Sorell / Peninsula 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 Sorell/Peninsula recommends the establishment of substations at Dunalley and Dodges Ferry. Two alternative development paths are discussed in the plan, with extension of the 110 kV network and 110/22 kV substations compared with the establishment of a 66 kV subtransmission network and 66/22 kV zone substations. NPV analysis indicates that the costs are equivalent within the margin of error of the study, however the 66 kV development option is ultimately recommended as it is considered the technically superior option.

There are no projects in the ten year plan for Sorell/Peninsula.

The five year plan for Sorell/Peninsula examines the distribution network of the Sorell terminal substation and the impact of the proposed conversion of Richmond zone substation to 33/11 kV. The only proposed distribution feeder works in the area are the conversion of portions of feeder 41512 to 11 kV as part of the Richmond upgrade.

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 / Peninsula area strategic plan**
8	East Coast area strategic plan
9	North East area strategic plan
10	Central area strategic plan
11	West Coast area strategic plan

1. Introduction

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

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

1.1 Background

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

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

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

1.2 Methodology

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

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

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

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

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

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

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

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

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

1.3 Assumptions

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

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

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

2. Area background

The Sorell-Peninsula planning area covers the South-East of Tasmania, including the Dodges Ferry, Forestier Peninsula, Midway Point, Sorell, and Tasman Peninsula areas.

Figure 10-1 provides a geographic view of the area under study.

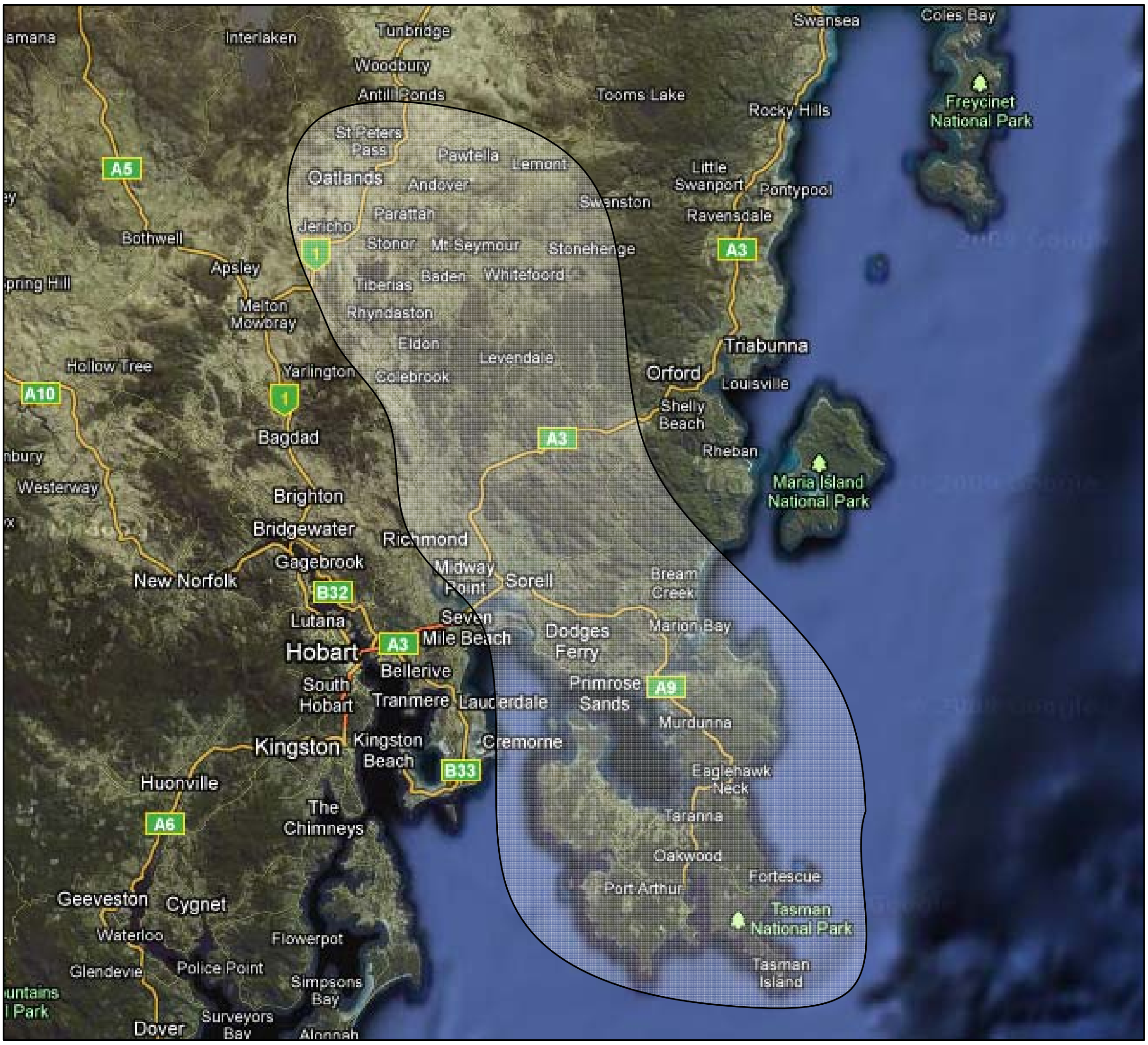


Figure 2-1 Sorell / Peninsula planning area geographical view

Sorell-Peninsula is considered a medium growth area, with a growth rate of 2-3% pa. In particular, significant urban development has taken place in the southern beaches around Frederick Henry bay, and growth is expected to continue. Areas of the Forestier and Tasman peninsulas have strong tourism and fishing industries.

The remainder of the planning area consists predominantly of rural-residential load.

2.1 Existing infrastructure

The substations within the Sorell-Peninsula planning area are listed in Table 2-1.

Table 2-1 Terminal substations in the Sorell-Peninsula planning area

Substation	Number of transformers	Transformer MVA	Transformer primary voltage	Transformer secondary voltage	Number of feeders
Sorell	2	22.5 MVA	110 kV	22 kV	8 distribution

As outlined above, Sorell terminal substation is the only substation within the Sorell-Peninsula planning area. Distribution within this planning area is at 22 kV. This differs from the neighbouring Hobart-East planning area whose distribution voltage is 11 kV, which prevents load transfer between substations in the Sorell-Peninsula and Hobart-East areas.

Sorell also supplies Aurora's Richmond 22/11 kV zone substation (part of the Hobart East planning area)

2.2 Council areas and restrictions

The Sorell-Peninsula planning area includes the Sorell and Tasman councils.

Sorell Council

The Sorell Council strategic plan indicates that the Sorell Council intends to manage residential and commercial growth within existing land use zones. The Vision East Consultation Report 2009 lists the town of Dunalley as an area appropriate for future growth and development.

Tasman Council

The strategic plan 2004-2014 indicates that the Tasman Council is focussed on maintaining and preserving the heritage of the area, and protection and regulation of the environment. The Vision East Consultation Report 2009 lists the towns of Nubeena, Port Arthur, Murdunna and Taranna as areas appropriate for future growth and development.

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.

Sorell terminal substation upgrade

The load on Sorell terminal substation currently exceeds its N-1 rating. Transend are committed to upgrading the existing 2 x 22.5 MVA 110/22 kV transformers to 2 x 60 MVA units in 2011.

Distribution feeder works

- Extension of 22 kV feeder 41518 from Sorell terminal substation to Lewisham 2009 to deload the existing Sorell 22 kV feeder 41517
- Reliability (TRIP) programs to be undertaken in 2009/10 in the Lewisham, Dodges Ferry, Primrose Sands and Forestier Peninsula areas
- Voltage support for peninsula feeders 41514 and 41515 (regulator upgrades and HV capacitor bank installation) in 2009/10
- Loop automation on sections of 22 kV feeders within the Tasman and Forestier Peninsula in 2009/10

3. Load forecast

Sorell terminal substation has experienced 2-3% growth per year over the last several years, and the Sorell region is considered one of the growth hotspots in the state.

The majority of the load growth is due to residential development at the southern beaches townships of Lewisham, Dodges Ferry, Carlton and Primrose Sands. This is expected to continue as infrastructure investment continues in the region.

Sorell terminal substation also supplies to the urban areas of Sorell and Midway point, and rural areas to the east and north of Sorell and on the Forestier and Tasman peninsulas to the south. It also supplies Aurora's Richmond zone substation, which in turn supplies the Richmond township and rural load north up to Colebrook. Load growth above the long term average at Sorell substation is considered unlikely in these areas.

As a result, to produce a conservative load forecast high growth has been applied at the southern beaches, while median growth rate has been applied at the remainder of the Sorell substation supply area.

The resulting 38 year load forecast and firm ratings for Sorell terminal substation are provided below.

