Central Area Strategic Plan
System Capacity Planning Project
Aurora Energy

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aurecon

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Contents

Executive summary

The long term plan for Central discusses two alternative development paths for the New Norfolk area, with the conversion of the 11 kV network to 22 kV and upgrade of the 110/22 kV substation compared with the retention of the 11 kV network and establishment of a new 110/11 kV terminal substation. The long term plan also recommends the installation of a second transformer at Meadowbank substation and load transfers from New Norfolk to Meadowbank to defer capacity limitations at New Norfolk terminal substation.

The ten year plan for Central recommends the replacement of ageing transformers (that are in poor condition) at Arthur's Lake and Tod's Corner substations.

The five year plan for Central examines the distribution networks of the eight Central area substations. No distribution feeder works have been identified in the five year plan for Central. The plan also recommends that Aurora undertake a study to determine the costs involved in converting the 11 kV network in New Norfolk to 22 kV, so that a long term development path may be chosen.

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 Central planning area borders all other planning areas, and consists of the large, sparsely populated inland region of Tasmania from Arthurs Lake in the north to New Norfolk in the south.

Figure 2-1 provides a geographic view of the area under study.

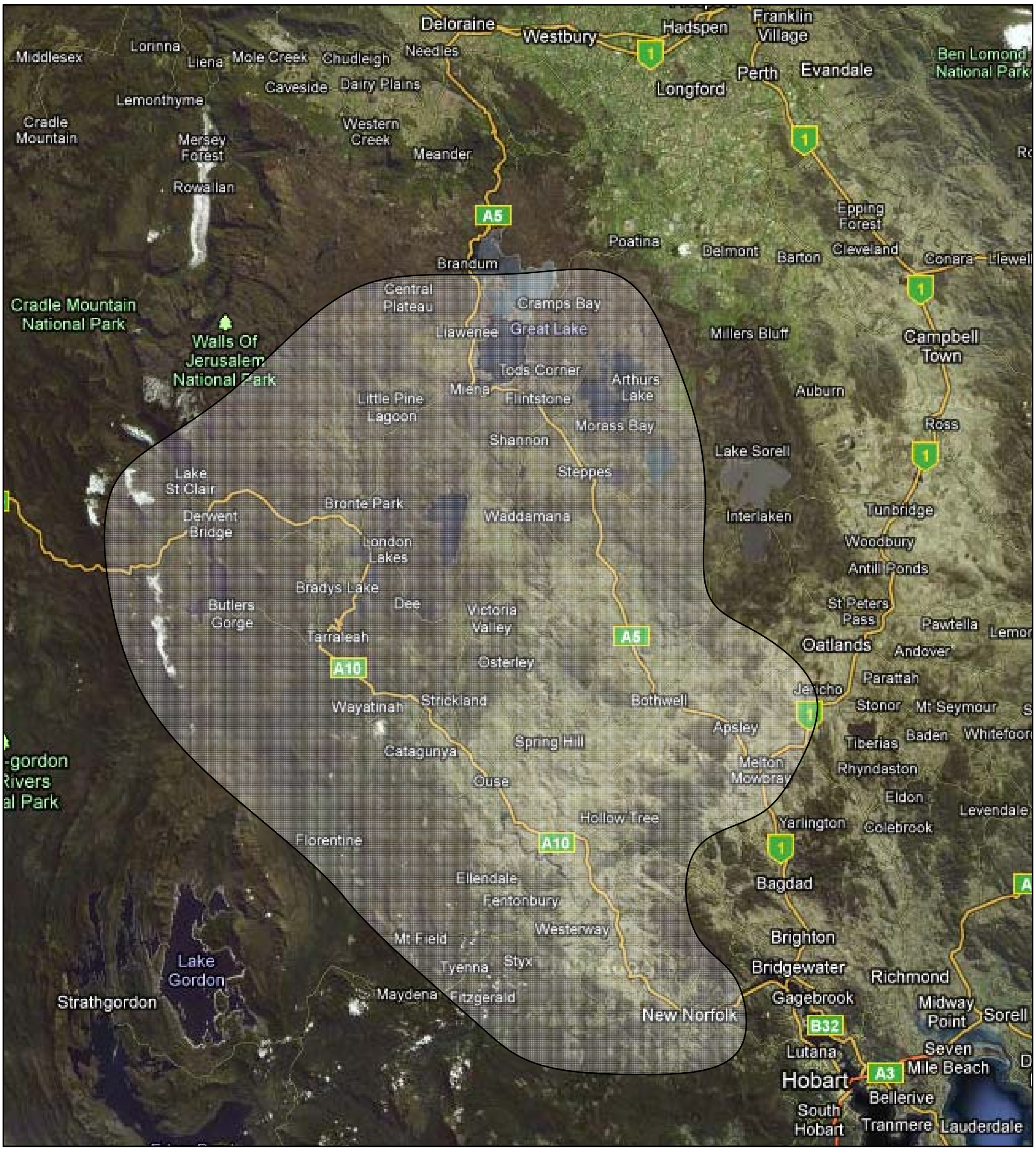

Figure 2-1 Central planning area geographic view

The Central planning area contains regions of medium growth towards the south, with the southern midlands area experiencing 2 - 3% growth over the last year. The highland areas to north and west of the Central area are considered low growth.

The area is predominantly composed of rural-residential and farming load, with significant hydro generation in the highlands.

2.1.1 Existing infrastructure

The substations within the Central planning area are listed in Table 2-1 and Table 2-2.

Table 2-1 Terminal substations in the Central planning area

Substation	Number of transformers	Transformer MVA	Transformer primary voltage	Transformer secondary voltage	Number of feeders
Arthur's Lake	1	12 MVA	110 kV	6.6 kV	1 distribution
Derwent Bridge	1	10 MVA	110 kV	22 kV	1 distribution
Gordon	1	10 MVA	110 kV	22 kV	1 distribution
Meadowbank	1	10 MVA	110 kV	22 kV	3 distribution
New Norfolk	2	30 MVA	110 kV	22 kV	6 distribution / subtransmission
Tungatinah	2	5 MVA	110 kV	22 kV	4 distribution
Waddamana	1	5 MVA	110 kV	22 kV	1 distribution

Table 2-2 Zone substations in the Central planning area

Substation	Number of transformers	Transformer MVA	Transformer primary voltage	Transformer secondary voltage	Number of feeders
Gretna*	2	1 MVA	22 kV	11 kV	2 distribution
New Norfolk	4	2.5 MVA	22 kV	11 kV	3 distribution
Tod's Corner	2	3 MVA	22 kV	6.6 kV	1 distribution
Wayatinah	4	1 MVA	11 kV	22 kV	3 distribution
Westerway*	2	1 MVA	22 kV	11 kV	2 distribution

**Substations to be decommissioned and 11 kV networks augmented to 22 kV.*

As outlined above, there is a mixture of distribution voltages within this planning area. The terminal substations within the Central area have 22 kV distribution networks, with the exception of Arthur's Lake, which supplies a pump station at 6.6 kV.

The zone substations have 11 kV distribution networks, with the exception of Tod's Corner and Wayatinah (which takes supply at 11 kV from the local hydro generator and steps up to 22 kV for distribution). This poses reliability issues due to the difficulty of transferring load between the interspersed 11 kV and 22 kV networks, as well as transferring load between neighbouring planning areas. Aurora are currently in the process of decommissioning the Gretna and Westerway zone substations and augmenting their 11 kV networks to 22 kV, after which only New Norfolk and Meadowbank substations will have interfaces with 11 kV networks.

Tod's Corner is supplied from a 1.6 MVA 6.6 kV generator which recovers energy from the water pumped from Arthur's Lake pump station. This generator only operates while Arthur's Lake is pumping, and it generates into Arthur's Lake terminal substation station through a 6 km 6.6 kV feeder.

2.2 Council areas and restrictions

The Central planning area encompasses the Central Highlands, Northern Midlands, Southern Midlands and Derwent Valley councils.

The joint land use planning strategy for all four councils implies that growth will be via infill and surrounding existing infrastructure.

2.3 Approved and proposed works

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

Gretna, Westerway and Hamilton zone substation decommissioning

The Gretna, Westerway and Hamilton zone substations are supplied at 22 kV from New Norfolk terminal substation. These zone substations are in poor condition and are approaching the end of their serviceable life. This project proposes to decommission the transformers, and augment the existing 11 kV distribution networks to 22 kV to be supplied from the existing subtransmission feeders, or transferred to the 22 kV network of neighbouring Meadowbank terminal substation.

Hamilton zone substation decommissioning was completed in 2009, with Westerway expected to be decommissioned by 2011/12 and Gretna by 2013/14.

New Norfolk and Wayatinah zone substation upgrade

The ageing transformers at Wayatinah and New Norfolk zone substations are to be replaced in 2009/10 and 2010/11 respectively. New Norfolk will have 2 x 15 MVA units (the old Sandy Bay 22/11 kV transformers), whereas Wayatinah will have a single 5 MVA transformer. Feeder 35011 from New Norfolk zone substation is also to be split under this project, with a 1 MVA load transfer from Chapel St feeder 20549.

Melton Mowbray and Kempton feeder augmentation

In order to address power quality issues during the starting of irrigation pumps, 11 kV feeders from Bridgewater terminal substation to the Melton Mowbray and Kempton areas are to be augmented to 22 kV and supplied from Meadowbank terminal substation.

Tungatinah terminal substation upgrade

Transend are proposing to replace the two transformers with a single transformer once justified by condition assessment. There is currently no indication from Transend when this will be required, however this will cause security of supply issues to the Aurora 22 kV network supplied from Tungatinah. The option to connect to the Wayatinah 22 kV network by installing 11 km over head feeder at a cost of $3 million has been ruled out as being too expensive. Discussions with Transend are ongoing regarding installation of a second transformer at Tungatinah.

Distribution feeder works

Reliability (TRIP) programs to be undertaken in the Oatlands area in 2010/11.

3. Load forecast

The Arthur's Lake, Derwent Bridge, Gordon, Tungatinah and Waddamana terminal substations have not been considered in the load forecast, since these substations supply small loads (less than 2 MVA) in isolated areas with limited growth potential. For similar reasons, load forecasts have not been considered for Tod's Corner zone substation.

The remaining Central area substations – New Norfolk and Meadowbank terminal substations and New Norfolk and Wayatinah zone substations have had medium growth rates applied for the purpose of the long term strategic study. These substations supply to the southern midlands area which has experienced a growth rate of 2 - 3% over the past two years. According to council planning documents, the majority of future growth in the area is planned as infill of existing settlements. Therefore it is considered unlikely that a high growth forecast will eventuate.

New Norfolk and Wayatinah zone substation loads have been estimated using 22 kV feeder loads, since zone substation forecasts were not available. Feeder loads from the past 10 years confirm that the growth at New Norfolk zone substation is approximately the same as that forecast for the terminal substation, so the terminal substation growth rate has been applied. Similarly, Meadowbank growths rates have been applied at Wayatinah substation.

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

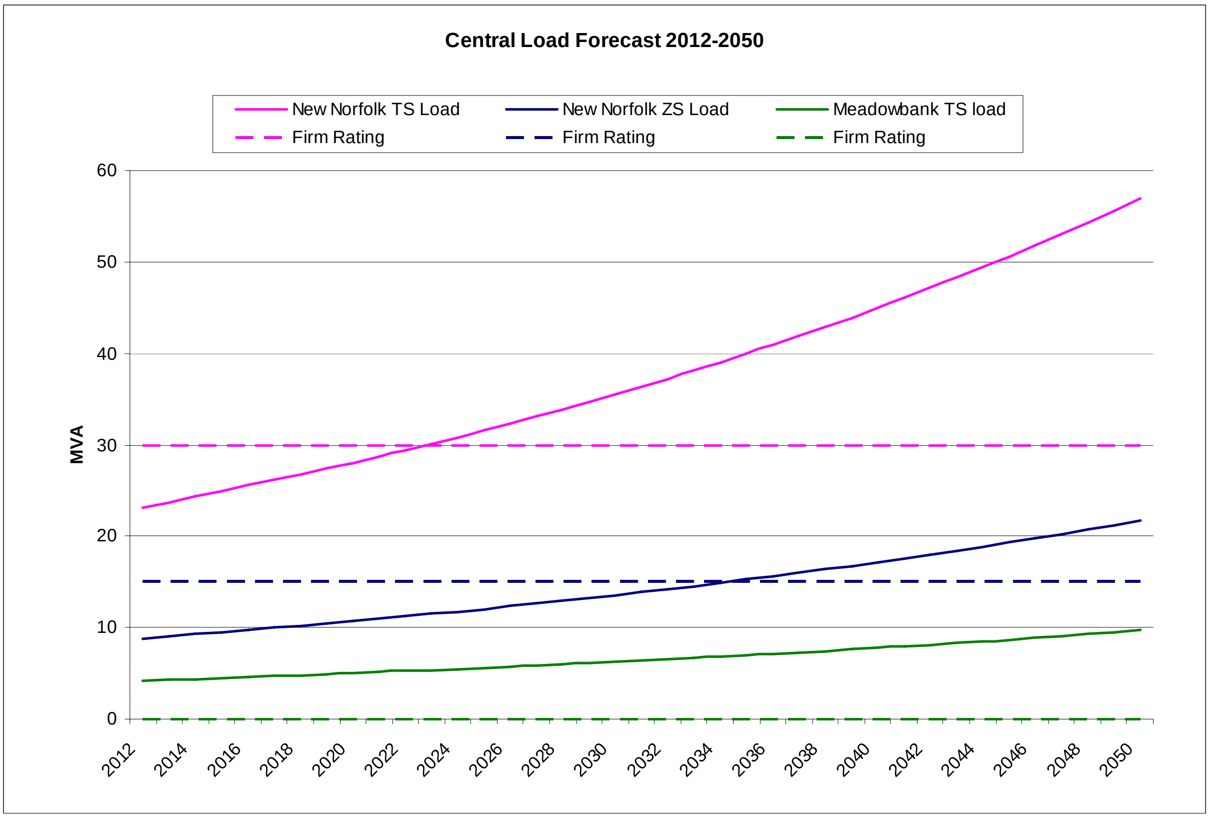

Figure 3-1 Central existing load forecast 2012-2050

Figure 3-2 provides a geographic view of the resulting load distribution in 2012 and 2050.

