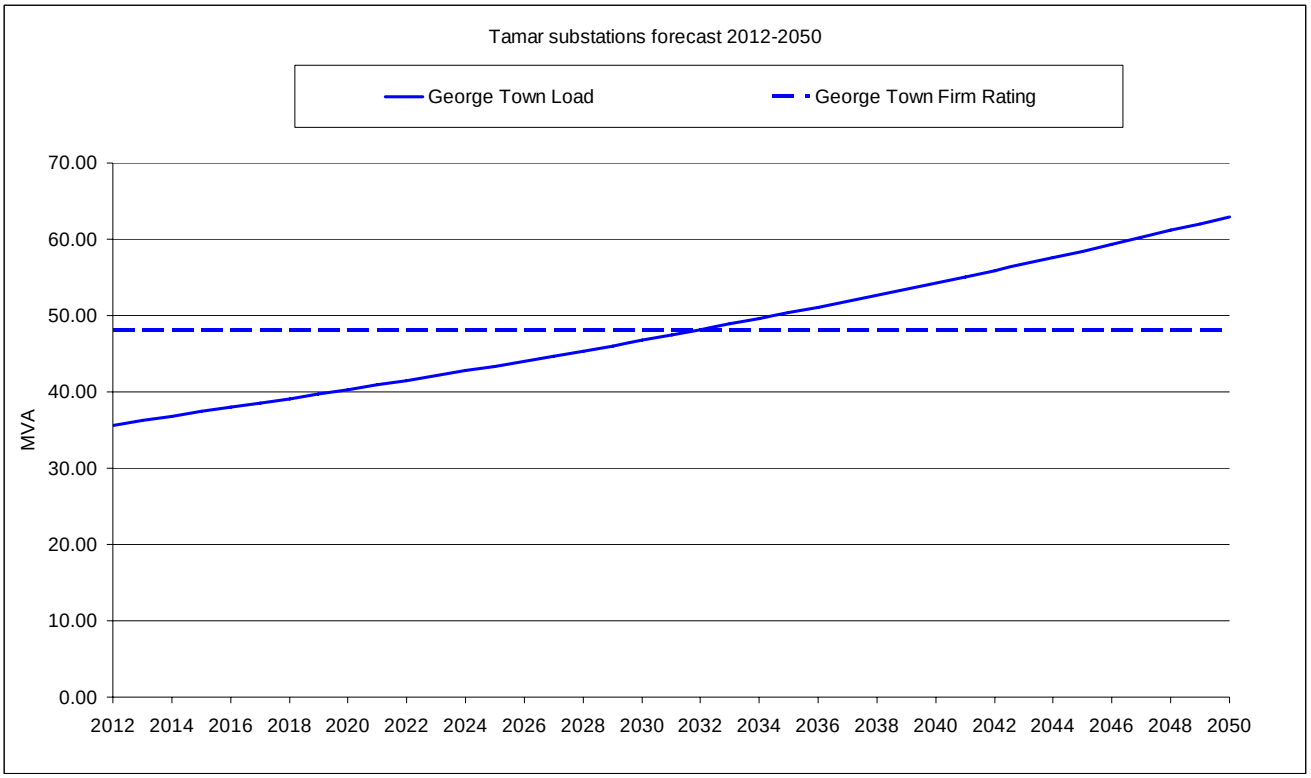

Figure 3-2 Substation load forecast for the George Town area

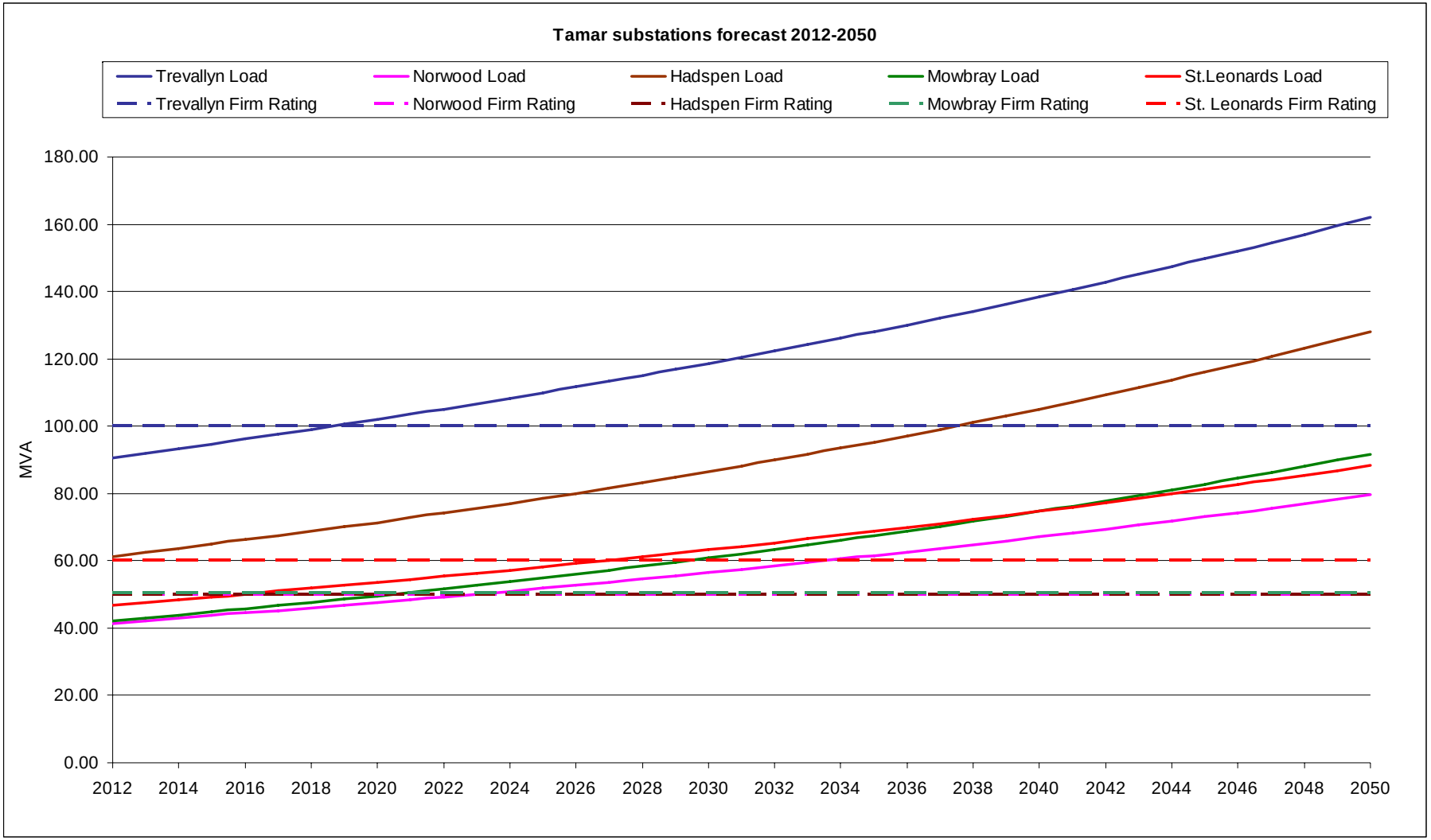

Figure 3-3 Substation load forecast for the Tamar area

The load distribution is further outlined in the geographic views in the following figures. The red circles denote the areas with a proposed high growth forecast.

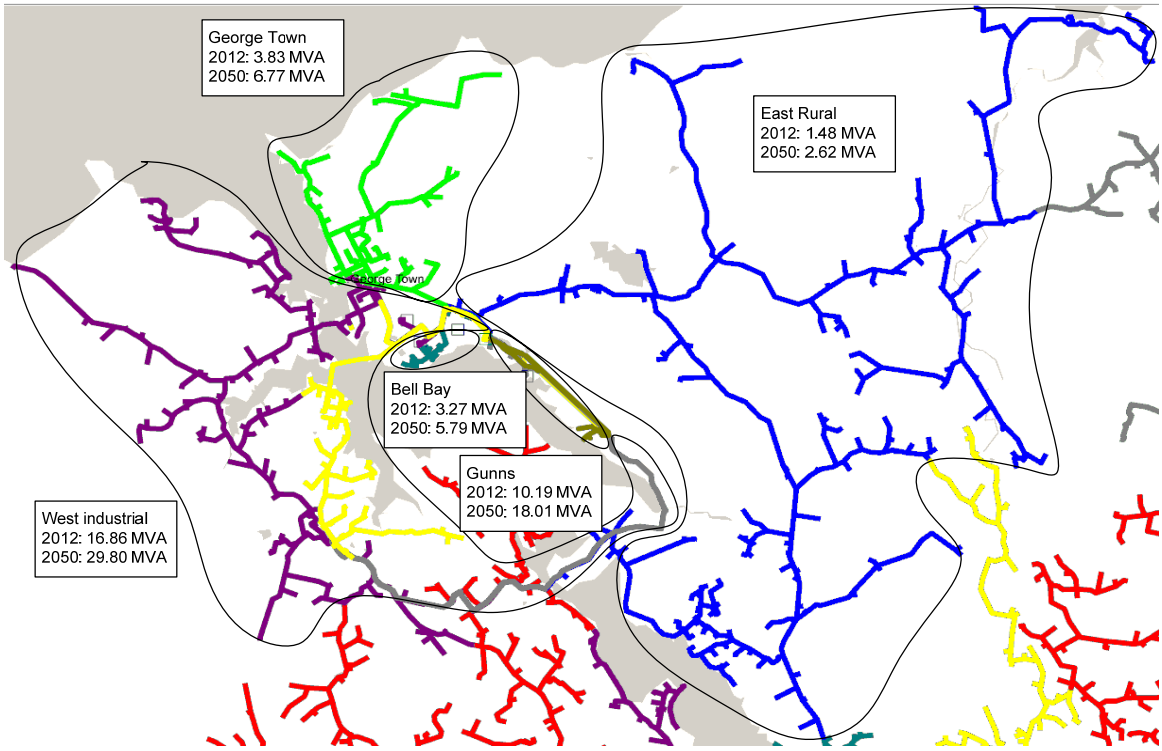

Figure 3-4 George Town forecast load distribution

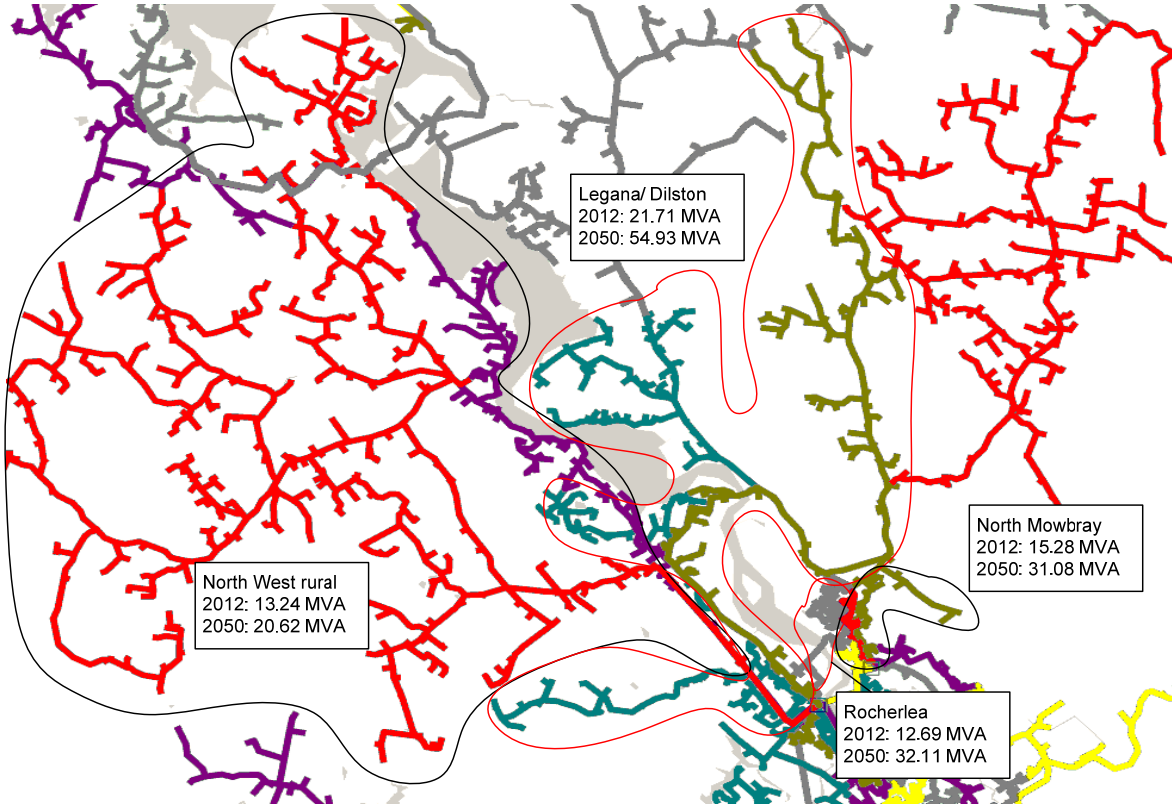

Figure 3-5 Northern area load distribution

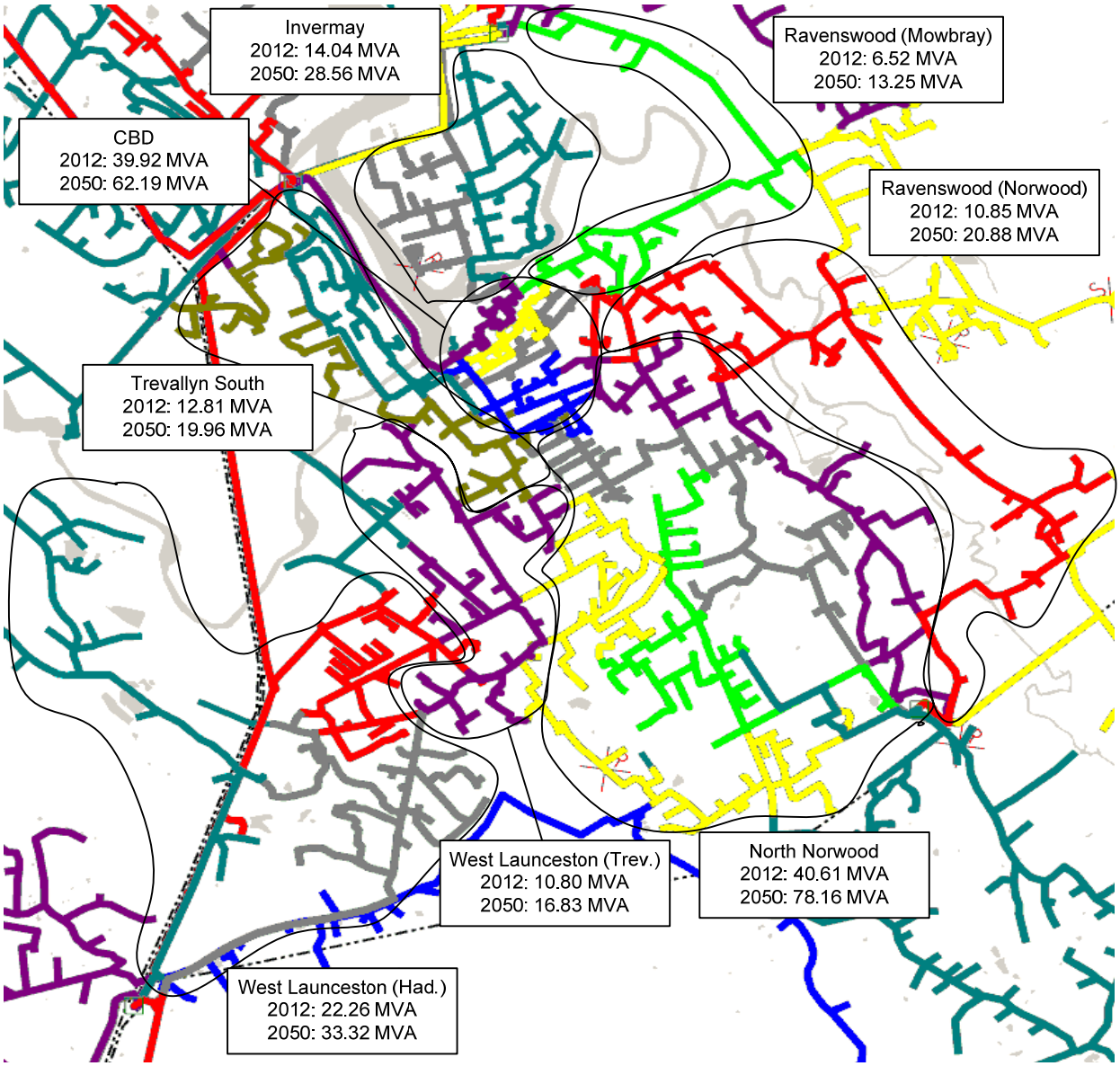

Figure 3-6 CBD and surrounds load distribution

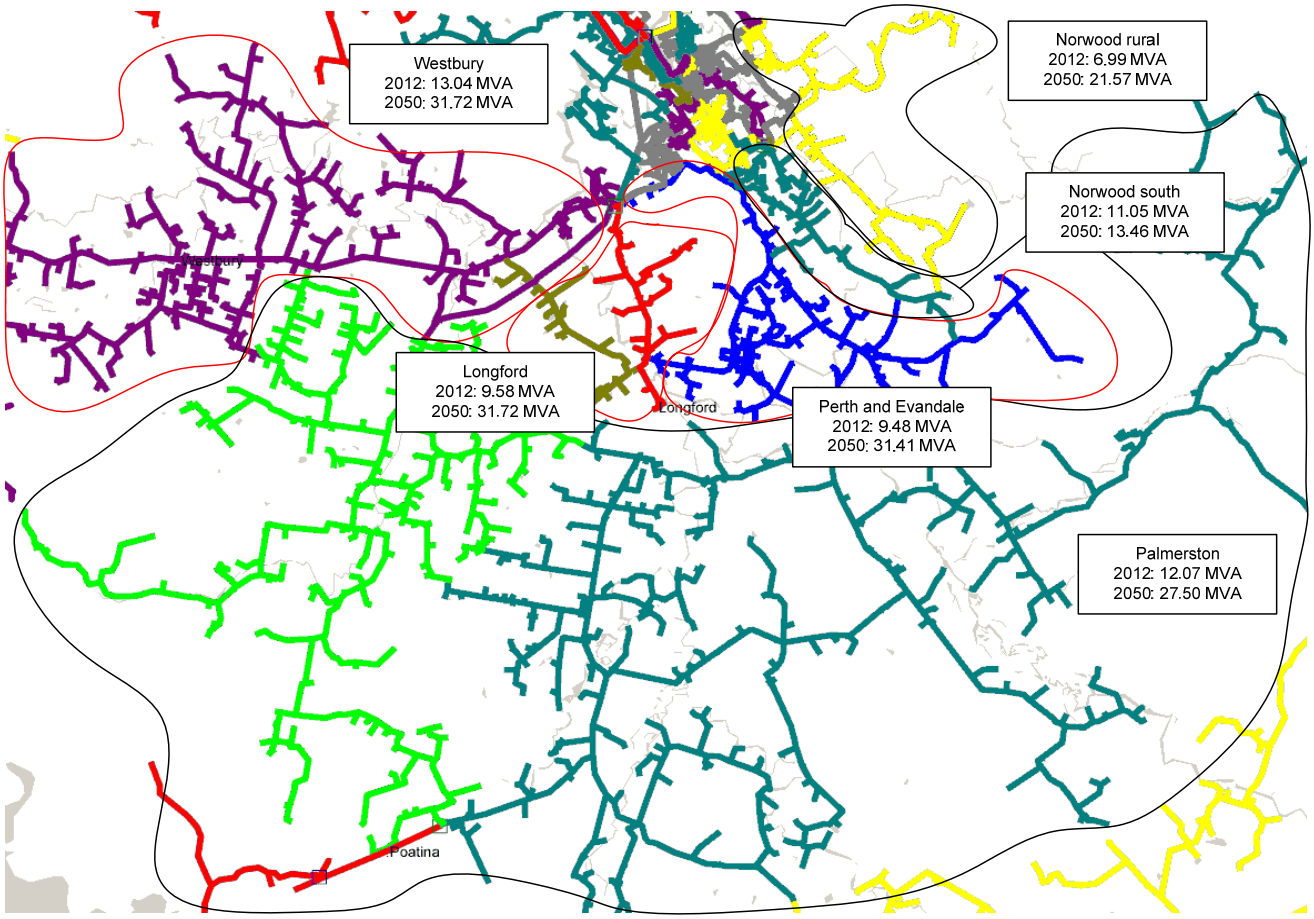

Figure 3-7 Southern area load distribution

4. Limitations

4.1 George Town

George Town terminal substation has two 48 MVA 110/22 kV transformers. The load in 2009 was 33.86 MVA and, using the medium growth forecast, the terminal substation load is predicted to reach firm capacity in 2032. One of the distribution feeders supplying 5 MVA of the gold mine near Beaconsfield was overloaded in 2009. The feeders supplying Gunns Mills and the dedicated gold mine feeder, F53004, were also heavily loaded. There are a number of large direct connected customers in the George Town supply area. The predicted growth in the area will be based on individual point load applications for new installations or expansions to existing large customers.

The George Town terminal substation supplies a range of reliability communities including an urban centre in George Town, high density rural on the western side of the river and a large area of industrial and residential low density rural communities.

The George Town 110/22 kV transformers were installed in 2001 and 2003. Assuming an asset life of 50 years, the transformers should not need to be replaced due to age limitations in the study timeframe.

4.2 Palmerston

Palmerston terminal substation has two 25 MVA 110/22-11 kV transformers. The load in 2009 was 11.17 MVA and, using the medium growth forecast, the terminal substation is predicted to reach firm capacity in 2046. Palmerston terminal substation has a higher peak summer demand due to the large irrigation load. There is a plan to install a new feeder from Palmerston to split F51003.

Palmerston terminal substation supplies a large area of low density rural communities.

The Palmerston 110/22 kV transformers were installed in 1994 and 2006. Assuming an asset life of 50 years, it is predicted that one transformer will need to be replaced around 2046.

4.3 Hadspen

Hadspen terminal substation has two 50 MVA 110/22 kV transformers. The terminal substation load in 2009 was 45.72 MVA and the firm capacity of the terminal substation will be exceeded in 2010 due to the installation of known point loads. The distribution feeder running towards Perth township and the Launceston airport was overloaded in 2009. An express feeder is planned to split this feeder and provide additional support to the growing industrial area near the airport. A new feeder is currently being installed to supply a new large customer in the Westbury area and is due for completion in April 2010.

Hadspen terminal substation supplies the urban communities of Hadspen, Westbury, Longford, Perth, Evandale and Launceston and the high density rural surrounding these main points.

The Hadspen 110/22 kV transformers were installed in 2006 and 2007. Assuming an asset life of 50 years, the transformers should not need to be replaced due to age limitations in the study timeframe.

4.4 Mowbray

Mowbray terminal substation has two 50MVA 110/22 kV transformers. The terminal substation capacity is currently limited to the N-1 super feeder rating of 40 MVA. This will increase in 2012 under the St Leonards project when the 110 kV ring around the city is completed. The load in 2009 was 36 MVA and the terminal substation is forecast N-1 overload in 2011. One distribution feeder to the Invermay area was overloaded in 2009.

Mowbray terminal substation supplies a large urban area in Launceston.

The Mowbray 110/22 kV transformers were installed in 2006 and 2009. Assuming an asset life of 50 years, the transformers should not need to be replaced due to age limitations in the study timeframe.

4.5 Norwood

Norwood terminal substation has two 50MVA 110/22-11 kV transformers. The load in 2009 was 68.71 MVA and the firm capacity of the terminal substation has been exceeded. Four distribution feeders were overloaded in 2009. The supply area of Norwood is limited due to cable access to the north and the installation of a third transformer is not considered a suitable option.

Norwood terminal substation supplies a high density commercial area in Kings Meadows, urban areas within Launceston and areas of high and low density rural in the surrounding suburbs.

The Norwood 110/22 kV transformers were installed in 1979 and 1995. Assuming an asset life of 50 years, it is predicted that the transformers will need to be replaced around 2029 and 2045.

4.6 Trevallyn

Trevallyn terminal substation has three 50 MVA 110/22 kV transformers. The load in 2009 was 104 MVA and the firm capacity has been exceeded. Four distribution feeders were overloaded in 2009.

Trevallyn terminal substation supplies the high density commercial area in the Launceston CBD, urban areas around Trevallyn and West Launceston and high and low density rural areas to the north of the terminal substation.

The Trevallyn 110/22 kV transformers were installed in 1999 (x2) and 2000. Assuming an asset life of 50 years, it is predicted that the transformers may need to be replaced towards the end of the study period.

5. Planning philosophy

The Launceston area will be supplied by five substations in 2012. These substations are all located at least 3 km from the CBD and are currently attempting to feed into the city as well as supplying out to the surrounding rural and residential areas. This philosophy will experience increased feeder congestion as the load in the inner circle increases and will have reliability issues from supplying the surrounding load using long 22 kV feeders.