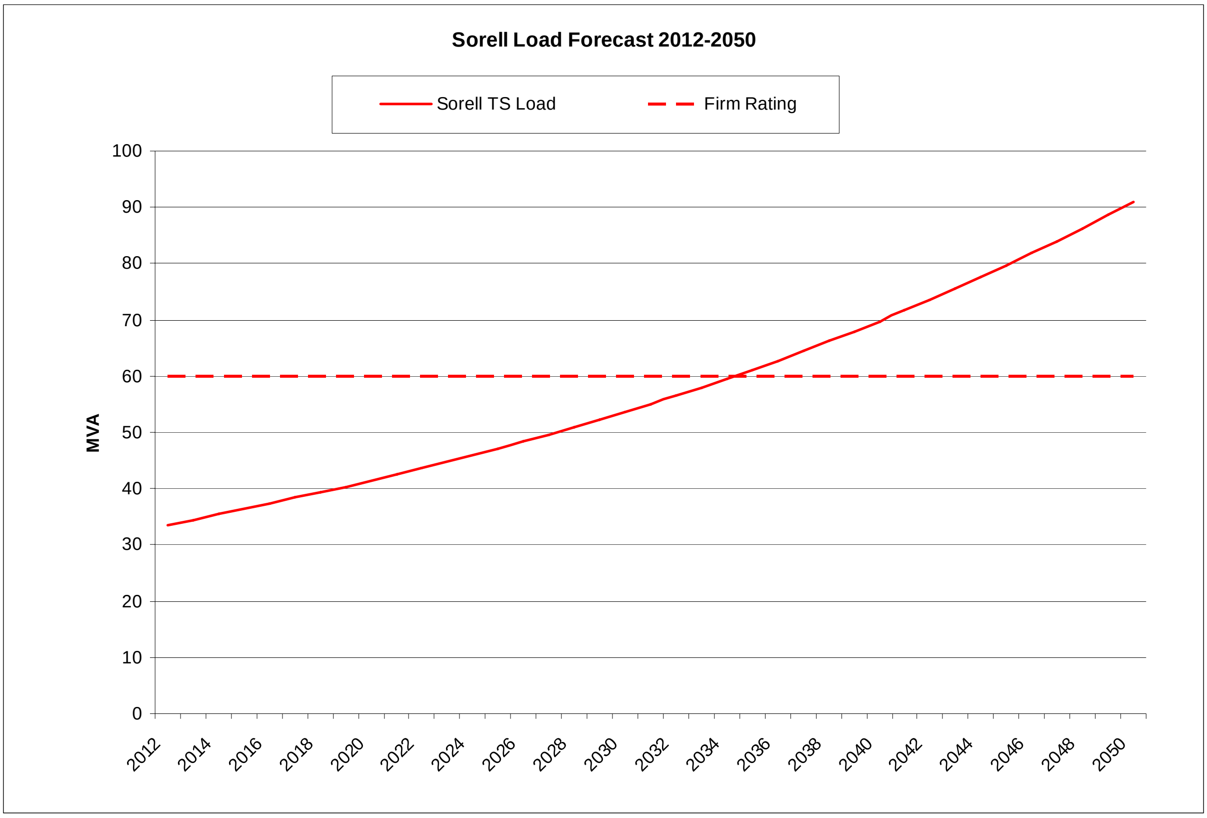


Figure 3-1 Sorell / Peninsula existing load forecast 2012-2050

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

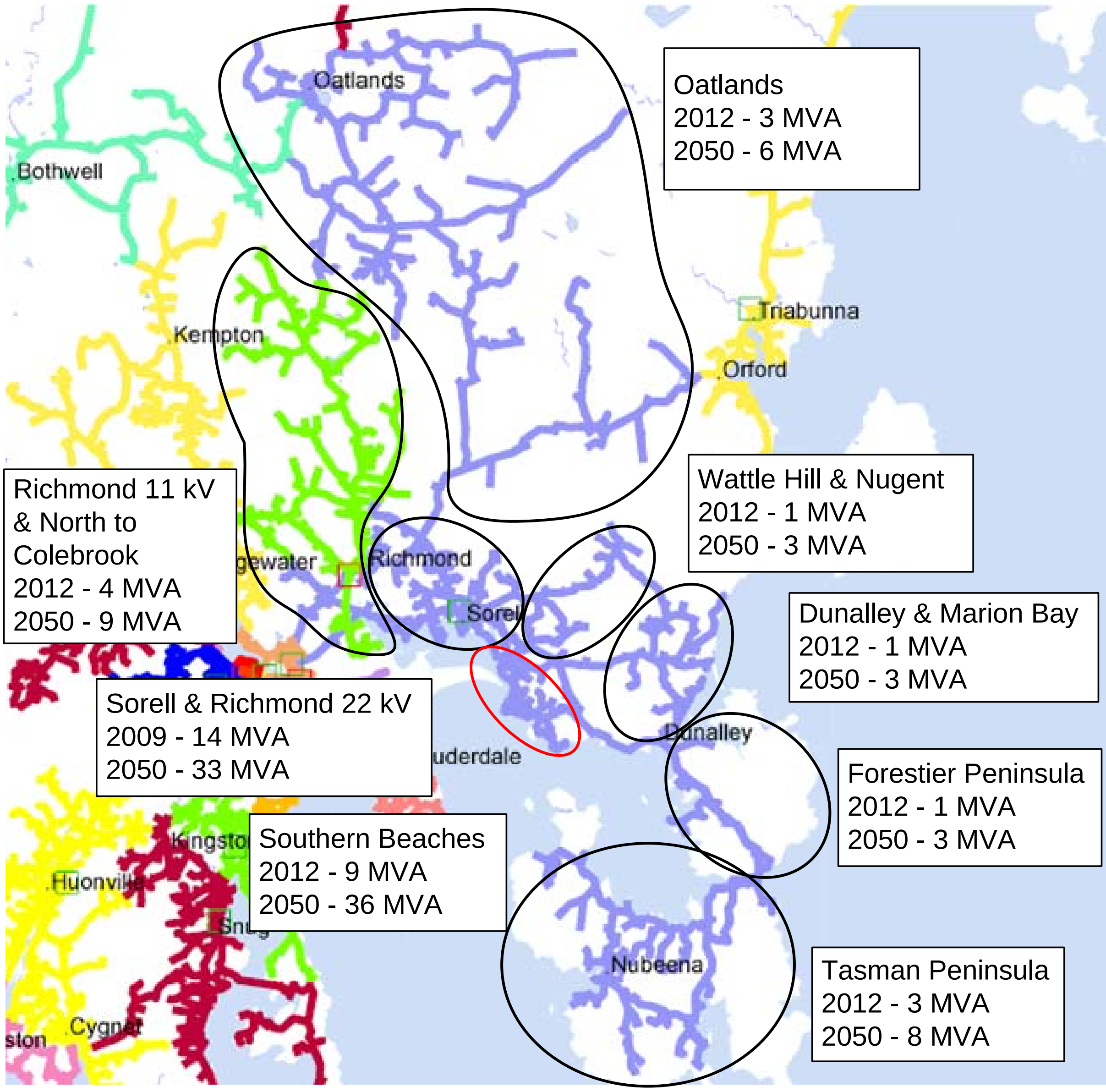


Figure 3-2 Sorell geographic load forecast 2012-2050

4. Limitations

4.1 Sorell terminal substation

Sorell terminal substation is equipped with 2 x 22.5 MVA 110/22 kV transformers, providing 22.5 MVA of firm capacity.

The load at Sorell currently exceeds substation firm capacity by approximately 10 MVA, however the installation of 2 x 60 MVA transformers by Transend in 2011 addresses this limitation until approximately 2035. It should be noted that this assumes the transfer of Richmond zone substation to Lindisfarne prior to 2035 – if Richmond is still supplied from Sorell the capacity limitation occurs in 2030.

4.2 Peninsula feeders voltage and reliability

There are currently voltage drop and reliability issues on the 22 kV feeders to the peninsula. These issues will be addressed somewhat by the Loop Automation, TRIP and voltage regulator projects scheduled over the next several years, however a longer term augmentation solution is likely to be required.

4.3 Oatlands feeder reliability

There are currently reliability issues on 22 kV feeder to Oatlands. There are no projects proposed to address these issues.

5. Planning philosophy

The Sorell/Peninsula planning area consists of areas of medium density load around the townships of Sorell, Richmond, Midway Point and the southern beaches, as well as areas of low density load around Oatlands, Dunalley and the peninsula.

The medium density areas are generally in close proximity to Sorell substation, so it is considered reasonable to continue to supply them from Sorell with 22 kV reinforcement for the scope of the study. The exception to this is the southern beaches area, which will eventually require a dedicated substation should high growth in this area continue.

Of the low density areas, Oatlands is supplied by a single 22 kV feeder with a backbone length of 60 km and the Oatlands area has a forecast load of 2.5 MVA and 6 MVA in 2012 and 2050 respectively. There is also the potential for a small amount of additional 22 kV load due to the conversion of 11 kV feeders to 22 kV in the Colebrook area. Dunalley and the peninsula are supplied by two 22 kV feeders with backbone lengths of 70 km. These areas have a combined forecast load of 6 MVA and 13 MVA in 2012 and 2050 respectively.

Both Oatlands and the peninsula are currently experiencing reliability issues and will ultimately require support in the form of 22 kV reinforcement from existing substations, or new substations in the area. The substation approach is preferred since this would considerably shorten the length of the feeders, providing better voltage regulation and reliability, as well as increased transfer capacity with adjacent substations.

A substation in the Dunalley area is considered a reasonable proposal, since the 2050 load in the Dunalley and peninsula area is forecast to be 13 MVA. Such a substation would effectively shorten the existing peninsula feeders by 30 km, and provide 22 kV support back to the southern beaches area. However it is difficult to justify the expenditure in the Oatlands area for a forecast load of 6-8 MVA in 2050.

Therefore the establishment of a substation in the Dunalley area is recommended, with Oatlands reliability to be addressed by 22 kV reinforcement from Sorell. The Oatlands reinforcement project is discussed further in the Hobart-East section of this report, since it ties in with the plan to convert the Colebrook area 11 kV network to 22 kV.

The introduction of 66 kV injection has been recommended for the Sorell planning area, due to the distance of the proposed Dunalley substation from the existing 110 kV transmission system. Such a solution has a number of benefits, including the lower cost of 66 kV substations and feeders, and the flexibility to establish future zone substations in areas of high load growth. Both the 66 kV and 110 kV options are discussed in the long term plan.

6. Long term strategy

Two paths of development have been considered to address the forecast limitations in the Sorell/Peninsula area. The first involves extension of the existing 110 kV transmission network and the establishment of 110/22 kV substations at Dunalley and in the vicinity of the southern beaches. As part of this option, a second 110 kV line is also ultimately required from Sorell to Triabunna.

The second development path involves the establishment of a 66 kV injection point at Sorell, with 66/22 kV zone substations at Dunalley and in the vicinity of the southern beaches. This allows the ultimate conversion of Triabunna to a 66/22 kV zone substation with the existing 110 kV feeder energised at 66 kV, and the establishment of a new 66 kV feeder. While this option has been chosen as the recommended development path, both development paths are considered in the proposed projects discussed 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 22 kV reinforcement to the peninsula

As discussed below, the establishment of Dunalley substation (either 110/22 kV or 66/22 kV) is proposed to address the peninsula feeder limitations in 2035. It is expected that the existing feeders are sufficient to supply to the peninsula until this time, with the aid of reliability programs and the installation of regulators or PMRs as required.

However, should it be determined that feeder reliability needs to be addressed prior to this date, the most cost effective way to address these limitations would be to run a new 22 kV feeder from Sorell to deload the beginning of feeder 41514. If the 66 kV development path is chosen, this feeder could be built at 66 kV to facilitate the future construction of the Sorell to Dunalley double circuit.

6.1.2 Upgrade Richmond zone substation to 33/11 kV

This project is discussed in the Hobart-East report, but as a result Sorell is deloaded by approximately 4 MVA in 2017.

6.1.3 22 kV reinforcement to Oatlands

This project is discussed in the Hobart-East report, as part of the proposal to convert the 11 kV network in the Colebrook area to 22 kV in 2020.

6.1.4 Establish Lindisfarne-Sorell 110 kV circuit

The load at Sorell and Triabunna is forecast to exceed the ESI 3000MWh limitation in 2025 for a failure of the Lindisfarne to Sorell double circuit. It is assumed that Transend will address this limitation by establishing a new 110 kV feeder from Lindisfarne to Sorell around this time.

It is expected that this project will have no impact on the development option chosen in the Sorell/Peninsula planning area and vice versa, so it will not be considered any further.

6.1.5 Establish Dunalley substation

To address the firm capacity limitation at Sorell terminal substation in 2035 and the expected reliability limitation on the peninsula feeders, it is proposed that a new substation be established in the vicinity of the township of Dunalley, supplied from Sorell terminal substation.

Dunalley substation would cut into existing 22 kV feeders 41514 and 41515 from Sorell to supply the peninsula (7.5 MVA), the Dunalley, Boomer Bay, Copping and Marion Bay area (2 MVA), and partially supply to the southern beaches (5 MVA). The resulting substation would be loaded approximately 15 MVA in 2035.

Following the establishment of Dunalley substation the peninsula feeders would be shortened by 30 km (resulting in approximately 50 km of backbone) and be loaded at less than 4 MVA each.

These works are expected to defer reliability limitations on the peninsula for the scope of the study. Should further reliability issues arise the most cost effective way of addressing this would be to run a new 22 kV feeder from Dunalley to deload the beginning of the two peninsula feeders and extending this feeder as reliability requirements dictate. It should be noted that this feeder may be difficult to construct as the two existing feeders already follow the only main road onto the peninsula. There is the option of an undersea 22 kV cable from Primrose Sands across the bay to the peninsula (4 km), however it is likely that reinforcement via overhead from Dunalley is cheaper.

66 kV option

Under the 66 kV development path Dunalley would be established as a 66/22 kV substation, supplied by a new 66 kV double circuit from Sorell. The 66 kV circuit would be run in the vicinity of the southern beaches to facilitate the future establishment of a zone substation in the area. A new 110/66 kV substation would also be established at Sorell at this time.

110 kV option

Under the 110 kV development path, Dunalley would be established as a 110/22 kV substation, supplied by a new 110 kV double circuit from Sorell (potentially teed off the existing Lindisfarne-Sorell circuits). The 110 kV circuit would be run in the vicinity of the southern beaches to facilitate the future establishment of a terminal substation in the area.