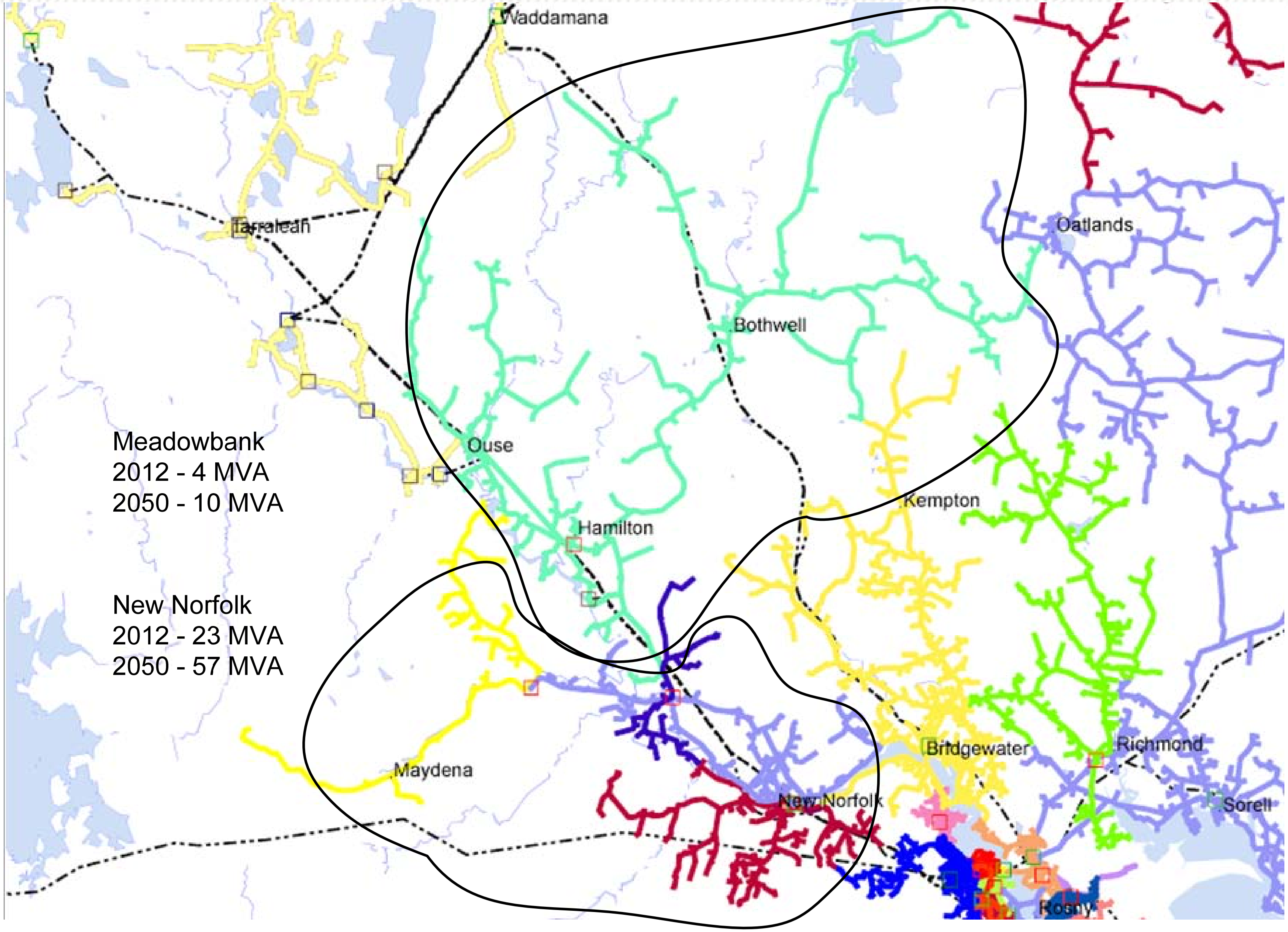

Figure 3-2 Central geographic load forecast 2012-2050

4. Limitations

4.1 Arthurs Lake terminal substation

Arthurs Lake terminal substation is equipped with a single 12 MVA 110/6.6 kV transformer (actually three single phase transformers), providing no firm capacity.

The Arthurs Lake substation was installed in 1964. This transformer supplies a single 8.5 MVA pump which is used to transfer water from Arthurs Lake to Great Lake for the hydro generation.

4.2 Derwent Bridge terminal substation

Derwent Bridge terminal substation is equipped with a single 10 MVA 110/22 kV transformer, providing no firm capacity. The transformer at Derwent Bridge substation was installed in 2008.

Derwent Bridge supplies a single 22 kV distribution feeder with no ties to any adjacent substation. The nearest distribution network is supplied from Tungatinah and establishment of a tie would require approximately 20 km of new overhead feeder at a cost of approximately $2 million.

With a peak load at Derwent Bridge of approximately 0.2 MVA, the lack of firm capacity is not considered a serious limitation, and certainly not justification for a second transformer or costly feeder works. Thus no practical development options were found for Derwent Bridge, and this substation has not been considered further in this report.

4.3 Gordon terminal substation

Gordon terminal substation is equipped with a single 10 MVA 220/22 kV transformer, providing no firm capacity. The transformer at Gordon substation was installed in 1978.

Gordon supplies a single 22 kV distribution feeder with no ties to any adjacent substation. The nearest distribution network is supplied from Westerway and establishment of a tie would require approximately 60 km of new overhead feeder at a cost of approximately $6 million.

With a peak load at Gordon of approximately 2 MVA, the lack of firm capacity is not considered a serious limitation, and certainly not justification for a second transformer or costly feeder works. Thus no practical development options were found for Gordon, and this substation has not been considered further in this report.

4.4 Meadowbank terminal substation

Meadowbank terminal substation is equipped with a single 10 MVA 110/22 kV transformer, providing no firm capacity.

The transformer at Meadowbank substation was installed in 1997.

4.5 New Norfolk terminal substation

New Norfolk terminal substation is equipped with 2 x 30 MVA 110/22 kV transformers, providing 30 MVA of firm capacity. The transformers at New Norfolk substation were installed in 1987.

The load at New Norfolk substation is forecast to reach approximately 57 MVA in 2050 under the medium growth forecast. Load is forecast to exceed firm capacity in 2023.

4.6 Tungatinah terminal substation

Tungatinah terminal substation is equipped with 2 x 5 MVA 110/22 kV transformers, providing 5 MVA of firm capacity. The transformers at Tungatinah substation were installed in 1953 and 1998.

Should Transend proceed with replacement of the transformers with a single unit, as discussed in section 2.3, there will be no firm capacity at Tungatinah. There is no load transfer capacity since Tungatinah 22 kV network has no feeder ties to adjacent substations.

4.7 Waddamana terminal substation

Waddamana terminal substation is equipped with a single 5 MVA 110/22 kV transformer, providing no firm capacity. The transformer at Waddamana substation was installed in 1997.

Waddamana has a peak load of approximately 1.2 MVA, which is adequately backed up by the Arthur’s Lake and Tod’s Corner substations for the scope of the study.

4.8 New Norfolk zone substation

New Norfolk zone substation is currently equipped with 4 x 2.5 MVA 22/11 kV transformers, however these are to be replaced by Aurora in 2010/11 with 2 x 15 MVA units, providing 15 MVA of firm capacity. These new transformers are 40 years old, having been formerly installed at Sandy Bay zone substation.

The load at New Norfolk zone substation is forecast to exceed firm capacity in 2035.

4.9 Tod’s Corner zone substation

Tod’s Corner zone substation is equipped with 2 x 3 MVA 22/6.6 kV transformers, providing 3 MVA of firm capacity.

The transformers at Tod’s Corner have been identified for replacement in Aurora’s asset replacement plan by 2020/21.

4.10 Wayatinah zone substation

Wayatinah zone substation is currently equipped with 4 x 1 MVA 22/11 kV transformers, however these are to be replaced by Aurora in 2009/10 a single 5 MVA unit, providing no firm capacity.

Wayatinah substation has a peak load of approximately 0.6 MVA, and is adequately backed up by a feeder tie to Meadowbank substation for the scope of the study.

5. Planning philosophy

The Central planning area mostly consists of small and remote substations with low growth and little transfer capacity to adjacent substations. The exception to this is the south of the planning area containing the New Norfolk and Meadowbank 110/22 kV terminal substations as well as several 22/11 kV zone substations. As such, little consideration has been given to development at substations like Waddamana, Tungatinah, Wayatinah, Derwent Bridge and Gordon, with focus mainly on the substations with higher load growth and magnitude to the south.

Aurora is in the process of converting the 11 kV networks of Westerway and Gretna zone substations to 22 kV, with Hamilton zone substation already completed in 2009. Once these projects are complete, New Norfolk zone substation, which supplies the town of New Norfolk on the south side of the river, will be the only remaining 11 kV network in the Central planning area. There is very little transfer capacity from New Norfolk zone substation to the neighbouring Hobart West substations of Bridgewater and Chapel St, and there is little potential for future growth between New Norfolk and Hobart due to the difficult, mountainous terrain that separates them.

Having New Norfolk load supplied at two different distribution voltage levels has several drawbacks, such as limiting the available load transfers between feeders, and the requirement to maintain two adjacent substations with redundant capacity, therefore the conversion of the New Norfolk 11 kV network to 22 kV is considered a good ultimate outcome. However the conversion is expected to be very costly and an accurate cost estimate should be obtained prior to committing to such a development path. The long term plan for New Norfolk discusses two development options.

Consideration has been given to the establishment of a substation in Bothwell at a previously decommissioned site under the Waddamana-Bridgewater 110 kV line. Such a substation would be relatively inexpensive to establish and would provide 22 kV support to the Oatlands area and limited support to the Ross area (limited due to the long distances involved). However Bothwell substation has not been recommended in this report as it is not considered a suitable location for a substation, being so distant from the areas of significant load density.

The preferred option to address the reliability issues in the Oatlands area is to provide support from Sorell at 22 kV by extending existing feeder 41512 once the Richmond 11 kV load has been transferred to Lindisfarne. With a forecast 2050 load in the Oatlands area of just 6 MVA, the two feeders from Sorell and support expected from a future substation in the Ross area, this arrangement is considered adequate for the scope of the study.

6. Long term strategy

The long term strategy for Central is primarily concerned with the Meadowbank and New Norfolk terminal substations and the New Norfolk zone substation to the south of the planning area. The exception to this is the transformer replacements required at Arthur's Lake and Tod's corner to remove the ageing transformers from service.

The plan proposes to install a second transformer at Meadowbank in 2023, with 22 kV load transfers from New Norfolk to Meadowbank, in order to establish firm capacity at Meadowbank and to deload New Norfolk terminal substation.

The long term plan presents two options for development at New Norfolk, depending on whether the 11 kV network is retained or converted to 22 kV. The 11 kV conversion option is considered technically superior, but the costs of the options are equivalent within the error of the analysis. It is recommended that a more detailed estimate of the project costs be undertaken prior to a development option being chosen.

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 million (RIT-D) or $5 million (RIT-T).

6.1 Proposed projects

6.1.1 Replace Arthurs Lake 110/22 kV transformers

The Arthurs Lake terminal substation was installed in 1964 which implies a predicted age limitation will be reached around 2014. Transend has indicated that the three single phase transformers will be replaced with a single 12 MVA 110/6.6 kV unit in 2013.

As this project primarily concerns Transend and Hydro Tasmania, and the Aurora load is supplied in accordance with the ESI regulations, this project is given no further consideration and it is assumed that the existing transformer will be replaced like-for-like in 2013.

6.1.2 Replace Tods Corner 22/6.6 kV transformers

The existing 2 x 22/6.6 kV transformers at Tods Corner substation have been deemed to be end-of-life by 2020. Therefore it is proposed that the transformers be replaced with a new 22/6.6 kV unit in 2020 and the existing 6.6 kV line between Tod's Corner and Arthur's Lake is retained.

This project is discussed in more detail in the ten year plan in Section 7.1.2.

6.1.3 Upgrade Meadowbank terminal substation and transfer load from New Norfolk

Meadowbank terminal substation is equipped with a single 10 MVA 110/22 kV transformer, resulting in no firm capacity. The existing transformer was installed in 1997 and is a standard Transend 10/17/25 MVA unit without radiator fans installed. Thus the installation of four fans will increase capacity to 25 MVA.

The load at Meadowbank is forecast to reach 9.7 MVA by 2050, so two 10 MVA transformers would ultimately be sufficient. However, New Norfolk terminal substation is also forecast to exceed firm capacity in 2023, and would require a separate project to address this limitation.

A better approach would be to install a second 110/22 kV transformer at Meadowbank and deload New Norfolk via 22 kV load transfers (approximately 3 MVA in 2023). It is expected that the decommissioning of Gretna and Westerway zone substations by 2013 will create transfer capacity from New Norfolk to Meadowbank, however additional 22 kV reinforcement such as voltage regulators may be required to achieve the full 3 MVA transfer.

The installation of radiator fans on the transformers would be required in 2029 when the load at Meadowbank is forecast to exceed 10 MVA firm capacity. If possible, further load transfers would then deload New Norfolk terminal substation until the aged transformers are replaced in 2037.

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

6.1.4 Upgrade New Norfolk terminal substation

New Norfolk terminal substation is subsequently forecast to exceed firm capacity in 2029. The New Norfolk existing 2 x 15 MVA 22/11 kV transformers are currently 40 years old and would be around 60 years old in 2029, so this project may need to be brought forward depending on the condition of the transformers. If the transformers are deemed to be in good condition at this time then the project may be able to be deferred by 22 kV load transfers to Meadowbank.

There are two proposed options to address the above limitations. The first option is to convert the 11 kV network to 22 kV, upgrade the terminal substation and decommission the zone substation. The second option involves the establishment of a new 110/11 kV substation at the site of the existing zone substation. It is assumed that replacing the existing 22/11 kV units like-for-like is not a viable option, since this is a configuration that Aurora are phasing out and would require the purchase and maintenance of non-standard transformers.

A preliminary NPV analysis for the two options, attached in Appendix B, indicates that the options are equivalent within the margin of error of the study. The NPV shows that option 1 is the superior option should the replacement of the 22/11 kV transformers be required for condition reasons prior to 2029 (i.e. refer to high growth option). However option two is superior in the low growth and high WACC scenarios due to the deferral of the 110/22 kV substation upgrade. It is recommended that the costs be evaluated in more detail prior to a development option being chosen. The options are discussed in more detail below.

Option 1 – Convert New Norfolk 11 kV network to 22 kV and decommission New Norfolk zone substation

This option involves the conversion of the existing New Norfolk 11 kV network to 22 kV, the decommissioning of New Norfolk zone substation and the upgrade of the New Norfolk terminal substation transformers to 60 MVA units.

It is expected that the long radial section of 11 kV feeder 35011 down Lachlan Rd would remain at 11 kV and be supplied by a 22/11 kV autotransformer. This section is isolated from the rest of the network by mountain ranges and is unlikely to experience significant growth, so the cost of conversion is unlikely to be justified. Sections of feeder 35013 would also remain at 11 kV, supplied by a 22/11 kV autotransformer, in order to retain the ties with the 11 kV networks from Chapel St and Bridgewater.

This option could be achieved in a number of ways, however a suggested path is as follows:

- Replace 2 x 110/22 kV 30 MVA transformers at New Norfolk terminal substation with 60 MVA units
- Run two new 22 kV cables from New Norfolk terminal substation to New Norfolk zone substation. Including the existing two transformer-ended feeders, this would provide four 22 kV feeder tails to which the four existing 11 kV feeders could be connected once converted to 22 kV.
- Convert New Norfolk 11 kV feeder 35010 to 22 kV. This could be accomplished by extending the feeder 5 km along Uxbridge Rd to tie with 22 kV feeder 37002 (currently Gretna 11 kV feeder, but will be converted to 22 kV in 2013). The distribution transformers would then be replaced and the line re-energised at 22 kV beginning at the remote end and working back towards the tail. The long radial section south down Glenfern Rd may need to be supplied by a generator while the transformers are replaced.