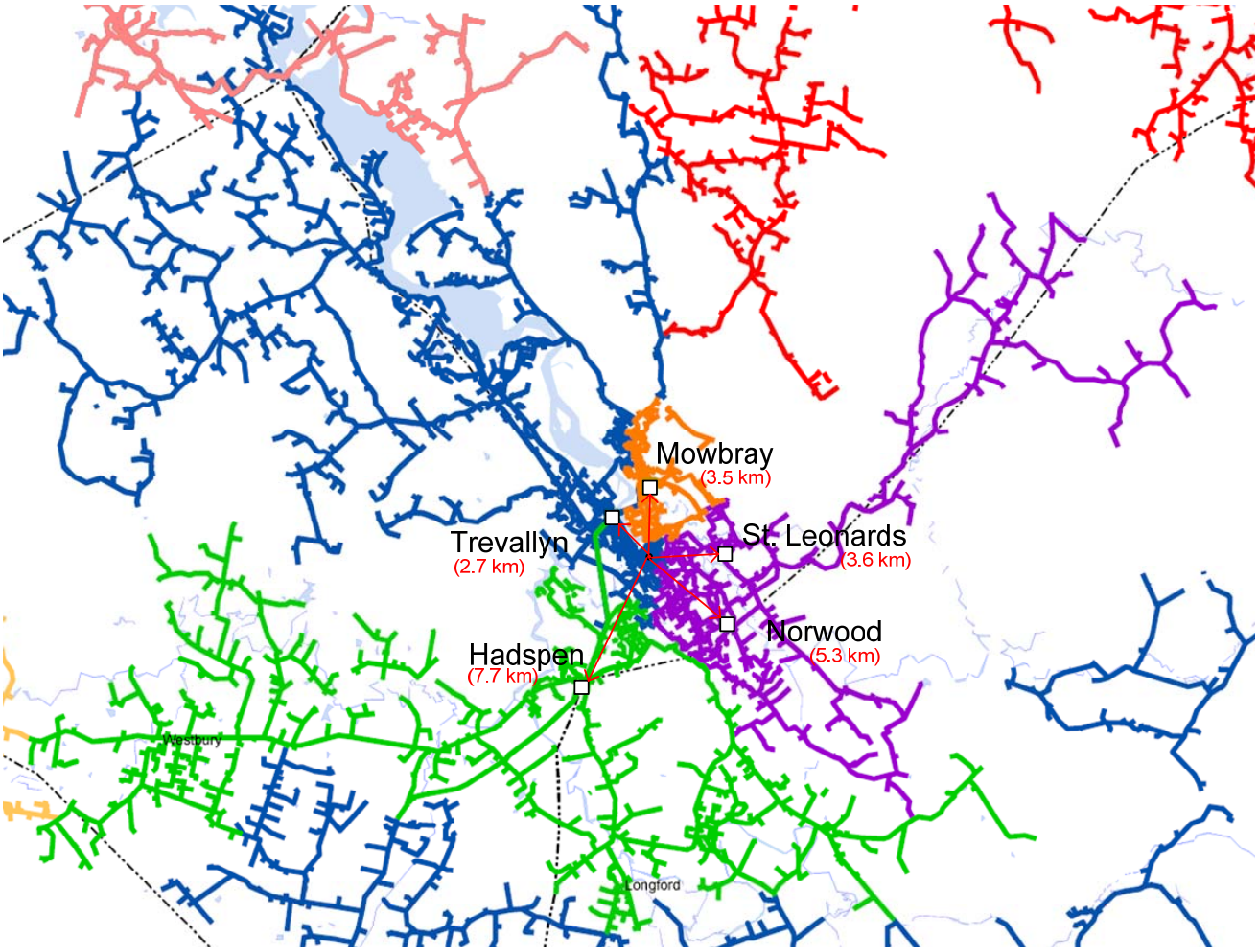

Figure 5-1 Southern area load distribution

The new planning philosophy for Launceston includes the installation of a substation in the heart of the CBD in 2027 to relieve the pressure on the surrounding substations and to reduce the feeder congestion associated with five substations feeding into a centre point. The five substations will still be directed inwards but will supply their immediate areas and new support substations will be established in large load centres on the outskirts of Launceston including Westbury, Longford and Exeter. The support substations will allow the five city substations to feed smaller geographical areas and will also provide the opportunity to split and shorten existing 22 kV feeders to improve reliability.

The Deloraine area is currently situated in the North Coast planning area and will be transferred to the Tamar area with the establishment of the Westbury substation.

Further information on the recommendation of the installation of a substation in the Launceston CBD is provided in Appendix C.

Conduit plans for the Tamar substations are required to allow for future feeders out of each of the substations, particularly the new St Leonards substation. The plans will outline the installation of banks of conduits on the main routes from the substations. Further information on this is provided in the five year plan in Section 8.

The long term plan for Tamar is based on the continuation of the existing philosophy of 110 kV transmission network with 110/22 kV terminal stations. An alternative strategy based on the introduction of a new 66 kV subtransmission voltage was also considered for the Launceston area. This included the establishment of a 110/66 kV terminal substation and multiple 66/22 kV zone substations. This option was discounted due to the higher cost for both initial and ultimate scenarios. Options analysis for the initial 66 kV projects is included in the projects as part of the ten year plan in Section 7.

6. Long term strategy

The proposed projects in the long term strategy are discussed in more detail below.

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 Westbury terminal substation

It is recommended that a new terminal substation is established in the Deloraine/Westbury area in 2017. Two 110/22 kV 60 MVA transformers should be installed. This will address the firm capacity issues at Hadspen and also at Railton in the North Coast area. Large industrial point loads are expected in the Westbury area and Hadspen will be unable to support the large load increases.

6.1.2 Longford 110/22 kV substation

It is recommended that a new terminal substation is established in the Longford area in 2021. Two 110/22 kV 60 MVA transformers should be installed. This will address the firm capacity issues at Hadspen and Norwood and will allow load to be shifted between the relieved substations and Trevallyn, Mowbray and St Leonards. This substation will supply the growing areas of Longford, Perth, Evandale and the Launceston airport.

6.1.3 East Launceston CBD terminal substation

It is recommended that a new terminal substation is established on the existing East Launceston CBD site in 2027. Two 110/22 kV 60 MVA transformers and new 22 kV switchgear should be installed. This will address the firm capacity issues of the Launceston substations and provide a reliable source of supply to the CBD. This will also help address the distribution feeder access limitations of running 22 kV feeders in from the surrounding substations.

Further information on the recommendation of the installation of a substation in the Launceston CBD is provided in Appendix C.

6.1.4 Norwood transformer replacement

It is recommended that the two 110/22 kV 50 MVA transformers at Norwood be replaced with 60 MVA units in 2029. This will address both capacity and predicted age limitations on the Norwood transformers.

6.1.5 Exeter 110/22 kV substation

It is recommended that a new terminal substation is established in the Exeter area in 2030. Two 110/22 kV 60 MVA transformers should be installed. This will address the firm capacity issues at George Town and Trevallyn and will allow load to be shifted between the Launceston substations.

6.1.6 Mowbray transformer replacement

It is recommended that the two 110/22 kV 50 MVA transformers at Mowbray be replaced with 60 MVA units in 2040. This will address a capacity limitation on the Mowbray transformers and delay the installation of a third transformer at St. Leonards.

6.1.7 St Leonards third transformer installation

It is recommended that a third 110/22 kV 60 MVA transformer be installed at St Leonards substation in 2043. This will address the firm capacity issues at the six Launceston substations. A number of new 22 kV distribution feeders will need to be installed to heavily loaded areas supplied by Mowbray.

6.1.8 Palmerston transformer replacement

It is recommended that the two 110/22 kV 25 MVA transformers at Palmerston be replaced with 30 MVA units in 2046. This will address both capacity and age limitations on the Palmerston transformers.

6.2 Summary of proposed works

A summary of the proposed works from 2012 to 2050 in the Tamar area is outlined in Table 6-1.

Table 6-1 Tamar project summary

Year	Proposed Project	Proposed Outcomes
2017	Westbury 110/22 kV substation	Address firm capacity issues at Hadspen substation, improved supply for Launceston area
2021	Longford 110/22 kV substation	Address firm capacity issues at Hadspen and Norwood substations, improved reliability of supply to Perth, Evandale, Longford and Launceston Airport
2027	East Launceston CBD 110/22 kV substation	Address firm capacity issues on city substations, improved reliability of supply for Launceston CBD
2029	Transformer replacement at Norwood	Increase firm capacity at Norwood, improved reliability for Norwood supply area
2030	Exeter 110/22 kV substation	Address firm capacity issues at George Town and Trevallyn substations, improved reliability for large rural area and industrial point loads
2040	Transformer replacement at Mowbray	Increase firm capacity at Mowbray, improved reliability for Mowbray supply area
2043	Third transformer at St Leonards	Address firm capacity issues at the city substations, improved reliability for Launceston area
2046	Transformer replacement at Palmerston	Increase firm capacity at Palmerston, improved reliability for Palmerston supply area

The resulting load forecast curves and new firm ratings are outlined in the following figures.

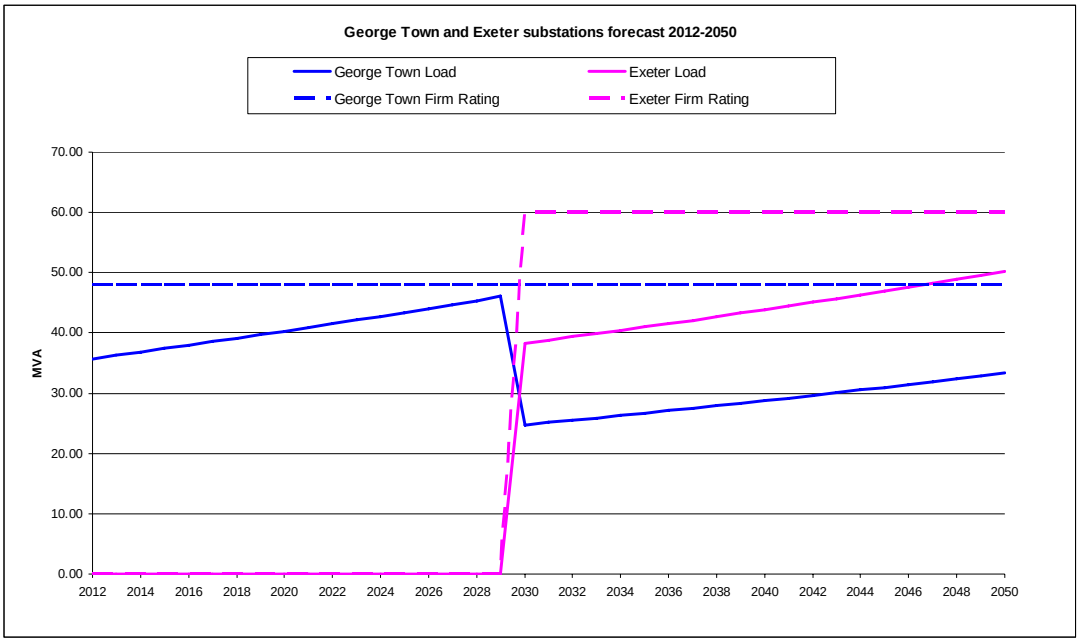

Figure 6-1 George Town and Exeter substation load forecasts and new ratings

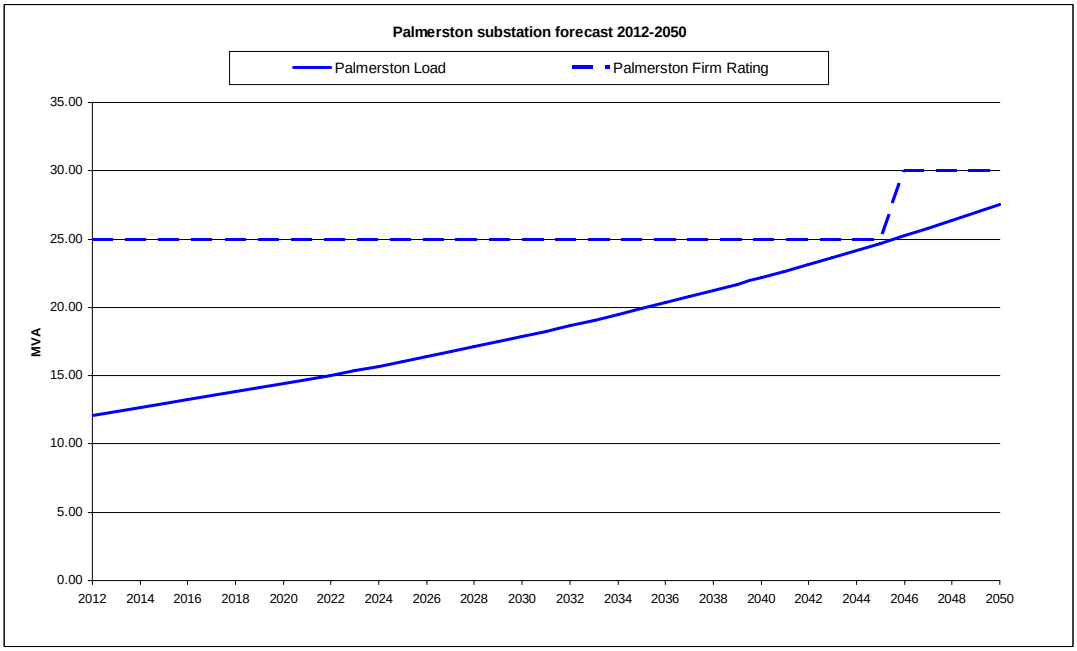

Figure 6-2 Palmerston substation load forecasts and new ratings

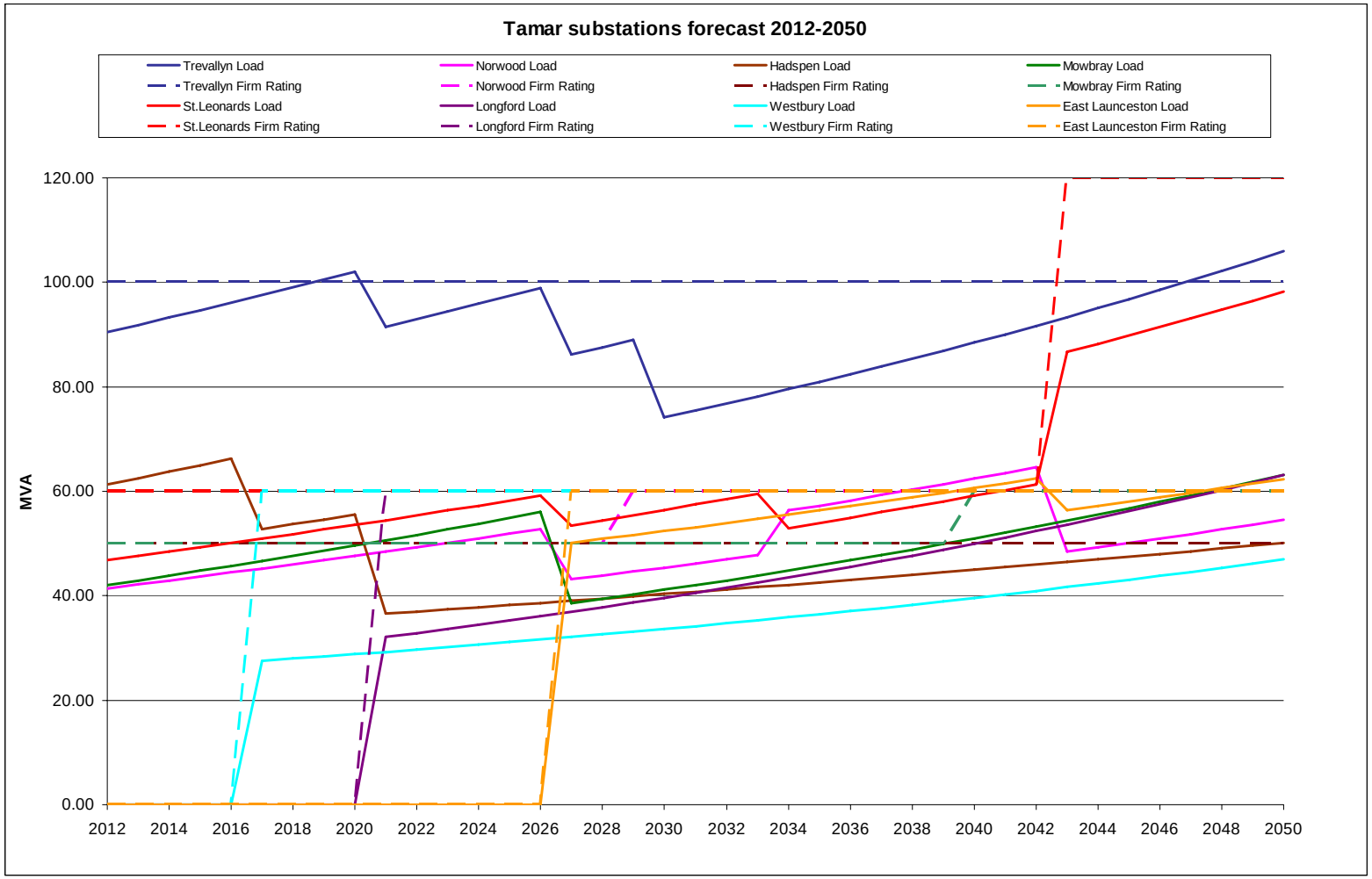

Figure 6-3 Tamar substation forecast and new ratings

The proposed new supply area (based on existing feeder structure) for each of the substations in 2050 is outlined in the figure below.

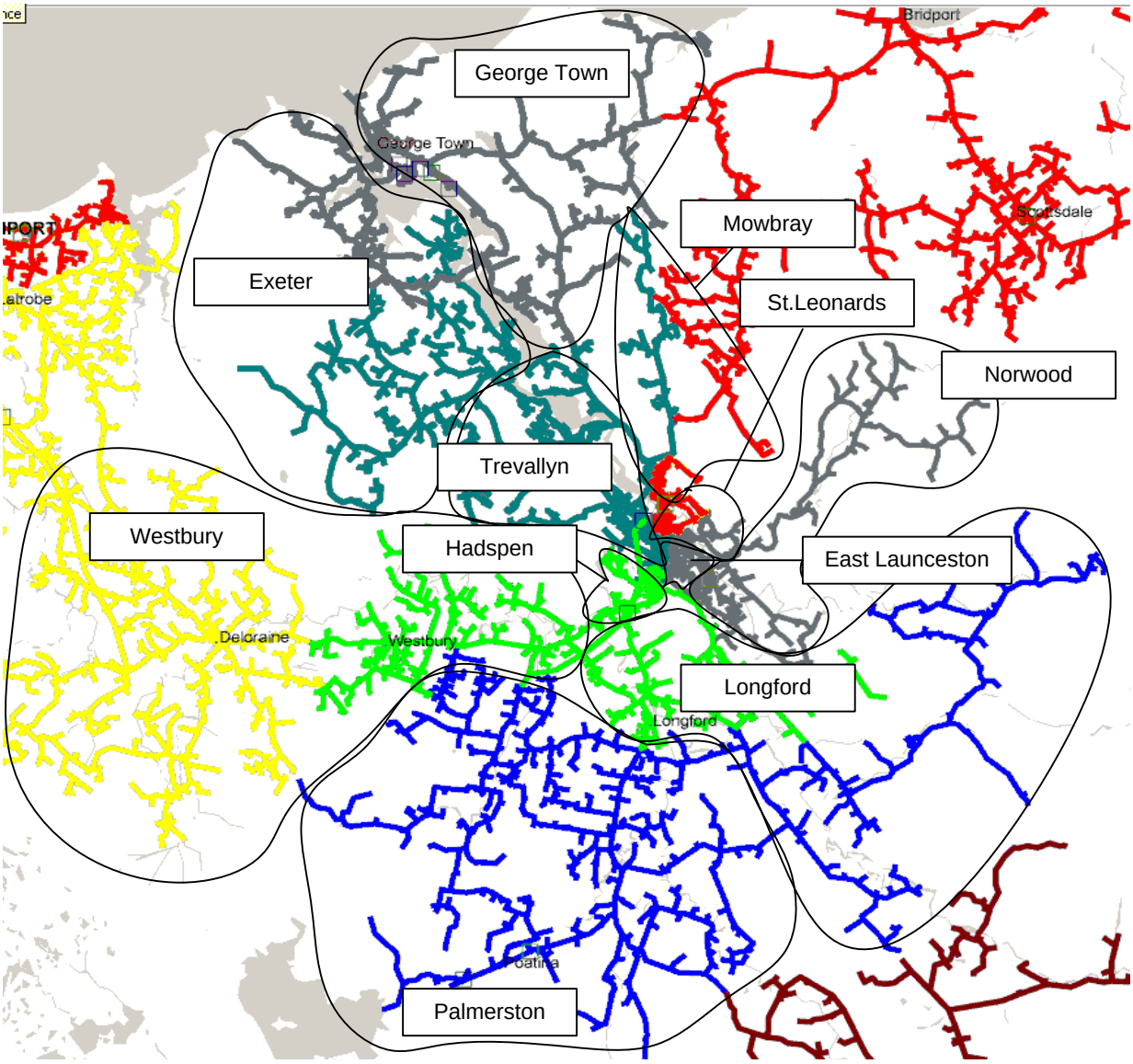

Figure 6-4 Tamar substation proposed supply areas in 2050

7. Ten year plan

The proposed projects to be completed under the ten year plan are 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 M (RIT-D) or $5 M (RIT-T).

7.1 Proposed projects

7.1.1 Westbury terminal substation

Westbury and Deloraine are growing industrial areas currently supplied by Hadspen and Railton substations. Large industrial point loads are expected in the Westbury area over the next few years.

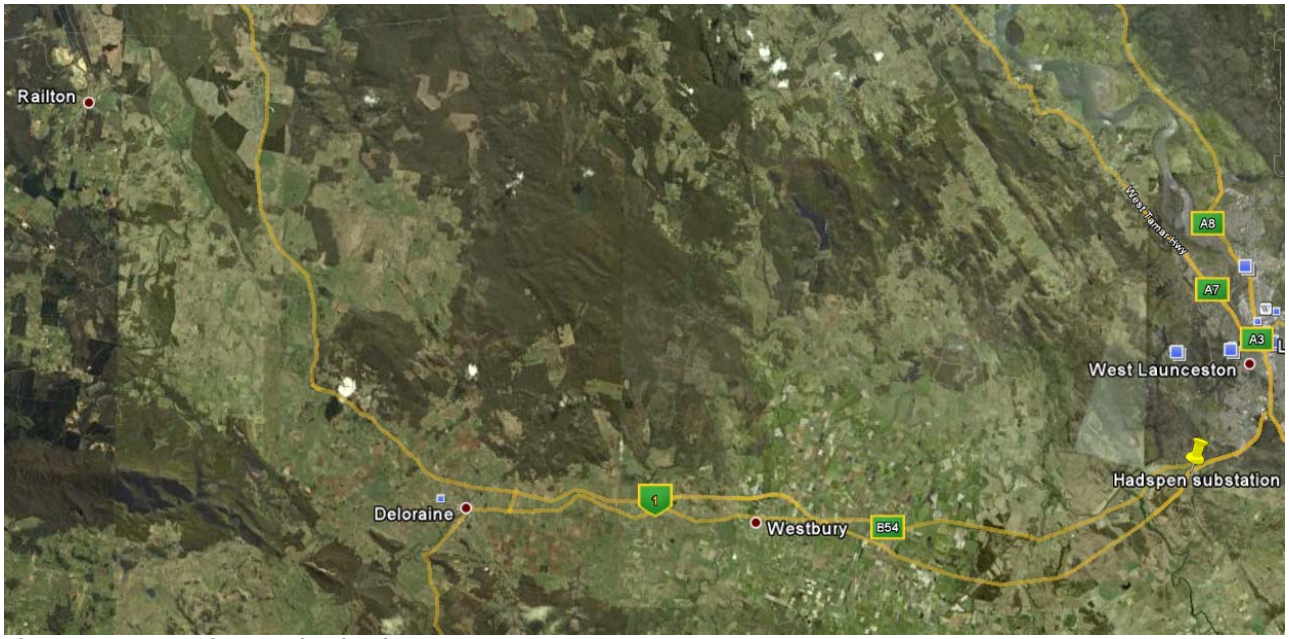

Figure 7-1 Westbury and Deloraine area

Limitations

Hadspen terminal substation has two 50 MVA 110/22 kV transformers. The terminal substation load in 2012 is forecast to be 61.25 MVA and it is forecast to grow to 74.14 MVA in 2022. This load is well above the firm capacity of the substation. Two 5 MVAr capacitor banks have recently been installed at Hadspen which will slightly reduce the peak load on the substation.

Railton terminal substation has two 50 MVA 110/22-11 kV transformers. The forecast load for 2012 is 52.02 MVA and it is forecast to grow to 56.15 MVA in 2022. The distribution feeders are heavily loaded and there are no spare circuit breakers on the 22 kV switchboard. Railton substation will be partially deloaded by the conversion of Wesley Vale substation to a new connection point in 2012. Two 5 MVAr capacitor banks have recently been installed at Railton which will slightly reduce the peak load on the substation.

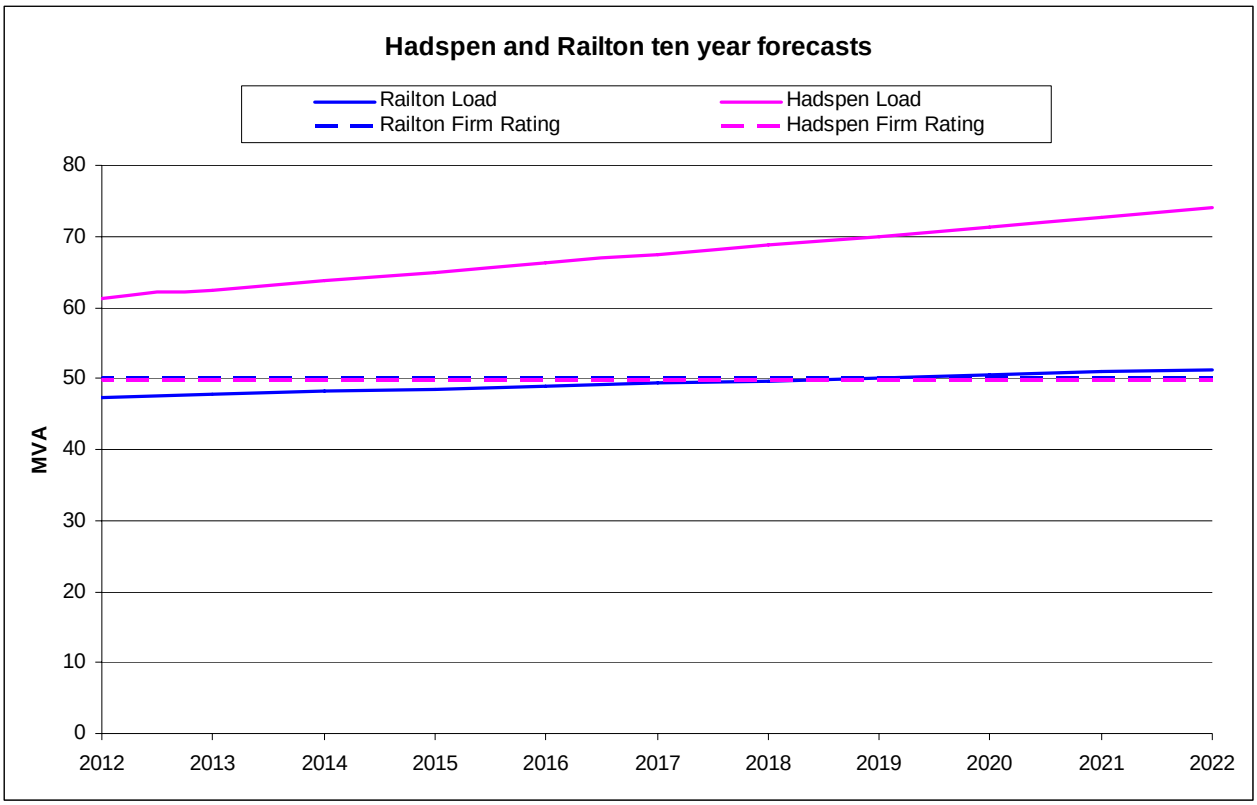

Figure 7-2 Substation ten year forecasts

Another main driver for this project is the reliability of the 22 kV network in the Deloraine and Westbury areas. These areas are fed by 30 and 40 km long 22 kV feeders from Hadspen and Railton and a number of the anticipated new point loads will be situated on the end of these feeders.