6.1.6 Establish Dodges Ferry substation

Sorell terminal substation is forecast to exceed firm capacity again in 2045. It is expected that the 22 kV network into the area from Sorell and Dunalley substations will also be heavily loaded at this time.

This limitation may be addressed by running additional feeders from Dunalley to the southern beaches, however it is expected that with the length of feeders and the density of load in the southern beaches, a substation in the area would be the preferred solution.

Therefore it is proposed to establish a new substation at Dodges Ferry in 2045. For both the 110 kV and 66 kV development options, the substation would consist of two transformers and be supplied by teeing off the Sorell to Dunalley circuits installed as part of the Dunalley project.

It should be noted that this project is heavily dependent on the load growth in the southern beaches area. Should the forecast load growth fail to eventuate then this project may be deferred beyond 2050.

6.1.7 Replace Triabunna transformers and establish second Sorell-Triabunna circuit

Triabunna is currently supplied from a single 110 kV circuit teeing of the Lindisfarne to Sorell line. The transformers at Triabunna are expected to reach end of life in 2056, with forecast load of around 20 MVA at this time.

It is expected that a second supply into Triabunna will be required in order to address the ESI requirements for the loss of a single item of plant (equivalent to 6.5 MVA continuous unsupplied load for the 2 day line repair time). The timing of these works is unknown and is dependent on load growth in the Triabunna area, as well as the available transfer capacity to Sorell and potentially to a future Swansea substations. For the purposes of this study it is assumed that the second circuit to Triabunna will be required around the same time as the transformer end of life in 2056.

66 kV option

Under the 66 kV development path, the reinforcement would be via a new 66 kV circuit from Sorell substation (approximately 50 km). The existing 110 kV line could then be re-energised at 66 kV, with the 110/22 kV transformers at Triabunna replaced with 66/22 kV units.

110 kV option

Under the 110 kV development path, the reinforcement would be via a new 110 kV circuit from Sorell substation (approximately 50 km).

6.2 Summary of proposed works

A summary of the proposed works from 2012 to 2050 in the Sorell / Peninsula planning area is outlined in Table 6-1.

Table 6-1 Sorell / Peninsula project summary

Year	Proposed Project	Proposed Outcomes
2012-2035	22 kV feeder reinforcement to the peninsula (potentially built at 66 kV)	Address voltage and reliability issues at the peninsula
2017	Upgrade Richmond zone substation to 33/11 kV	Convert sections of 22 kV encroaching on Hobart-East to 11 kV and establish a 33 kV feeder from Lindisfarne
2020	22 kV feeder reinforcement to Oatlands	Address voltage and reliability issues at Oatlands
2025	Establish Lindisfarne-Sorell 110 kV circuit	Address ESI 3000MWh rule for loss of Lindisfarne-Sorell double circuit 110 kV line
2035	Establish Dunalley substation	Deload Sorell and address peninsula feeder voltage drop and reliability
2045	Establish Dodges Ferry substation	Deload Sorell and 22 kV feeders to the southern beaches
2056	Replace Triabunna transformers and establish second Sorell-Triabunna circuit	Replace ageing transformers at Triabunna and provide N-1 security for 110 kV feeder faults

The resulting load forecast curves are shown in Figure 6-1. The forecast curves below are applicable for the 110 kV and 66 kV development paths, as the location and timing of the proposed substations is identical for both.

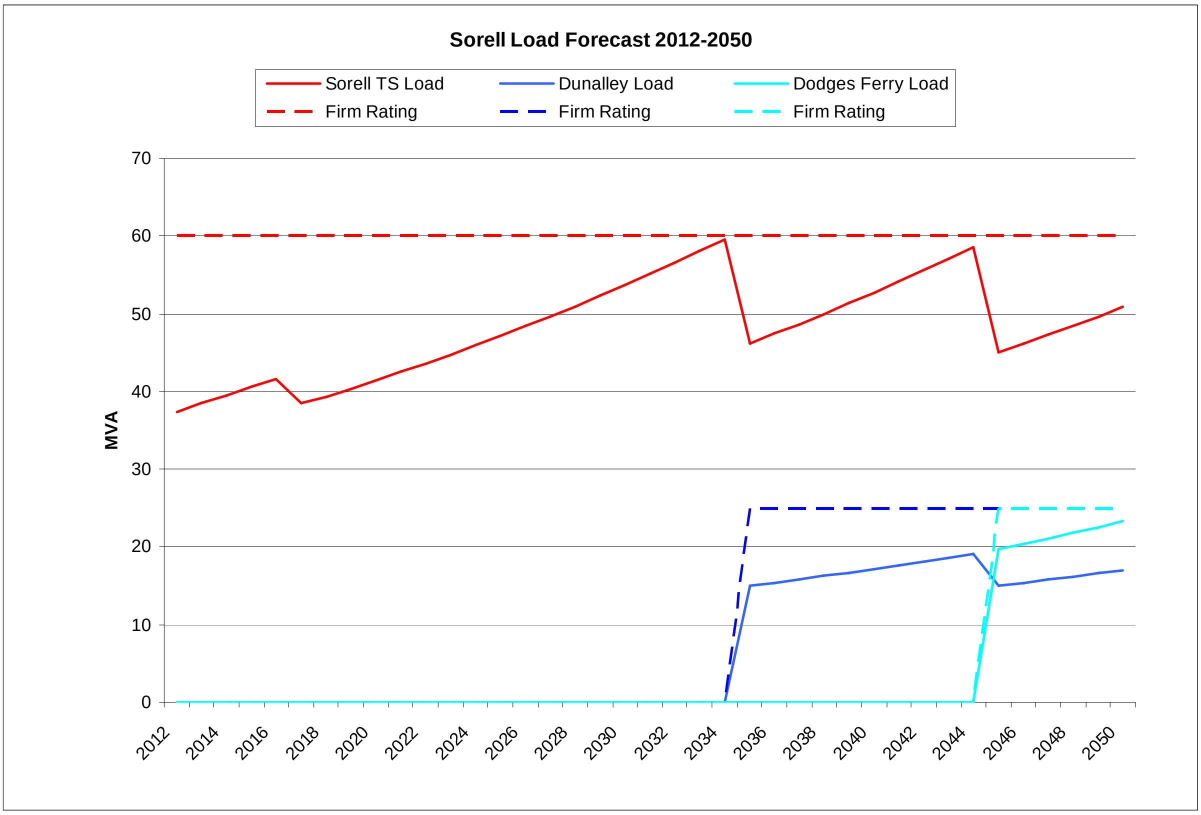


Figure 6-1 Sorell / Peninsula load forecast 2012-2050

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

Table 6-2 Technical comparison of options

Option	Advantages	Disadvantages
66 kV option	• Flexibility to establish zone substations in areas of high load growth • 66 kV circuits are smaller and may be run on wooden poles, thus have less community impact • Provides N-1 security on feeders to Triabunna at a low cost • Ability to stage 66 kV feeders to the peninsula by energising at 22 kV initially • Aurora have ownership of 22 kV CBs, which simplifies operation of the distribution network	• 66 kV is a non-standard voltage level in Tasmania at present (although expected at Roseberry in the near future) • Requires the establishment of a 110/66 kV substation at Sorell • Requires transfer of assets from Transend to Aurora (Triabunna substation)
110 kV option	• Consistent with the Transend 40 year plan • Lower losses than the 66 kV option	

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

Table 6-3 Cost comparison of options

Option	Initial Capital Cost	Total Capital Cost	Net Present Value
66 kV option	34.4	64.1	9.0
110 kV option	37.5	85.3	11.1

As outlined above, the 66 kV option is expected to be the lower cost option. Details of the NPV analysis are given in Appendix B.

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

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

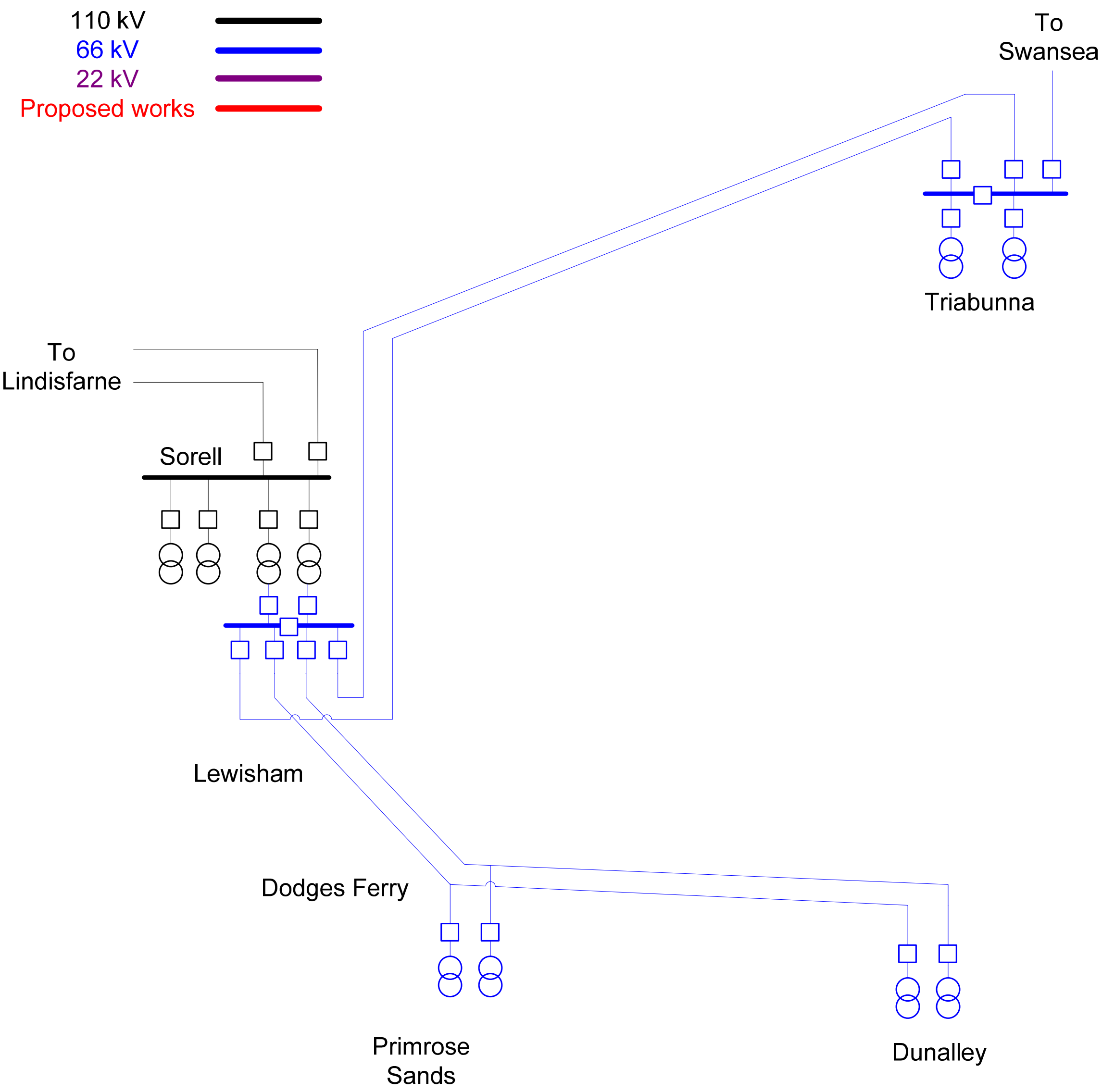


Figure 6-2 Proposed schematic network diagram of the Sorell/Peninsula 66 kV option