- Convert New Norfolk 11 kV feeder 35012 to 22 kV. It is expect that this could be accomplished using the existing ties to feeder 35010 to energise the remote end of the feeder at 22 kV and working back towards the tail
- Convert New Norfolk 11 kV feeder 35011 to 22 kV. The long radial section down Lachlan Rd would remain at 11 kV, supplied by a 22/11 kV autotransformer and a new 22 kV tie to feeder 35010. The sections of 35011 in New Norfolk could then be converted to 22 kV beginning at the autotransformer site and working back towards the tail.
- Convert New Norfolk 11 kV feeder 35013 to 22 kV. It is expected that only the sections close to the substation would be converted, with the 11 kV network in Malbina and Molesworth supplied by an autotransformer near the intersection of the Lyell Hwy and Molesworth Rd. This would allow the 11 kV ties to Bridgewater and Chapel St to be retained.

A geographic diagram of the proposed network is shown in Figure 6-1.

If the 22/11 kV transformers still have usable life in 2029 it may be possible to stage the 11 to 22 kV conversion over several years. However the transformer replacement at New Norfolk terminal substation would have to proceed in 2029.

Option 2 – Establish New Norfolk 110/11 kV substation

This option involves the conversion of New Norfolk zone substation to 110/11 kV, supplied by teeing off the existing New Norfolk to Creek Rd/Chapel St 110 kV lines. This option has the benefit that it deloads the New Norfolk 110/22 kV substation, which defers the firm capacity limitation there for the scope of the study (although the transformers reach nominal end-of-life in 2037 so they would need to be replaced at this time anyway).

Tie capacity between the 22 and 11 kV networks in New Norfolk may be obtained under this option by installing 22/11 kV autotransformers in strategic locations in the network.

6.1.5 Upgrade New Norfolk terminal substation

The New Norfolk 110/22 kV transformers were installed in 1987 and so are predicted to be nominally end of life by 2037. Therefore it is proposed that these transformers be replaced around 2037.

If the New Norfolk 11 kV network has been converted to 22 kV by this time the new 110/22 kV transformers should be 60 MVA units and the replacement cannot be deferred as a firm capacity limitation is expected around the same time. However if the 110/11 kV option discussed above has been chosen, the new 110/22 kV transformers can be 25 MVA units and the replacement may be deferred if the existing transformers are deemed to be in good condition.

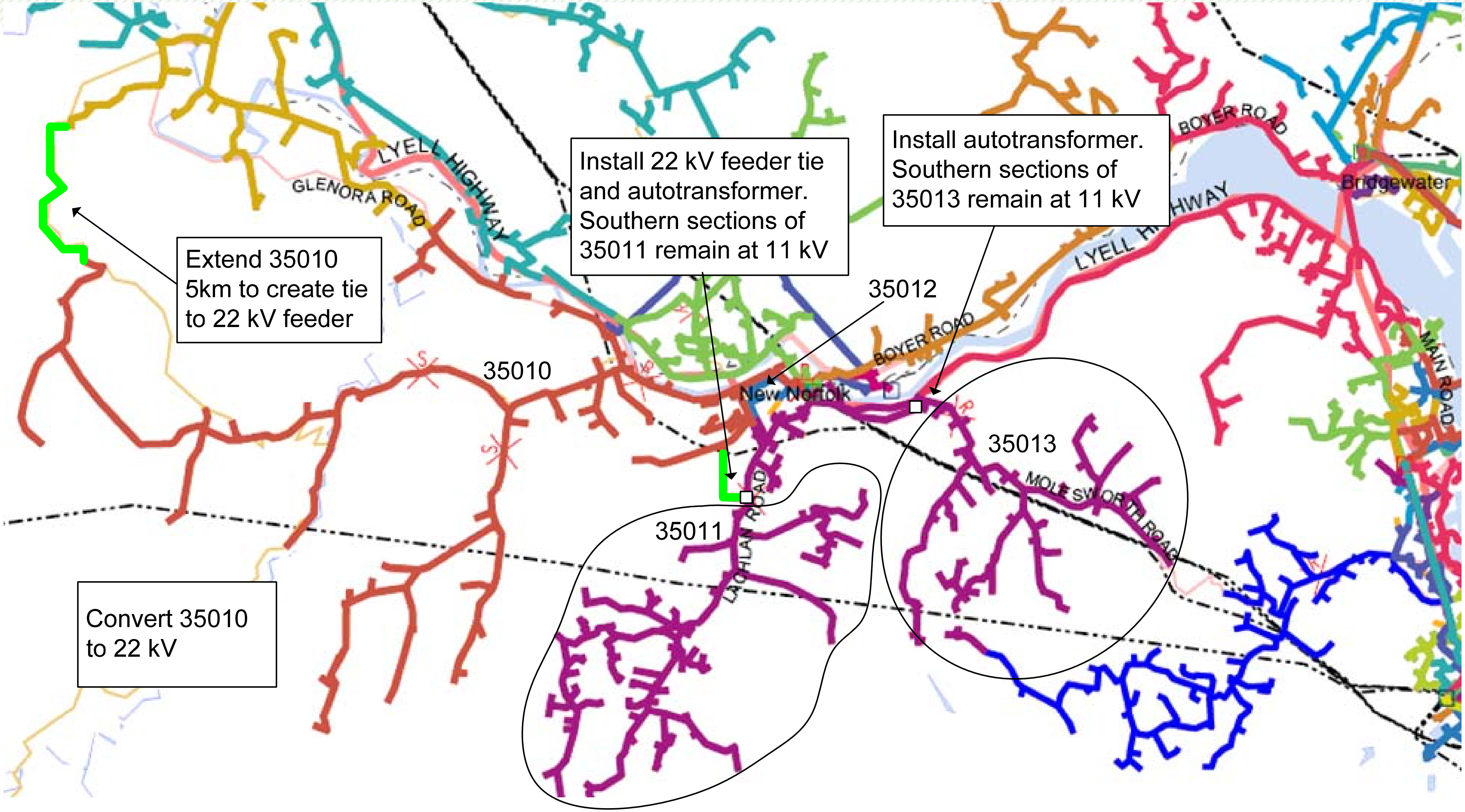

Figure 6-1 **New Norfolk proposed geographic diagram**

6.2 Summary of proposed works

A summary of the proposed works from 2012 to 2050 in the Central planning area is outlined in Table 6-1 and Table 6-2 for option 1 and option 2 respectively.

Table 6-1 Central project summary (option 1)

Year	Proposed Project	Proposed Outcomes
2013	Replace Arthurs Lake 110/22 kV transformers	Replace ageing transformers
2020	Replace Tods Corner 22/6.6 kV transformers	Replace ageing transformers
2023	Install 2nd transformer at Meadowbank terminal substation	Provide firm capacity at Meadowbank and deload New Norfolk terminal substation
2029	Install fans on Meadowbank transformers	Increase firm capacity at Meadowbank substation
2029	Convert New Norfolk 11 kV network to 22 kV and decommission zone substation	Address firm capacity at New Norfolk zone substation and recover ageing 22/11 kV transformers.
2029	Upgrade New Norfolk terminal substation	Replace ageing transformers

Table 6-2 Central project summary (option 2)

Year	Proposed Project	Proposed Outcomes
2013	Replace Arthurs Lake 110/22 kV transformers	Replace ageing transformers
2020	Replace Tods Corner 22/6.6 kV transformers	Replace ageing transformers
2023	Install 2nd transformer at Meadowbank terminal substation	Provide firm capacity at Meadowbank and deload New Norfolk terminal substation
2029	Install fans on Meadowbank transformers	Increase firm capacity at Meadowbank substation
2029	Establish New Norfolk 110/11 kV substation	Address firm capacity at New Norfolk zone substation and and recover ageing 22/11 kV transformers.
2037	Upgrade New Norfolk terminal substation	Replace ageing transformers

The resulting load forecast curves are given in Figure 6-2 and Figure for option 1 and option 2 respectively.

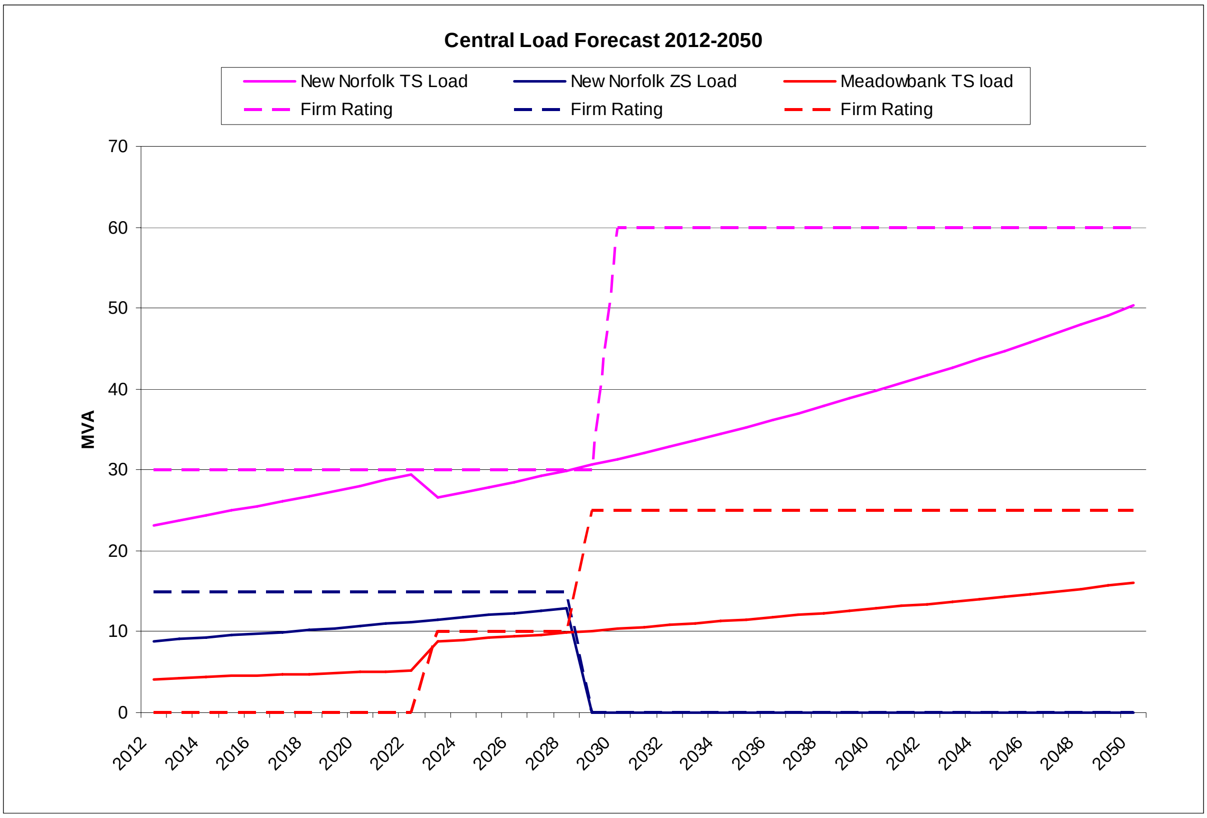

Figure 6-2 Central proposed load forecast 2012 - 2050 option 1

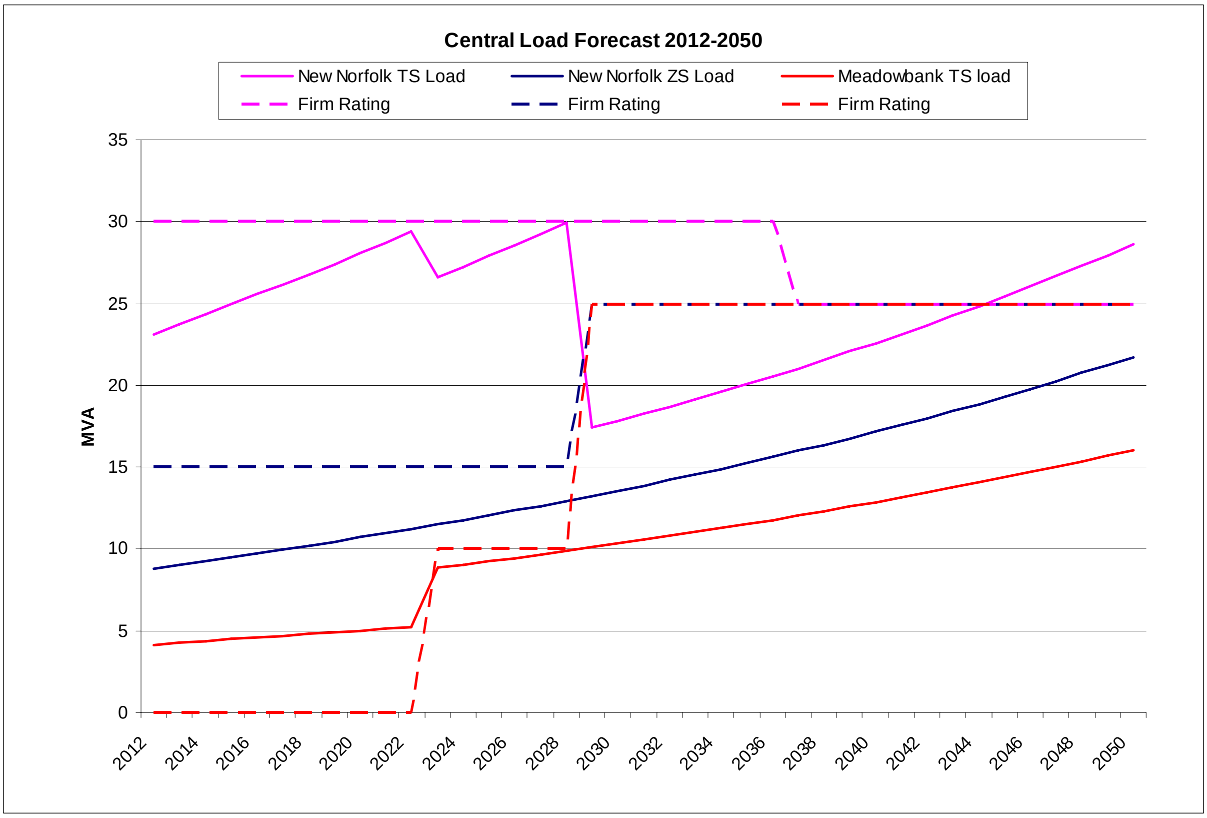

Figure 6-3 Central proposed load forecast 2012 - 2050 option 2

7. Ten year plan

The ten year plan for the Central planning area concerns only the age replacement of transformers at Arthur's Lake and Tod's Corner substations.

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

7.1 Proposed projects

7.1.1 Upgrade Arthur's Lake terminal substation

Arthurs Lake terminal substation is equipped with a single 12 MVA 110/6.6 kV transformer, providing no firm capacity. The transformer was installed in 1964 which implies a predicted nominal end of life in 2014.

The transformer primarily supplies the Hydro Tasmania pumping station, with approximately 0.5 MW of Aurora customer load.

The Transend Capital Works Program indicates that the transformer is to be replaced like-for-like by December 2013. There are currently no plans to install a second transformer at Arthurs Lake.