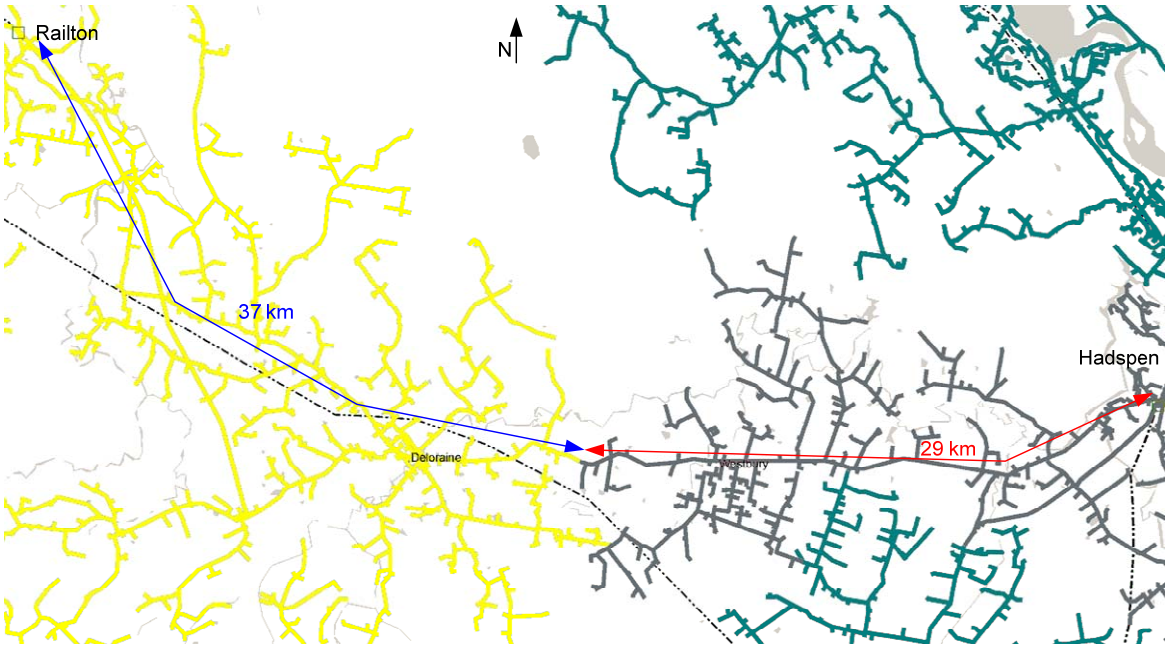

Figure 7-3 Deloraine and Westbury areas

Option 1 – Installation of a new 110/22 kV connection point at Westbury

The first option involves the establishment of a new terminal substation in the Westbury area in 2017. Two 110/22 kV 60 MVA transformers and 22 kV switchgear should be installed. This will address the firm capacity issues at Hadspen and Railton and improve the reliability of the 22 kV network currently supplied from Railton.

Option 2 – Installation of a third transformer at Hadspen and new 22 kV feeders to Westbury

This option involves the installation of a third transformer at Hadspen and new 22 kV feeders to supply the increasing load at Westbury. This will address the firm capacity issues at Hadspen.

Option 3 – Installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Westbury

This option involves the installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Westbury. Two new 60 MVA transformers will be installed at Longford and a new 66 kV circuit to a new zone substation at Westbury with two 25 MVA 66.22 kV transformers. This will address the firm capacity issues at Hadspen.

Option 4 – Non-network option

No non-network alternatives have been considered.

Option 5 – Do nothing option

The do nothing option is not considered a feasible option as the firm capacity at Hadspen and Railton has been exceeded.

Technical comparison

Table 7-1 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Installation of a new 110/22 kV connection point at Westbury	• Address firm capacity limitations at Hadspen and Railton • Greatest reliability improvement • Highest operational flexibility • Consistent with network development plan (remove surrounding load from Hadspen so it can feed towards Launceston) • Utilises existing 22 kV feeders	• Requires new site

Option	Description	Advantages	Disadvantages
2	Installation of a third transformer at Hadspen and new 22 kV feeders to Westbury	• Increases firm capacity at Hadspen by 50 MVA • Addresses firm capacity limitation at Hadspen • Utilises existing site	• Does not address firm capacity issues at Railton – The project for the replacement of the Wesley Vale transformers will need to be brought forward to assist Railton (Refer to North Coast report) • Additional feeders required from Railton to address reliability issues on 22 kV feeders (new circuit breakers or 22 kV network reconfiguration will be required) • Not consistent with strategic plan (Hadspen to feed toward Launceston) • Construction of long 22 kV feeders required (30 km Hadspen to Westbury) • Increased O&M costs on new long 22 kV feeders
3	Installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Westbury	• Addresses firm capacity limitation at Hadspen and Railton • Utilises existing 22 kV feeders • Utilises existing Longford site	• Requires new site at Westbury • Requires additional site at Deloraine for a zone substation in 2027 • Required construction of 66 kV subtransmission circuits

Cost comparison

Table 7-2 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	19.2	26.9	15.8
2	15.9	32.1	18.0
3	30.0	56.0	28.8

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 development

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

The scope of works for Transend includes:

- Establishment of a new site in the Deloraine/Westbury area
- Cut in of the new site to the transmission network
- Installation of 2 x 60 MVA 110/22 kV transformers
- Installation of a new switchgear and control building with two buses of 22 kV switchgear

The scope of works for Aurora includes:

- Installation of 22 kV feeder tails to cut into the existing feeders (further details are provided in the five year plan in Section 8.2)

The resulting forecast and geographic diagrams for the new Westbury substation are shown in the figures below.

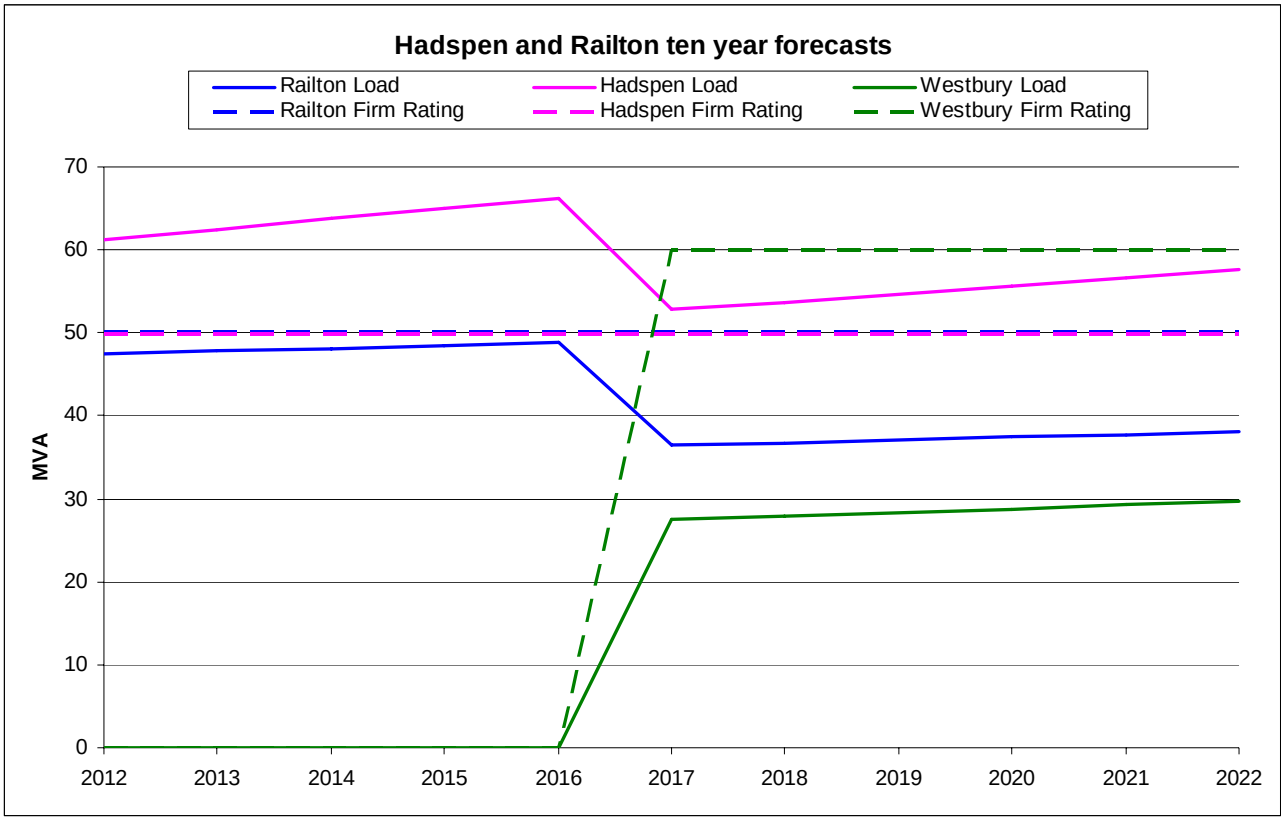

Figure 7-4 Substation ten year forecasts

It has been assumed that a small load transfer will be possible to relieve Hadspen to below its firm rating. The project to install Longford substation in 2021 will further relieve Hadspen.

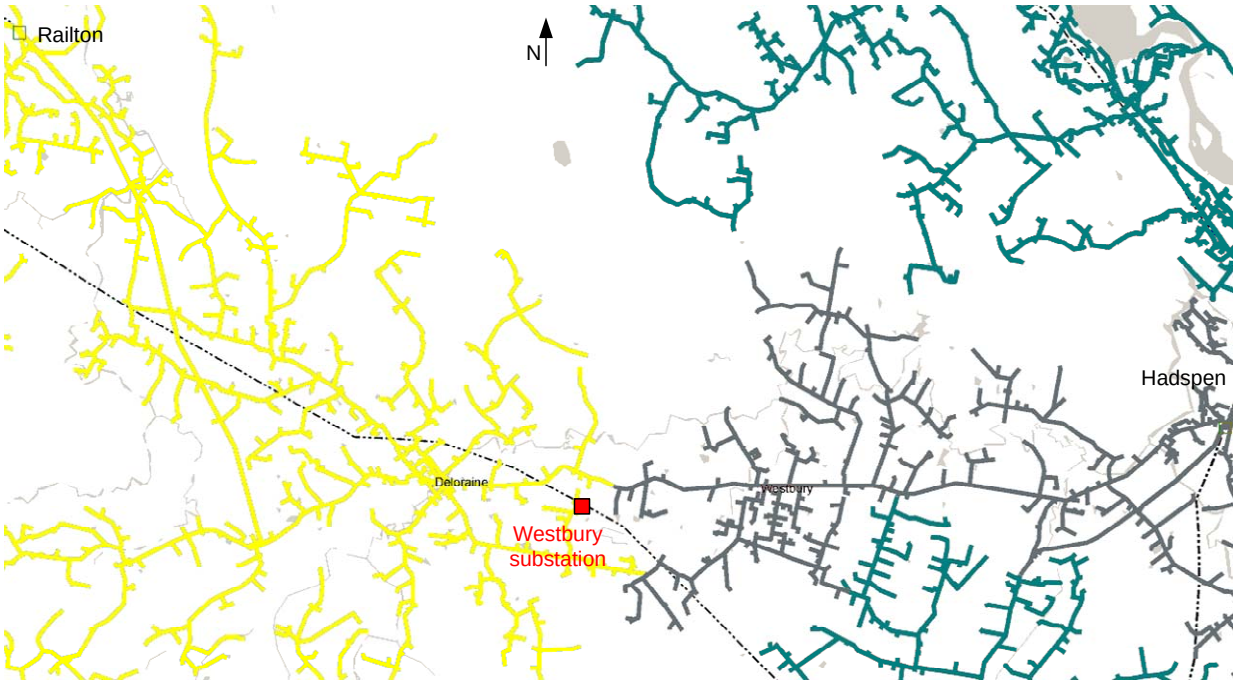

Figure 7-5 Proposed Westbury substation geographic (approximate location)

This project may require a significant amount of transmission works and the installation of both the Westbury and Longford substations will provide the opportunity to reconfigure the network in the area to address any 220 kV and 110 kV limitations. Transmission line costs have not been taken into account in the options analysis. Aurora has advised that consideration needs to be given by Transend to different options for the transmission network in the area. If construction of a new line to supply Westbury is required, the third transformer at Hadspen option may become the preferred option or the installation of Longford substation may need to be brought forward.

Related projects

The installation of the Westbury substation in 2017 addresses the firm capacity issues at both Hadspen and Railton substations. Any changes to the proposed option or the timing of this project will affect both of these substations. This project links with the conversion of the Wesley Vale substation in 2012 and the replacement of the Wesley Vale transformers due to age limitations in 2021. Both of these projects will relieve Railton substation and the timing of the projects will be affected based on the Westbury project. For further information on the Wesley Vale conversion and transformer upgrade, refer to the North Coast area strategic plan.

The installation of the Westbury substation also affects the proposed installation of the Longford substation in 2021. The alternate options for both the Westbury and Longford substations are a third transformer at Hadspen or the installation of a 66 kV injection point and multiple zone substations. Any changes to the proposed Westbury option will affect the Longford project. For further information on the Longford project, refer to the following section.

7.1.2 Longford 110/22 kV substation

Perth, Evandale, Longford and the Launceston Airport are growing industrial and residential areas currently supplied by Hadspen and Norwood substations. Large industrial point loads are expected in the Launceston Airport area.

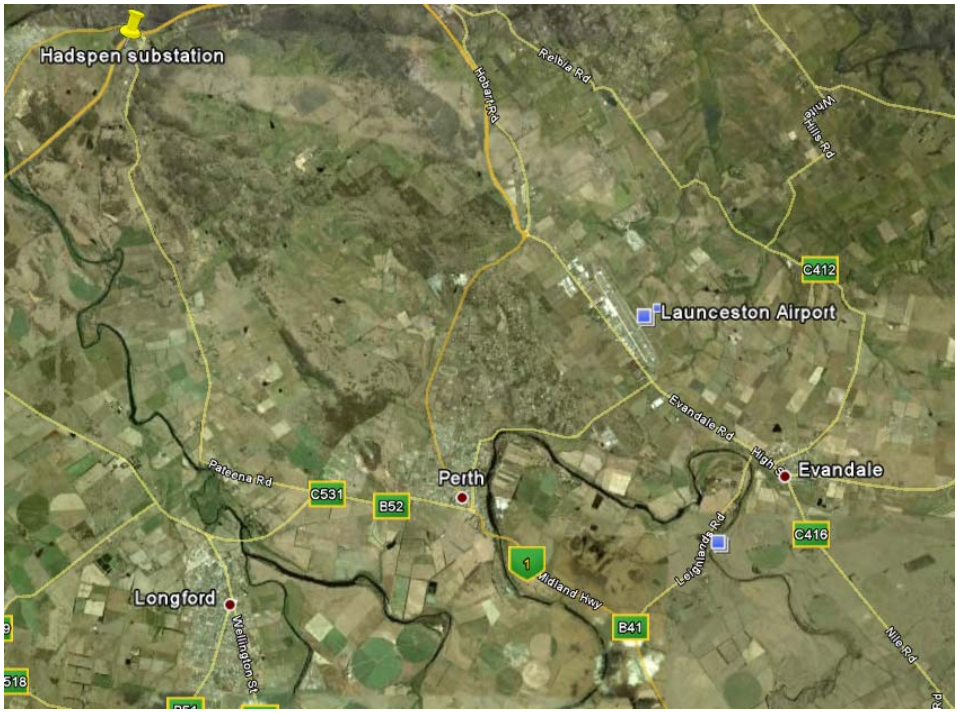

Figure 7-6 Longford, Perth, Evandale and Launceston Airport area

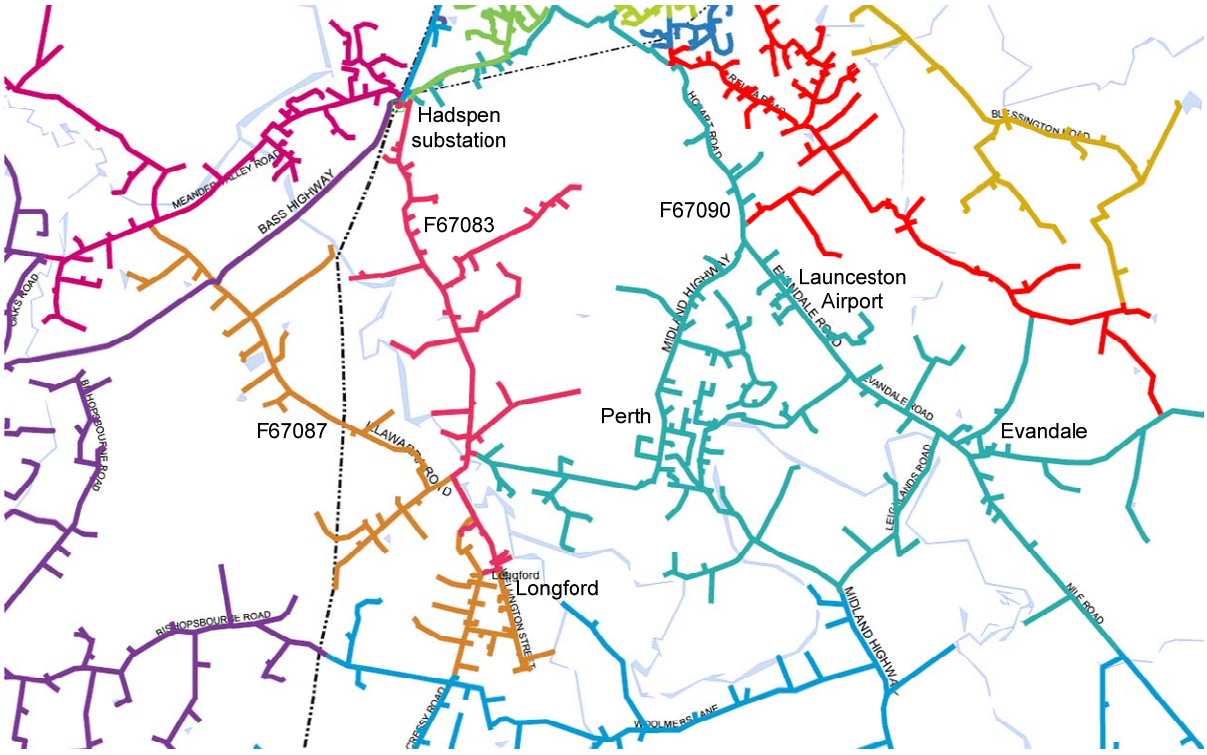

Figure 7-7 Existing 22 kV distribution network

Limitations

Hadspen terminal substation has two 50 MVA 110/22 kV transformers. The terminal substation load in 2012 is forecast to be 61.25 MVA and it is forecast to grow to 74.14 MVA in 2022. The substation will be deloaded by the installation of the new Westbury connection point but will again reach firm capacity due to load growth south-west of the substation.

Norwood terminal substation has two 50MVA 110/22-11 kV transformers. The load in 2012 is forecast to be 43.41 MVA and it is forecast to grow to 51.66 MVA. The firm capacity of the terminal substation will be exceeded.

The Westbury substation has been included in this forecast representation and the Hadspen and Norwood 2012 loads take into account the load transfer to the new St Leonards substation.

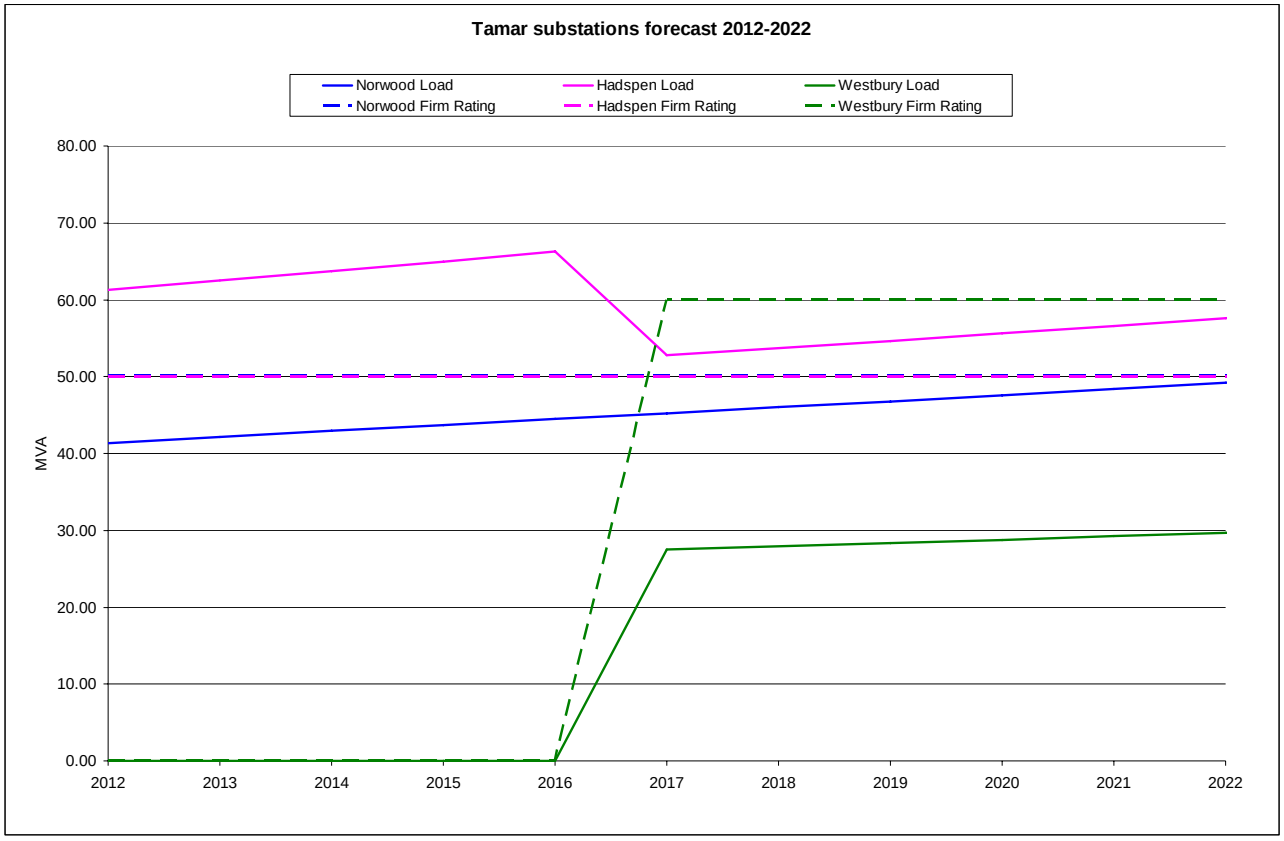

Figure 7-8 Substation ten year forecasts

Option 1 – Installation of 110/22 kV connection point in Longford

This option involves the establishment of a new terminal substation in the Longford area in 2021. Two 110/22 kV 60 MVA transformers and 22 kV switchgear should be installed. This will address the firm capacity issues at Hadspen and Norwood and will allow load to be shifted between the relieved substations and Trevallyn, Mowbray and St Leonards. This substation will supply the growing areas of Longford, Perth, Evandale and the Launceston airport.

Option 2 – Installation of a third transformer at Hadspen and new 22 kV feeders

This option involves the installation of a third transformer at Hadspen and new 22 kV feeders to supply the increasing load at Longford, Perth, Evandale and the Launceston Airport.

Option 3 – Installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Breadalbane

This option involves the installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Breadalbane. Two new 60 MVA transformers will be installed at Longford and a new 66 kV circuit to a new zone substation at Breadalbane with two 25 MVA 66.22 kV transformers. This will address the firm capacity issues at Hadspen.

Option 4 – Non-network option

No non-network alternatives have been considered.

Option 5 – Do nothing option

The do nothing option is not considered a feasible option as the load is above firm capacity at Hadspen substation and above group firm capacity for the five substations supplying Launceston.

Technical comparison

Table 7-3 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Installation of a new 110/22 kV connection point at Longford	• Address firm capacity limitations at Hadspen and the substations supplying Launceston • Highest operational flexibility • Consistent with network development plan (remove surrounding load from Hadspen so it can feed towards Launceston) • Utilises existing Transend site under existing 110 kV line • Frees up feeder tails from Hadspen to supply into the West Launceston area	•
2	Installation of a third transformer at Hadspen and new 22 kV feeders	• Increases firm capacity at Hadspen by 50 MVA • Addresses firm capacity limitation at Hadspen • Utilises existing site	• Not consistent with network development plan (Hadspen to feed toward Launceston) • Construction of new 22 kV feeders required • Feeder congestion at Hadspen substation
3	Installation of a 110/66 kV substation at Longford and a 66/22 kV zone substation at Breadalbane	• Addresses firm capacity limitation at Hadspen • Utilises existing 22 kV feeders • Utilises existing Longford site	• Requires new site at Breadalbane • New 66 kV subtransmission circuits required • Second zone substation required in six years to relieve firm capacity at Breadalbane

Cost comparison

Table 7-4 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	17.6	18.6	8.9
2	16.8	21.5	9.2
3	29.0	44.0	19.3

The above cost comparison of options indicates that option 1 provides the lowest cost solution. A high feeder cost has been assumed for the second option to account for the feeder congestion in exiting the Hadspen substation. This will need to be further reviewed in the detailed planning analysis. Details of the NPV analysis are given in Appendix B.