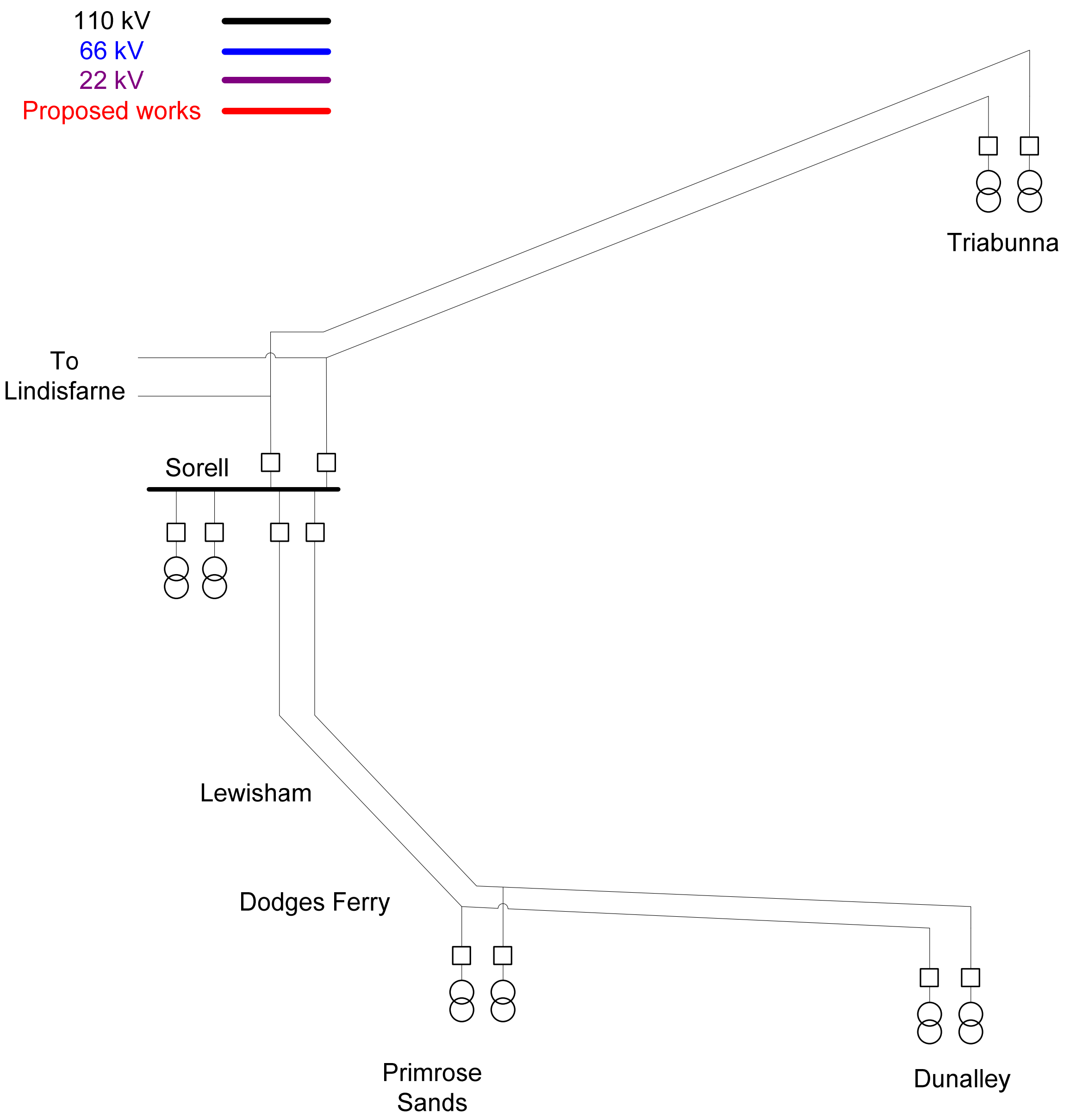


Figure 6-3 Proposed schematic network diagram of the Sorell/Peninsula 110 kV option

7. Ten year plan

There are no projects in the ten year plan for the Sorell/Peninsula area. The upgrade of Richmond substation and 22 kV reinforcement to Oatlands are discussed in the Hobart-East report in the ten year plan.

8. Five year plan

8.1 Sorell substation

Sorell terminal substation supplies a large footprint in the south-east of Tasmania, including the township of Sorell and west to Midway Point, the rural areas north to Oatlands, the southern beaches including Dodges Ferry and Lewisham, and further south to the Dunalley area and the Forestier and Tasman peninsulas.

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).

8.1.1 Limitations

Using the medium growth forecast, Sorell substation load is forecast to grow from 37 MVA in 2012 to 42 MVA in 2017, well below the substation firm capacity of 60 MVA (assuming completion of the Transend project to replace the transformers in 2011). The five year load forecast for Sorell substation is given in Figure 8-1.

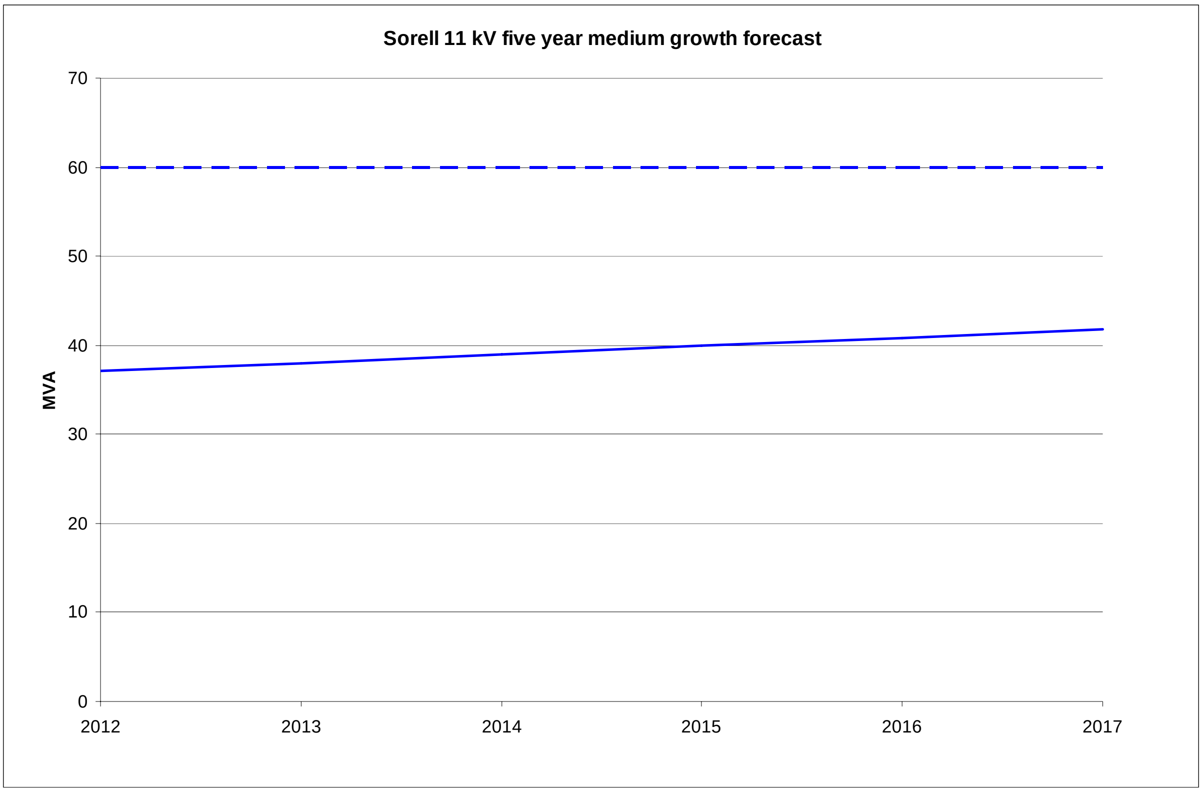


Figure 8-1 Sorell five year medium growth forecast

The 22 kV network from Sorell consists of eight distribution feeders and there are no spare feeder circuit breaker available.