As this project primarily concerns Transend and Hydro Tasmania, and the Aurora load is supplied in accordance with the ESI regulations, this project is given no further consideration and it is assumed that the existing transformer will be replaced like-for-like in 2013.

7.1.2 Replace Tod's Corner 22/6.6 kV transformers

Limitations

Tod's Corner zone substation is equipped with 2 x 3 MVA 6.6/22 kV transformers, providing a firm capacity of 3 MVA.

There is a 1.6 MW hydro generator at Tod's Corner which is used to recover energy from water pumped from Arthurs Lake to Great Lake by the 8.5 MVA pump station at Arthurs Lake. The generator feeds into a 6.6 kV overhead feeder from Tod's Corner to Arthurs Lake substation and as a result reduces the energy usage of the pump station.

The normally-open transformers at Tod's Corner are intended as a backup for the 22 kV network from Waddamana. That is, for contingencies on 22 kV feeder 49202, the transformers are brought into service thus supplying 49202 via the Arthurs Lake 110/6.6 kV transformer and the 6.6 kV feeder. These transformers have been deemed to be end of life by 2020.

The 22 kV network from Waddamana to Tod's Corner and Arthurs Lake supplies approximately 0.5 MVA of load, most of which is supplied to holiday shacks along the lakes. There can be problems with access to the area during the winter months, which could result in extended outages for faults on the 22 kV network. Thus the 6.6 kV link between Tod's Corner and Arthurs Lake is considered an important backup supply and improves the reliability of supply to the area.

There is also a 500 kVA 6.6/22 kV transformer at Arthurs Lake which normally supplies a small amount of load in the area.

Schematic and geographic diagrams of the existing configuration are shown in Figure 7-1 and Figure 7-2.

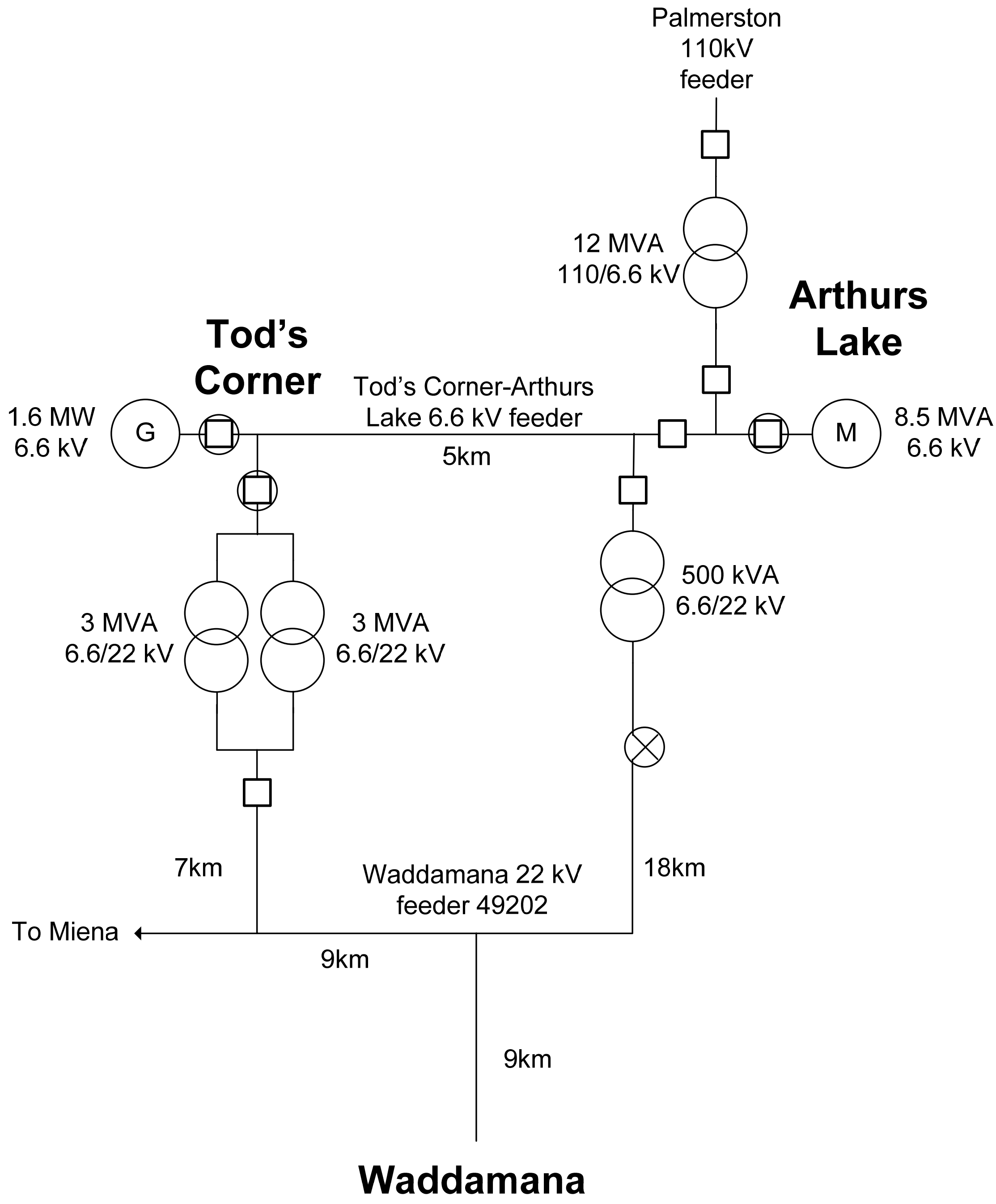

Figure 7-1 Tod's Corner and Arthurs Lake existing schematic diagram

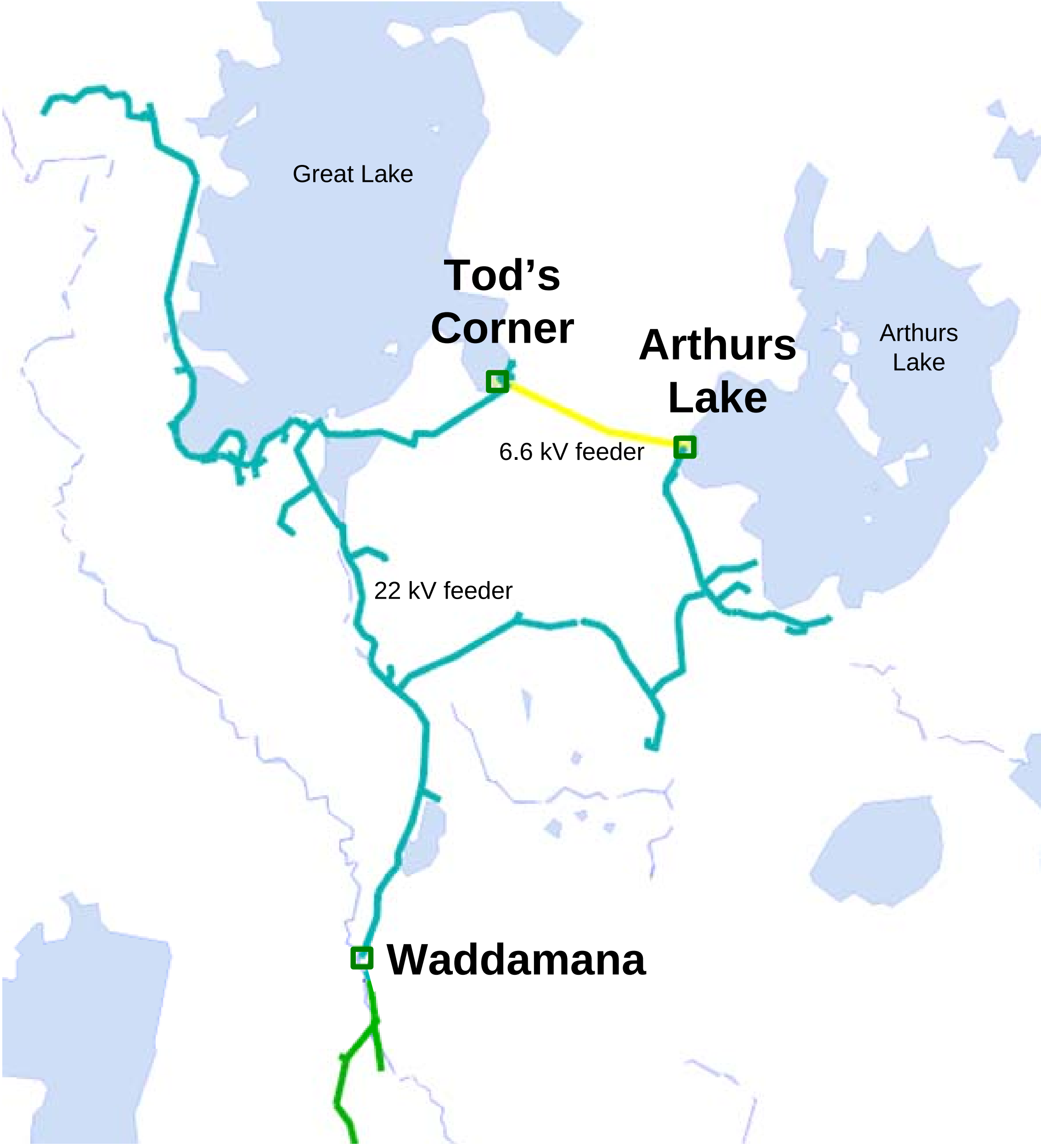

Figure 7-2 Tod's Corner and Arthurs Lake existing geographic diagram

Option 1(recommended option) – Replace Tod's Corner transformers

This option involves the replacement of the existing 6.6/22 kV transformers at Tod's Corner with a single 2 MVA unit in 2020.

As this project is justified on condition grounds and proposes a like-for-like replacement, for regulatory purposes it is considered a refurbishment project rather than an augmentation project. As such, a Regulatory Investment Test (RIT) is not required for this project.

Option 2– Replace Tod's Corner transformers and upgrade 6.6 kV feeder to 22 kV

This option involves the replacement of the existing 6.6/22 kV transformers at Tod's Corner with a single 2 MVA unit in 2020.

Also as part of this option the 6.6 kV overhead line between Tod's Corner and Arthurs Lake is upgraded 22 kV and connected to the existing 22 kV network from Waddamana.

Option 3 – Decommission Tod's Corner transformers and upgrade Arthurs Lake 6.6/22 kV transformer

This option involves the removal from service of the Tod's Corner 6.6/22 kV transformers and the replacement of the Arthur's Lake 500 kVA transformer with a 2 MVA unit in 2020.

As a consequence the Tod's Corner generator can supply only via the 6.6 kV feeder to Arthur's Lake, with no redundant backup.

This option also requires the reconductoring of approximately 6 km of 3/2.75 GI conductor to allow any significant load be transferred to Arthurs Lake.

Technical comparison

Table 7-1 Technical comparison of options

Option	Description	Advantages	Disadvantages
1	Replace Tod's Corner transformers	• Provides the generator with better redundancy than the other options, since it can supply to Arthurs Lake at 6.6 kV or into the 22 kV network • Provides backup supply close to the bulk of the load (Miena)	• Non-standard 6.6 kV voltage level remains in the network
2	Replace Tod's Corner transformers and upgrade 6.6 kV feeder to 22 kV	• Removes non-standard 6.6 kV voltage level from the network	• Lose the ability to generate directly into Arthurs Lake (limited by the 500 kVA transformer at Arthurs Lake) • Higher generation losses due to the long 22 kV feeder route to Waddamana • Arthurs Lake is limited to 500 kVA backup supply to the 22 kV network
3	Decommission Tod's Corner transformers and upgrade Arthurs Lake 6.6/22 kV transformer		• Loss of redundancy at Tod's Corner (6.6 kV feeder fault would isolate the generator) • Reduction in reliability since the feeder ring is broken • Requires 22 kV feeder reconductoring

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

Cost comparison

Table 7-2 Cost comparison of options

Option	Initial Capital Cost ($M)	Total Capital Cost ($M)	Net Present Value ($M)
1	0.25	0.25	0.13
2	0.39	0.39	0.20
3	0.85	0.85	0.45

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

Recommended option

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

The scope of works at Tod's Corner substation includes:

- Recovery of the existing 2 x 3 MVA 6.6/22 kV transformers and 6.6 kV transformer PMR
- Installation of 1 x 2 MVA 6.6/22 kV transformer

The resulting schematic diagram is shown in Figure 7-3.

It should be noted that the 2 MVA transformer size has been recommended based on the smallest size transformer capable of providing backup to the 1.6 MW generator, assuming typical generator characteristics. The generator specifications should be consulted to confirm that the transformer size is appropriate.

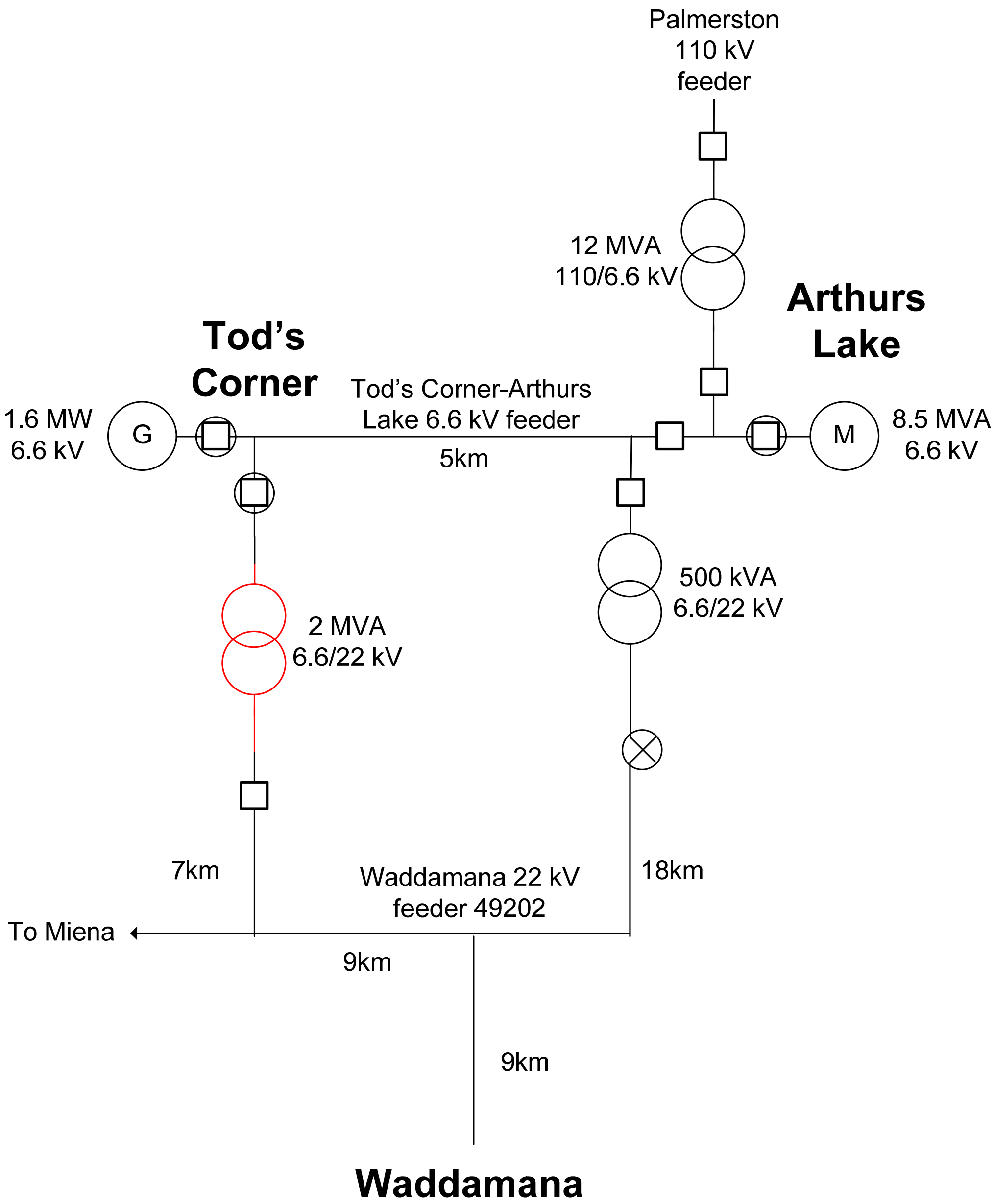

Figure 7-3 Tod's Corner and Arthurs Lake proposed schematic diagram

7.2 Summary of proposed works

The proposed works from 2012 to 2022 in the Central planning area are listed in Table 7-3.