Recommended development

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

The scope of works for Transend includes:

- Development of the existing Longford site
- Cut in of the new site to the 110 kV network
- Installation of 2 x 60 MVA 110/22 kV transformers
- Installation of a new switchgear and control building with two buses of 22 kV switchgear

The scope of works for Aurora includes:

- Installation of six 22 kV feeder tails to cut into the existing feeders. The proposed routes include two feeders towards Longford, one feeder towards Palmerston F51003, one feeder towards Perth and two feeders towards the Launceston Airport and Evandale. This will need to be further reviewed as the load in the area grows and the planning analysis is completed for the project.

The resulting forecast, schematic and geographic diagrams for the new Longford substation are shown in the figures below.

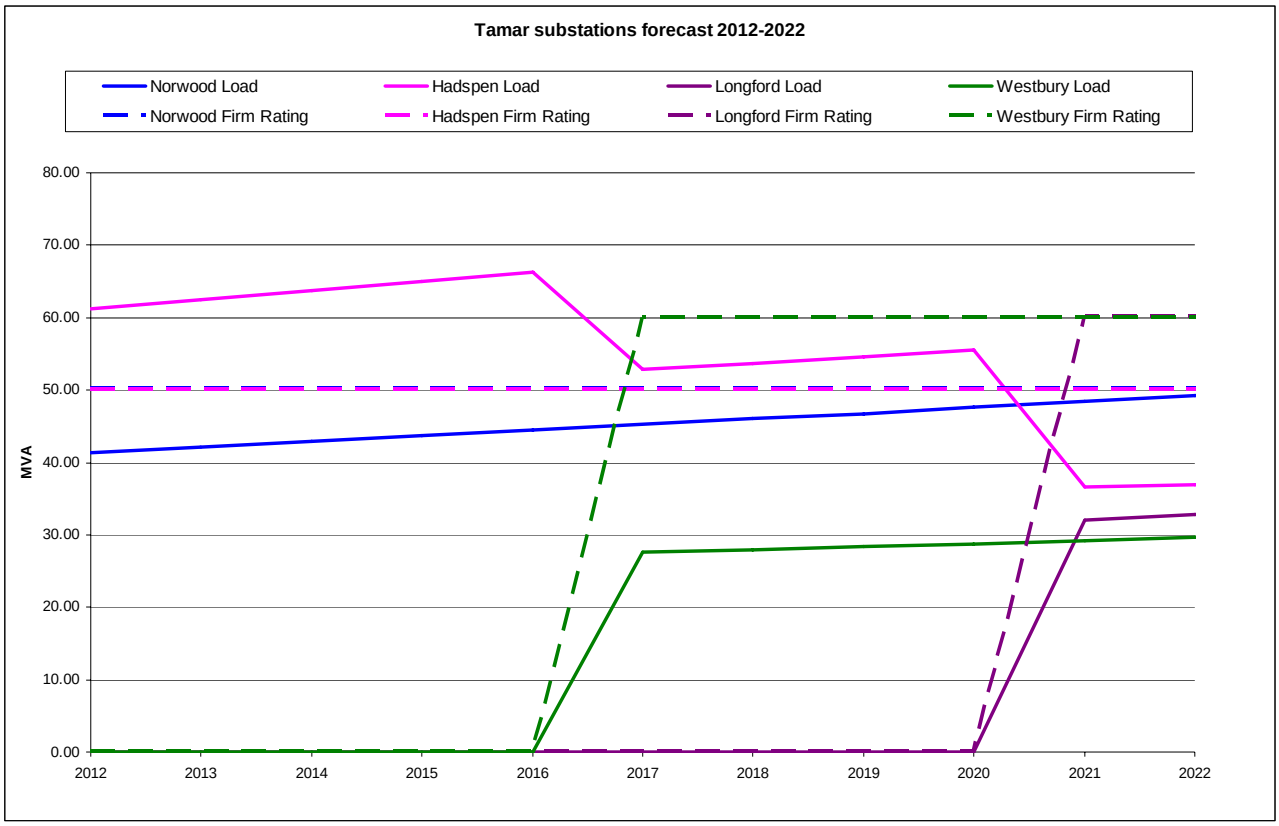

Figure 7-9 Substation ten year forecasts

The load at Norwood will remain constant when Longford is established as load transfers may be performed between Norwood and the Launceston substations to redistribute the load and relieve all Launceston substations.

As mentioned in the Westbury project, a significant amount of transmission works will may be required during the installation of both the Westbury and Longford substations which will provide the opportunity to reconfigure the network in the area to address any 220 kV and 110 kV limitations. Aurora has advised that consideration needs to be given by Transend to different options for the transmission network in the area.

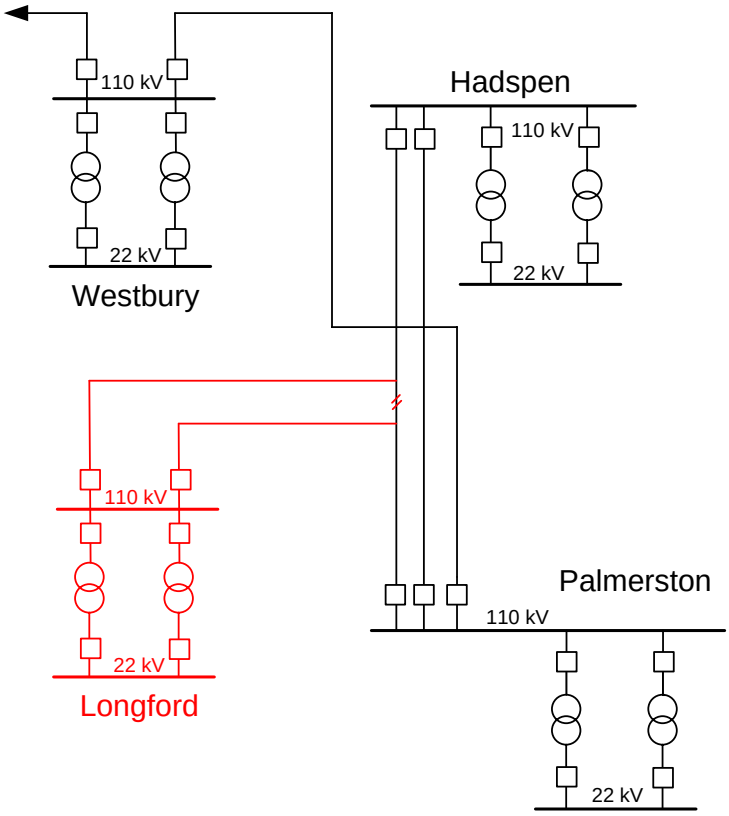

Figure 7-10 Longford substation network schematic

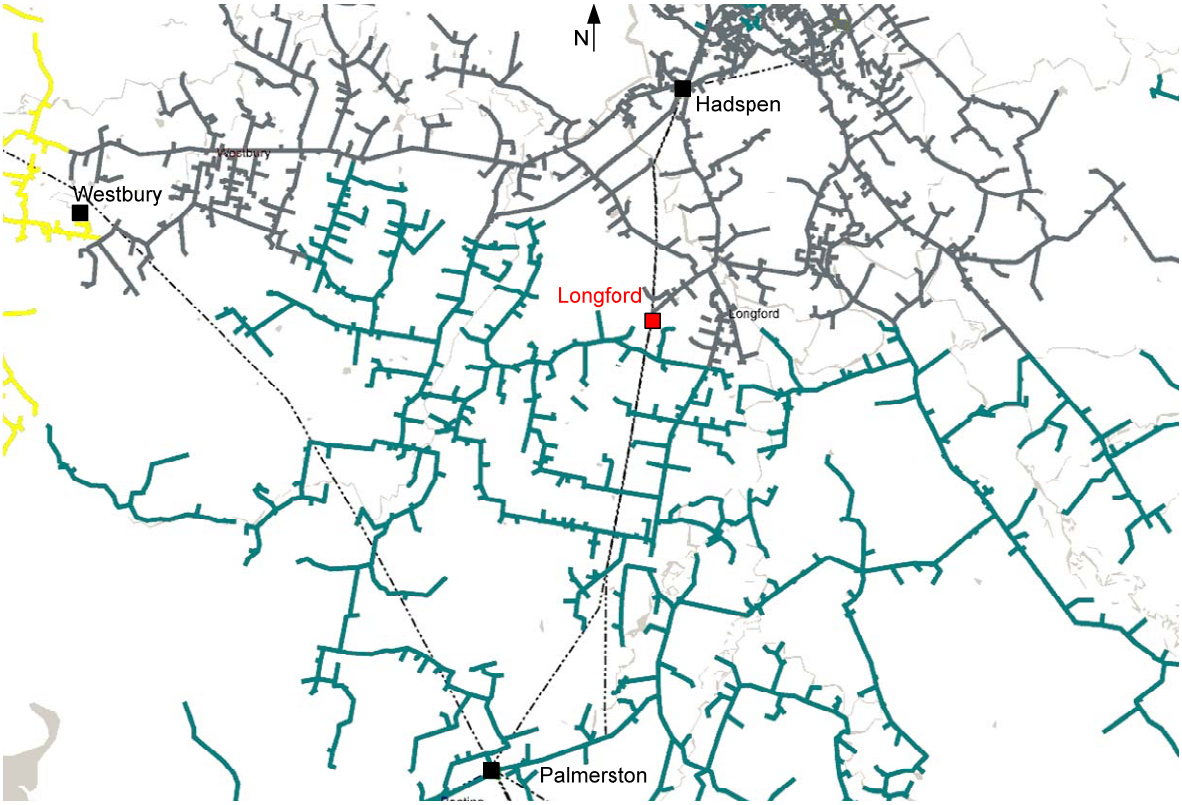

Figure 7-11 Longford substation network schematic

Related projects

The installation of the Longford substation is linked with the proposed installation of the Westbury substation in 2017. The alternate options for both the Longford and Westbury substations are a third transformer at Hadspen or the installation of a 66 kV injection point and multiple zone substations. Any changes to the proposed Longford option may affect the Westbury project. For further information on the Westbury project, refer to the previous section.

7.2 Summary of proposed works

The proposed works from 2012 to 2022 in the Tamar planning area are listed in Table 7-5.

Table 7-5 Tamar project summary

Year	Proposed Project	Proposed Outcomes
2017	Westbury 110/22 kV substation	Address firm capacity issues at Hadspen substation, improved supply for Launceston area
2021	Longford 110/22 kV substation	Address firm capacity issues at Hadspen and Norwood substations, improved reliability of supply to Perth, Evandale, Longford and Launceston Airport

8. Five year plan

A five year plan for each of the substations (including proposed new substations) in the Tamar 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 M (RIT-D) or $5 M (RIT-T).

8.1 Hadspen substation

Hadspen terminal substation supplies the urban communities of Hadspen, Westbury, Longford, Perth, Evandale and Launceston and the high density rural surrounding these main points.

8.1.1 Limitations

Using the medium growth forecast, the Hadspen terminal substation load in 2012 is forecast to be 59.57 MVA and it is forecast to grow to 63 MVA in 2017. This load is well above the firm capacity of the substation. Two 5 MVAr capacitor banks have recently been installed at Hadspen which will slightly reduce the peak load on the substation.

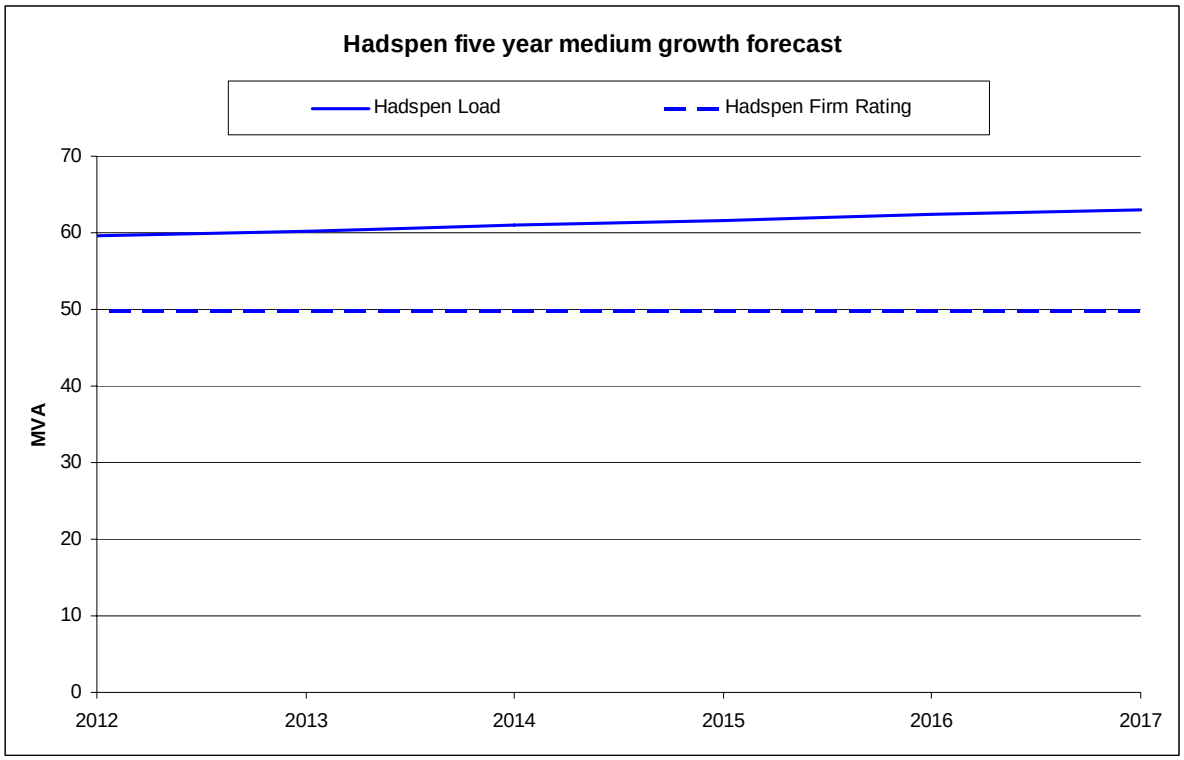

Figure 8-1 Substation five year medium growth forecast

The existing 22 kV network consists of eight feeders and there are two spare 22 kV circuit breakers available. However, a new feeder to Westbury and a new feeder towards Launceston airport will both be in service before the start of the study period in 2012 and will utilise the remaining spare circuit breakers. The Hadspen 22 kV supply area is shown in the following figure.

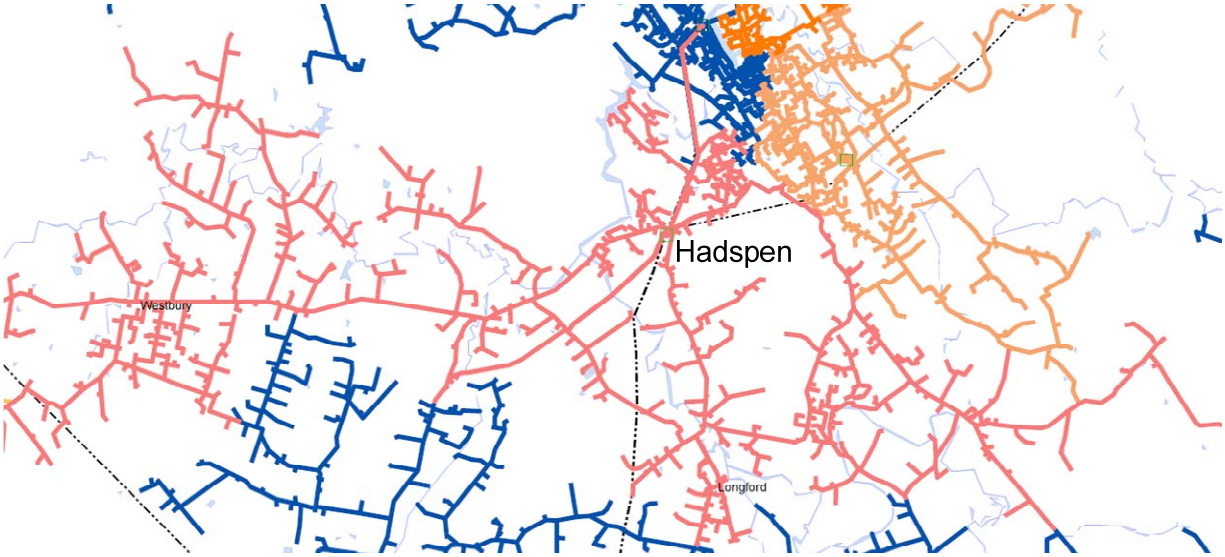

Figure 8-2 Hadspen 22 kV supply area

The individual 22 kV feeders from Hadspen substation are shown in the following figure.

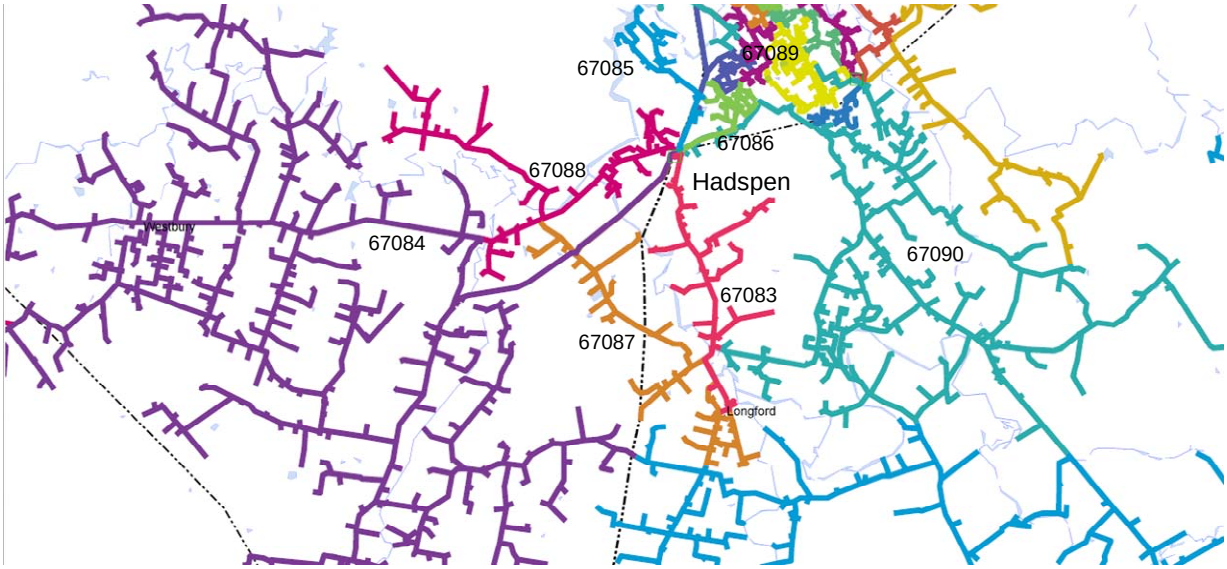

Figure 8-3 Hadspen 22 kV feeders (January 2010)

A five year feeder forecast has been developed using the actual peak feeder loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-1 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Westbury	67084	7.65	7.74	7.83	7.92	8.01	8.09
	67088	5.26	5.33	5.39	5.45	5.51	5.57
Longford	67087	0.35	0.36	0.36	0.36	0.37	0.37
	67083	12.42	12.56	12.71	12.85	13.00	13.13
Perth/ Evandale	67090	12.46	12.60	12.75	12.89	13.04	13.17
West Launceston	67085	6.16	6.24	6.31	6.38	6.45	6.52
	67086	6.50	6.58	6.65	6.73	6.80	6.88
	67089	7.70	7.79	7.88	7.97	8.06	8.14

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that limitations are present at Longford and Perth/Evandale. Load transfers at Longford between the two existing feeders will address the limitation on F67083. One of the new feeders from Hadspen to be installed before 2012 will address the overload on F67090.

The two feeders, F67084 and F67088, are reasonably well loaded and large point loads are forecast for the area. These feeders also have reliability issues due to the length of the feeders and the large point loads at the end of the feeders. A new feeder is due to be installed from Hadspen by 2011/12 to relieve F67088 and to provide another source of supply for the upgrade to the industrial subdivision at Westbury.

The feeder routes from Hadspen substation towards the surrounding load centres are heavily congested for an approximate radius of 2-3 km. There are also issues associated with crossing a major gas line, a river and sharing the Department of Infrastructure, Energy and Resources (DIER) easements. Many of the feeders from Hadspen are long with load centres towards the end of feeders.

Hadspen substation has existing transfer capability with Trevallyn, Palmerston and Norwood. The following figures are from the load transfer models provided by Aurora.

Table 8-2 Forecast transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Hadspen - Trevallyn	61041	2.4	2.5	0.0	0.0	0.0	0.0
	61037	7.0	7.1	7.2	7.3	7.4	7.5
	61032	6.0	6.1	6.2	6.3	6.4	6.4
Hadspen – Palmerston	51002	1.7	1.7	1.6	1.6	1.6	1.7
	51003	2.0	1.9	1.7	1.6	1.5	1.4
Hadspen – Norwood	65060	5.3	5.3	5.2	5.2	5.1	5.0
	65061	4.9	0.0	0.0	0.0	0.0	0.0
	65062	4.3	0.0	0.0	0.0	0.0	0.0
Total transfers	-	33.6	24.6	21.9	22	22	22

The actual load at Hadspen is already exceeding the firm capacity of the substation. There is reasonable transfer capability available to both the Norwood and Trevallyn substations. The new St Leonards substation will relieve Norwood and load transfers should be available to partially deload Hadspen until the new Westbury substation is installed in 2017.

8.1.2 Proposed projects

Westbury substation

The Westbury substation is proposed to be installed in 2017 to relieve the firm capacity limitation at Hadspen and Railton and improve reliability in the Westbury/Deloraine area. For information on the options analysis for this project, please refer to the ten year plan in Section 7.1.1. For information on the scope of work under the five year plan please refer to Section 8.2. The effect of the installation of Westbury substation on Hadspen is outlined below.

The resulting Hadspen five year forecast is shown in the following figure.

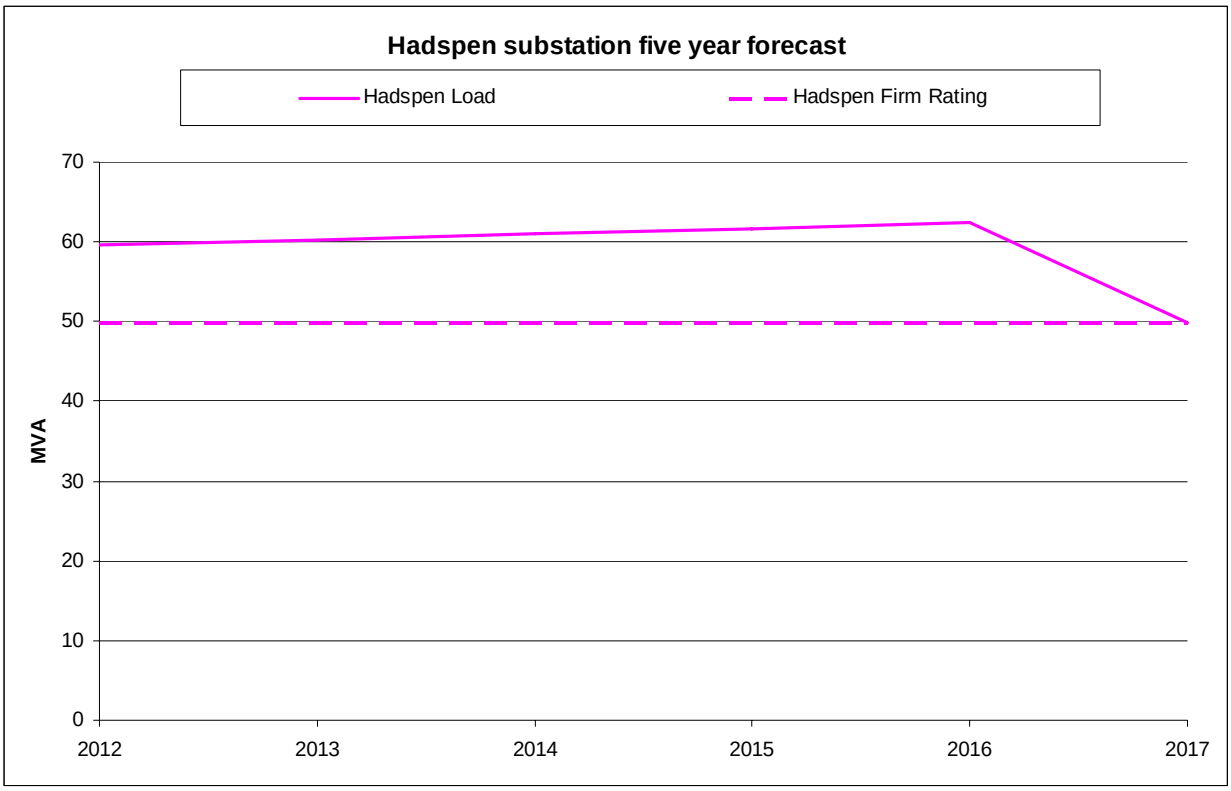

Figure 8-4 Hadspen forecast with the installation of Westbury substation

As outlined above, Hadspen load is reduced below firm capacity in 2017.

The resulting Hadspen feeder loads are shown in the following table.

Table 8-3 Hadspen substation proposed feeder forecast

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Hadspen	67084	7.82	7.91	8.00	8.09	8.18	0*
	67088	5.47	5.54	5.60	5.67	5.73	3.8

As outlined above, feeders 67084 and 67088, are deloaded by the establishment of Westbury substation. The feeder 67084 will be available to be redirected as a new feeder towards the Longford area.

New feeder projects

Based on the medium growth forecast, there are no feeder overloads forecast for the first five years of the study period. The capacity and reliability of the existing feeders has been addressed in projects in the lead up to the start of the study period. The existing transfer capability is sufficient for the five year period.

8.1.3 Ultimate configuration

Substation

Hadspen is expected to remain a two transformer substation up to 2050. The installation of the Westbury and Longford substations will remove the need for a third transformer at Hadspen within the long term study period. The two existing transformers will be replaced with 60 MVA units when the age limitation is reached.

Feeders

With Westbury substation to the west, the highway to the east and Longford substation to the south, it is expected that the majority of future feeders required from Hadspen will be in the northern direction to West Launceston. Due to existing feeder congestion at the Hadspen substation, it is recommended that provision be made for additional conduits to be installed during small projects to provide routes for future projects to the north. The existing feeder tails running to Westbury and Longford will be able to be reconfigured and redirected towards the north as required.