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

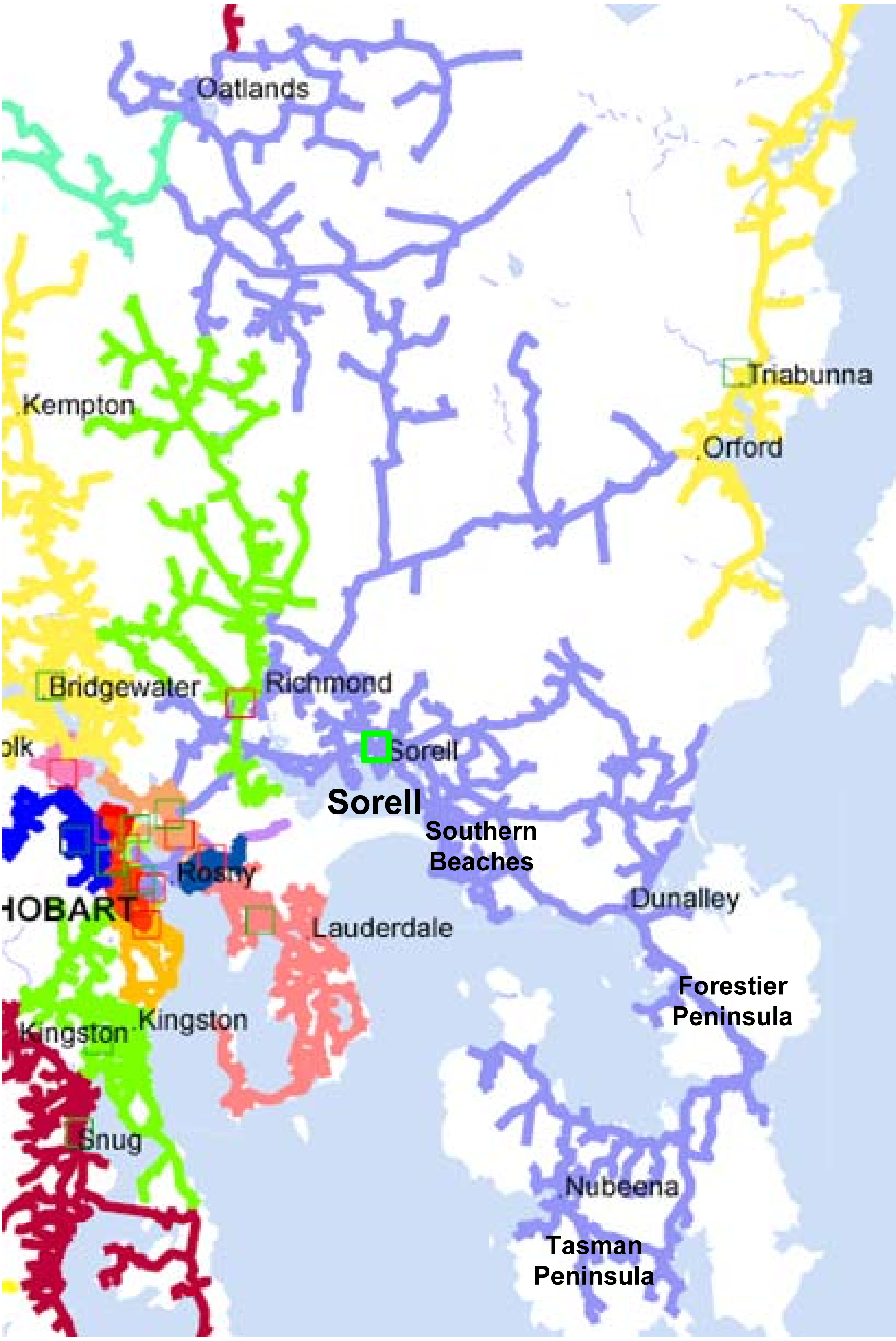


Figure 8-2 **Sorell 22 kV supply area**

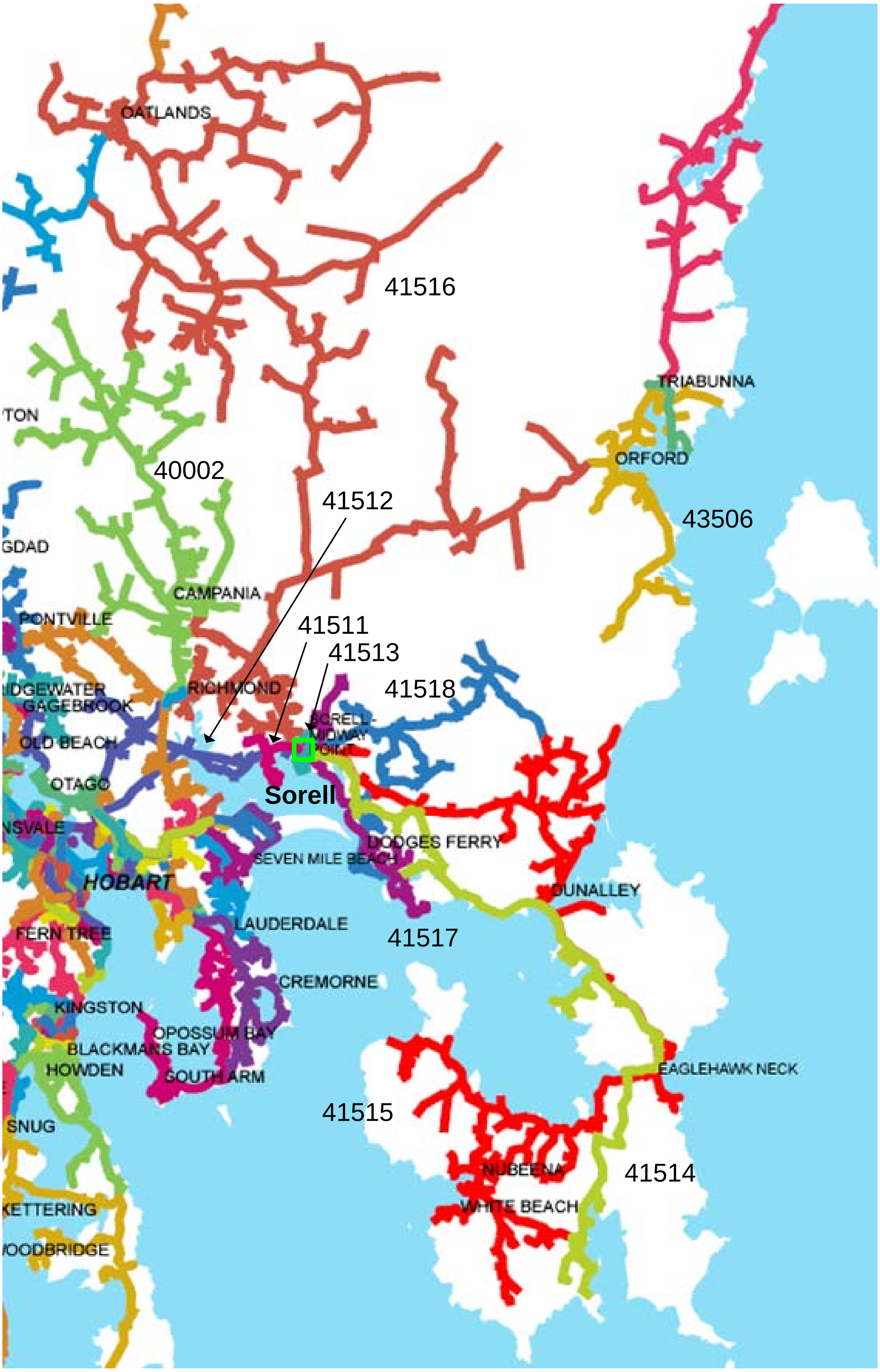


Figure 8-3 Sorell 22 kV feeders

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 Sorell substation feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
41511	3.9	4.0	4.1	4.2	4.3	4.4
41512	5.2	5.4	5.5	5.6	5.8	5.9
41513	5.1	5.2	5.3	5.5	5.6	5.7
41514	2.8	2.9	3.0	3.0	3.1	3.2
41515	4.9	5.0	5.2	5.3	5.4	5.5
41516	4.3	4.5	4.6	4.7	4.8	4.9
41517	3.8	3.9	4.0	4.1	4.2	4.3
41518	3.8	3.9	4.0	4.1	4.2	4.3

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

The available transfer capacity from Sorell substation to the Triabunna and Meadowbank substations is outlined in Table 8-2.

Table 8-2 Sorell substation transfer capability

Substation	Feeder	2012 transfer (MVA)	2013 transfer (MVA)	2014 transfer (MVA)	2015 transfer (MVA)	2016 transfer (MVA)	2017 transfer (MVA)
Triabunna	43506	1.5	1.5	1.5	1.5	1.5	1.5
Meadowbank	45002	1.3	1.3	1.2	1.1	1.1	1.1
Total transfers	-	2.8	2.8	2.7	2.6	2.6	2.6

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

8.1.2 Proposed projects

Upgrade Richmond zone substation to 33/11 kV

This project is discussed in the Hobart-East report, however as a result it is expected that feeder 41512 will be deloaded by approximately 5 MVA (Richmond 11 kV load and portion of 22 kV feeder west of the coal river).

The resulting five year load forecast for Sorell substation is given in Figure 8-4.

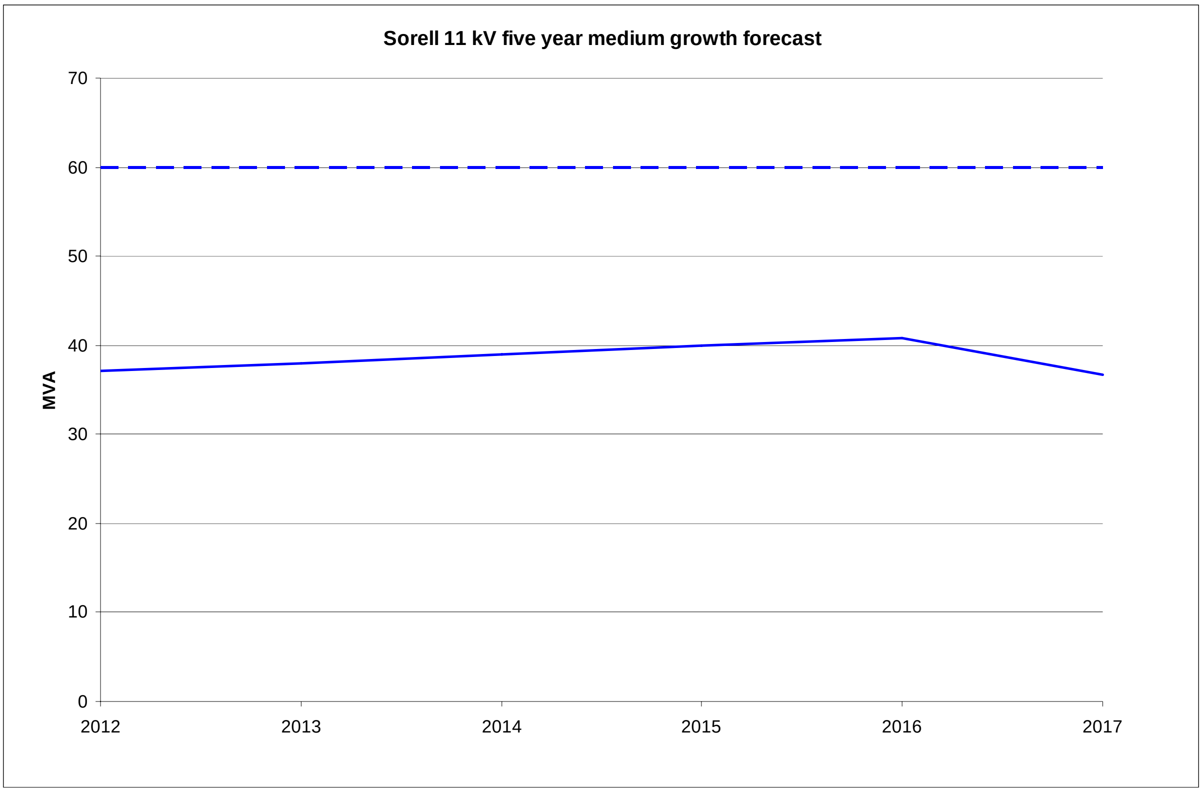


Figure 8-4 Sorell proposed five year medium growth forecast

As outlined above, Sorell load is well below firm capacity for the period of study.

The resulting Sorell feeder loads are shown in Table 8-3.

Table 8-3 Sorell substation proposed feeder forecast

Feeder/s	2012 load (MVA)	2013 load (MVA)	2014 load (MVA)	2015 load (MVA)	2016 load (MVA)	2017 load (MVA)
41512	5.2	5.4	5.5	5.6	5.8	0.9

As outlined above, feeder 41512 is deloaded by the establishment of Richmond 33/11 kV zone substation.

The long term plan proposes the extension of 41512 to split feeder 41516 and supply the northern Richmond 11 kV network after it is converted to 22 kV.

8.1.3 Ultimate configuration

Substation

Sorell is expected to remain a two 110/22 kV transformer substation up to 2050. The transformers at Sorell are not expected to require replacement on condition grounds prior to 2050, however the switchboard will require replacement or extension in order to establish future 22 kV feeders out of the substation.

The long term plan discusses the potential for a 110/66 kV substation at the existing Sorell substation site in 2035. This would comprise of two 110/66 kV transformers and 66 kV switchgear, and would require the establishment of a 110 kV bus.

Should the 66 kV option not proceed at Sorell, it is likely that the 110 kV bus would still ultimately be required to supply future feeders to 110/22 kV substations from Sorell.

Feeders

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

It is expected that the proposal to extend feeder 41512 north to split 41516 will provide adequate supply to the Oatlands area for the scope of the study.

The southern beaches and peninsula area is not expected to require feeder reinforcement in the short term. When future feeders are required, consideration should be given to building the 22 kV feeders at 66 kV to simplify the establishment of future zone substations in the areas.