Table 7-3 Central project summary

Year	Proposed Project	Proposed Outcomes
2013	Upgrade Arthurs Lake terminal substation	Replace ageing 110/6.6 kV transformer
2020	Upgrade Tods Corner zone substation	Replace ageing 22/6.6 kV transformers

8. Five year plan

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

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

8.1 Arthurs Lake substation

Arthurs Lake terminal substation is discussed as part of Waddamana substation in Section 8.3.

8.2 Tods Corner substation

Tods Corner zone substation is discussed as part of Waddamana substation in Section 8.3.

8.3 Waddamana substation

Waddamana terminal substation supplies the townships of Waddamana and Victoria Valley, as well as to the shacks around Great Lake and Arthurs Lake.

8.3.1 Limitations

Using the medium growth forecast, Waddamana substation load is forecast to grow from 1.25 MVA in 2012 to 1.34 MVA in 2017. There is currently no firm capacity at Waddamana, however there is adequate backup from Tods Corner and Arthurs Lake via the 22 kV network for the period of study. The five year load forecast for Waddamana substation is given in Figure 8-1.

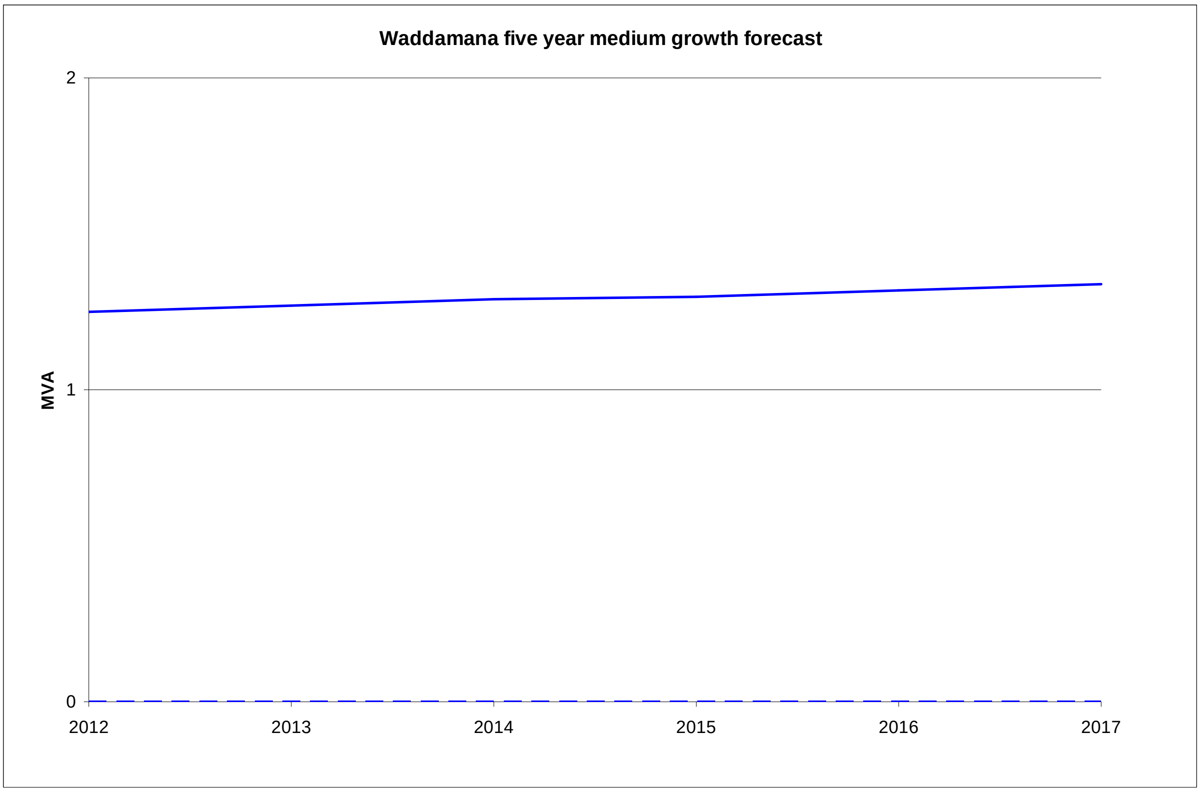

Figure 8-1 Waddamana five year medium growth forecast

It should be noted that of the above load at Waddamana, a small amount (approximately 0.5 MVA) is actually normally supplied from Arthurs Lake substation.

The 22 kV network from Waddamana consists of a single distribution feeder. There are no circuit breakers at Waddamana – the existing feeder is supplied from an Aurora PMR.

The Waddamana supply area is shown in Figure 8-2 below.

Figure 8-2 Waddamana 22 kV supply area

8.3.2 Proposed projects

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

8.3.3 Ultimate configuration

Substation

Waddamana is expected to remain a single 110/22 kV transformer substation up to 2050, as the backup supply from Arthurs Lake and Tods corner will provide sufficient backup for the foreseeable future.

The transformer at Waddamana was installed in 1997, so it is expected to be end of life around 2047.

Feeders

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

Due to the low load growth in the area, and the backup supply provided by Arthurs Lake and Tods Corner, the Waddamana feeder network is not expected to require augmentation for the foreseeable future.

8.4 Tungatinah substation

Tungatinah terminal substation supplies the townships of Tarraleah and Bronte, as well as providing 22 kV supply to the Tarraleah and Lake Echo hydro power stations.

8.4.1 Limitations

Using the medium growth forecast, Tungatinah substation load is forecast to grow from 2.08 MVA in 2012 to 2.18 MVA in 2017, well below the firm capacity of 5 MVA at Tungatinah. The five year load forecast for Tungatinah substation is given in Figure 8-3.

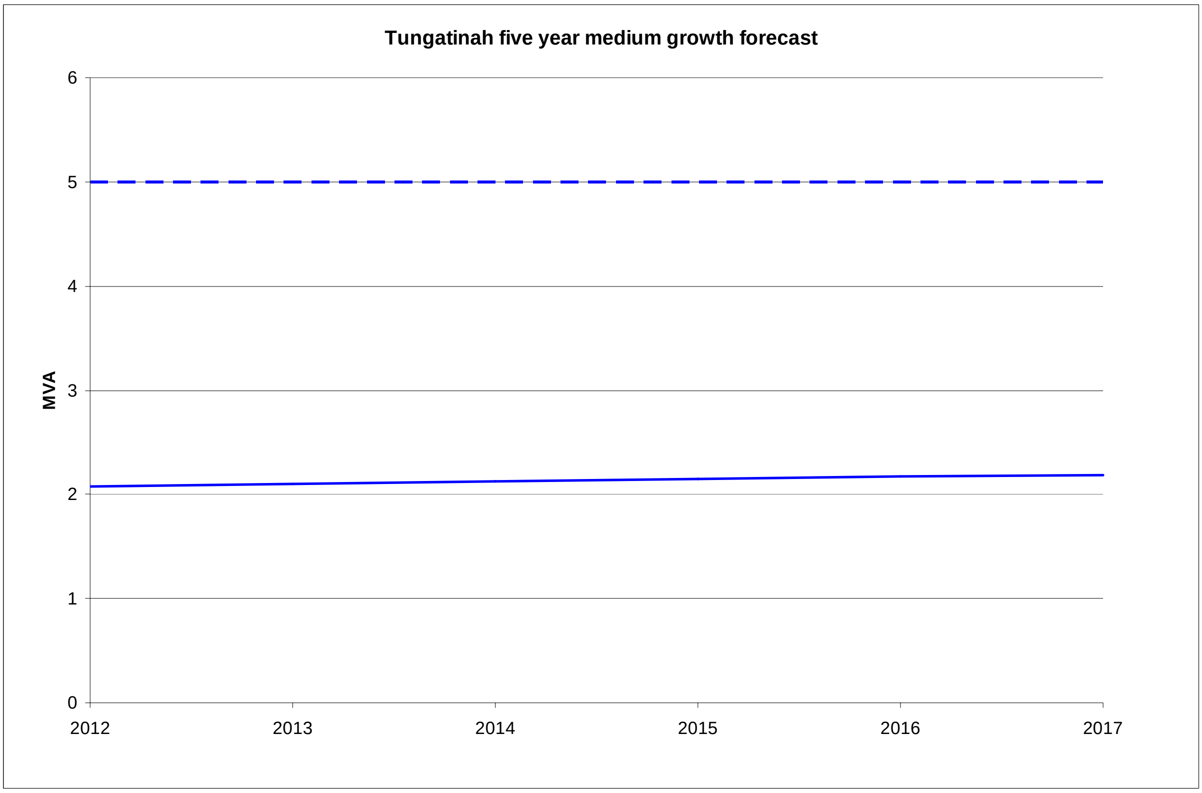

Figure 8-3 Tungatinah five year medium growth forecast

The 22 kV network from Tungatinah consists of four distribution feeders and there are is a single spare circuit breaker for future feeders.

The Tungatinah supply area and 22 kV feeders are shown in Figure 8-4 and Figure 8-5 below.

Figure 8-4 **Tungatinah 22 kV supply area**

Figure 8-5 Tungatinah 22 kV feeders

The feeder loads were not available so no feeder forecast has been developed for Tungatinah, however no limitations are expected given the substation peak load of around 2 MVA.

8.4.2 Proposed projects

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

8.4.3 Ultimate configuration

Substation

Transend are proposing to replace the existing 2 x 5 MVA 110/22 kV transformers with a single transformer once the replacement is justified by condition assessment. This would cause security concerns to the Aurora load supplied from Tungatinah, as there will be no backup supply for loss of a transformer. With a peak load of approximately 2 MVA, the lack of firm capacity is not considered a serious limitation, and is not expected to justify a second transformer for the scope of the study.

Feeders

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

The feeder network is not expected to require augmentation for the scope of the study. A feeder tie to Wayatinah (approximately 11 km and $3M) is a possibility as a way of providing backup to the load at Tungatinah, however this is not expected to be justified for the scope of the study.

8.5 Wayatinah substation

Wayatinah zone substation supplies the township of Wayatinah and the hydro power stations at Liapootah, Wayatinah, Catagunya, Repulse and Cluny.

8.5.1 Limitations

Using the medium growth forecast, Wayatinah substation load is forecast to grow from 0.64 MVA in 2012 to 0.73 MVA in 2017. There is currently no firm capacity at Wayatinah, however there is adequate backup from Meadowbank via the 22 kV network for the period of study. The five year load forecast for Wayatinah substation is given in Figure 8-6.

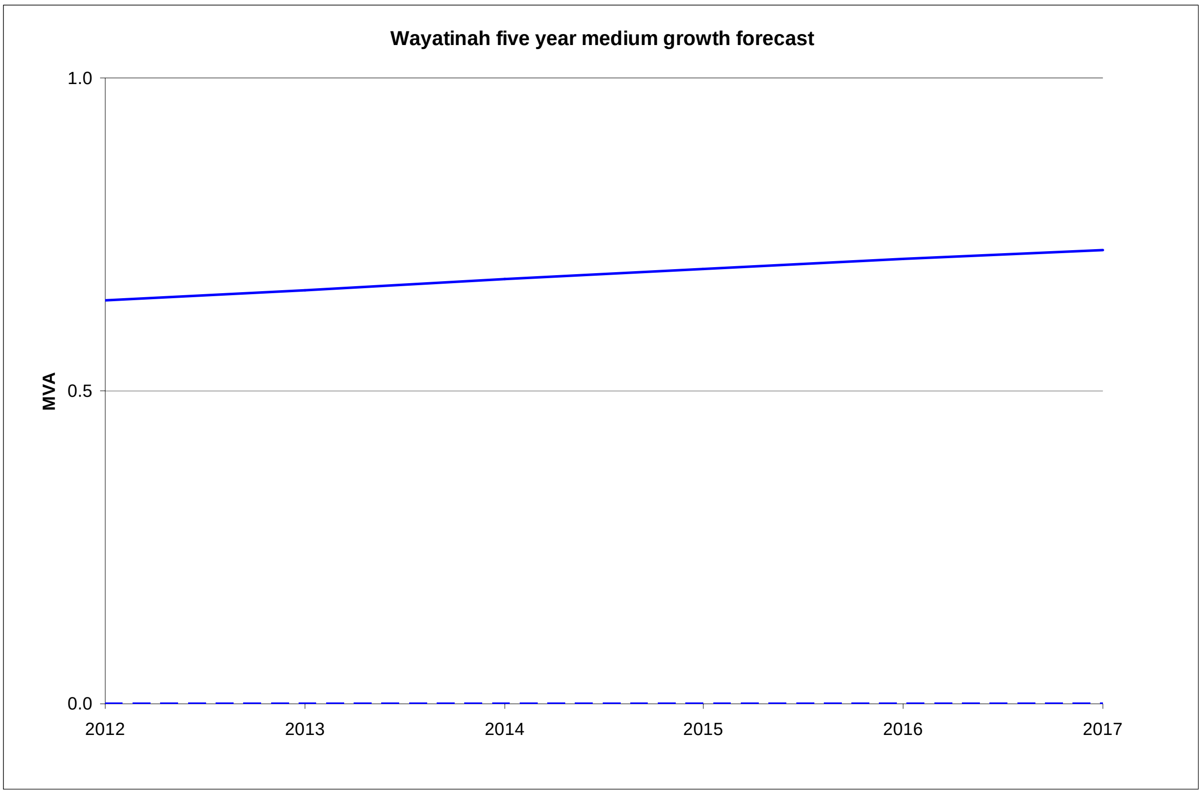

Figure 8-6 Wayatinah five year medium growth forecast

The 22 kV network from Wayatinah consists of three distribution feeders, one of which is a normally open backup.

The Wayatinah supply area and 22 kV feeders are shown in Figure 8-7 and Figure 8-8 below.