As noted above there are no spare circuit breakers at Hadspen substation. The transfer capability of the existing Hadspen feeders should be monitored and additional ties between feeders installed as required.

8.2 Westbury substation

The Westbury substation is proposed to be installed in 2017 to relieve the firm capacity limitations at Hadspen and Railton and improve reliability in the Westbury/Deloraine area. For information on the options analysis for this project, please refer to the ten year plan in Section 7.1.1. This section of the report will focus on the scope of work for Aurora under the five year plan. The installation of the Westbury substation will transfer the Deloraine area from the North Coast area to the Tamar area.

Assuming a site location on Exton Road, the scope of works for this project includes:

- Installation of a 1.3 km 22 kV double circuit overhead line to cut into F85002 on Meander Valley Road. One new feeder will utilise F85002 and will pick up a small part of 85006 to the north east of Deloraine. The second new feeder will utilise F67084 and will take the Westbury load north of Meander Valley Road and part of F67088.
- Installation of a new short feeder tail to cut into 85002 on Exton Road to create a second Westbury feeder. This feeder will pick up the load on F67084 south of Meander Valley Road and part of F51002 from Palmerston.
- Installation of a new 2.5 km double circuit overhead line along Exton Road to cut into F85002 on Osmaston Road. The first circuit will take the load on 85002 south east of Deloraine and will pick up part of F85006. The second circuit will continue on approximately 7 km to split 85006 and provide a third feeder into the heavily loaded Deloraine area.
- Install a new 9 km overhead line along Exton Road and the Bass Highway to Tasmanian Alkaloids on Birralee Road.

The proposed works and the feeder supply areas are shown in the following figures.

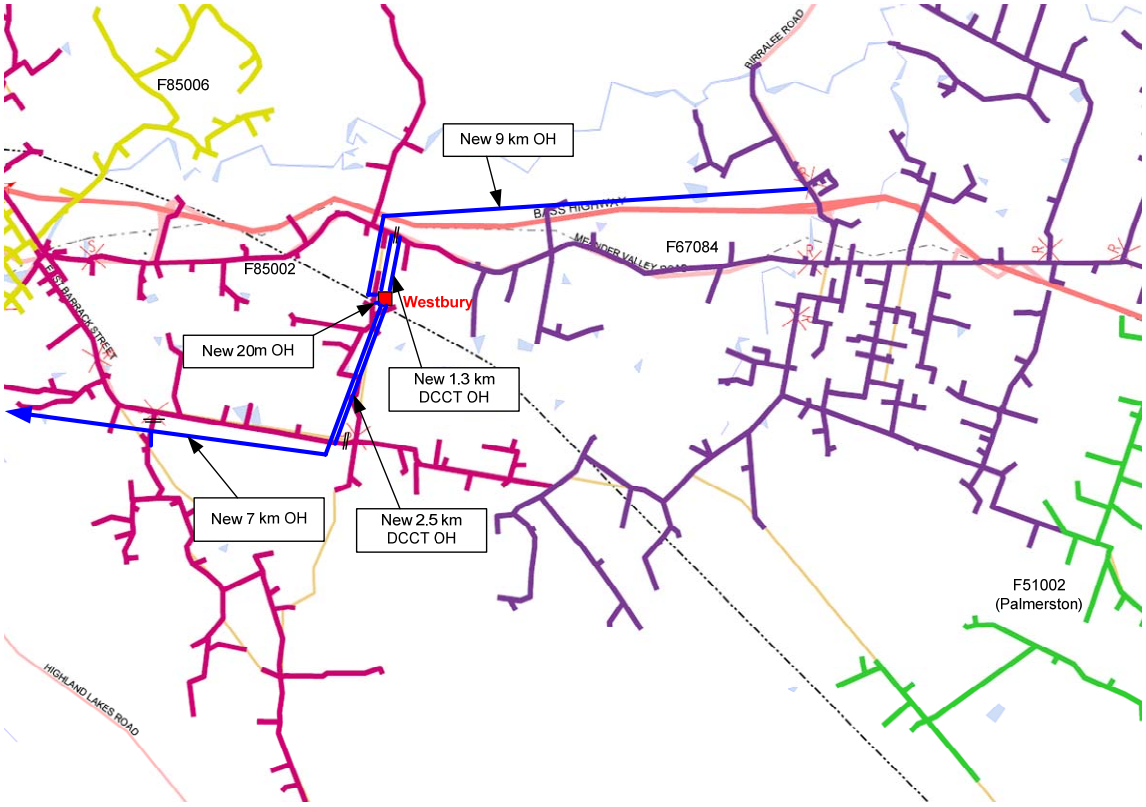

Figure 8-5 Westbury substation 22 kV feeder works

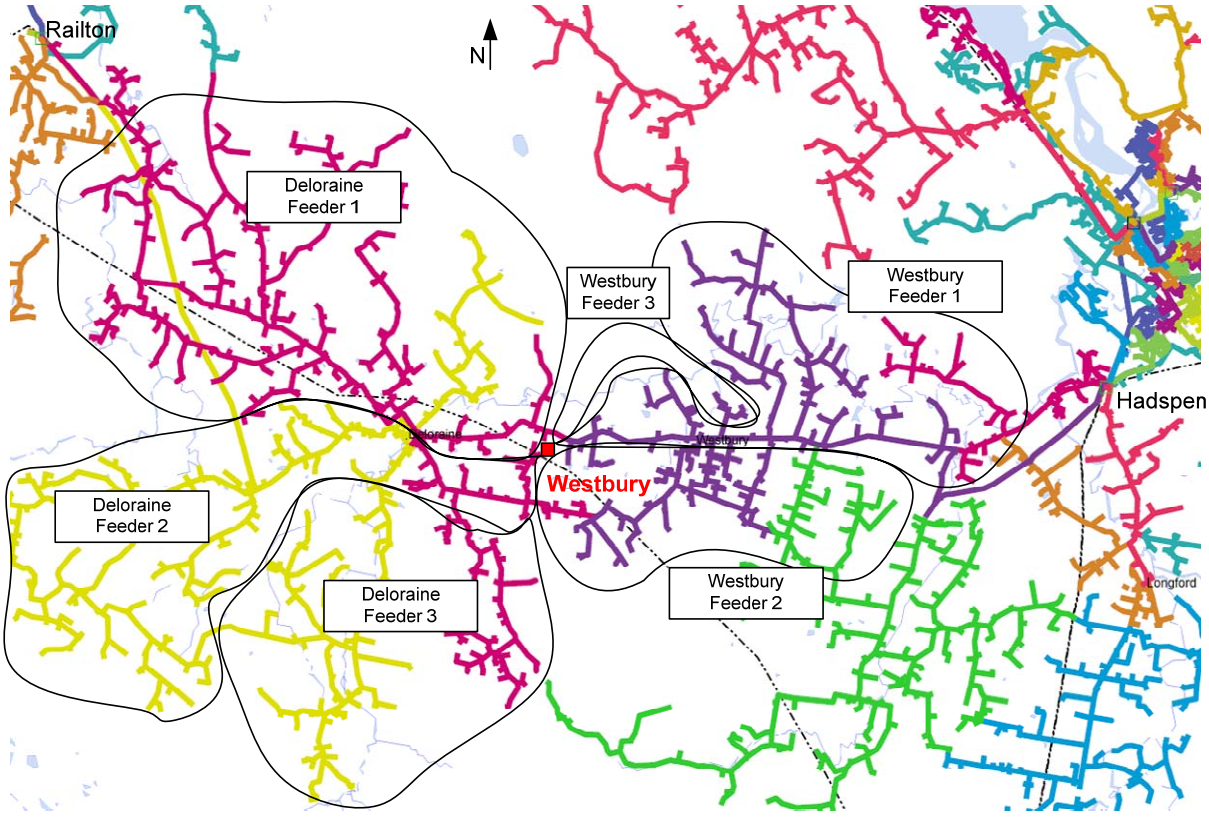

Figure 8-6 Westbury substation new approximate 22 kV feeder supply areas

DINIS has been used to calculate approximate feeder loads for the new feeders from the Westbury substation. The load on Westbury feeder 2 will be dependent on the increase in load at Tasmanian Alkaloids. Further detailed analysis will be required on the final 22 kV configuration based on the chosen substation site location.

Table 8-4 Proposed new feeder growth

Area	Feeder/s	2017 load (MVA)	2018 load (MVA)	2019 load (MVA)	2020 load (MVA)	2021 load (MVA)	2022 load (MVA)
Deloraine	1	7.3	7.4	7.6	7.7	7.8	8.0
	2	6.2	6.3	6.4	6.5	6.7	6.8
	3	3.2	3.3	3.3	3.4	3.4	3.5
Westbury	1	6.6	6.7	6.7	6.8	6.9	7.0
	2	1.6	1.6	1.6	1.7	1.7	1.7
	3	2.6	2.6	2.7	2.7	2.7	2.7

As outlined above there are no forecast feeder limitations in the five years following the establishment of Westbury substation, based on the feeder planning rating of 10 MVA.

8.2.1 Proposed projects

The Westbury substation is to be established in the final year of the five year plan period so there are no further projects required for this substation supply area.

8.2.2 Ultimate configuration

Substation

Westbury is expected to remain a two transformer substation up to 2050. The transformers will not be due for age replacement in the long term study period. It is not expected that a third transformer will be required in the long term period but room should be allowed during the design of the substation.

Feeders

The requirement for future feeders will be dependent on the development of land in the area. When installing conduits on the major routes from the substation, additional conduits should be installed to allow for future feeders in any direction.

Transfer capability will be established with Railton and Hadspen when the substation is installed. This capability should be monitored and additional ties between feeders constructed where required. It is expected that load will need to be transferred between feeders in the Deloraine area depending on the rate of growth in the area.

8.3 Norwood substation

Norwood substation supplies a large area of Launceston, Ravenswood in the east and rural areas to the south. The existing supply area will shrink with the installation of St Leonards substation and will be focused mainly towards east and south Launceston.

8.3.1 Limitations

Using the medium growth forecast, the Norwood terminal substation load in 2012 is forecast to be 41.38 MVA and it is forecast to grow to 45.23 MVA in 2017. This load is just below the firm capacity of the substation and may be higher depending on the load transfers completed as part of the St Leonards substation project.

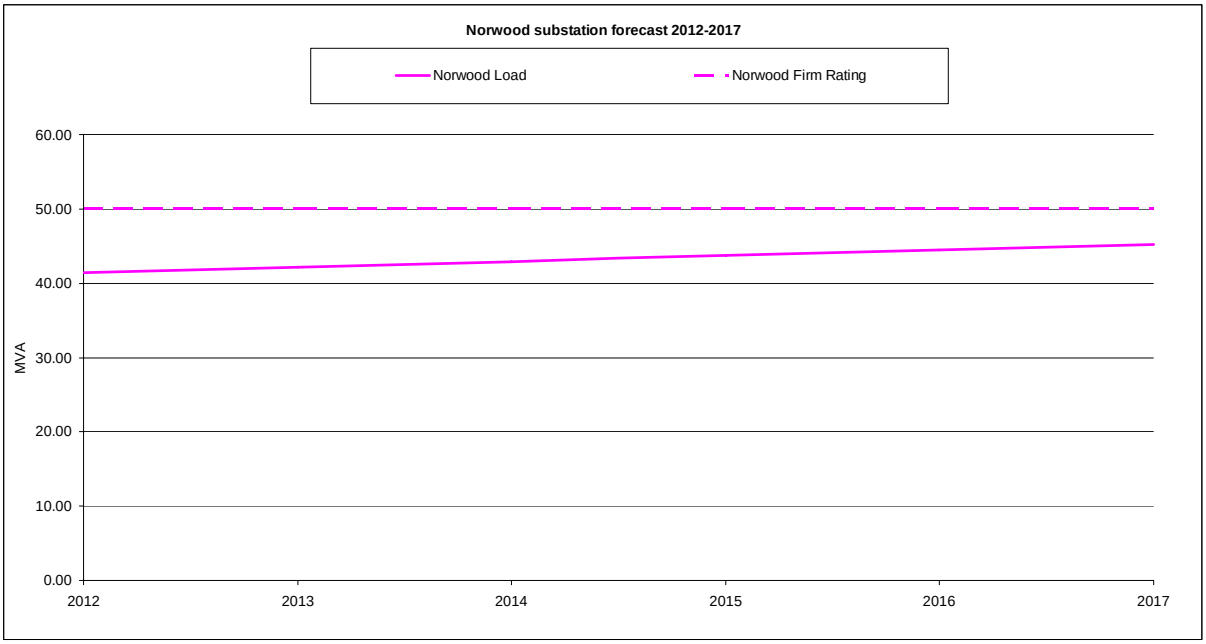

Figure 8-7 Substation five year medium growth forecast

The existing network consists of 8 feeders and there are no spare 22 kV circuit breakers available at the substation. The Norwood 22 kV supply area and individual 22 kV feeders are shown in the following figures.

Figure 8-8 Norwood 22 kV supply area

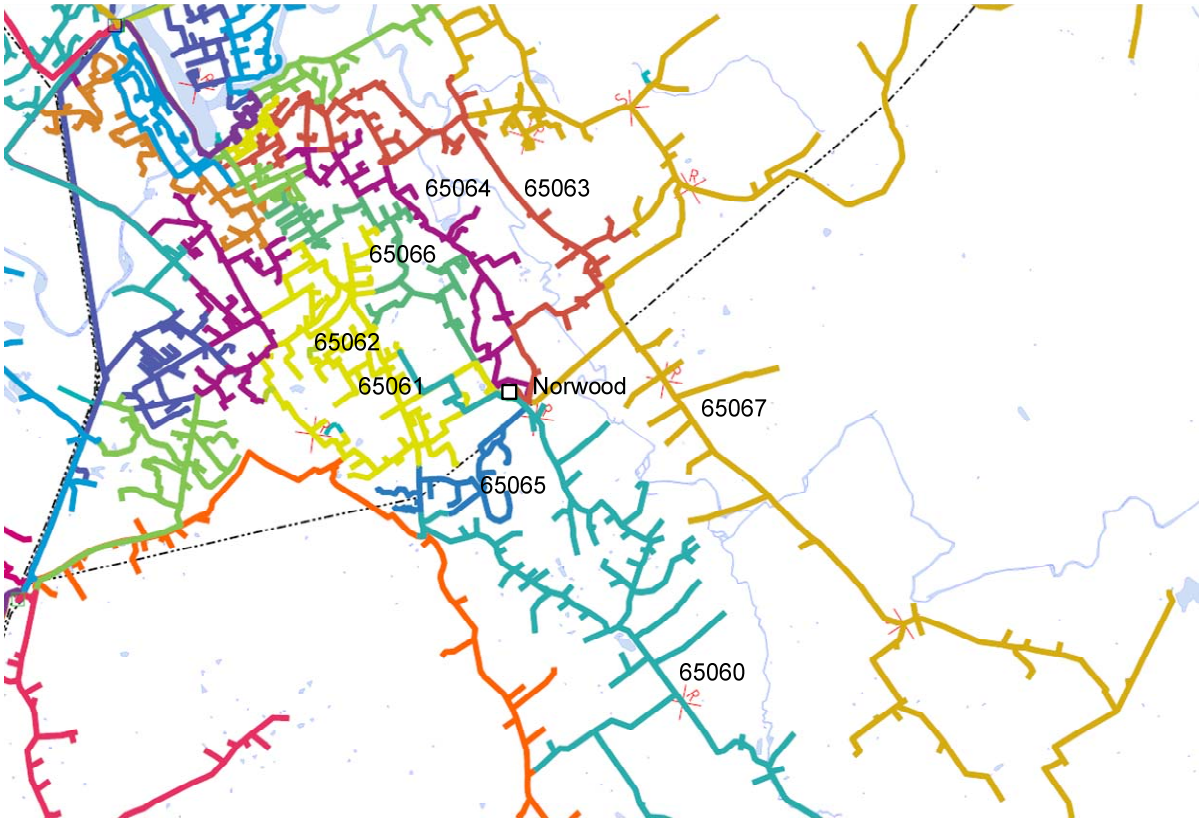

Figure 8-9 Norwood 22 kV supply area

A five year feeder forecast has been developed using the actual peak loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-5 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
South	65060	1.95	1.98	2.02	2.06	2.09	2.13
	65065	8.02	8.17	8.32	8.47	8.62	8.76
South-East	65067	7.56	7.70	7.84	7.98	8.13	8.27
Ravenswood	65063	10.97	11.17	11.38	11.58	11.79	11.99
North	65061	9.32	9.49	9.66	9.84	10.01	10.18
	65062	8.57	8.73	8.88	9.04	9.20	9.36
	65066	11.39	11.61	11.82	12.03	12.24	12.45
	65064	11.26	11.47	11.68	11.89	12.10	12.31

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that limitations are present on four of the eight feeders from Norwood substation. However, the installation of new feeders from the new St Leonards substation will deload the Norwood feeders. Load will be taken from feeders 65067, 65063, 65062, 65066 and 65064.

The feeder 65063 currently supplies Ravenswood and will be deloaded by the new St Leonards feeders. This feeder can be redirected towards the northern Norwood feeders to assist with the load growth in the area. This is further outlined in Section 8.3.2.

Norwood substation has existing transfer capability with Hadspen, Trevallyn and Mowbray, and will have transfer capability with the new St Leonards substation. The following figures are from the load transfer models provided by Aurora.

Table 8-6 Forecast transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Norwood – Hadspen	67090	2.6	2.6	2.5	2.3	2.2	2.0
	HSF1b	4.7	4.6	4.4	4.3	4.1	3.9
	HSF2b	8.8	9.0	9.0	9.0	8.9	8.9
Norwood – Trevallyn	61031	3.1	2.2	2.1	2.0	1.9	1.7
Norwood – Mowbray	62009	6.0	3.2	3.0	2.9	2.8	2.7
	62006	7.7	7.9	7.8	7.7	7.6	7.5
Total transfers	-	32.9	29.5	28.8	28.2	27.5	26.7

There is reasonable transfer capability to both the Hadspen and Mowbray substations and more will become available when St Leonards substation is in operation.

8.3.2 Proposed projects

Norwood northern feeder reconfiguration

The feeder 65063 currently supplies Ravenswood and in towards the CBD. This feeder and the other northern feeders will be deloaded when the St Leonards feeders are installed in 2012. The proposed load to be transferred from Norwood onto St Leonards is shown geographically in the following figure (based on details from the application notice).

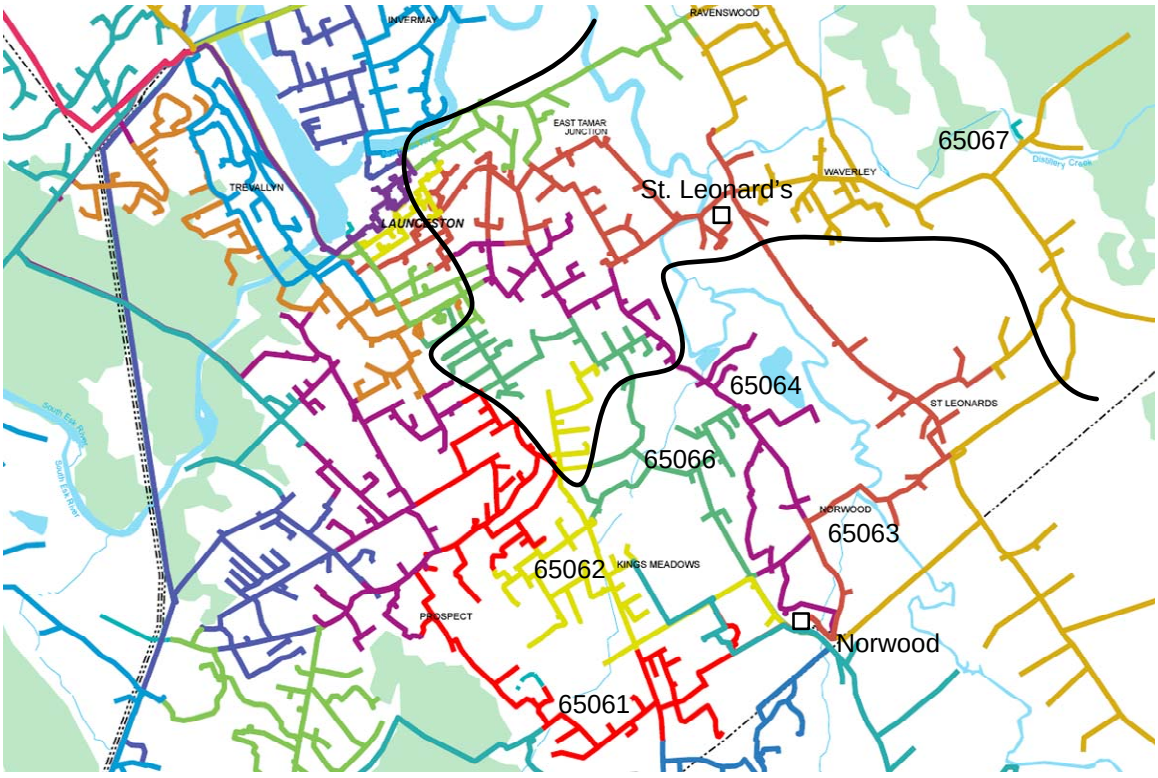

Figure 8-10 Norwood 22 kV supply area with new St Leonards supply area

The northern feeders 65061, 65062, 65066 and 65064 can be reconfigured to utilise the tail from 65063 as another feeder into the area. Feeder 65063 is well positioned to supply the load on 65064 will maintaining supply and transfer capacity to St Leonards. The tail for 65064 can then be utilised to take load from 65061, 65062 and 65066 as required. This reconfiguration will provide an additional feeder into the northern area without having to find a path through congested feeder routes from the Norwood substation.

The timing and details for this project will be dependent on the final configuration of the St Leonards 22 kV feeders and the load growth on the deloaded Norwood feeders.

8.3.3 Ultimate configuration

Substation

Norwood is expected to remain a two transformer substation up to 2050. The two existing transformers will be replaced with 60 MVA units when the age limitation is reached. Due to feeder congestion, a third transformer at Norwood has not been included in the long term strategy. The installation of the St Leonards and future CBD substations will deload the Norwood substation.

Feeders

The majority of load supplied by Norwood is to the north of the substation. The installation of the St Leonards substation will allow the reconfiguration of the existing feeders to the north. Longford substation will further deload Norwood and reduce the supply area of the substation. There is feeder congestion when exiting the substation and there are no spare circuit breakers available so efficient use of the existing tails will be a high priority. The transfer capability of the existing Norwood feeders should be monitored and additional ties installed as required.

8.4 Mowbray substation

Mowbray terminal substation supplies the areas of Mowbray, Rocherlea, Invermay, Inveresk and Ravenswood.

8.4.1 Limitations

Using the medium growth forecast, the Mowbray terminal substation load in 2012 is forecast to be 41.4 MVA and it is forecast to grow to 45.11 MVA in 2017. The load is below the firm capacity of the substation. Mowbray will be partially deloaded when St Leonards substation is installed in 2012 and also due to the recent installation of two 5 MVAr capacitor banks.

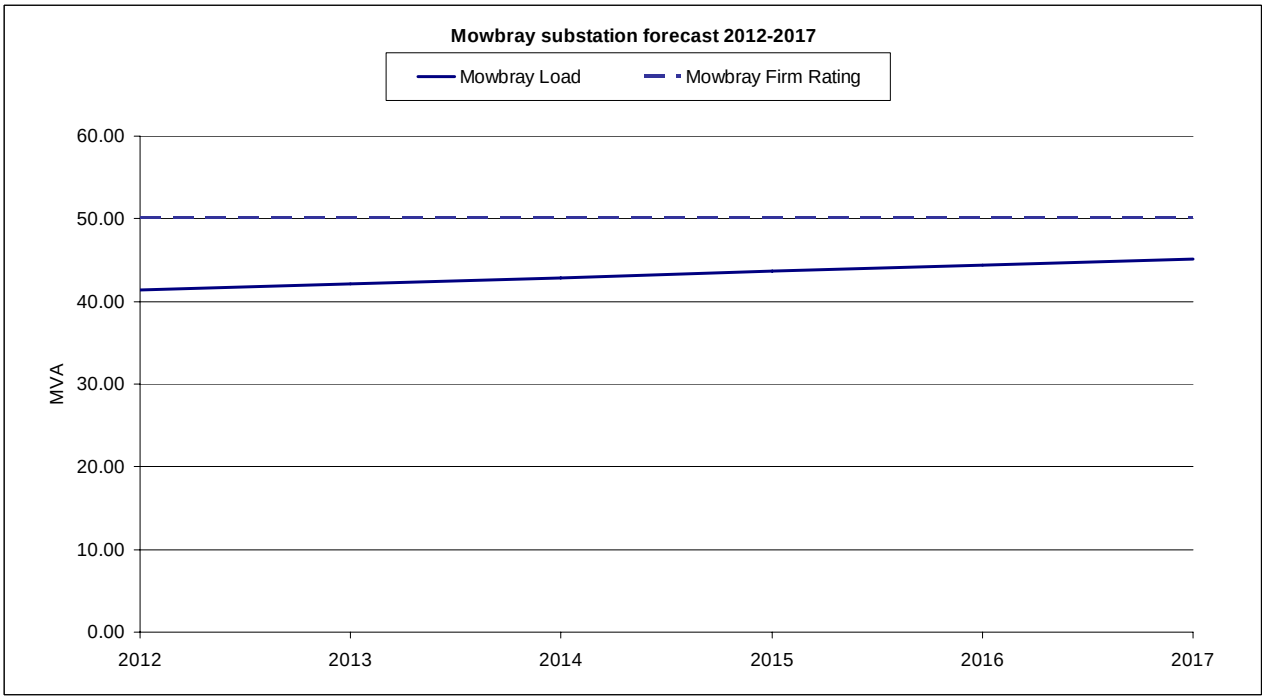

Figure 8-11 Substation five year medium growth forecast

The existing 22 kV network consists of six feeders and two super feeders to Trevallyn. There are no spare circuit breakers available at the substation. The two super feeders will be available for use when the 110 kV transmission line from St Leonards is constructed. The feeder tail for a future feeder, 62011, has been installed out of Mowbray substation. The Mowbray 22 kV supply area and the individual 22 kV feeders are shown in the following figures.