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	Sorell 66 kV vs 110 kV	6.2

Sorell 66 kV vs 110 kV NPV analysis

Base Year

2010

OPTION 1

Establish Sorell 66 kV injection point and zone substations at Dunalley and Dodges Ferry

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%
2035	**2030**	**2040**	Sorell firm capacity and Peninsula reliability	Establish 66 kV injection at Sorell and zone substation at Dunalley - 2 x 110/66 kV transformers and 66 kV bus - 110 kV bus - 30 km 66 kV DCCT to Dunalley - 2 x 66/22 kV transformer zone substation	$34,400	$8.73	$6.90	$5.46	$11.48	$9.51	$7.89	$6.63	$5.00	$3.78
2045	**2040**	**2050**	Sorell/Dunalley firm capacity	Establish 66 kV zone substation at Dodges Ferry - Tee off Dunalley 66 kV DCCT (assumed 5km) - 2 x 66/22 kV transformer zone substation	$10,650	$1.56	$1.12	$0.81	$2.05	$1.55	$1.17	$1.19	$0.81	$0.56
2056	**2046**	**2066**	Triabunna ESI 25MW rule and transformer end of life (2056)	Establish Triabunna zone substation - 60km 66 kV SCCT - Replace transformers with 66/22 kV units - Energise existing 110 kV line at 66 kV	$19,000	$1.52	$0.99	$0.64	$2.64	$1.88	$1.34	$0.88	$0.52	$0.31
					Total	**$11.81**	**$9.00**	**$6.91**	**$16.17**	**$12.94**	**$10.40**	**$8.70**	**$6.33**	**$4.65**

OPTION 2

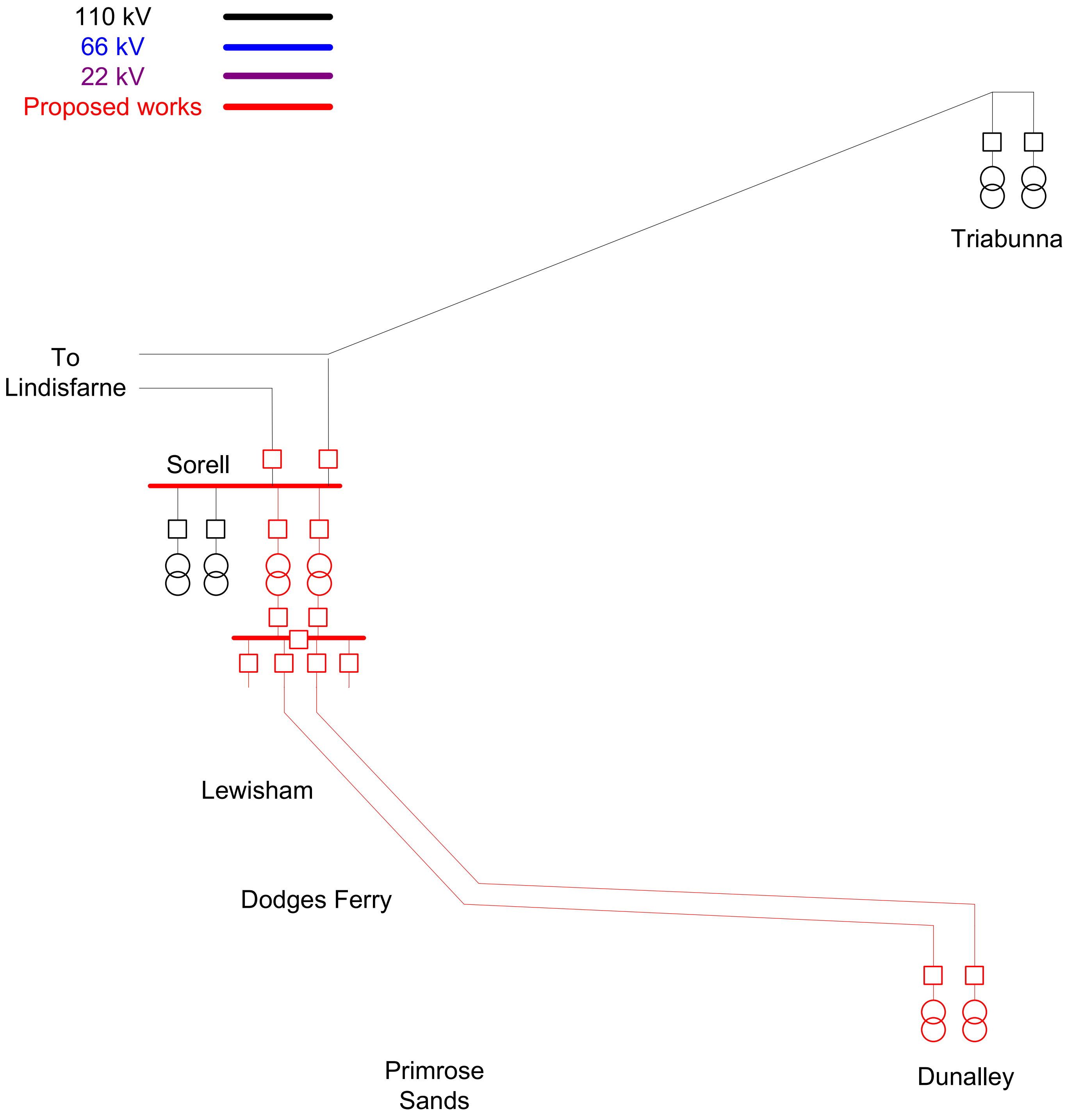
Establish Dunalley and Dodges Ferry 110/22 kV substations

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%
2035	**2030**	**2040**	Sorell firm capacity and Peninsula reliability	Establish 110 kV substation at Dunalley - 30 km 110 kV DCCT to Dunalley - 110 kV bus at Sorell - 2 x 110/22 kV 60 MVA transformer terminal substation	$37,500	$9.51	$7.52	$5.95	$12.52	$10.37	$8.60	$7.23	$5.45	$4.12
2045	**2040**	**2050**	Sorell/Dunalley firm capacity	Establish 110 kV substation at Dodges Ferry - Tee off Dunalley 110 kV DCCT (assumed 5km) - 2 x 110/22 kV transformer substation	$20,250	$2.97	$2.13	$1.54	$3.90	$2.94	$2.22	$2.26	$1.55	$1.07
2056	**2046**	**2066**	Triabunna ESI 25MW rule and transformer end of life (2056)	Establish second 110 kV circuit to Triabunna - 50km 110 kV SCCT - Replace 2 x 110/22 kV transformers	$27,500	$2.20	$1.43	$0.93	$3.82	$2.72	$1.94	$1.27	$0.75	$0.45
					Total	**$14.68**	**$11.08**	**$8.42**	**$20.24**	**$16.03**	**$12.77**	**$10.76**	**$7.75**	**$5.63**

Appendix C
Staging diagrams for Sorell options

Appendix C

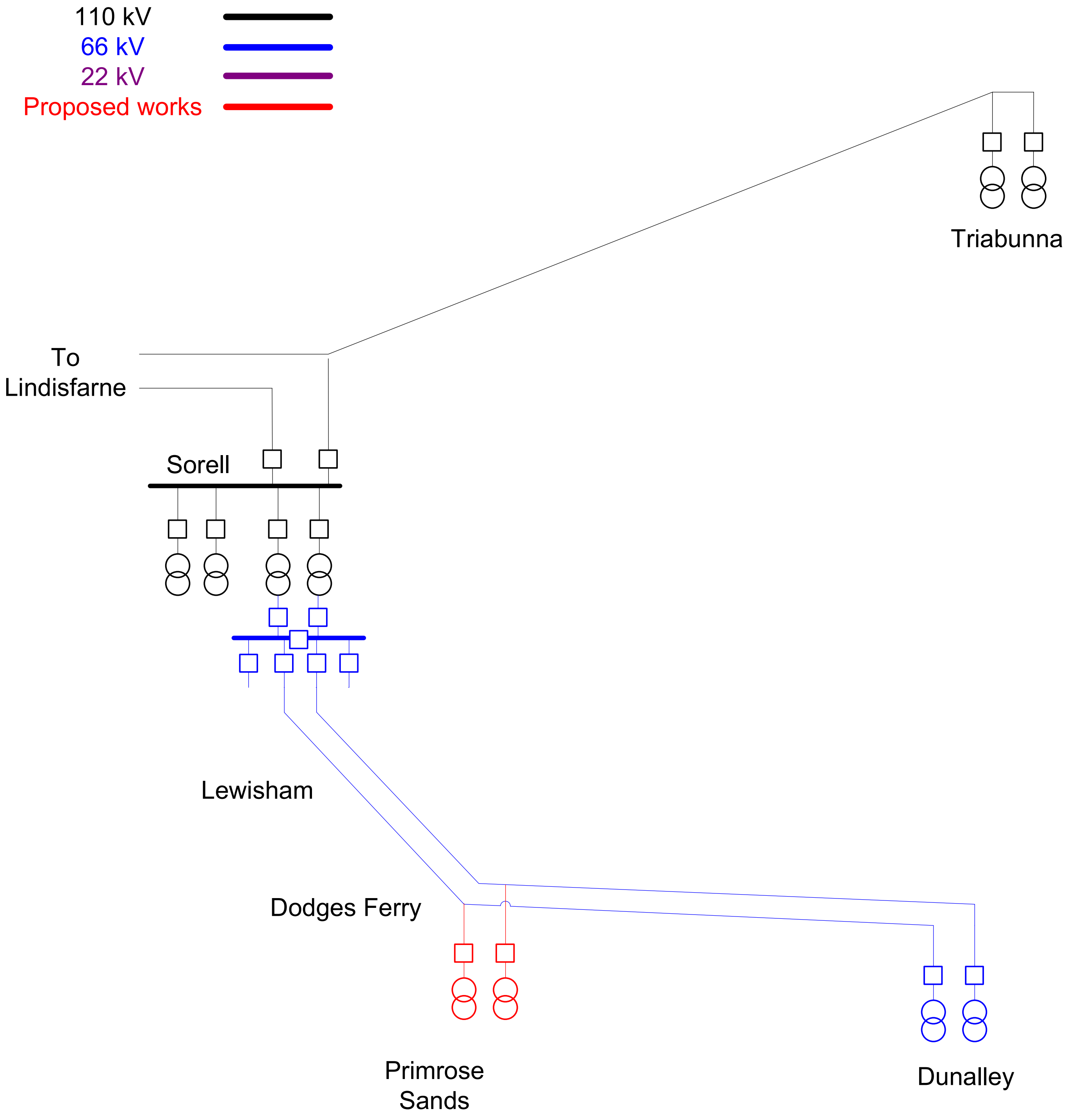
Option 1 - Establish Sorell 66 kV injection point and zone substations at Dunalley and Dodges Ferry



<u>Stage 1 – 2035</u>

Establish 110/66 kV Sorell 66 kV injection and Dunalley 66/22 kV substation $34.4M:
- 2 x 110/66 kV transformers, 110 kV bus and 66 kV switchgear at Sorell
- 30 km 66 kV double circuit from Sorell to Dunalley
- 66/22 kV zone substation at Dunalley