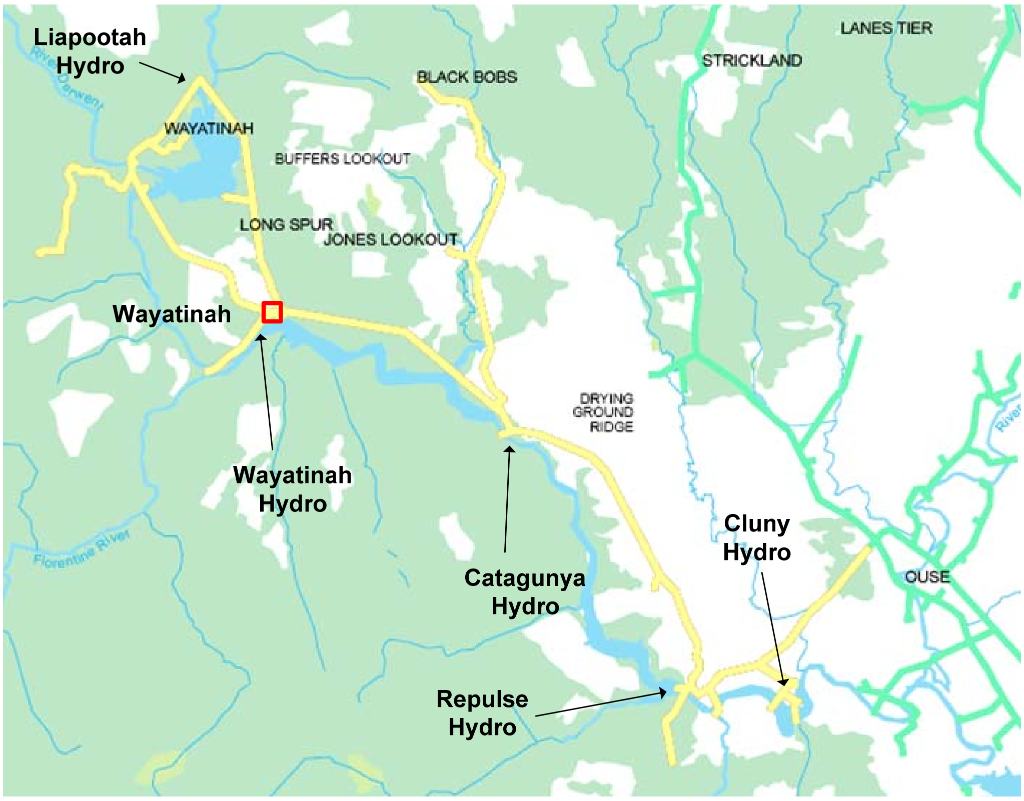

Figure 8-7 Wayatinah 22 kV supply area

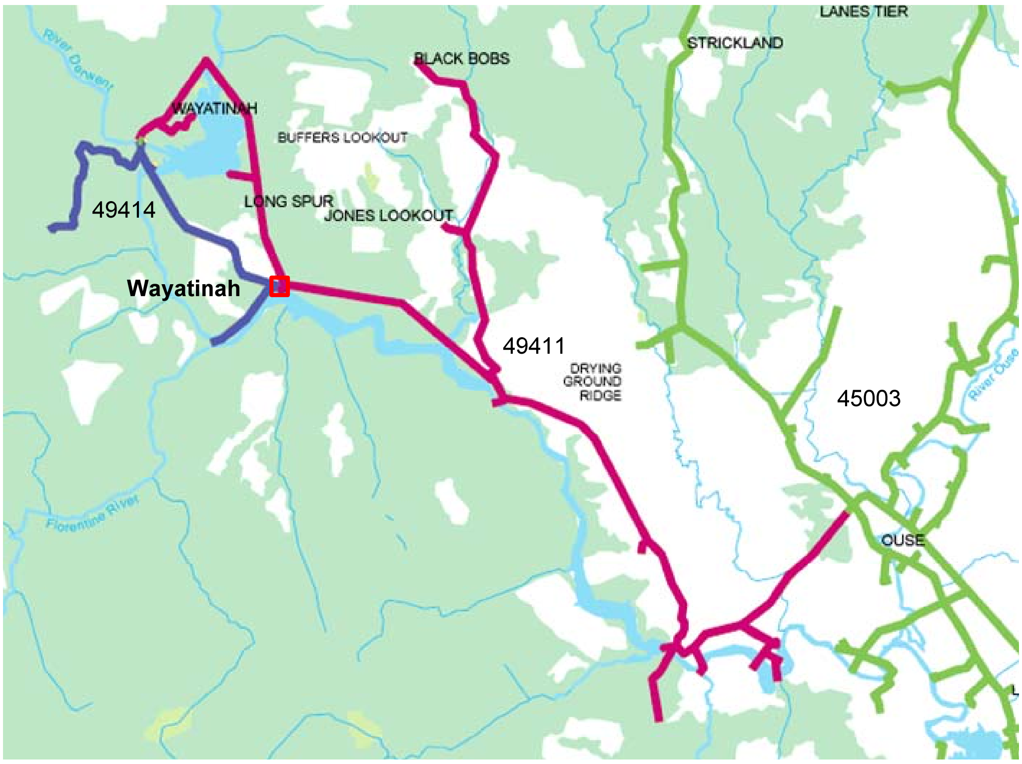

Figure 8-8 Wayatinah 22 kV feeders

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

Table 8-1 Wayatinah substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
49411	0.3	0.3	0.3	0.4	0.4	0.4
49414	0.9	0.9	0.9	0.9	1.0	1.0

As outlined above, no feeders are forecast to exceed the 10 MVA planning rating by 2017.

There is currently no transfer capacity from Wayatinah to Meadowbank, however this is expected to change with the installation of a voltage regulator prior to 2012.

8.5.2 Proposed projects

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

8.5.3 Ultimate configuration

Substation

Wayatinah is expected to remain a single 110/22 kV transformer substation up to 2050, as the backup supply from Meadowbank will provide sufficient backup for the foreseeable future.

The transformer at Wayatinah is to be installed in 2009/10, so it not expected to reach end of life by 2050.

Feeders

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

Due to the low load growth in the area, and the backup supply provided by Meadowbank, the Wayatinah feeder network is not expected to require augmentation for the foreseeable future.

8.6 Meadowbank substation

Meadowbank terminal substation supplies the townships of Gretna, Hamilton, Ouse, Bothwell and east to Oatlands, as well as providing 22 kV supply to the Meadowbank Hydro power station.

8.6.1 Limitations

Using the medium growth forecast, Meadowbank substation load is forecast to grow from 4.2 MVA in 2012 to 4.7 MVA in 2017. There is currently no firm capacity at Meadowbank, however there are adequate 22 kV load transfers available to Sorell and Wayatinah to supply the majority of Meadowbank load for the period of study. The five year load forecast for Meadowbank substation is given in Figure 8-9.

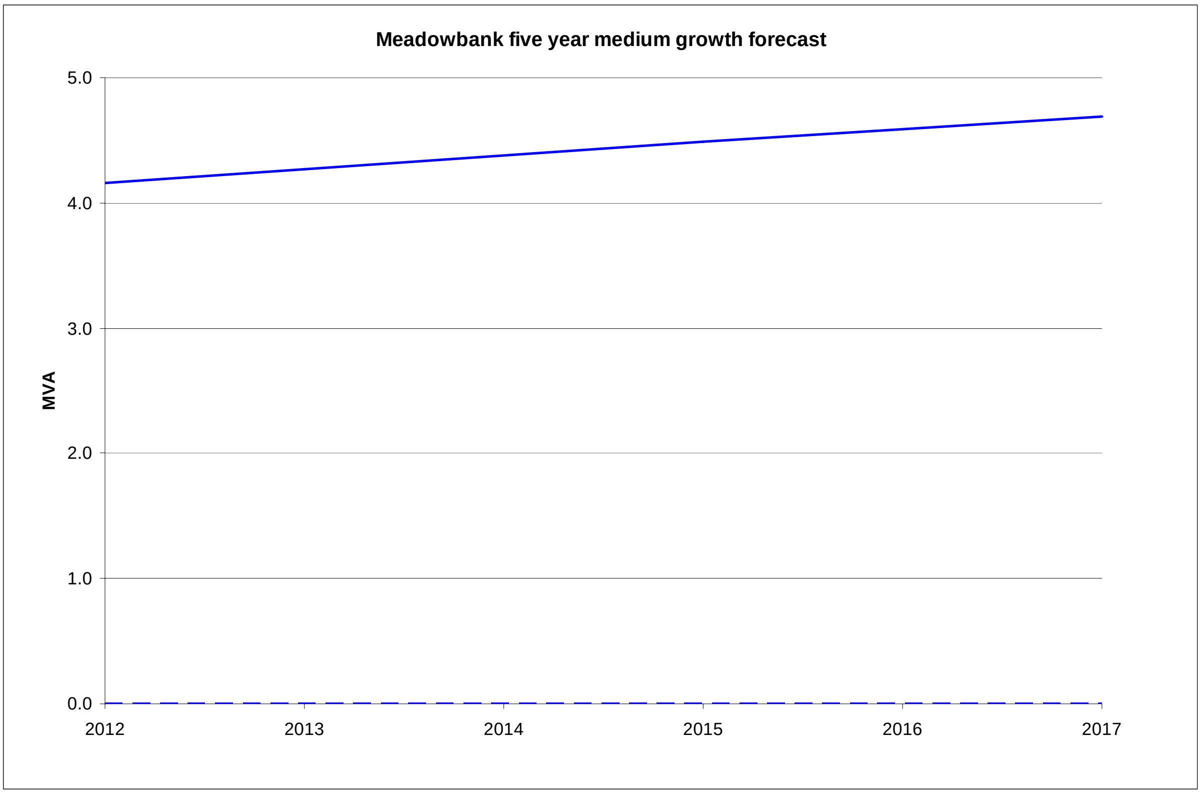

Figure 8-9 Meadowbank five year medium growth forecast

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

The Meadowbank supply area and 22 kV feeders are shown in Figure 8-10 and Figure 8-11 below.