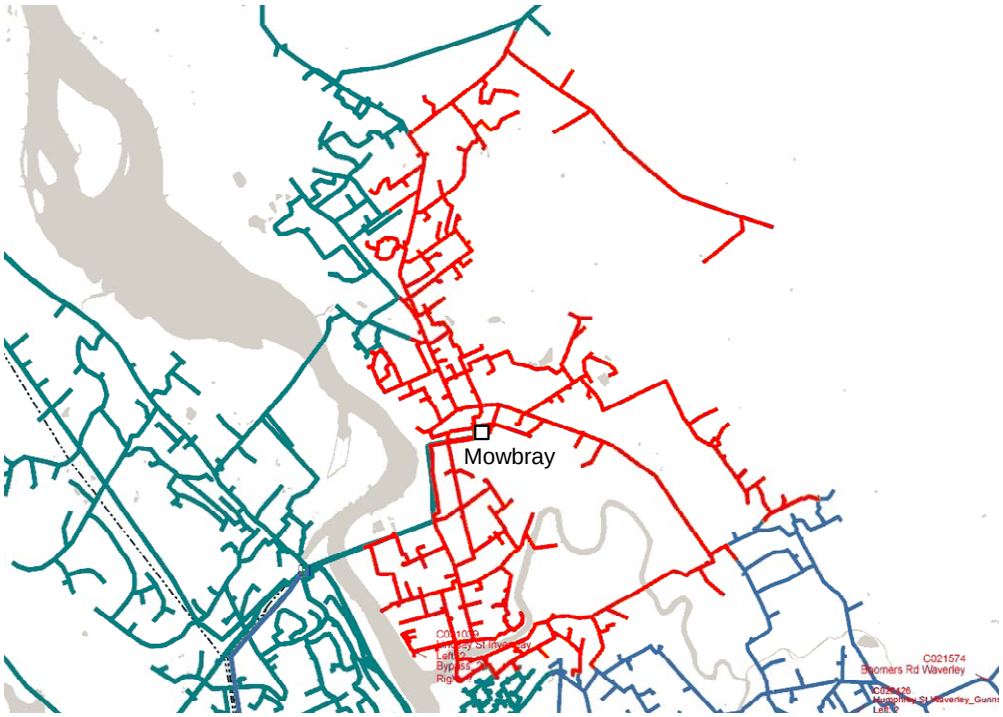

Figure 8-12 Mowbray 22 kV supply area

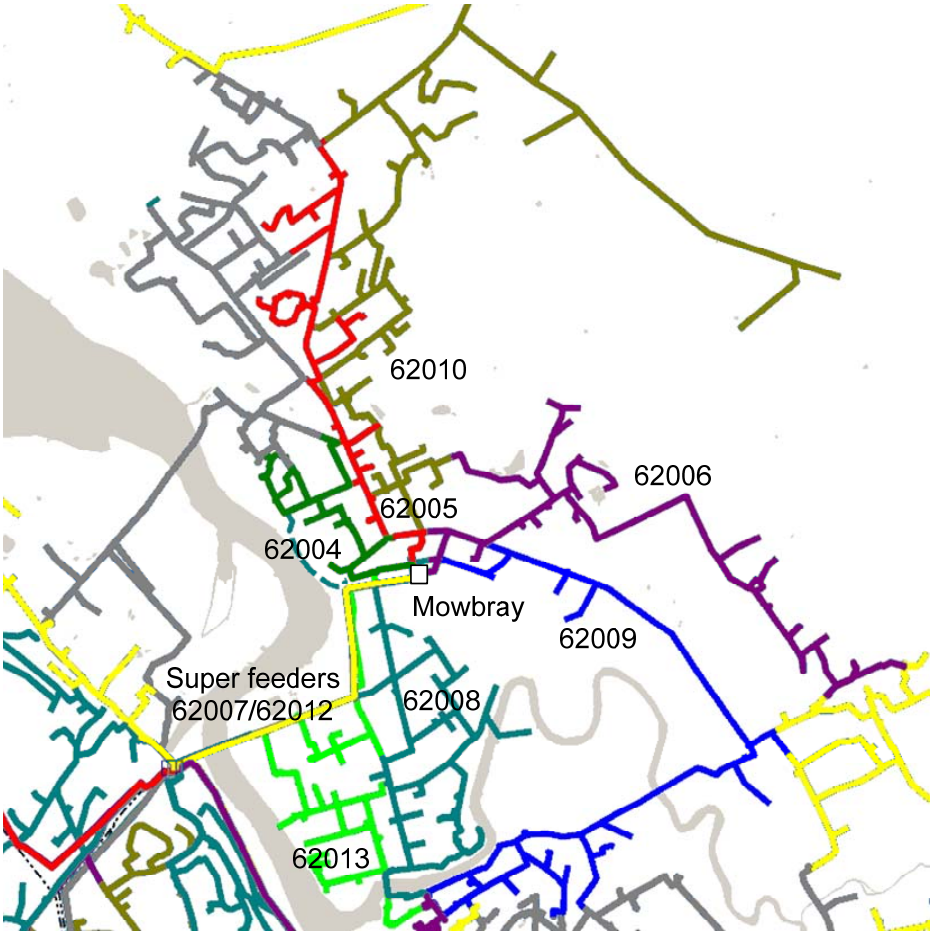

Figure 8-13 Mowbray 22 kV individual feeders

A five year feeder forecast has been developed using the actual peak loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-7 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Inveresk	62008	8.14	8.30	8.47	8.63	8.79	8.96
	62013	7.77	7.93	8.08	8.24	8.40	8.56
Ravenswood/CBD	62009	6.37	6.50	6.63	6.76	6.89	7.02
East	62006	4.08	4.16	4.24	4.33	4.41	4.49
North	62005	6.96	7.10	7.24	7.38	7.52	7.67
	62010	6.93	7.07	7.21	7.35	7.49	7.63
	62004	4.20	4.29	4.37	4.46	4.54	4.63
	62011	0.00	-	-	-	-	-

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there are no limitations present on the seven operating feeders.

The Inveresk area feeders are both heavily loaded and load increases are expected in this area. The installation of a new feeder from the St Leonards substation is expected to provide an additional supply into the heavily loaded area.

Two of the northern feeders are heavily loaded over the five year period and the feeder from Trevallyn into the area is overloaded. Feeder reconfiguration to transfer load on to 62004 will address the limitation on 61029 and better utilise 62004. The feeder tail for an additional future feeder, 62011, has been installed out of Mowbray substation. It is likely that this feeder will be required to feed north to deload the feeders in the northern area.

Some minor reconfiguration works will be needed on the super feeders based on the availability of St Leonards and the completion of the 110 kV into Mowbray.

Mowbray substation has existing transfer capability with Norwood substation, and will have transfer capability with the new St Leonards substation. The following figures are from the load transfer models provided by Aurora.

Table 8-8 Forecast transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Mowbray – Norwood	65067	2.5	2.5	2.3	2.1	2.0	1.8
Total transfers	-	2.5	2.5	2.3	2.1	2.0	1.8

There is only a small transfer capability between Mowbray and Norwood. The transfer capability will increase when St Leonards substation is in operation. The other Norwood and Trevallyn feeders adjacent to the Mowbray network are currently too heavily loaded to be utilised for load transfers. Projects to decrease load on these feeders will provide additional transfer capability to Mowbray.

8.4.2 Proposed projects

There are no proposed projects in the Mowbray area during the five year plan period.

8.4.3 Ultimate configuration

Substation

Due to space restrictions at the substation, a third transformer is not an option at Mowbray substation unless more land is obtained. The two existing transformers will be replaced with 60 MVA units when the age limitation is reached. The installation of the St Leonards and future CBD substations will deload the Mowbray substation.

Feeders

The Mowbray supply area will be focused towards the northern load in the ultimate configuration. The installation of the St Leonards and CBD substations will allow the reconfiguration of the existing feeders to the south. Additional conduits should be installed in the northern direction for the predicted future growth in the Rocherlea area. The transfer capability of the existing Mowbray feeders should be monitored and additional ties between feeders installed as required.

8.5 Trevallyn substation

Trevallyn substation supplies the Launceston CBD, Trevallyn, Rocherlea, Dilston and areas to the north of the Trevallyn substation.

8.5.1 Limitations

Using the medium growth forecast, the Trevallyn terminal substation load in 2012 is forecast to be 89.44 MVA and it is forecast to grow to 94.92 MVA in 2017. The load is below the firm capacity of the substation. Trevallyn is currently over firm capacity in 2009 but will be deloaded when St Leonards substation is installed in 2012 and also due to the recent installation of four 5 MVAr capacitor banks.

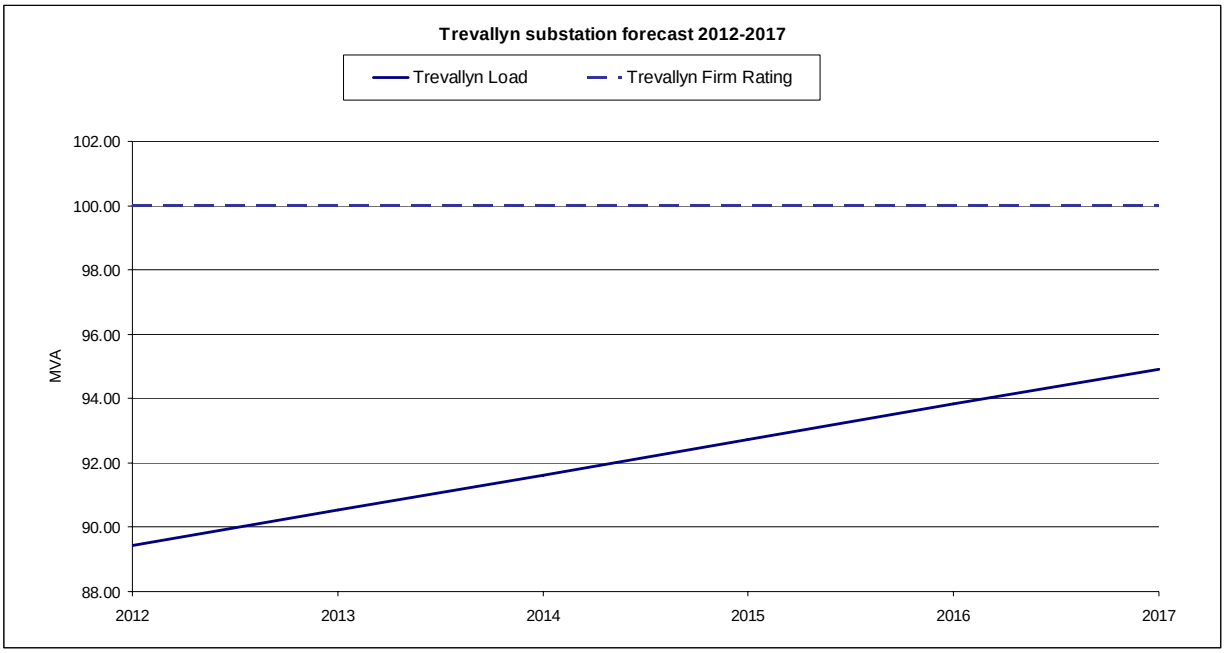

Figure 8-14 Substation five year medium growth forecast

The existing 22 kV network consists of fifteen feeders and two super feeders to Mowbray. There are four spare circuit breakers available at the substation. The two super feeders will be redirected into the CBD when the 110 kV transmission line from St Leonards is constructed. This will provide two additional feeders from Trevallyn substation. The feeder tails for two additional future feeders, 61022 and 61030, have been installed out of Trevallyn substation for future use. The Trevallyn 22 kV supply area and the individual 22 kV feeders are shown in the following figures.

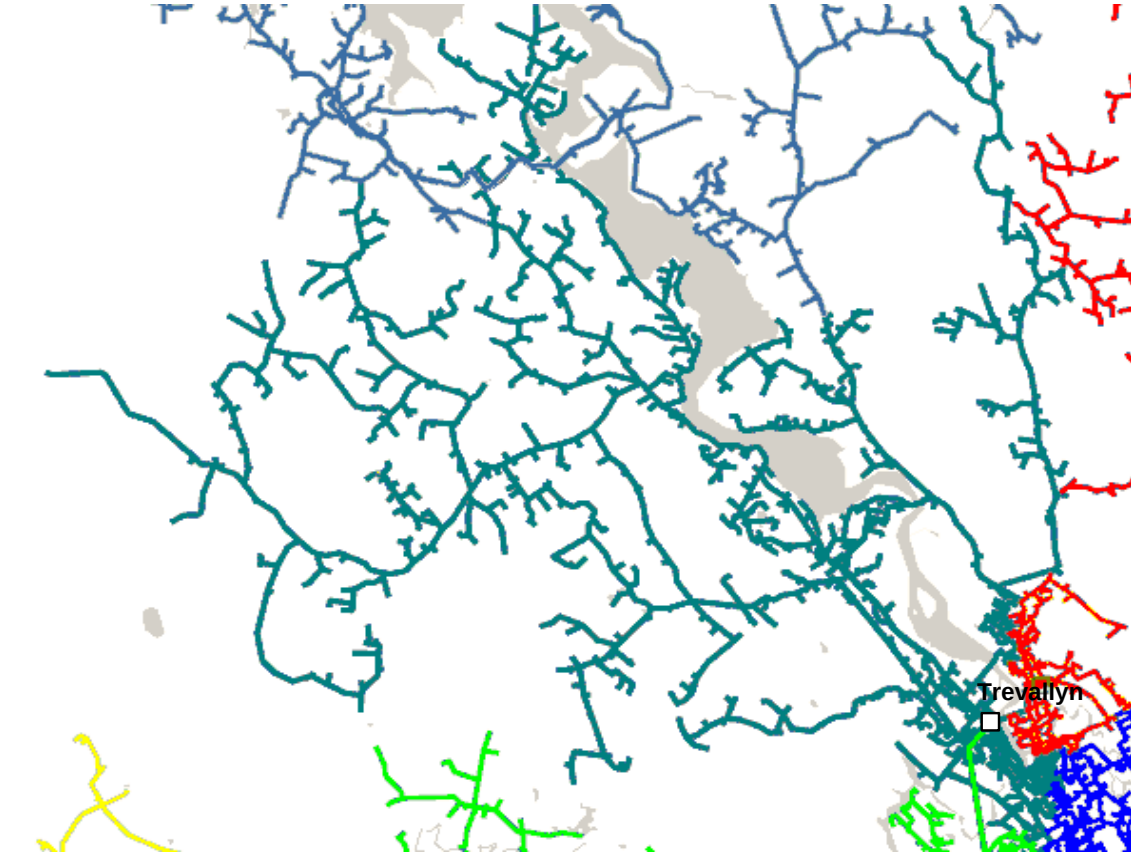

Figure 8-15 Trevallyn 22 kV supply area

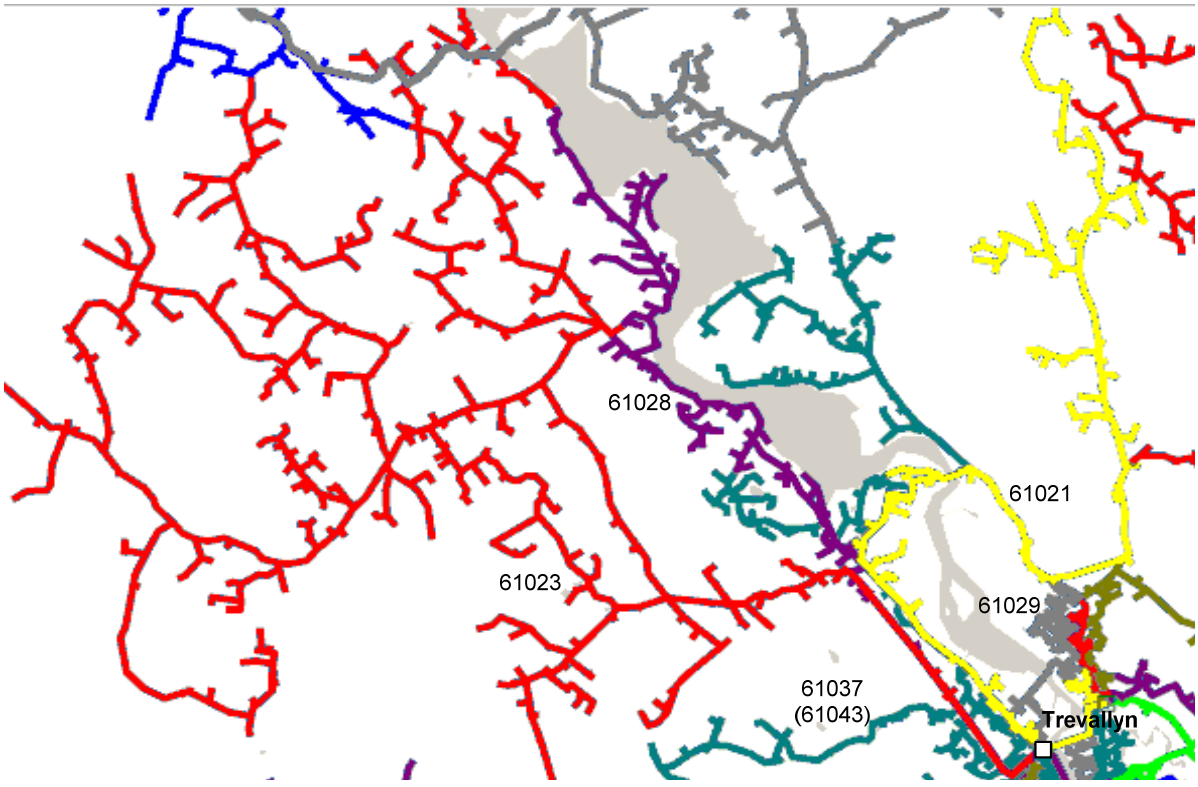

Figure 8-16 Trevallyn 22 kV rural feeders

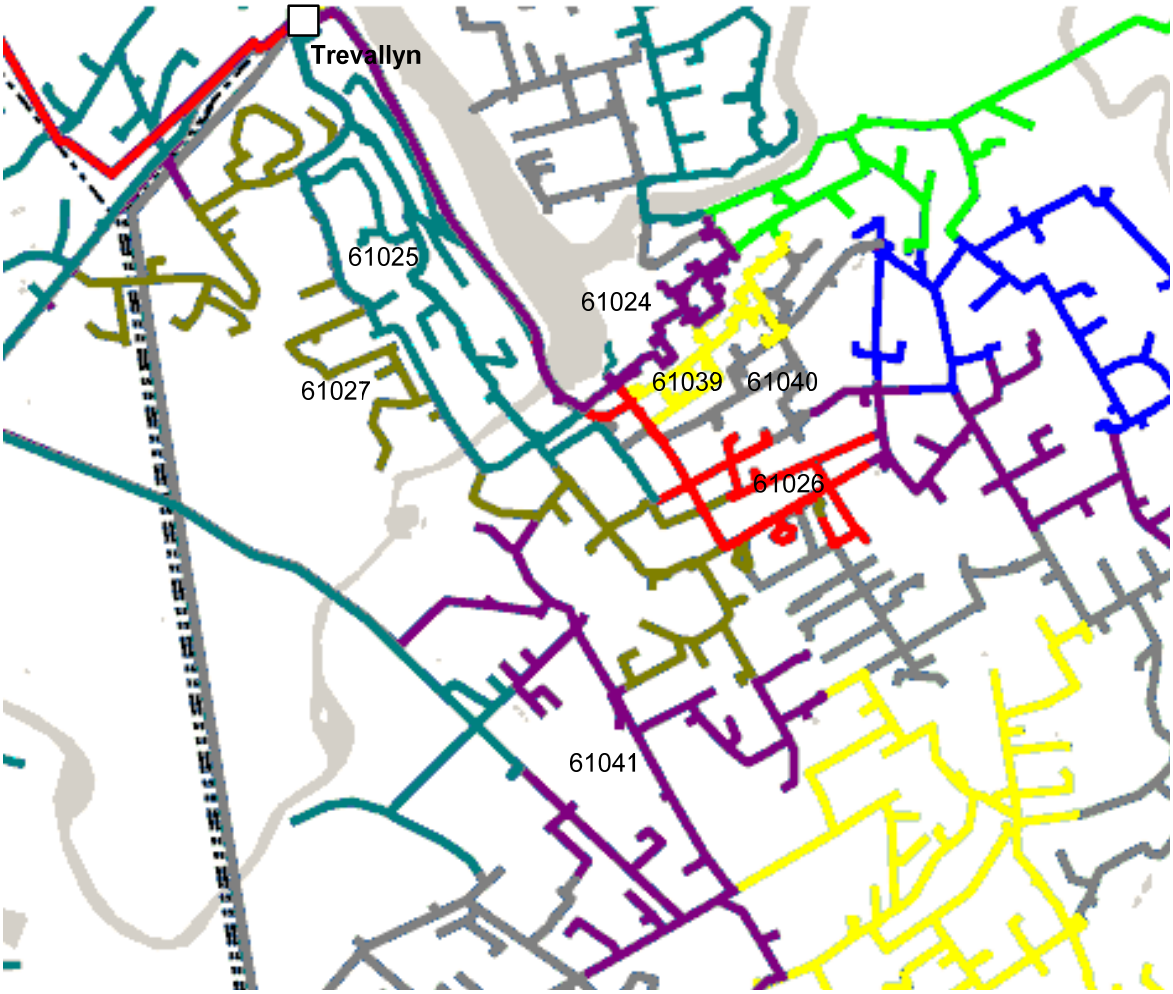

Figure 8-17 Trevallyn 22 kV CBD feeders

A five year feeder forecast has been developed using the actual peak loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-9 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
North West rural	61023	7.03	7.12	7.21	7.29	7.38	7.47
	61028	5.10	5.16	5.22	5.28	5.35	5.41
Legana/Dilston	61021	6.05	6.13	6.20	6.28	6.35	6.43
	61037	9.55	9.67	9.78	9.90	10.02	10.14
	61043	N/O	N/O	N/O	N/O	N/O	N/O
Rocherlea	61029	11.52	11.66	11.80	11.94	12.09	12.23
CBD	61024	7.82	7.92	8.02	8.11	8.21	8.30
	61026	8.88	8.99	9.09	9.20	9.31	9.42
	61039	7.37	7.46	7.55	7.64	7.73	7.82
	61040	8.51	8.61	8.72	8.82	8.93	9.03

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
South Trevallyn	61025	3.75	3.79	3.84	3.89	3.93	3.98
	61027	8.35	8.45	8.55	8.66	8.76	8.86
West Launceston	61041	10.78	10.91	11.05	11.18	11.31	11.44
Future feeders	61022	0.00	-	-	-	-	-
	61030	0.00	-	-	-	-	-

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that limitations are present on five of the fifteen operating feeders.

The feeder 61037 will reach the maximum feeder rating of 10 MVA in the five year period. This feeder has a normally open tie to feeder 61043 which is currently out of service due to a waterlogged cable. When this feeder is back in operation, the load will need to be balanced between the two feeders.

The feeder 61029 to Rocherlea is heavily loaded and is above firm capacity. Work is being completed before 2012 under Projects T001 and T002 to deload the feeder. The surrounding Mowbray feeders 62005, 62010 and 62004 will be reconfigured to share the load in the area. The future feeder 62011 from Mowbray may also need to be redirected into the northern area depending on load growth.

The four feeders from Trevallyn into the Launceston CBD are heavily loaded and two are above firm. The super feeders from Trevallyn originally supplied the CBD before being redirected to Mowbray. The feeders can be returned to the original configuration supplying the CBD in 2012. This will provide two new supplies into the CBD and the super feeders will be normally open at Mowbray as a tie between the substations. Some minor reconfiguration works will be needed on the super feeders.

The West Launceston feeder 61041 is above firm capacity. There are feeders from Hadspen, Trevallyn, Norwood and St Leonards surrounding 61041. With the super feeders deloading the CBD feeders and the new St Leonards feeders deloading Norwood feeders, it is expected that load transfers will be available to assist 61041. The installation of the Westbury substation in 2017 and Longford substation in 2021 will deload Hadspen and free up feeder tails from the substation that can be redirected into West Launceston. Ultimately, the West Launceston load will be removed from Trevallyn onto Hadspen.

A new link will be installed prior to 2012 between the south Trevallyn feeders, 61025 and 61027, to provide transfer capacity between the two feeders.

Trevallyn substation has existing transfer capability with Hadspen substation and will have transfer capability with St Leonards substation depending in the final 22 kV feeder configuration. The following figures are from the load transfer models provided by Aurora.

Table 8-10 Forecast transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Trevallyn - Hadspen	67089	4.3	4.5	4.6	4.7	4.8	5.0
	HSF1a	8.8	8.3	8.6	8.8	9.0	9.3
Total transfers	-	13.1	12.8	13.2	13.5	13.8	14.3

There is reasonable transfer capability between Trevallyn and Hadspen. The transfer capability will increase when St Leonards substation is in operation. The Mowbray feeders adjacent to the Trevallyn

network are currently too heavily loaded to be utilised for load transfers. Projects to decrease load on these feeders will provide additional transfer capability to Trevallyn.

8.5.2 Proposed projects

There are no proposed projects in the Trevallyn area during the five year plan period.

8.5.3 Ultimate configuration

Substation

Trevallyn substation has three 110/22 kV transformers which are not predicted to be due for age replacement within the period of the long term study.

Feeders

The ultimate supply area is much smaller than the existing area and includes part of the Launceston CBD and small areas to the north (including Legana/Dilston) and south of the substation. The load to the far north will be supplied from the new Exeter substation and the West Launceston area to the south will be supplied by Hadspen. The main CBD load will be supplied by the new East Launceston CBD substation. Mowbray substation will be directed to supply the Rocherlea area currently supplied by Trevallyn. The existing feeders will be deloaded over time as the supply area reduces. The transfer capability of the existing Trevallyn feeders should be monitored and additional ties between feeders installed as required.

8.6 George Town substation

George Town substation currently supplies a number of large industrial customers near George Town and the town itself.

8.6.1 Limitations

Using the medium growth forecast, the George Town terminal substation load in 2012 is forecast to be 35.64 MVA and it is forecast to grow to 38.56 MVA in 2017. The load is below the firm capacity of the substation.