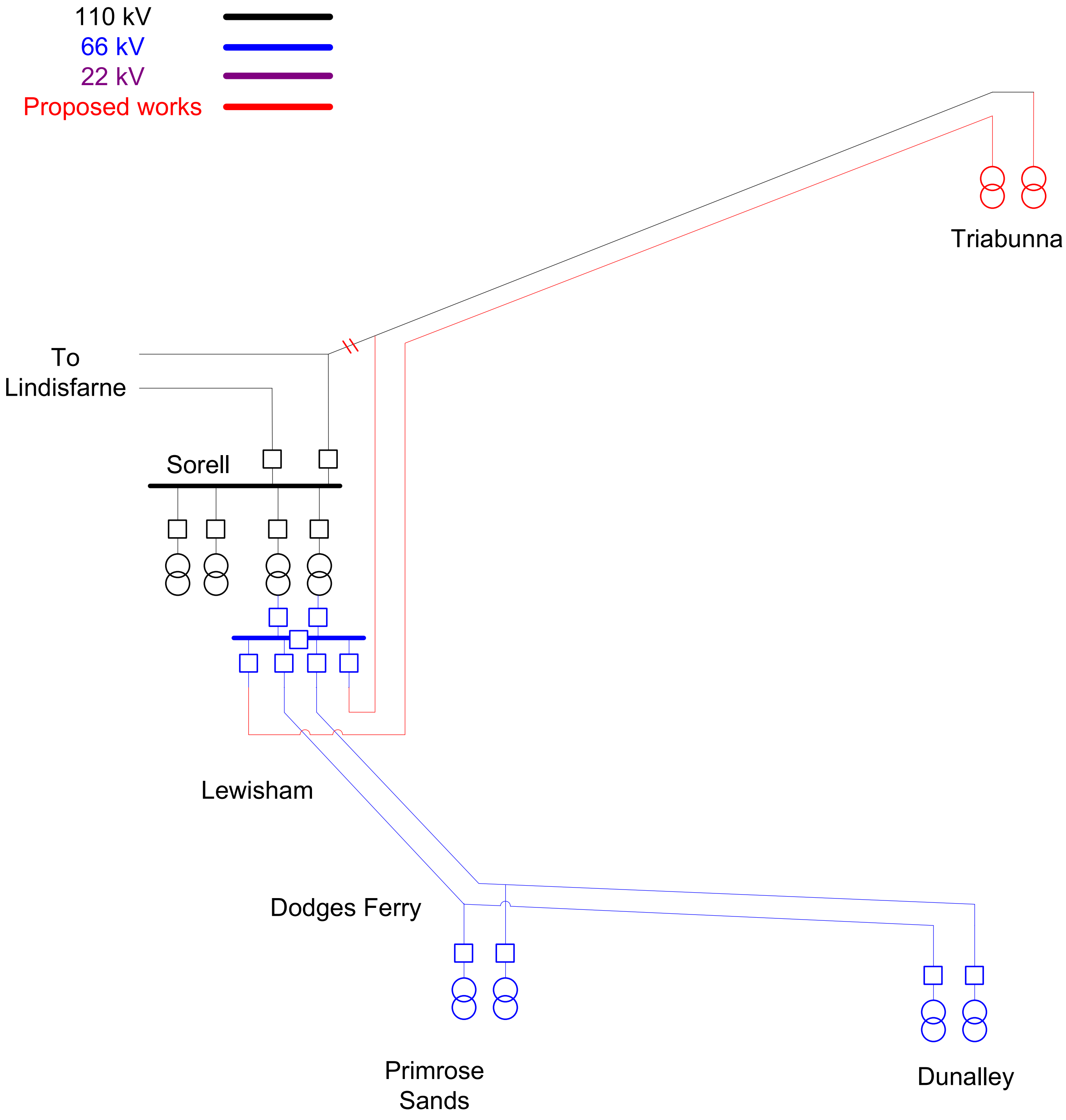
This project addresses the firm capacity limitation at Sorell as well as improving reliability to the Peninsula by effectively shortening the existing two 22 kV feeders from Sorell.



<u>Stage 2 – 2045</u>

Establish Dodges Ferry 66/22 kV substation $10.7M:
- 5 km 66 kV double circuit to tee off existing Sorell-Dunalley 66 kV feeders
- 66/22 kV zone substation at Dodges Ferry

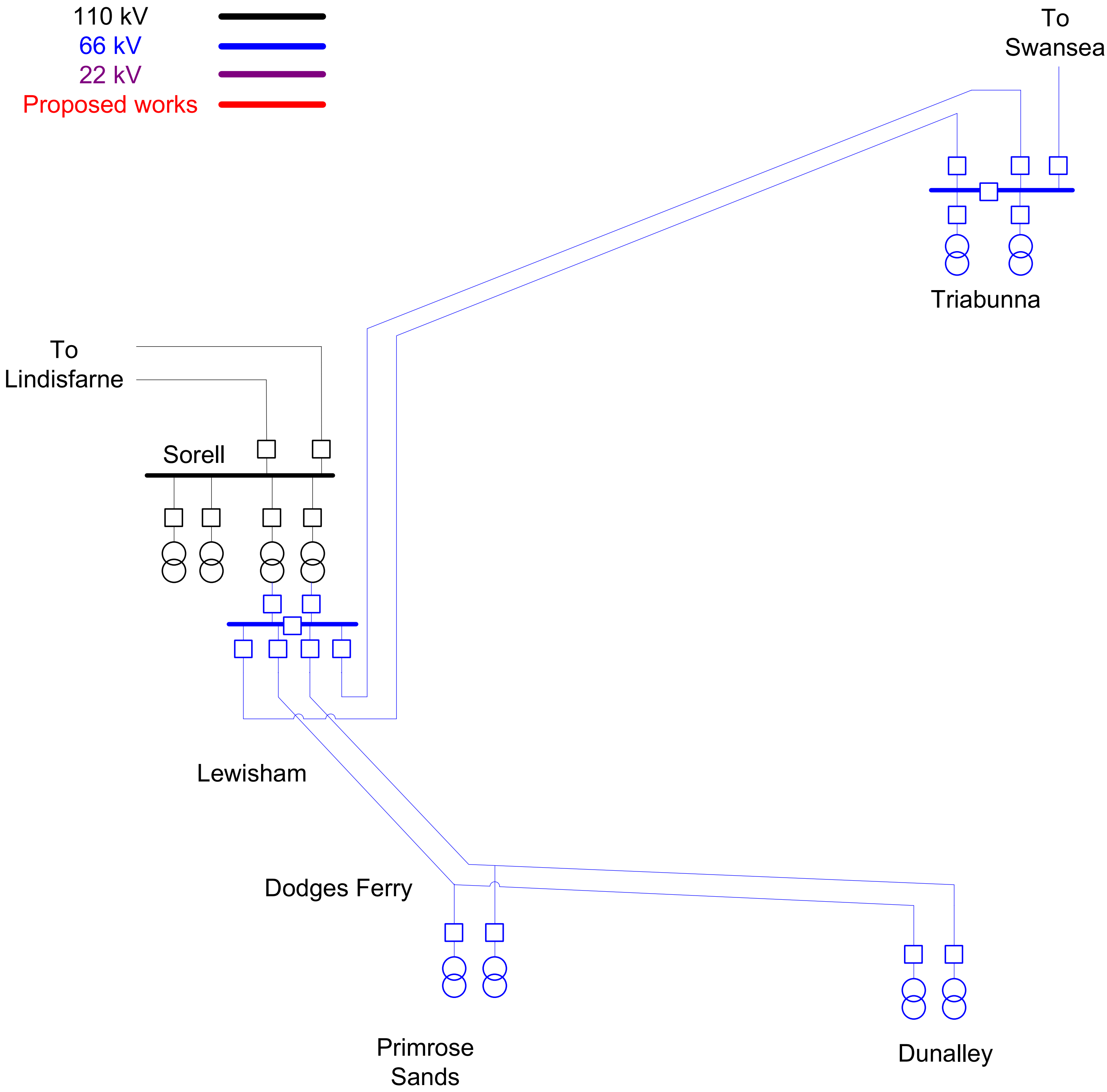
This project addresses the firm capacity limitation at Sorell.



<u>Stage 3 – 2055</u>

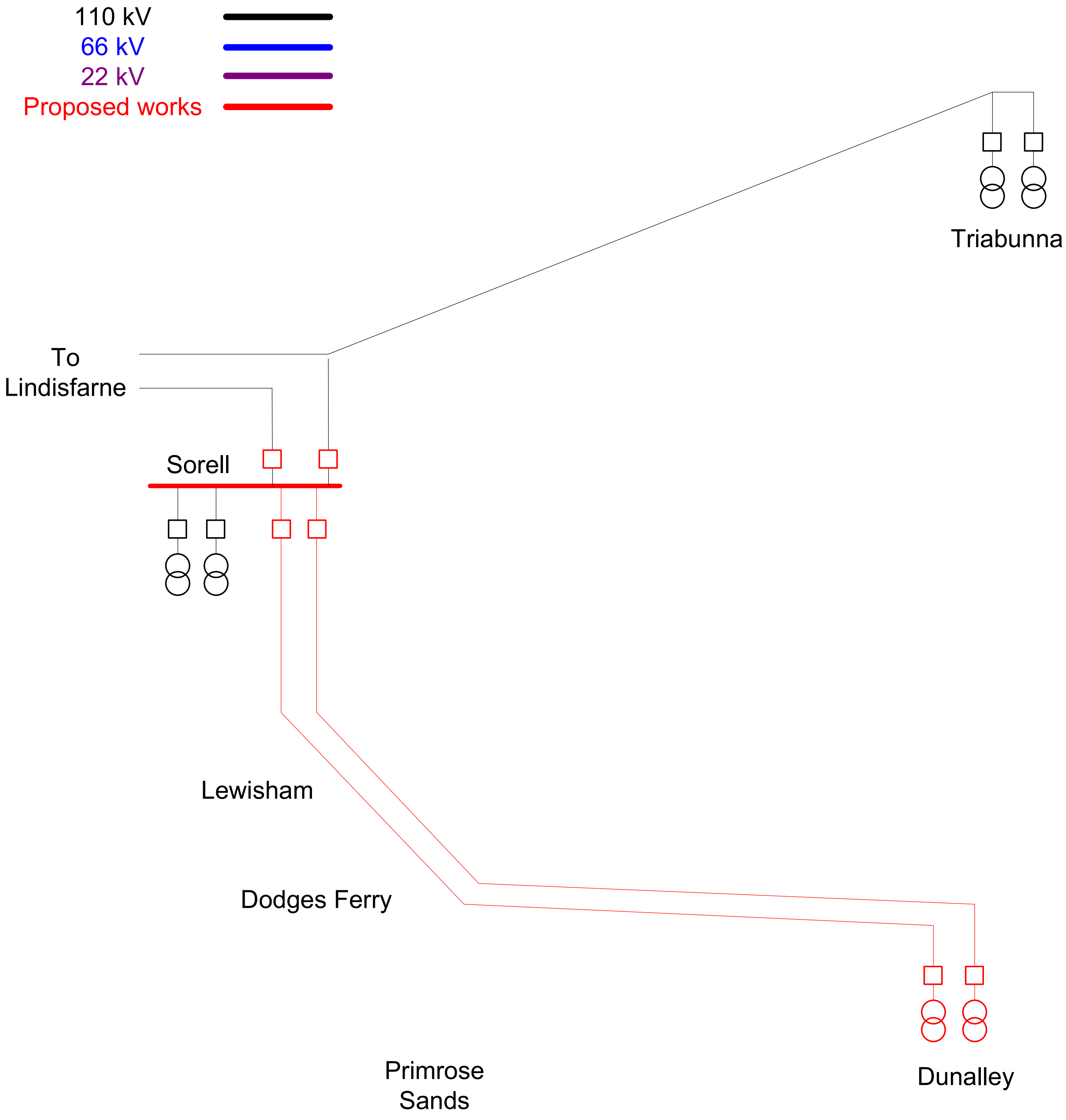
Establish Triabunna 66/22 kV substation $19M:
- 60 km 66 kV single circuit from Sorell to Triabunna
- Replace 110/22 kV transformers with 66/22 kV units
- Re energise existing Sorell-Triabunna 110 kV line at 66 kV

This project addresses the 25 MW ESI limitation on the Sorell-Triabunna 110 kV line as well as the end of life of the Triabunna 110/22 kV transformers (2056)


110 kV
66 kV
22 kV
Proposed works
To Swansea
Triabunna
To Lindisfarne
Sorell
Lewisham
Dodges Ferry
Primrose Sands
Dunalley