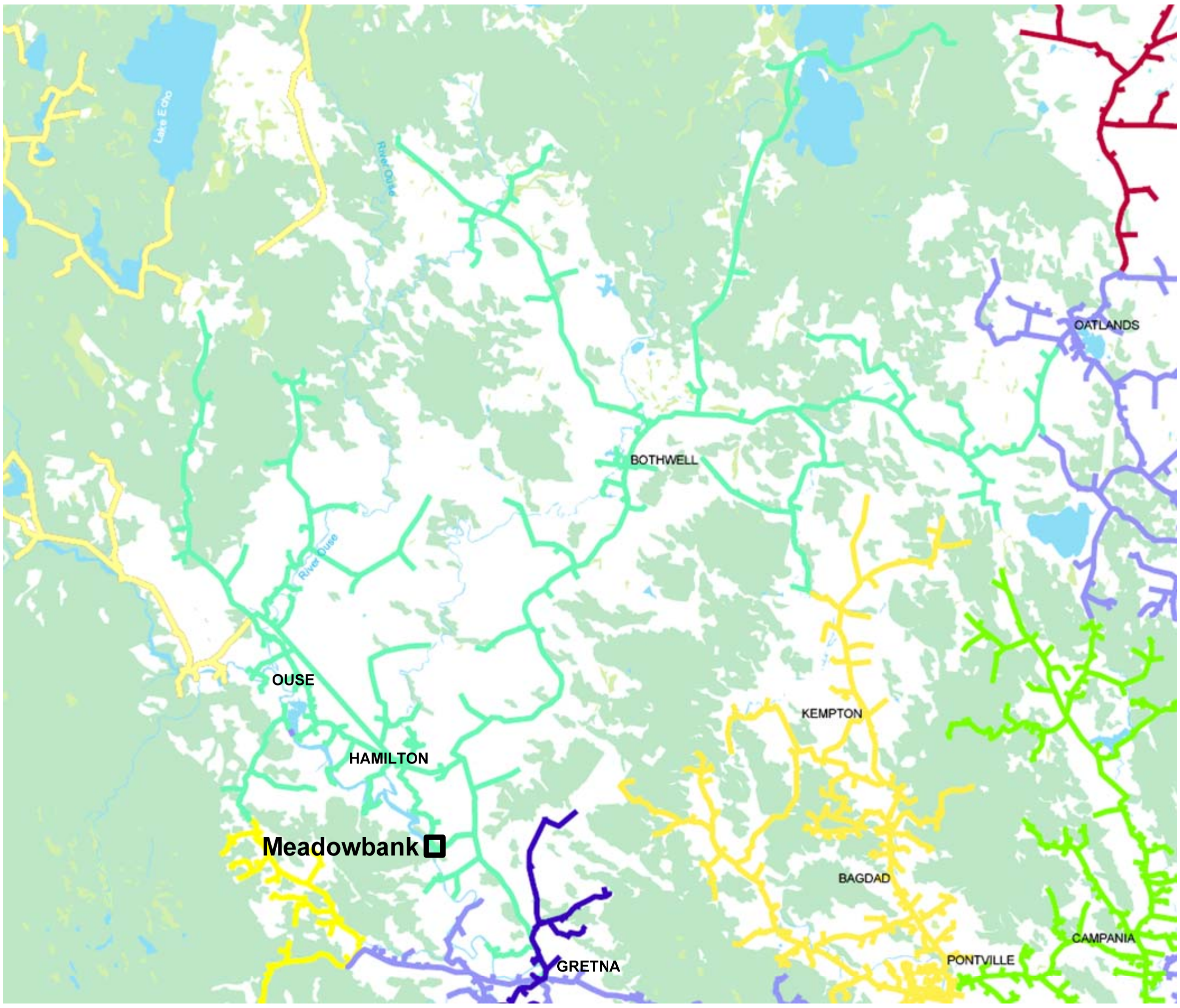

Figure 8-10 Meadowbank 22 kV supply area

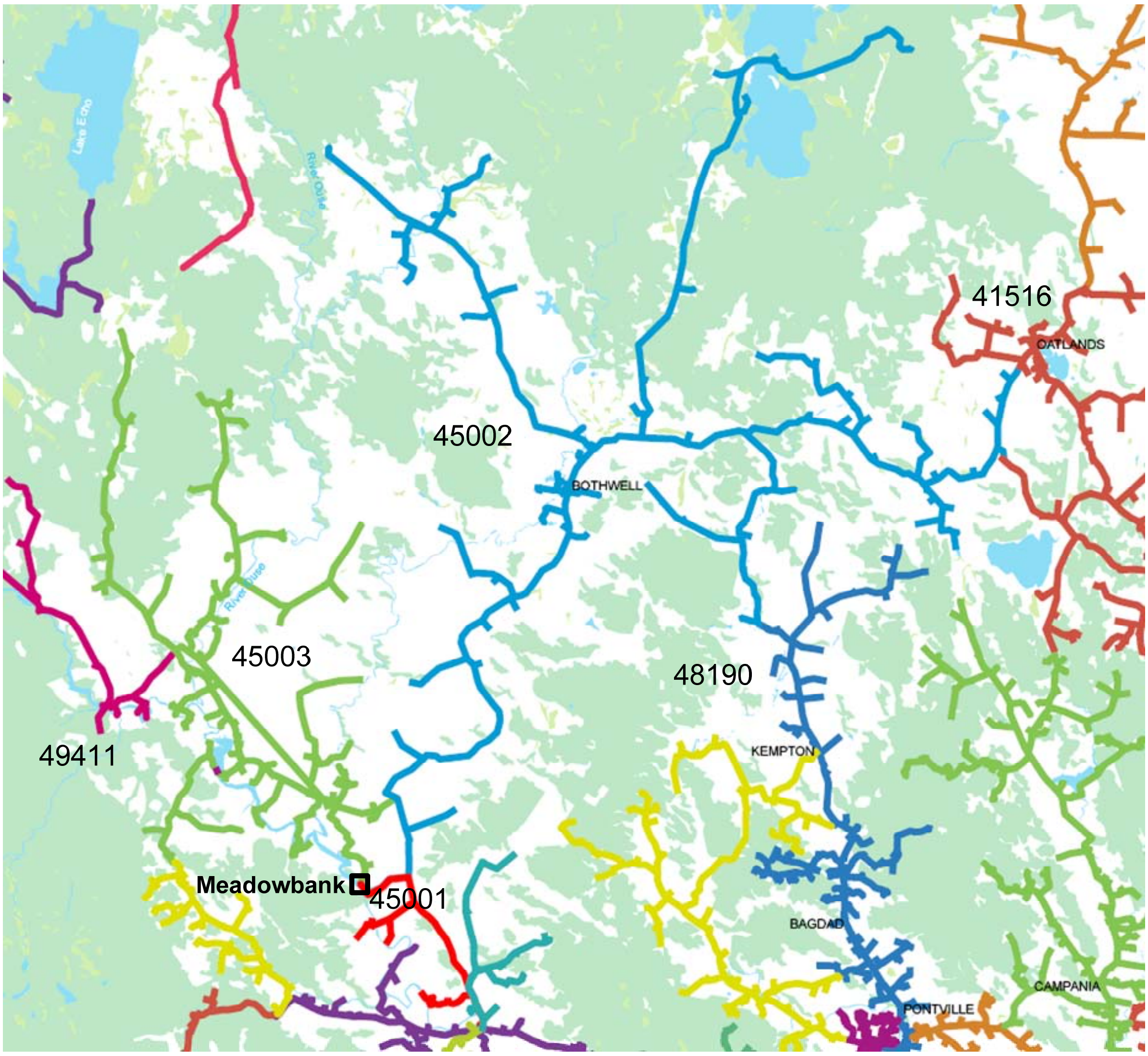

Figure 8-11 Meadowbank 22 kV feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-2.

Table 8-2 Meadowbank substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
45001	1.8	1.9	1.9	2.0	2.0	2.1
45002	1.7	1.8	1.8	1.9	1.9	1.9
45003	3.3	3.4	3.5	3.6	3.7	3.8

As outlined above, no feeders are forecast to exceed the 10 MVA planning rating by 2017.

The available transfer capacity from Meadowbank substation to Wayatinah substation is outlined in Table 8-3.

Table 8-3 Meadowbank substation transfer capability

Substation	Feeder	2012 Transfer (MVA)	2013 Transfer (MVA)	2014 Transfer (MVA)	2015 Transfer (MVA)	2016 Transfer (MVA)	2017 Transfer (MVA)
Wayatinah		1.9	1.9	1.9	1.8	1.8	1.8
Total transfers	**-**	**1.9**	**1.9**	**1.9**	**1.8**	**1.8**	**1.8**

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

8.6.2 Proposed projects

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

8.6.3 Ultimate configuration

Substation

The long term plan proposes the installation of a second 110/22 kV transformer at Meadowbank in 2023, and the installation of radiator fans on both transformers in 2029. The existing transformer was installed in 1997, so is predicted to require replacement around 2047.

Feeders

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

Load on feeder 45002 to Bothwell and Oatlands is expected to increase with the conversion of the 11 kV network around Kempton and Melton Mowbray to 22 kV. However the proposal to extend a second Sorell feeder to the Colebrook will provide an additional source of 22 kV supply in the area. This configuration is expected to be adequate up to 2050.

Feeder 45003 to the north is expected to require reinforcement in the long term, should load growth continue at the current rate. The obvious way to address limitations on this feeder would be to run a new tail to split the existing feeder, as the feeder backbone contains long sections in parallel.

The long term plan proposed that feeder 45001 to the south be used to deload New Norfolk terminal substation in 2023. The installation of voltage regulators may be required to achieve this load transfer.

8.7 New Norfolk terminal substation

New Norfolk terminal substation supplies the northern portion of New Norfolk, as well as the townships of Gretna and Westerway. The substation also provides 22 kV supply to New Norfolk zone substation and the industrial area at Boyer. The Westerway and Gretna zone substations, also currently supplied from New Norfolk terminal substation, are expected to be decommissioned by 2014, with the 11 kV networks to be converted to 22 kV.

8.7.1 Limitations

Using the medium growth forecast, New Norfolk terminal substation load is forecast to grow from 23 MVA in 2012 to 26 MVA in 2017, which is below the substation firm capacity of 30 MVA. The five year load forecast for New Norfolk terminal substation is given in Figure 8-12.

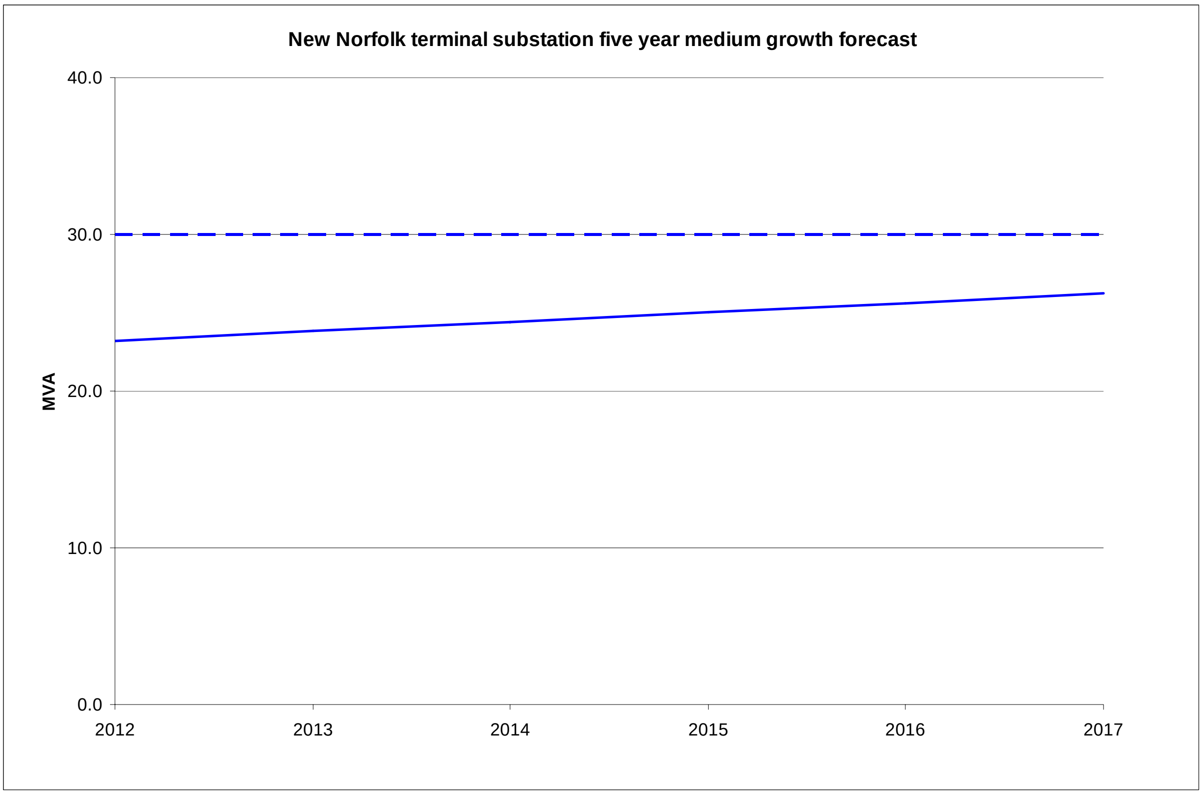

Figure 8-12 New Norfolk terminal substation five year medium growth forecast

The 22 kV network from New Norfolk consists of six distribution feeders, and there are five spare circuit breakers for future feeders.

The New Norfolk supply area and distribution feeders are shown in Figure 8-13 and Figure 8-14 below. Note that these figures are for both the terminal and zone substations at New Norfolk, and show the Gretna and Westerway zone substations which will be decommissioned by 2014.

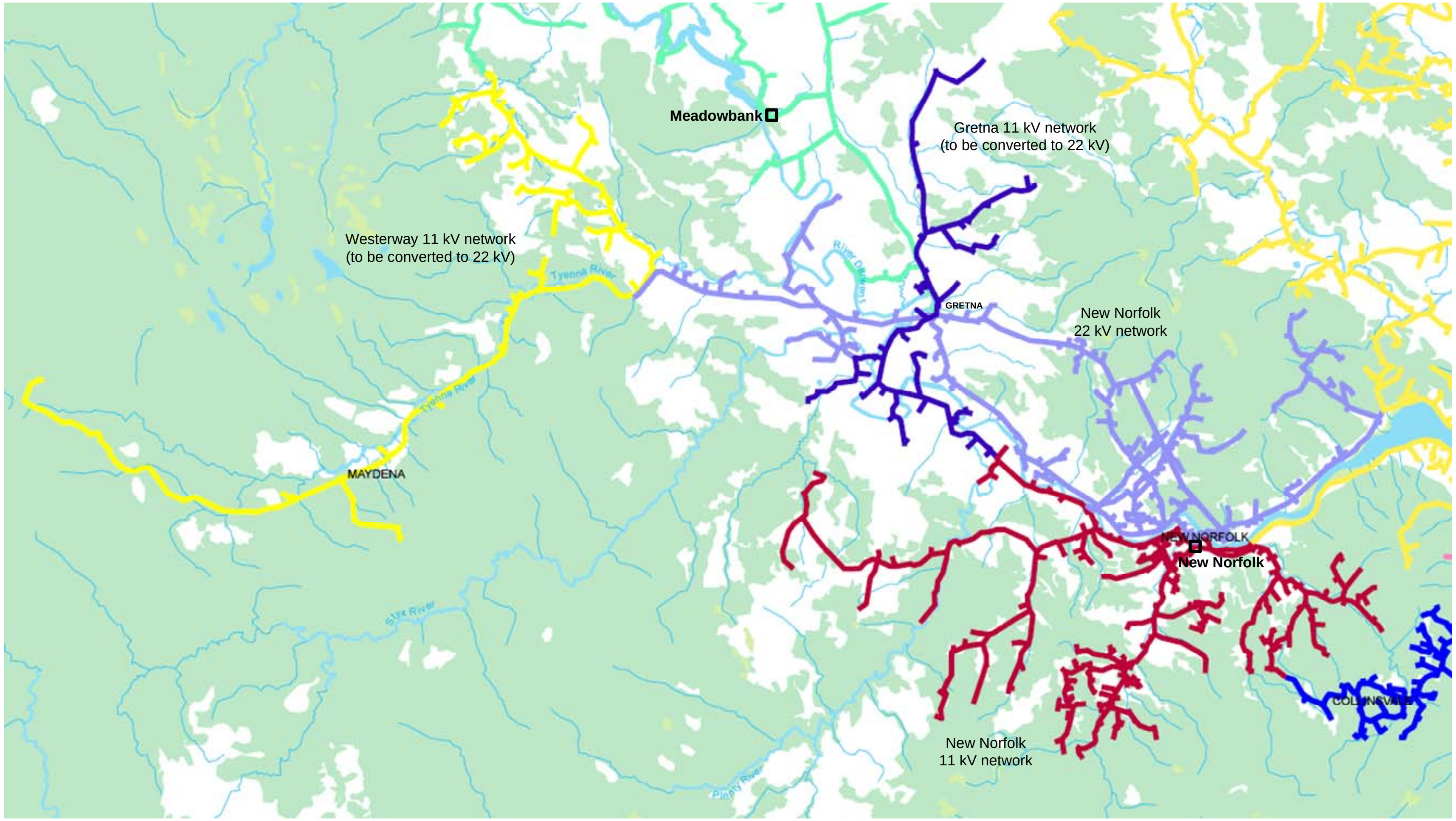

Figure 8-13 New Norfolk supply area

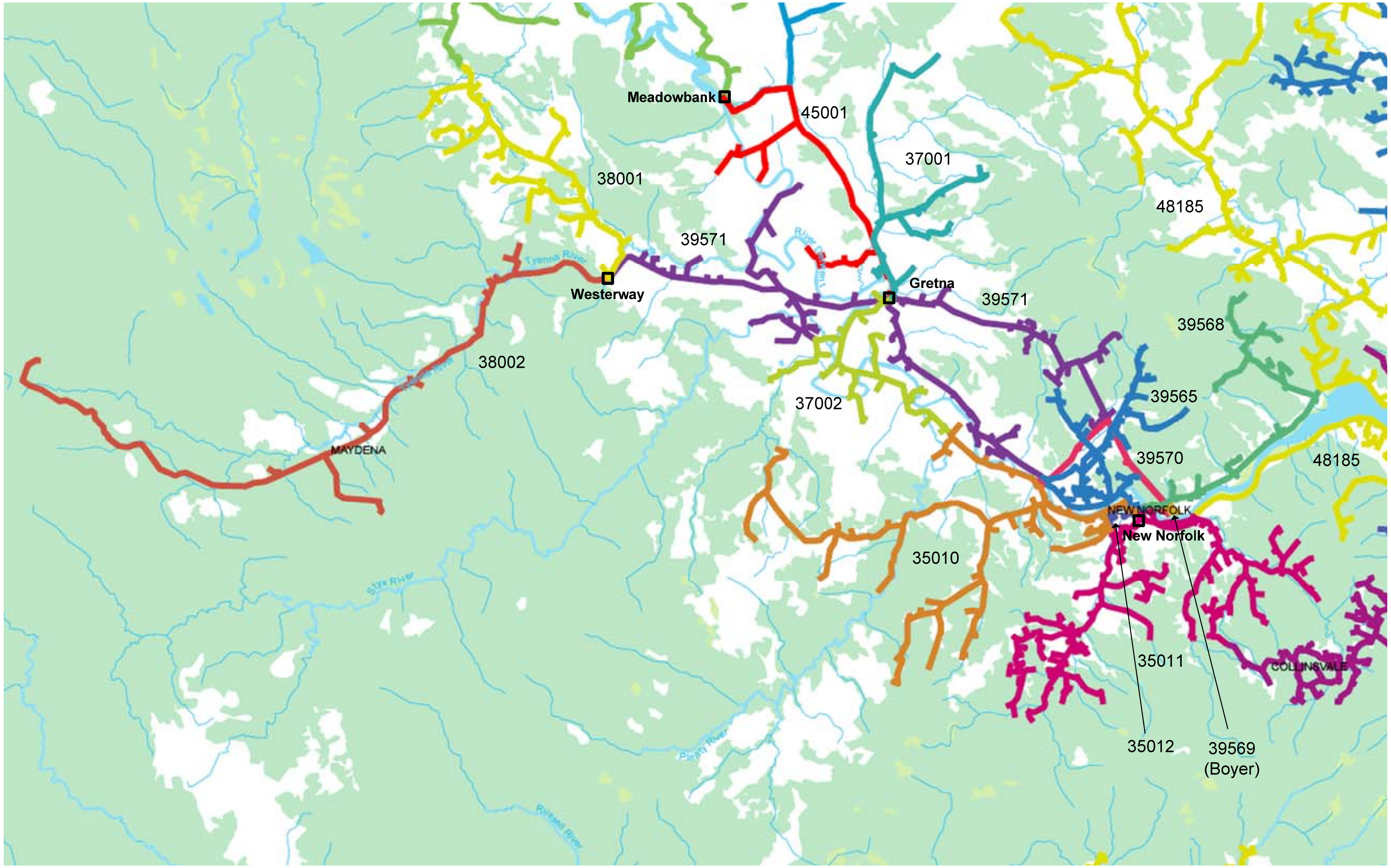

Figure 8-14 New Norfolk feeders

A five year feeder forecast has been developed by applying the substation medium growth rate to the feeder peak loads. The feeder forecast is outlined in Table 8-4.