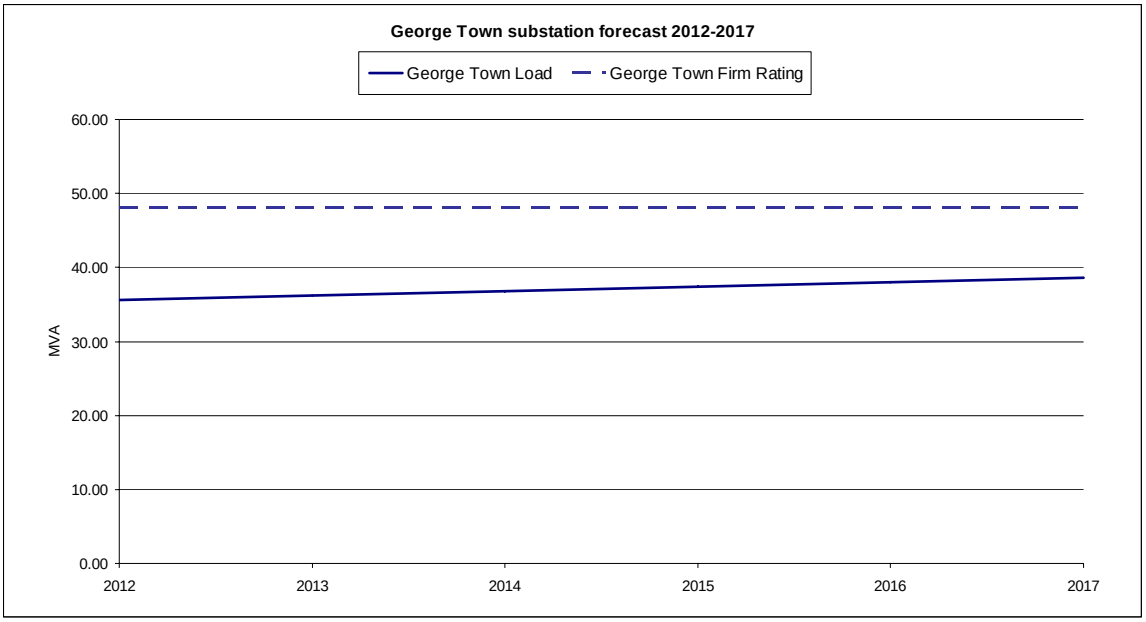

Figure 8-18 Substation five year medium growth forecast

The existing 22 kV network consists of ten feeders. There are four spare circuit breakers available at the substation. The George Town 22 kV supply area and the individual 22 kV feeders are shown in the following figures.

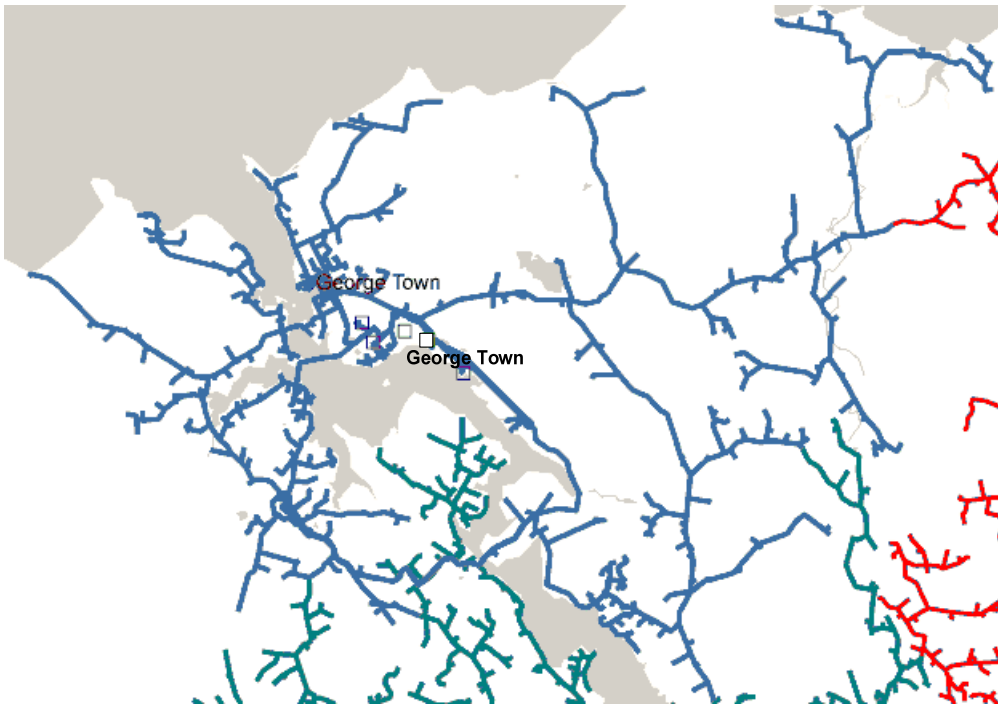

Figure 8-19 George Town 22 kV supply area

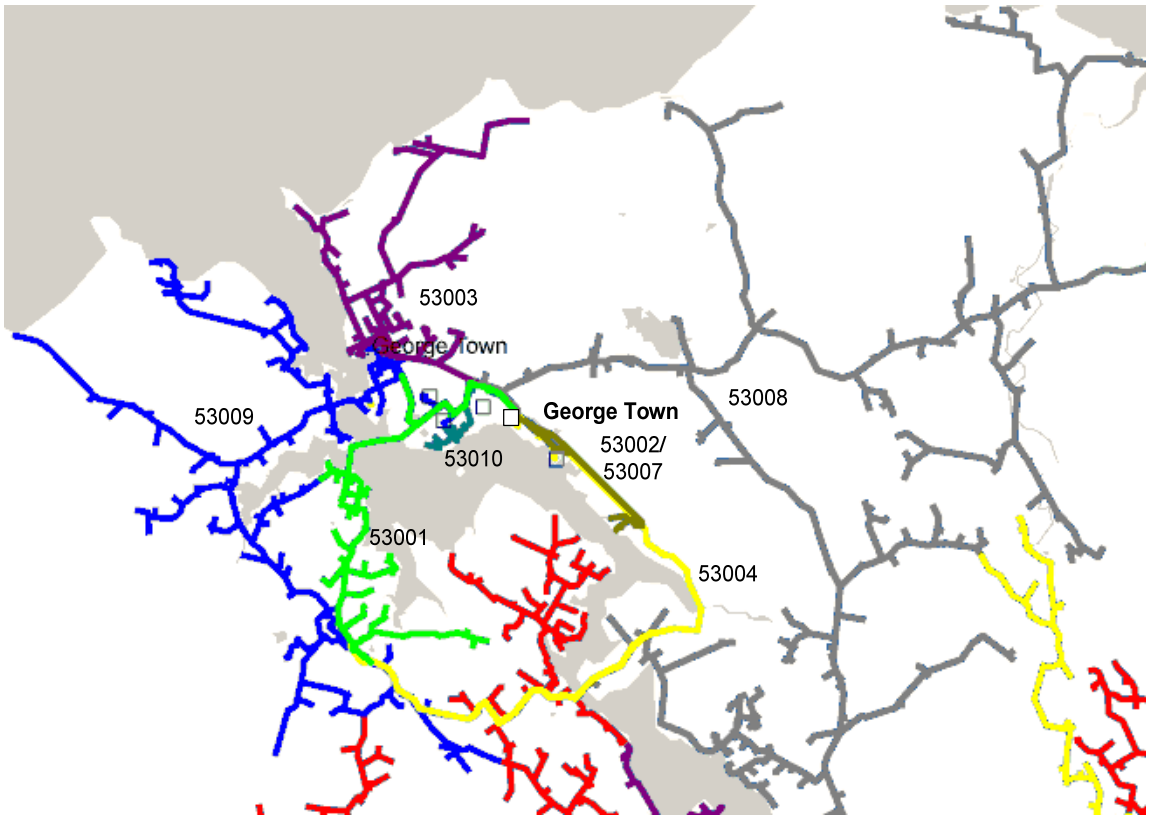

Figure 8-20 George Town 22 kV feeders

A five year feeder forecast has been developed using the actual peak loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-11 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
West	53001	4.73	4.81	4.88	4.96	5.04	5.11
	53009	10.76	10.94	11.12	11.29	11.47	11.64
	53004	5.89	5.99	6.09	6.19	6.28	6.38
East rural	53008	2.41	2.45	2.49	2.53	2.57	2.61
Gunns	53002	8.05	8.19	8.32	8.45	8.59	8.71
	53007	1.47	1.50	1.52	1.55	1.57	1.59
George Town	53003	6.06	6.16	6.27	6.37	6.46	6.56
Bell Bay	53010	4.59	4.67	4.74	4.82	4.89	4.97
Future feeders	53005	0.00	-	-	-	-	-
	53006	0.00	-	-	-	-	-

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that a limitation is present on one of the eight operating feeders.

Two feeders, 53004 and 53009, currently supply the mine at Beaconsfield. 53004 has a continuous rating of 10 MVA and there is an allowance of 5 MVA for the mine on feeder 53009. The feeder 53009 currently supplies the CBD load in George Town. This load can be transferred onto feeder 53003 to balance the load across the two feeders. This will delay the need for a new submarine cable under the river.

There are two existing feeder tails, 53005 and 53006, running south from the substation towards Gunns mill. These feeders can be utilised for future point loads in the area.

George Town substation does not have any transfer capability within the network. This is due to the location of the substation and the nature of the load. The majority of the customers on the George Town 22 kV network are large industrial point loads which causes difficulties for transfers between feeders.

8.6.2 Proposed projects

There are no proposed feeder projects in the George Town area for the five year plan.

8.6.3 Ultimate configuration

Substation

George Town substation has two 110/22 kV 38 MVA transformers which are not due for age replacement within the period of the long term study. The installation of the Exeter substation will deload the George Town substation significantly in 2030 and reduce the supply area of the substation.

Feeders

The ultimate supply area for George Town substation is smaller than the existing area. The load on the western side of the river will be supplied from the new Exeter substation which will provide some 22 kV transfer capability to George Town substation. The transfer capability of the existing George Town feeders should be monitored and additional ties between feeders installed as required. This may not be possible for some of the large point loads so additional feeders may be required based on point load customer requirements.

8.7 Palmerston substation

Palmerston substation supplies a large rural area to the south of Launceston.

8.7.1 Limitations

Using the medium growth forecast, the Palmerston terminal substation load in 2012 is forecast to be 12.07 MVA and it is forecast to grow to 13.54 MVA in 2017. The load is well below the firm capacity of the substation.

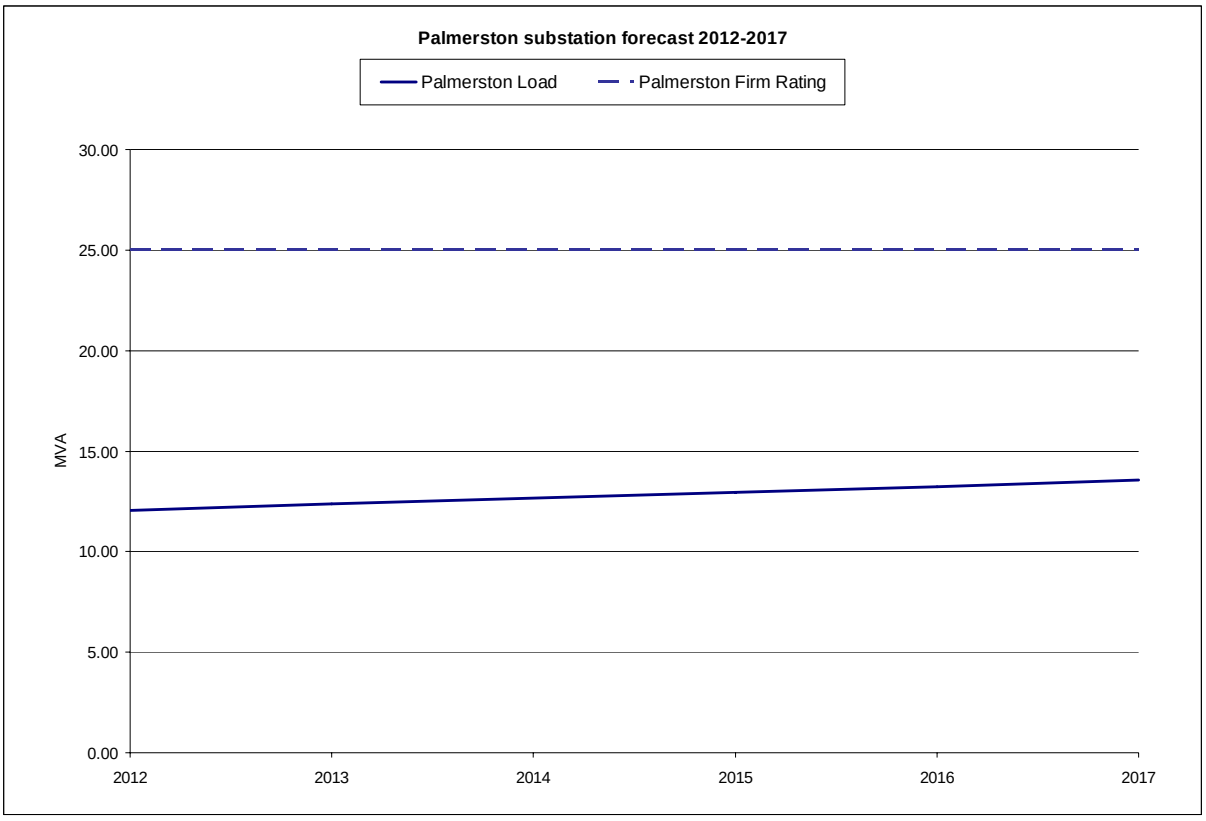

Figure 8-21 Substation five year medium growth forecast

The existing 22 kV network consists of three feeders. There are no spare circuit breakers available at the substation. The Palmerston 22 kV supply area and the individual 22 kV feeders are shown in the following figures.

Figure 8-22 Palmerston 22 kV supply area

Figure 8-23 Palmerston 22 kV feeders

A five year feeder forecast has been developed using the actual peak loads from 2009 and the forecast medium substation growth. The forecast for each feeder is outlined in the following table.

Table 8-12 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Palmerston	51001	1.22	1.25	1.28	1.31	1.34	1.37
	51002	4.15	4.25	4.35	4.46	4.56	4.66
	51003	7.58	7.76	7.95	8.13	8.32	8.50

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there are no limitations present. F51003 is reasonably well loaded and suffers from reliability issues due to the length of the feeder. This will be addressed by the installation of a new feeder to split F51003 and provide backup to F51002. This is further outlined in Section 8.7.2.

Palmerston substation has existing transfer capability with Hadspen and Norwood substations. The following figures are from the load transfer models provided by Aurora.

Table 8-13 Forecast transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Palmerston – Hadspen	67084	4.5	4.4	4.3	4.2	4.0	3.9
	67082	1.4	1.4	1.5	1.5	1.6	1.6
Palmerston - Norwood	65060	1.4	1.4	1.4	1.3	1.3	1.3
Total transfers	-	7.3	7.2	7.2	7	6.9	6.8

There is reasonable transfer capability to Norwood and Hadspen. The transfer capacity will increase with the installation of Westbury substation in 2017 and Longford substation in 2021.

8.7.2 Proposed projects

F51003 reliability project

F51003 is reasonably well loaded and suffers from reliability issues due to the length of the feeder. There is limited transfer capability to the adjacent Palmerston feeders so a permanent load transfer is not considered a suitable solution. A new feeder will be installed from Palmerston to split the existing feeder to improve reliability and provide transfer capability to F51002. A new feeder tail will run along Saundridge Road and connect to F51003 near T540871. The backbone of the spur will need to be upgraded to Elphinstone Road to provide a strong tail for the new feeder. The proposed connection is shown in the Figure 8-24.

The proposed feeder loads are shown in the following table.

Table 8-14 Forecast feeder growth with new feeder

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Palmerston	51003	4.42	4.53	4.64	4.75	4.85	4.96
	New	2.82	2.89	2.96	3.03	3.10	3.16

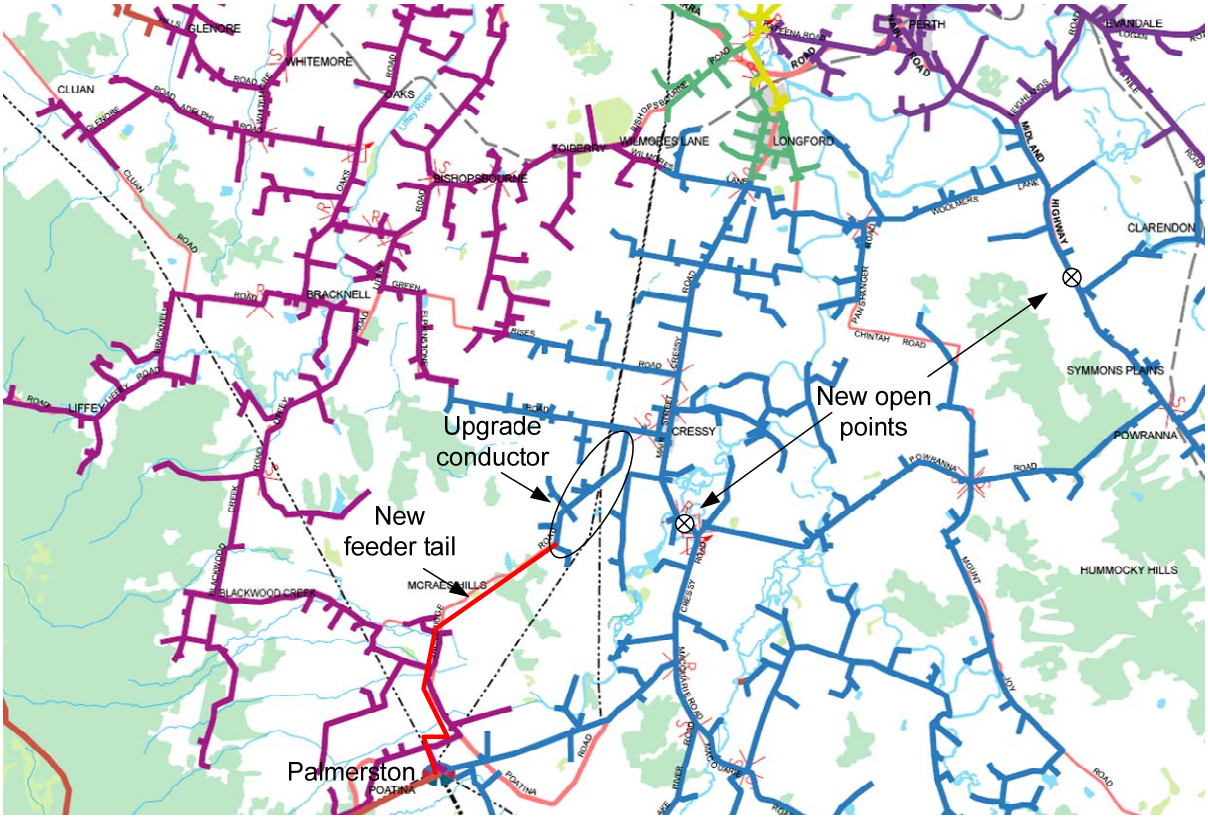

Figure 8-24 Palmerston new feeder installation

8.7.3 Ultimate configuration

Substation

Palmerston substation has two 110/22 kV 25 MVA transformers which are predicted to be due for age replacement towards the end of the long term study. Additional switchgear will be installed when the transformers are replaced to provide spare circuit breakers for future feeders.

Feeders

The installation of Westbury and Longford substations in 2017 and 2021 will deload the Palmerston feeders and provide the opportunity to install additional feeders if required. The reconfigured feeders should also be available to assist Avoca substation after the installation of the Longford substation (to delay the requirement for a Ross/Campbell Town substation). The transfer capability of the existing Palmerston feeders should be monitored and additional ties between feeders installed as required.

8.8 St Leonards substation

St Leonards substation is currently in the planning stage and will be in operation in 2012. It will supply the St Leonards/Ravenswood area and into the urban area currently supplied by Norwood. It will also supply into Inveresk to assist the Mowbray substation.

8.8.1 Limitations

Using the medium growth forecast and a proposed load in 2012, the St Leonards terminal substation load in 2012 is forecast to be 46.81 MVA and it is forecast to grow to 51 MVA in 2017. The load is below the firm capacity of the substation.

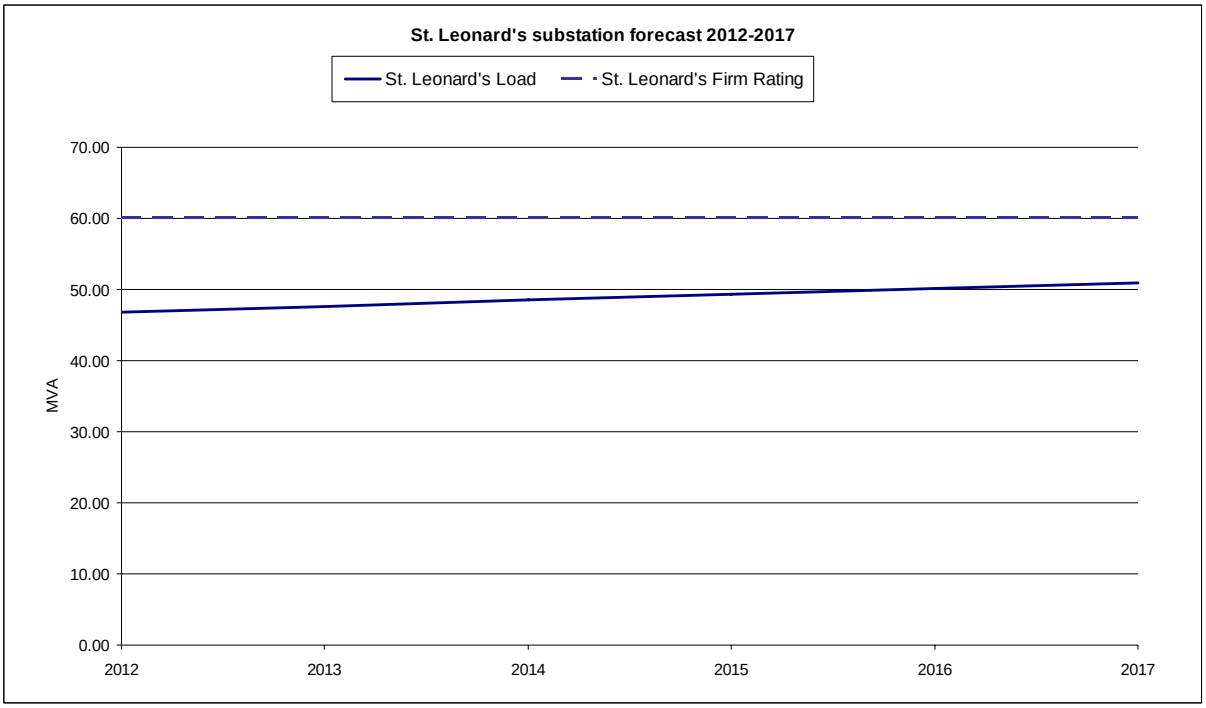

Figure 8-25 Substation five year medium growth forecast

From information provided in the draft application agreement, the proposed 22 kV network will initially consist of six new feeders. Four additional feeders will then be installed in the following year. There will be two spare 22 kV circuit breakers available for new feeders. There will be restricted access to the substation for 22 kV feeders due to the position of the substation on an internal block.

The proposed St Leonards 22 kV supply area from the application agreement is shown in the following figure.

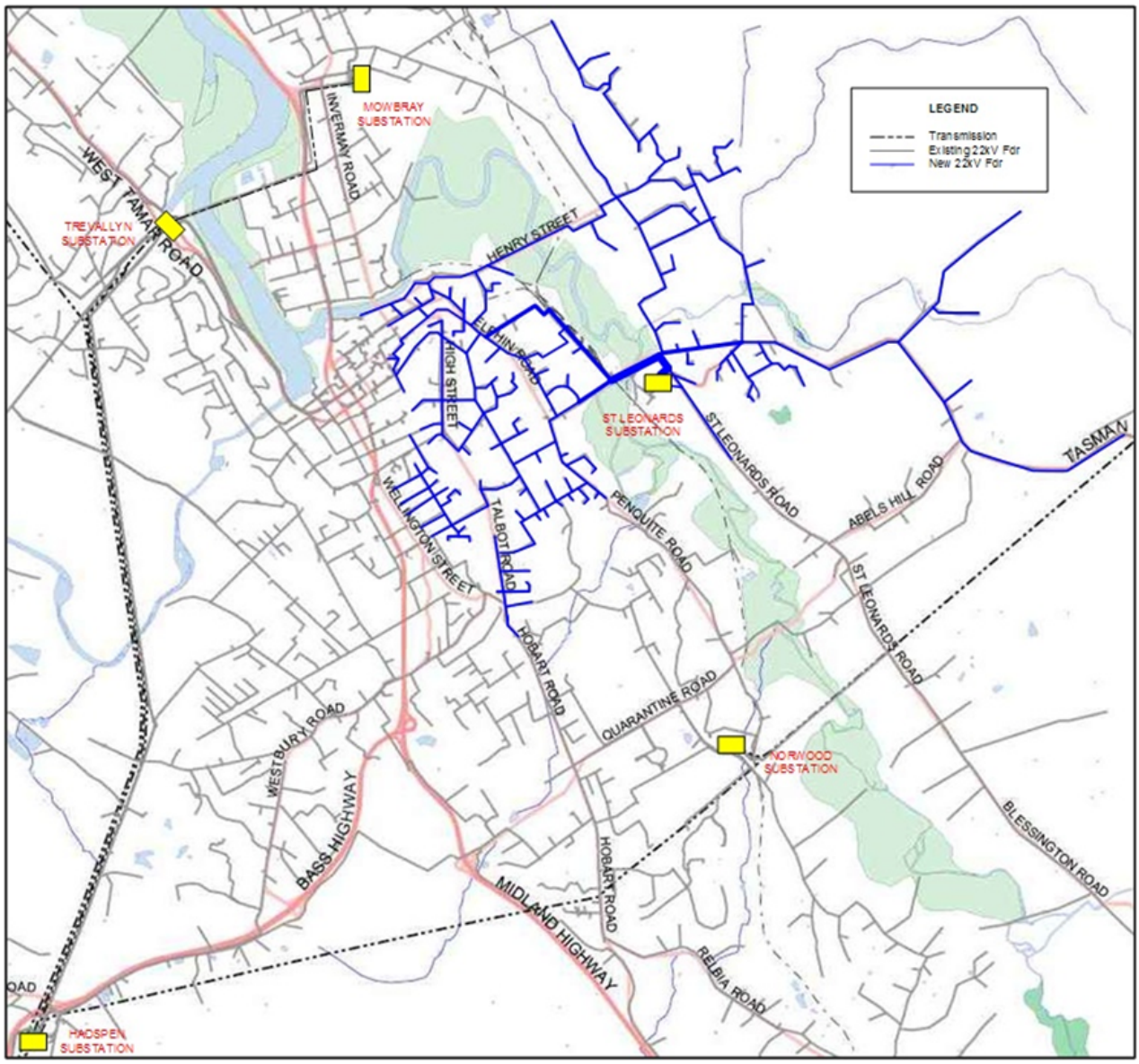

Figure 8-26 St Leonards proposed 22 kV supply area

A five year feeder forecast has been developed using proposed loads from the draft application. These numbers will be further refined in the planning process for St Leonards substation. The forecast for each feeder is outlined in the following table based on the substation growth at Norwood substation.