Table 8-4 New Norfolk terminal substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
39563	8.8	9.1	9.3	9.5	9.8	10.0
39565	5.3	5.4	5.5	5.7	5.8	6.0
39568	2.3	2.4	2.4	2.5	2.6	2.6
39569	0.1	0.1	0.1	0.1	0.1	0.1
39570	6.0	6.1	6.3	6.4	6.6	6.8
39571	4.2	4.3	4.4	4.6	4.7	4.8

As outlined above, feeder 39563 is forecast to reach 10 MVA in 2017. This is not considered a serious limitation, as 39563 is a dedicated cable to New Norfolk zone substation and in the unlikely event of a fault on this short cable New Norfolk zone is adequately backed up by feeder 39565 (although some load may need to be shifted away from 39565 to implement the transfer).

Feeders 39565 and 39570 are dedicated feeders to the mill at Boyer and the Metro Water Board respectively.

Feeder 39571 supplies the zone substations at Gretna and Westerway. The load on this feeder is not expected to be impacted significantly when the zone substations are decommissioned.

There is no available transfer capacity from New Norfolk terminal substation to adjacent substations.

8.7.2 Proposed projects

Cost evaluation for conversion of 11 kV network to 22 kV

As discussed in the long term plan, there are two development options for the New Norfolk area, with the chosen option dependent on the costs involved in converting the 11 kV network to 22 kV. Therefore it is proposed that Aurora carry out a study to determine the costs involved in replacing the New Norfolk 11 kV cables and distribution transformers, as well as reinsulating 11 kV overhead lines to 22 kV. A suggested scope for the conversion is discussed in the long term plan, however detailed analysis may reveal a more efficient development path.

8.7.3 Ultimate configuration

Substation

New Norfolk terminal substation is expected to remain a two transformer substation up to 2050. The long term plan discusses two development options for New Norfolk area, with the chosen option dependent on a more detailed cost evaluation of conversion of the 11 kV network to 22 kV. However the only impact at New Norfolk terminal substation is the size of the transformers to be installed (25 MVA vs 60 MVA).

The transformers at New Norfolk were installed in 1987, so they are predicted to require replacement by 2037. Depending on which development option is chosen, their replacement may need to be brought forward to 2029 to address the firm capacity limitation at the substation.

Feeders

As discussed above, there are no feeder limitations on the New Norfolk 22 kV network up to 2017.

The dedicated feeder to New Norfolk zone substation is expected to be adequate up to 2029, at which time 22 kV supply will no longer be required to the substation. Should growth on the zone substation exceed expectation prior to 2029, it may be necessary to run a new cable to New Norfolk zone substation (approximately 300m). If the 11 to 22 kV conversion option is chosen, it may be beneficial to run a new cable earlier, as multiple 22 kV cables will be needed at the zone to cut over the converted 11 kV feeders. However if the 110/11 kV option is chosen such a cable would be redundant after the upgrade in 2029.

Feeders 39565 and 39571 will eventually experience capacity limitations however it is expected that these can be relieved by running new feeders as necessary to split the existing network.

8.8 New Norfolk zone substation

New Norfolk zone substation supplies the southern portion of New Norfolk and the townships of Glenfern, Lachlan, Molesworth and Glenlusk.

8.8.1 Limitations

Using the medium growth forecast, New Norfolk zone substation load is forecast to grow from 8.8 MVA in 2012 to 10.0 MVA in 2017, which is below the substation firm capacity of 15 MVA (following the installation of the old Sandy Bay transformers in 2010/11). The five year load forecast for New Norfolk zone substation is given in Figure 8-15.

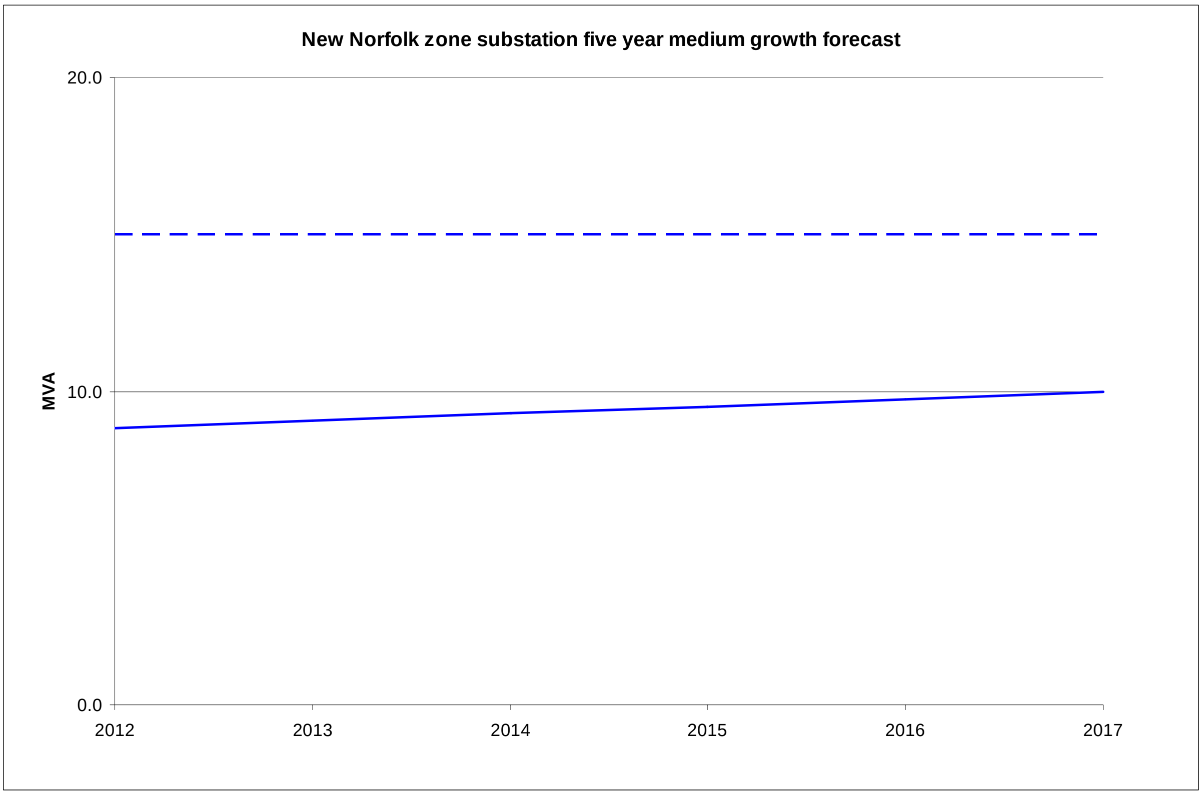

Figure 8-15 New Norfolk zone substation five year medium growth forecast

The 11 kV network from New Norfolk consists of a three distribution feeders, with a fourth proposed for commissioning in 2010. There are no circuit breakers at New Norfolk zone substation, with PMRs used for feeder protection.

The New Norfolk zone substation supply area and distribution feeders are shown in the New Norfolk terminal substation section in Figure 8-13 and Figure 8-14 on pages 39 and 40 respectively.

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

Table 8-5 New Norfolk zone substation feeder forecast

Feeder/s	2012 Load (MVA)	2013 Load (MVA)	2014 Load (MVA)	2015 Load (MVA)	2016 Load (MVA)	2017 Load (MVA)
35010	3.2	3.3	3.3	3.4	3.5	3.6
35011	1.8	1.8	1.9	1.9	2.0	2.0
35012	2.5	2.6	2.7	2.7	2.8	2.9
35013	1.7	1.7	1.8	1.8	1.9	1.9

As outlined above, no feeders are forecast to exceed the 5 MVA planning rating by 2017.

Feeder 35013 above is a new feeder proposed by Aurora to split 35011 in 2010. The loads shown above are the expected loads following this project.

There is no available transfer capacity from New Norfolk zone substation to adjacent substations.

8.8.2 Proposed projects

Cost evaluation for conversion of 11 kV network to 22 kV

As discussed in the long term plan, there are two development options for the New Norfolk area, with the chosen option dependent on the costs involved in converting the 11 kV network to 22 kV. Therefore it is proposed that Aurora carry out a study to determine the costs involved in replacing the New Norfolk 11 kV cables and distribution transformers, as well as reinsulating 11 kV overhead lines to 22 kV. A suggested scope for the conversion is discussed in the long term plan, however detailed analysis may reveal a more efficient development path.

8.8.3 Ultimate configuration

Substation

The transformers at New Norfolk zone substation are to be replaced with 15 MVA units which are already 40 years old, and it is uncertain how many years of useful operation may be obtained. The long term plan proposes the next stage of works at New Norfolk zone substation to be in 2029, however this may need to be brought forward based on the condition of the transformers.

The long term plan discusses two development options for New Norfolk zone substation. The first is the decommissioning of the zone substation and conversion of the 11 kV network to 22 kV, with the option being the conversion of the zone substation into a 110/11 kV terminal substation.

Feeders

As discussed above, there are no feeder limitations on the New Norfolk 11 kV network up to 2017.

Feeder 35010 is the only feeder expected to experience capacity limitations in the near future (around 2030 and possibly later if load can be transferred to adjacent feeders). This limitation would be addressed by the conversion of the 11 kV network to 22 kV (proposed for 2029 in the long term plan), however if the network remains at 11 kV a new feeder may need to be run to deload 35010 at this time.

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	Convert New Norfolk 11 kV network to 22 kV and decommission New Norfolk zone substation	6.2
2	Replace Tod's Corner 22/6.6 kV transformers	7.1.2

Convert New Norfolk 11 kV network to 22 kV and decomission New Norfolk zone substation NPV analysis (Central area)

Base Year
2010

OPTION 1
Convert New Norfolk 11 kV network to 22 kV

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%
2029	2020	2035	New Norfolk terminal substation firm capacity	11 kV network to 22 kV: - Establish 22 kV ties (5km + 2km) - Convert 11 to 22 kV ~ 150 transformers - Reinsulate to 22 kV 80 km - 2 x autotransformer substations - 2 x 22 kV CBs at New Nofolk terminal - 2 x 22 kV feeders (200m)	$5,850	$2.06	$1.72	$1.44	$3.38	$3.08	$2.80	$1.48	$1.17	$0.93
2029	2028	2030	New Norfolk terminal substation transformer end of life	Replace transformers with 2 x 60 MVA	$6,000	$2.12	$1.77	$1.48	$2.23	$1.89	$1.59	$2.00	$1.66	$1.38
					Total	**$4.18**	**$3.49**	**$2.93**	**$5.61**	**$4.96**	**$4.40**	**$3.49**	**$2.83**	**$2.30**

OPTION 2
Establish New Norfolk 110/11 kV 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%
2029	2020	2035	New Norfolk terminal substation firm capacity	Establish New Norfolk 110/11 kV substation - 2 x 25 MVA transformers - tee off existing 110 kV lines - use existing 11 kV switchboard	$9,000	$3.17	$2.65	$2.22	$5.20	$4.73	$4.31	$2.28	$1.80	$1.43
2037	2030	2050	New Norfolk terminal substation transformer end of life	Replace transformers with 2 x 25 MVA	$5,000	$1.14	$0.88	$0.68	$1.67	$1.38	$1.15	$0.56	$0.38	$0.26
					Total	**$4.31**	**$3.53**	**$2.91**	**$6.87**	**$6.11**	**$5.46**	**$2.84**	**$2.19**	**$1.69**

Replace Tod's Corner transformers NPV analysis (Central area)

Base Year

2010

OPTION 1

Replace Tod's Corner transformers

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Tod's Corner Ageing 6.6/22 kV transformers	Replace transformers: - Decommission existing site $50k - 2 x 2 MVA 6.6/22 kV transformers (1 for spares) $100k - Site civil works (transformer bunding, foundation, earth grid, fence etc) $50k - Labour costs (installation, testing, commisisoning) $50k	$250	$0.14	$0.13	$0.12	$0.15	$0.14	$0.13	$0.14	$0.12	$0.11
					Total	$0.14	$0.13	$0.12	$0.15	$0.14	$0.13	$0.14	$0.12	$0.11

OPTION 2

Replace Tod's Corner transformers and upgrade 6.6 kV feeder

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Tod's Corner Ageing 6.6/22 kV transformers	Replace transformers and convert 6.6 to 22 kV: - Decommission existing site $50k - 2 x 2 MVA 6.6/22 kV transformers (1 for spares) $100k - Site civil works (transformer bunding, foundation, earth grid, fence etc) $50k - Labour costs (installation, testing, commisisoning) $50k - 100 m 22 kV overhead $10k - Convert 5 km 6.6 kV to 22 kV $125k	$385	$0.22	$0.20	$0.18	$0.23	$0.22	$0.20	$0.21	$0.19	$0.17
					Total	$0.22	$0.20	$0.18	$0.23	$0.22	$0.20	$0.21	$0.19	$0.17

OPTION 3

Recover Tod's Corner transformers

Development Year			System Limitation	Description of Works		Medium Growth Net Present Value in $ M			High Growth Net Present Value in $ M			Low Growth Net Present Value in $ M		
Medium	High	Low			Cost $k	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%	5.64%	6.64%	7.64%
2020	2019	2021	Tod's Corner Ageing 6.6/22 kV transformers	Decomission Tod's Corner and upgrade Arthurs Lake transformer: - Decommission existing site $50k - 2 x 2 MVA 6.6/22 kV transformers (1 for spares) $100k - Site civil works (transformer bunding, foundation, earth grid, fence etc) $50k - Labour costs (installation, testing, commisisoning) $50k	$250	$0.14	$0.13	$0.12	$0.15	$0.14	$0.13	$0.14	$0.12	$0.11
2020	2019	2021	Backup from Arthurs Lake limited by 3/2.75 GI conductor	Reconductor 6km 3/2.75 GI	$600	$0.35	$0.32	$0.29	$0.37	$0.34	$0.31	$0.33	$0.30	$0.27
					Total	$0.49	$0.45	$0.41	$0.52	$0.48	$0.44	$0.46	$0.42	$0.38

Appendix C
Glossary

Appendix C – 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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