Table 8-15 Forecast feeder growth

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
Waverley/Nunamara rural	2	N/A	4.81	4.90	4.99	5.07	5.16
Elphin	3	5.27	5.37	5.47	5.56	5.66	5.76
South Launceston	4	8.41	8.57	8.72	8.88	9.04	9.19

Area	Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
East Launceston/CBD	5	4.87	4.96	5.05	5.14	5.23	5.32
	8	4.43	4.51	4.60	4.68	4.76	4.84
	11	N/A	5.41	5.51	5.61	5.71	5.80
Ravenswood	6	N/A	1.81	1.84	1.88	1.91	1.94
	9	N/A	3.76	3.83	3.90	3.97	4.03
Newstead	7	5.82	5.93	6.04	6.15	6.25	6.36
St Leonards	10	2.31	2.35	2.40	2.44	2.48	2.52

The forecast feeder loads have been assessed against a maximum feeder rating of 10 MVA for overhead and underground feeders. From the table above, it appears that there are no limitations present.

St Leonards substation will have transfer capability with Norwood, Mowbray and Trevallyn substations.

8.8.2 Proposed projects

There are no additional feeder projects to those proposed in the existing draft application notice in the five year plan for the St Leonards substation.

8.8.3 Ultimate configuration

Substation

St Leonards substation will have two new 110/22 kV 60 MVA transformers. Allowance has been made in the layout for a third transformer. The strategic plan for the Tamar area recommends the installation of a new CBD substation to address firm capacity issues in the Launceston area in 2027. The third transformer at St Leonards will then be installed when the firm capacity of the Launceston area is exceeded again in 2046. Additional switchgear will be included with the installation of the third transformer.

Feeders

A conduit plan for the St Leonards substation will be required to ensure the capacity of the substation can be fully utilised. Larger feeder tails will be required to reduce the effect of derating in the cable access routes from the substation. The transfer capability of the existing St Leonards feeders should be monitored and additional ties installed as required.

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	Establish Westbury substation	7.1.1
2	Establish Longford substation	7.1.2

Westbury substation NPV analysis (Tamar and North Coast areas)

Base Year

2010

OPTION 1

Establish Westbury 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%
2017	2016	2018	Hadspen firm capacity exceeded	Establish 110/22 kV substation at Westbury - 110 kV cut in - 3 x 110 kV CBs - 2 x 60 MVA 110/22 kV transformers - 16 x 22 kV CBs and 22 kV feeders	$19,247	$13.11	$12.27	$11.50	$13.85	$13.09	$12.37	$12.41	$11.51	$10.68
2021	2020	2022	Wesley Vale transformer age limitation	Upgrade Wesley Vale substation - 2 x 60 MVA 110/22 kV transformers	$6,000	$3.28	$2.96	$2.67	$3.47	$3.15	$2.87	$3.11	$2.77	$2.48
2027	2026	2028	Westbury feeder limitations	Two new feeders from Westbury substation	$1,625	$0.64	$0.54	$0.46	$0.68	$0.58	$0.50	$0.61	$0.51	$0.43
					Total	**$17.03**	**$15.78**	**$14.63**	**$17.99**	**$16.82**	**$15.75**	**$16.12**	**$14.79**	**$13.59**

OPTION 2

Install a third transformer at Hadspen

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%
2017	2016	2018	Hadpsen firm capacity exceeded	Install a third transformer at Hadspen - 1 x 60 MVA 110/22 kV transformer - 8 x 22 kV CBs - 1 x 22 kV feeder from Hadspen - Westbury - 1 x 22 kV feeder Railton-Deloraine - 1 x 22 kV feeder Wesley Vale - Railton	$15,860	$10.80	$10.11	$9.47	$11.41	$10.78	$10.20	$10.23	$9.48	$8.80
2018	2017	2019	Railton firm capacity exceeded (group)	Upgrade Wesley Vale substation - 2 x 60 MVA 110/22 kV transformers	$6,000	$3.87	$3.59	$3.33	$4.09	$3.83	$3.58	$3.66	$3.36	$3.09
2019	2018	2020	Deloraine feeder reliability issues	One new feeder from Railton - Deloraine	$4,020	$2.45	$2.25	$2.07	$2.59	$2.40	$2.23	$2.32	$2.11	$1.93
2027	2026	2028	Westbury feeders firm capacity and reliability	Two new feeders from Hadspen - Westbury	$6,240	$2.46	$2.09	$1.78	$2.59	$2.23	$1.92	$2.32	$1.96	$1.66
					Total	**$19.58**	**$18.05**	**$16.66**	**$20.68**	**$19.24**	**$17.93**	**$18.53**	**$16.92**	**$15.48**

OPTION 3

Establish Longford 110/66 and Westbury zone

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%
2017	2016	2018	Hadpsen firm capacity exceeded	Establish 110/66 kV Longford substation - 110 kV cut in - 3 x 110 kV CBs - 2 x 60 MVA 110/66 kV transformers - 8 x 66 kV CBs	$14,000	$9.54	$8.93	$8.36	$10.07	$9.52	$9.00	$9.03	$8.37	$7.77
2017	2016	2018	Hadpsen firm capacity exceeded	Establish Westbury 66/22 kV zone substation - 66 kV feeders - 3 x 66 kV CBs - 2 x 25 MVA 66/22 kV transformers - 16 x 22 kV CBs and 22 kV feeders	$16,000	$10.90	$10.20	$9.56	$11.51	$10.88	$10.29	$10.32	$9.57	$8.88
2021	2020	2022	Wesley Vale transformer age limitation	Upgrade Wesley Vale substation - 2 x 60 MVA 110/22 kV transformers	$6,000	$3.28	$2.96	$2.67	$3.47	$3.15	$2.87	$3.11	$2.77	$2.48
2027	2026	2028	Westbury zone firm capacity exceeded	Establish Deloraine 66/22 kV zone substation - 66 kV feeders - 3 x 66 kV CBs - 2 x 25 MVA 66/22 kV transformers - 16 x 22 kV CBs and 22 kV feeders	$20,000	$7.87	$6.70	$5.72	$8.31	$7.15	$6.16	$7.45	$6.29	$5.32
					Total	**$31.58**	**$28.79**	**$26.31**	**$33.36**	**$30.70**	**$28.32**	**$29.90**	**$27.00**	**$24.44**

Longford NPV analysis (Tamar area)

Base Year

2010

OPTION 1

Establish Longford 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%
2021	2020	2022	Hadspen system capacity exceeded	Establish 110/22 kV substation at Longford - 110 kV cut in - 3 x 110 kV CBs - 2 x 60 MVA 110/22 kV transformers - 16 x 22 kV CBs and 22 kV feeders	$17,580	$9.61	$8.67	$7.82	$10.16	$9.24	$8.42	$9.10	$8.13	$7.27
2036	2035	2037	Longford feeders approaching firm	Two new feeders from Longford	$1,025	$0.25	$0.19	$0.15	$0.26	$0.21	$0.16	$0.23	$0.18	$0.14
					Total	**$9.86**	**$8.86**	**$7.97**	**$10.42**	**$9.45**	**$8.58**	**$9.33**	**$8.31**	**$7.41**

OPTION 2

Install a third transformer at Hadspen

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%
2021	2020	2022	Hadpsen firm capacity exceeded	Install a third transformer at Hadspen - 1 x 60 MVA 110/22 kV transformer - 8 x 22 kV CBs - 1 x 22 kV feeder from Hadspen - Longford - 1 x 22 kV feeder Hadspen - Evandale - 1 x 22 kV feeder Hadspen - Palmerston - 2 x 22 kV feeders Hadspen - West Launceston	$16,767	$9.17	$8.27	$7.46	$9.69	$8.82	$8.03	$8.68	$7.75	$6.93
2036	2035	2037	22 kV feeders approaching firm	Two new feeders from Hadspen	$4,750	$1.14	$0.89	$0.70	$1.20	$0.95	$0.75	$1.08	$0.84	$0.65
					Total	**$10.31**	**$9.16**	**$8.16**	**$10.89**	**$9.77**	**$8.78**	**$9.76**	**$8.59**	**$7.58**

OPTION 3

Establish Longford 110/66 and Breadalbane zone

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%
2021	2020	2022	Hadspen firm capacity exceeded	Longford 110/66 and Breadalbane zone	$29,000	$15.86	$14.30	$12.90	$16.75	$15.25	$13.89	$15.01	$13.41	$11.99
2027	2026	2028	Breadalbane zone firm capacity exceeded	New zone and complete ring	$15,000	$5.90	$5.03	$4.29	$6.24	$5.36	$4.62	$5.59	$4.72	$3.99
					Total	**$21.76**	**$19.33**	**$17.19**	**$22.99**	**$20.61**	**$18.51**	**$20.60**	**$18.12**	**$15.97**

Appendix C
Launceston CBD substation

Appendix C

Launceston CBD substation

As mentioned in the planning philosophy, the Launceston area will be supplied by five substations in 2012. These substations are all located at least 3 km from the CBD and are currently attempting to feed into the city as well as supplying out to the surrounding rural and residential areas.

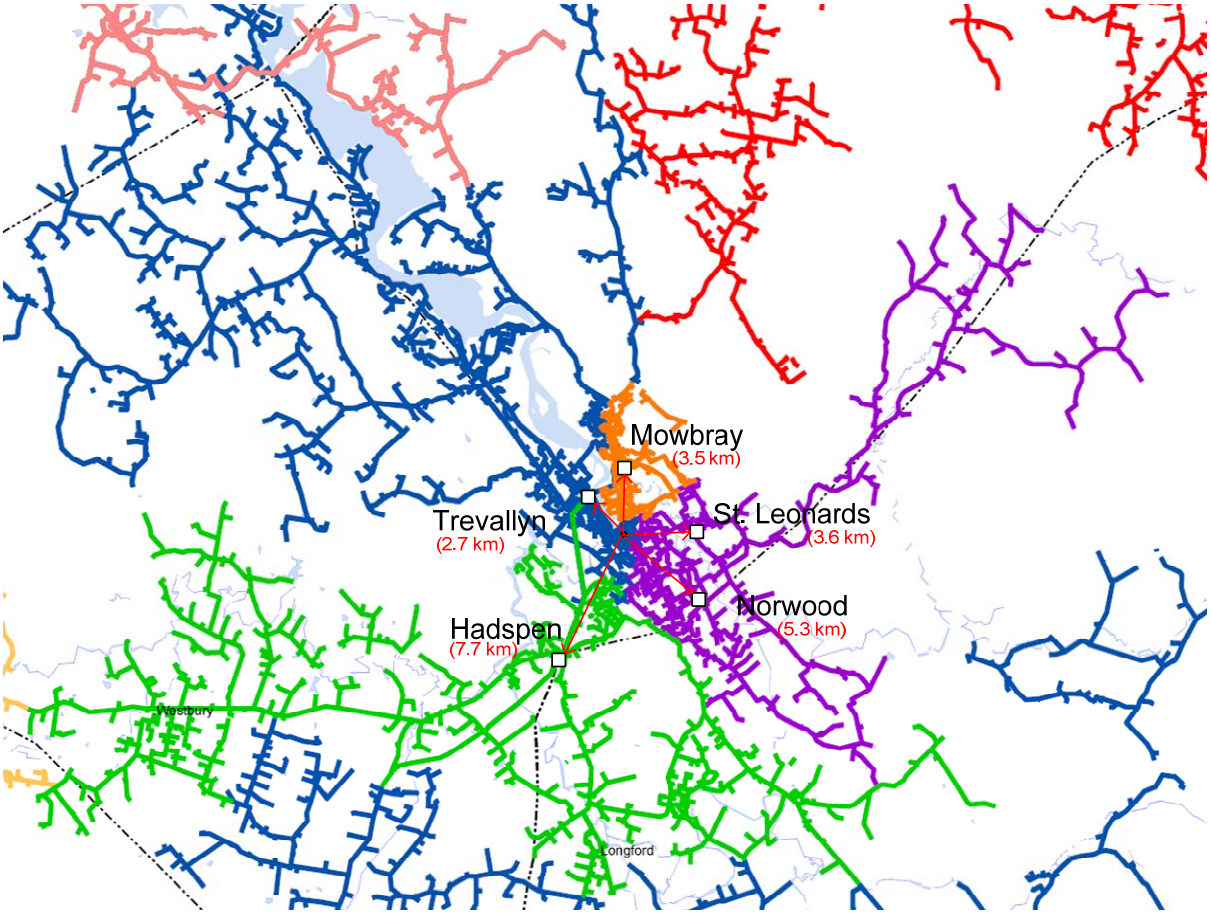

Figure 8-27 Geographical representation of CBD substation locations

Limitations

The group firm capacity of the five substations supplying the Launceston area will be exceeded in 2027. It has been assumed that load transfers will be possible up until this point to redistribute the load between the five substations. The installation of Westbury and Longford substations will relieve Hadspen and the group in 2017 and 2021 but group firm capacity will again be exceeded in 2027.

The Launceston area will experience increased feeder congestion as the load in the inner circle increases. Reliability will also be an issue as the area is currently supplied using long 22 kV feeders with large loads at the end of feeders.

The load in 2050 in the CBD area is forecast to reach 62.19 MVA. The areas surrounding the CBD are also forecast to be heavily loaded. The forecast load for each area is shown in the following figure.

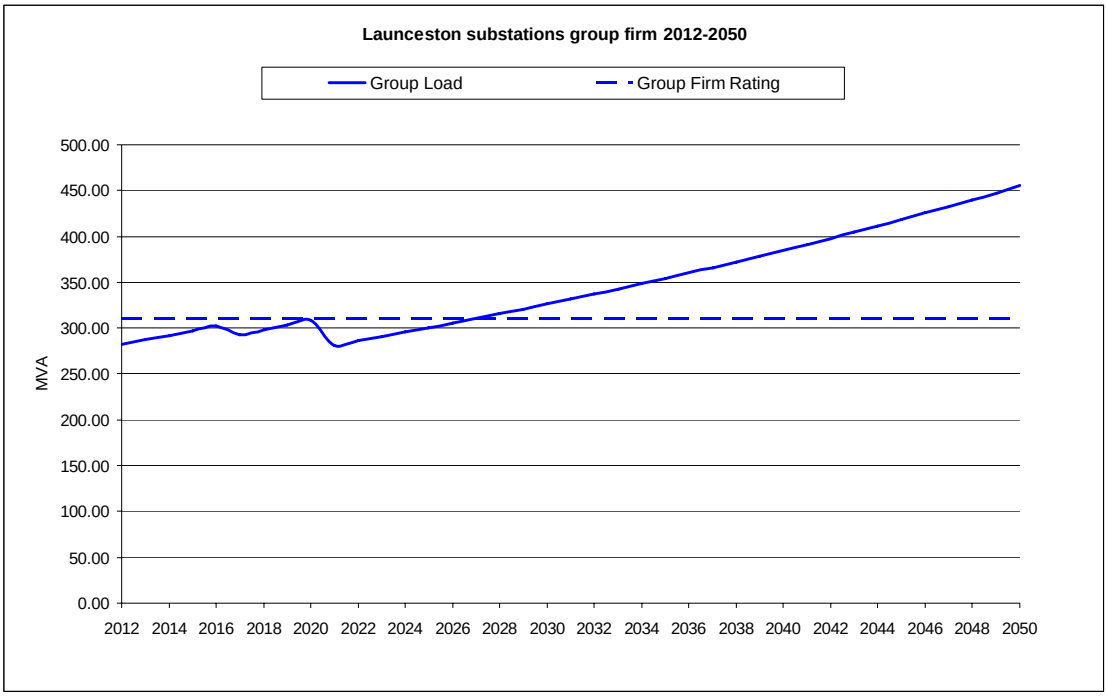

Figure 8-28 Launceston substation group firm forecast

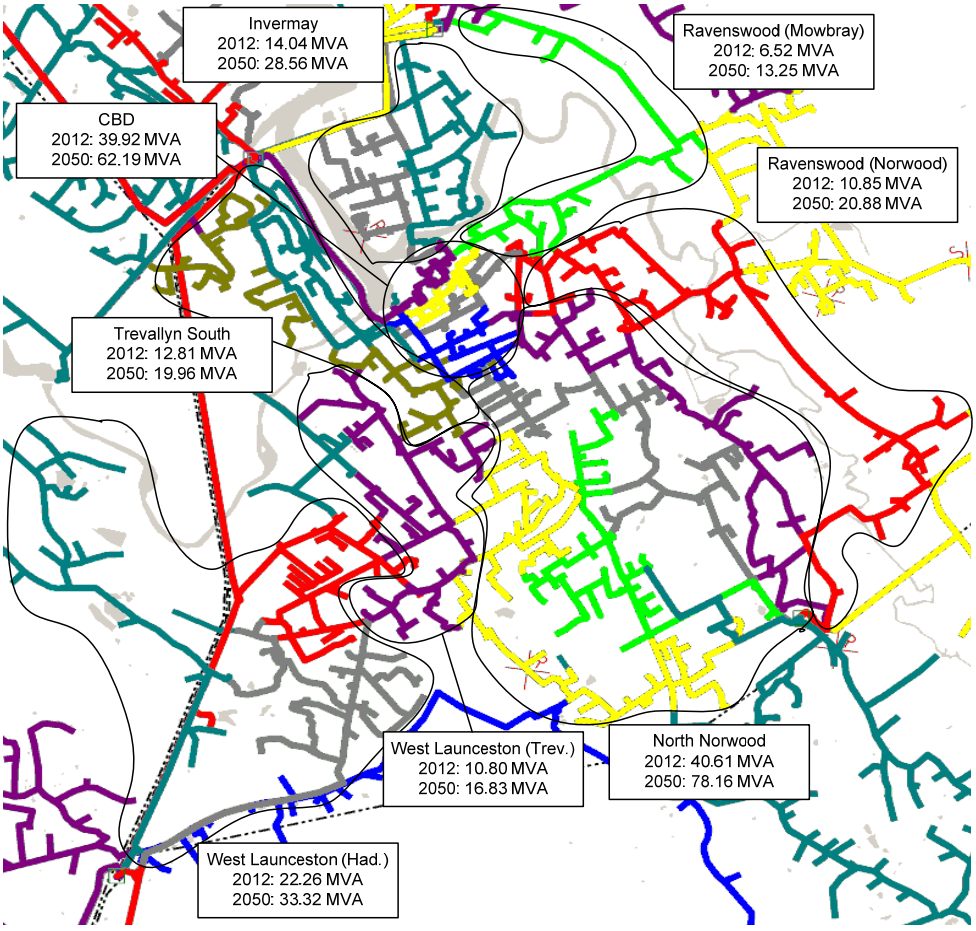

Figure 8-29 Launceston substation area forecasts

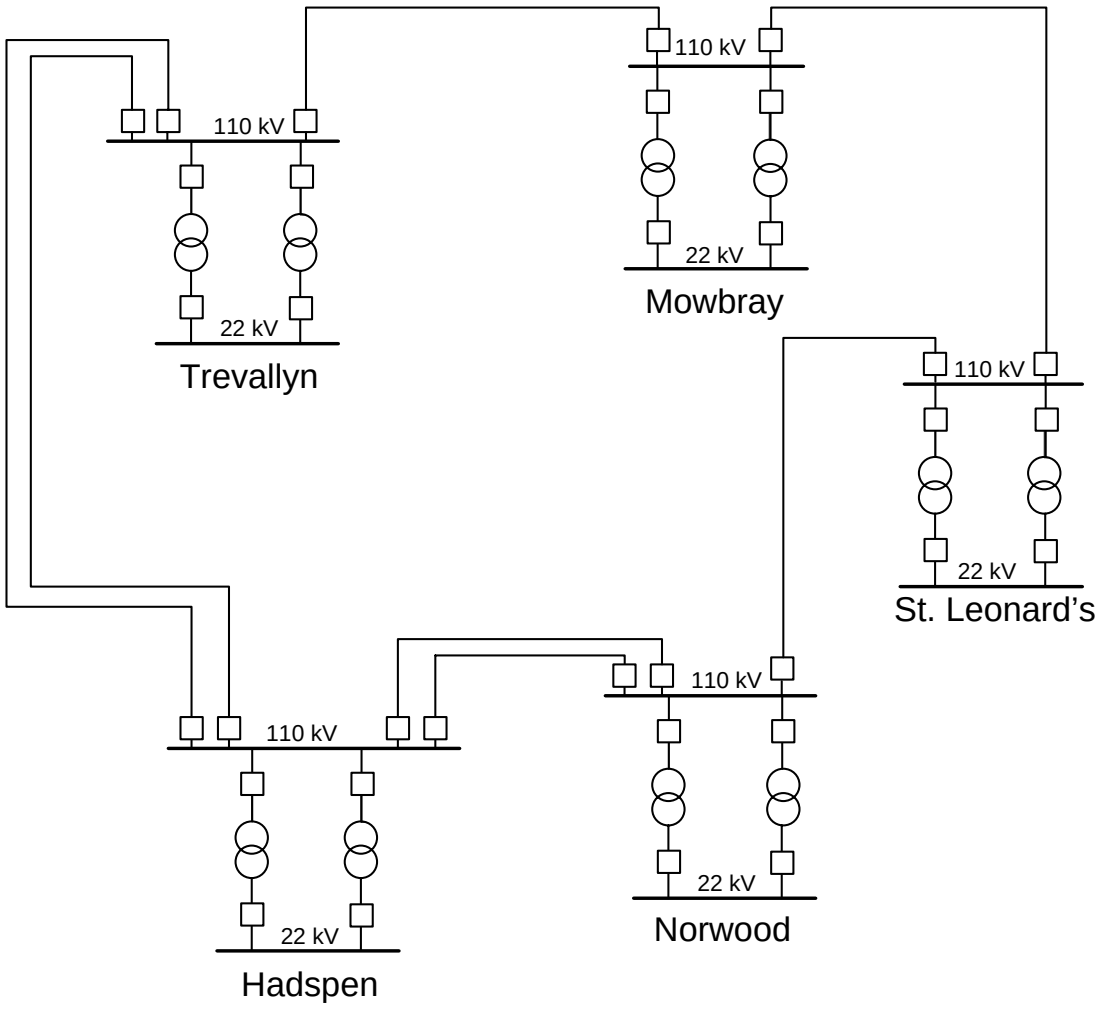

Figure 8-30 Launceston substations 110 kV schematic

Option 1 – Establish a new substation at the existing East Launceston CBD site

The first option involves the establishment of a new terminal substation in the Launceston CBD at the existing East Launceston CBD site in 2027. Two 110/22 kV 60 MVA transformers and 22 kV switchgear will be installed. A new 110 kV cut in of the cable between Mowbray and St Leonards will be required. The double circuit cable will be approximately 3.5 km in length.

Option 2 – Installation of a third transformer at St Leonards substation

The second option involves the installation of a third transformer at the St Leonards substation. A new 110/22 kV 60 MVA transformer and a third bus of 22 kV switchgear will be installed.

Option 3 – Non-network option

No non-network alternatives have been considered.

Option 4 – Do nothing option

The do nothing option is not considered a feasible option as the firm capacity at Hadspen and Railton has been exceeded.

Technical comparison

Table 8-16 Technical comparison summary

Option	Description	Advantages	Disadvantages
1	Installation of a new 110/22 kV connection point at the East Launceston CBD site	• Increases group firm capacity by 60 MVA • Will provide transfer capability to the five substations in the ring due to connections to adjacent feeders • Lower system losses due to locating the substation close to the load • Highest operational flexibility • Consistent with planning philosophy for the area • Utilises existing 22 kV feeders – short feeder tails • Utilises existing site	• 110 kV transmission works required
2	Installation of a third transformer at St Leonards and new 22 kV feeders	• Increases group firm capacity • Utilises existing site	• Unlikely to be able to utilise the full firm capacity of 120 MVA at St Leonards • Transfer capability to assist other substations will be limited by the location of new feeders out of St Leonards • Will create cable congestion at St Leonards and the other Launceston substations • Cable tails out of the substation will need to be larger to account for derating • Construction of longer 22 kV feeders required • Not consistent with the planning philosophy for the area

The details of the costs used in the NPV are outlined below.

Table 8-17 NPV cost breakdown

Costs	East Launceston CBD substation	St Leonards third transformer
Estimated substation and transmission costs	2027 – New East Launceston CBD substation - $41 million	2027 – Third transformer at St. Leonards - $9 million
	2043 – Third transformer at St. Leonards - $9 million	2039 – New East Launceston CBD substation - $41 million
Estimated distribution costs	2027 – 10 new feeders from CBD substation and 2 new feeders from St Leonards - $6 million	2027 – Four new feeders from St Leonards and two each from Mowbray, Hadspen and Trevallyn - $16 million
	2043 – 4 new feeders from St Leonards - $3 million	2039 - 10 new feeders from CBD substation and 2 new feeders from St Leonards - $6 million

Cost comparison

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	47.0	59.0	17.2
2	25.0	72.0	15.7

Recommended development

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

The NPV analysis shows the options to be equivalent based on a high level estimate. The NPV analysis is very dependent on both the timing and the 22 kV feeder costs. It is recommended that a study be completed to determine a detailed 22 kV feeder estimate based on equivalent options.

The scope of works for the first stage for Transend includes:

- Installation of a new 110 kV UG DCCT cable from the existing cable between Mowbray and St. Leonards.
- Installation of 2 x 60 MVA 110/22 kV transformers at the existing East Launceston CBD site
- Installation of a new switchgear and control building with two buses of 22 kV switchgear

The scope of works for Aurora includes:

- Installation of 22 kV feeder tails to cut into the existing CBD feeders

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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