Ultimate

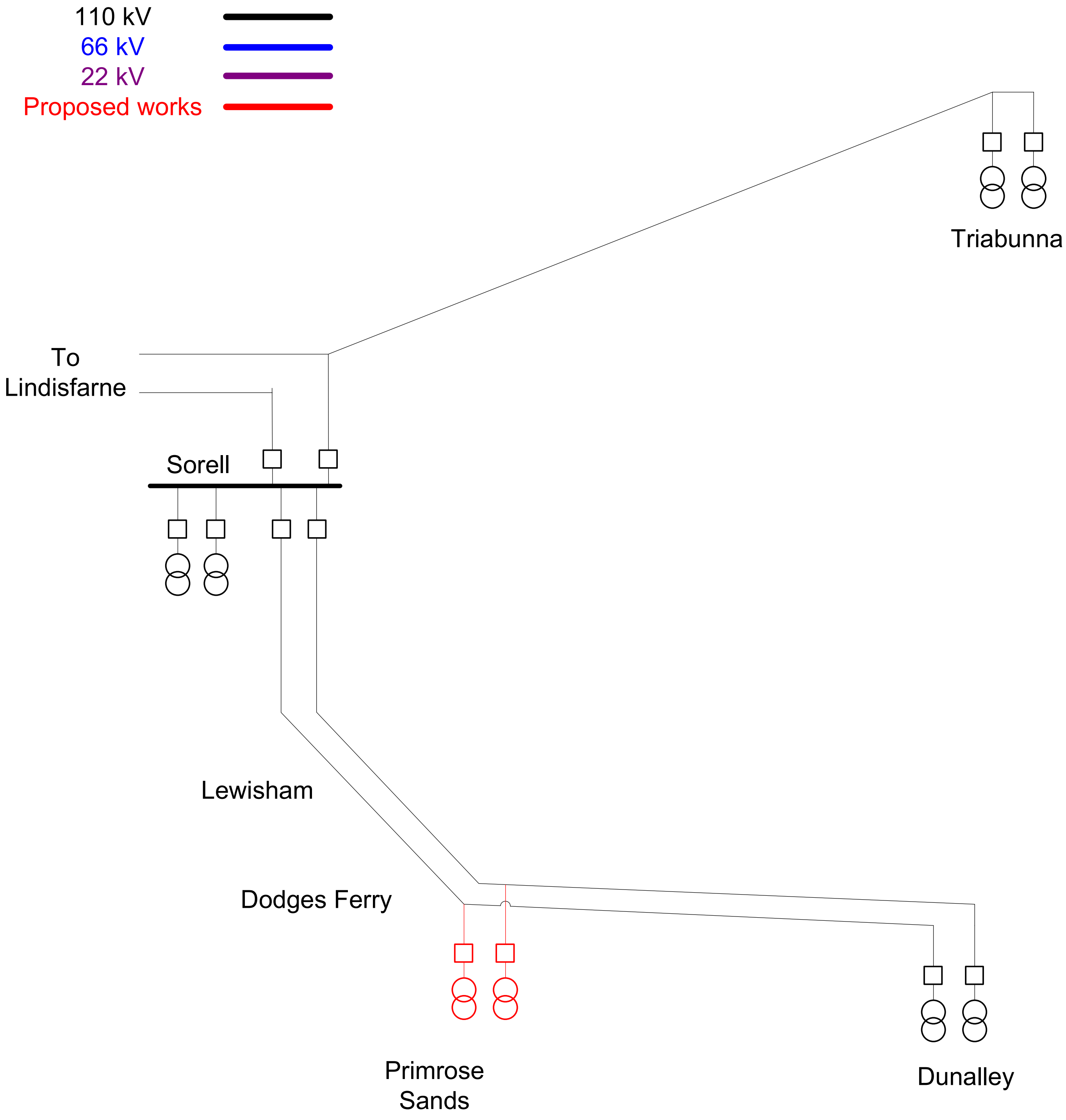
Option 2 – Establish Dunalley and Dodges Ferry 110/22 kV substations



<u>Stage 1 – 2035</u>

Establish Dunalley 110/22 kV substation $37.5M:
- 110 kV bus at Sorell
- 30 km 110 kV double circuit from Sorell to Dunalley
- 110/22 kV terminal substation at Dunalley

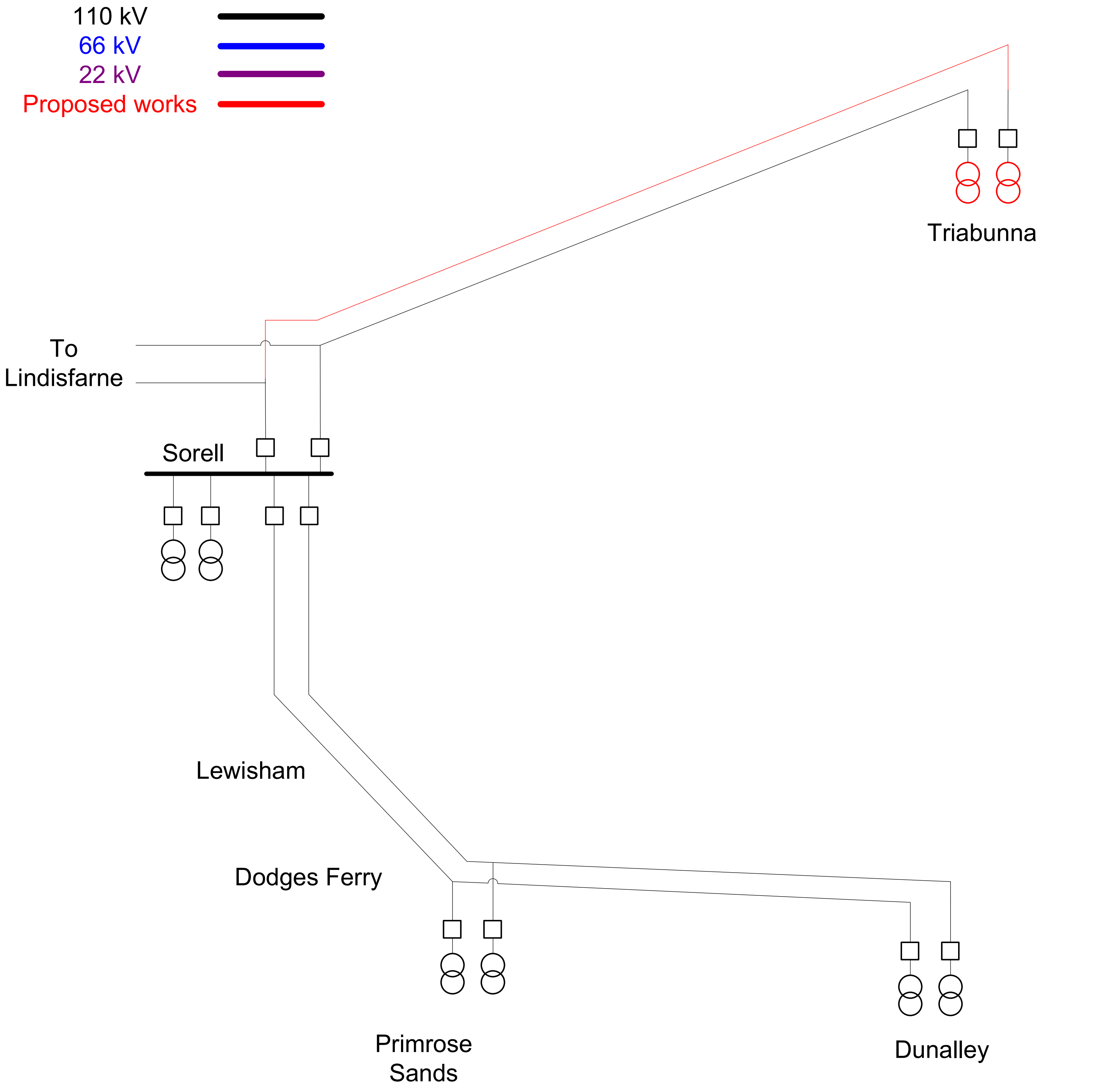
This project addresses the firm capacity limitation at Sorell as well as improving reliability to the Peninsula by effectively shortening the existing two 22 kV feeders from Sorell.



<u>Stage 2 – 2045</u>

Establish Dodges Ferry 110/22 kV substation $20.3M:
- 5 km 110 kV double circuit to tee off existing Sorell-Dunalley 110 kV feeders
- 110/22 kV zone substation at Dodges Ferry

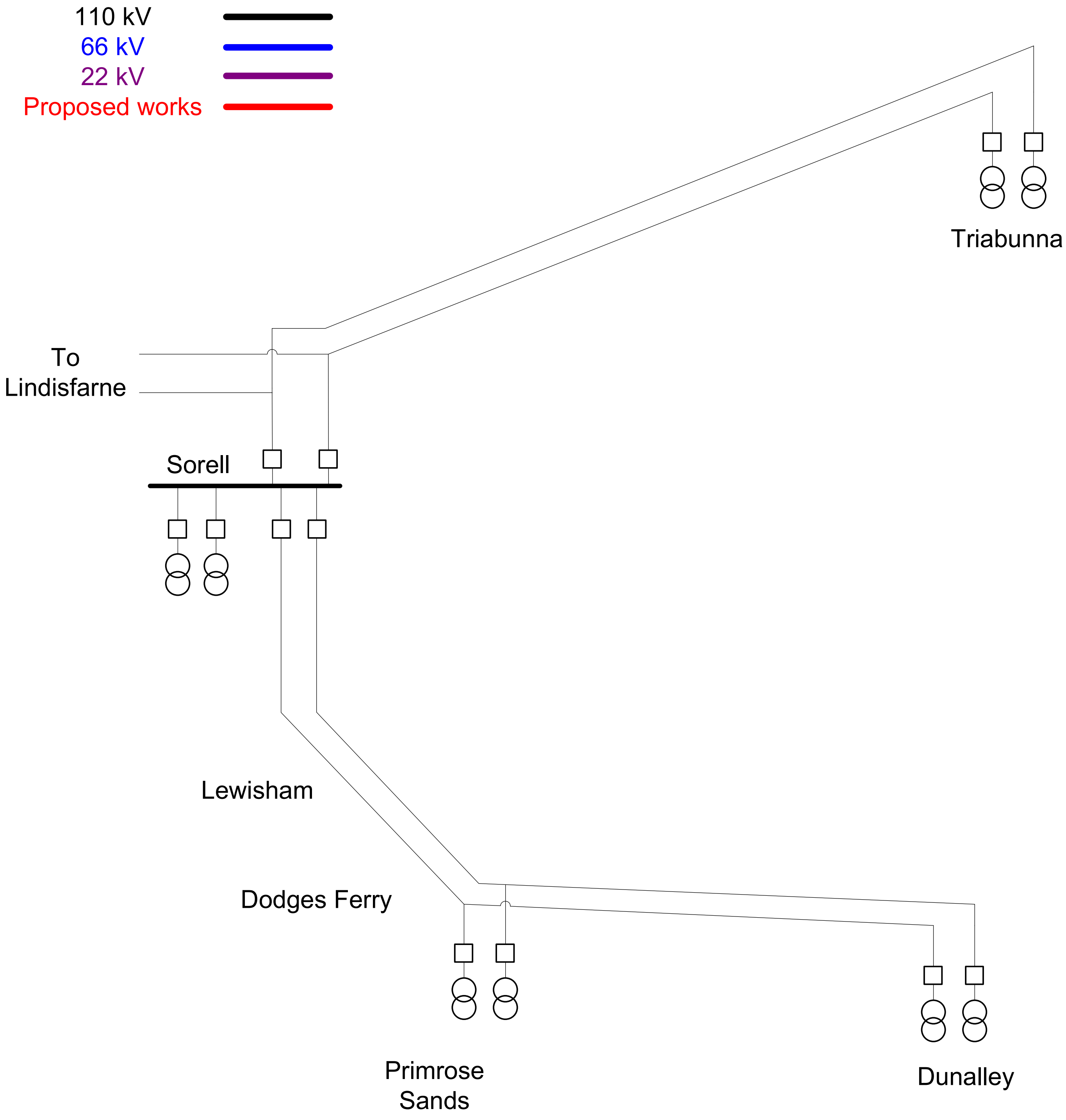
This project addresses the firm capacity limitation at Sorell.



Stage 3 – 2055

Establish second 110 kV circuit from Sorell to Triabunna and replace transformers $27.5M:
- 50 km 110 kV single circuit
- Replace 2 x 110/22 kV transformers

This project addresses the 25 MW ESI limitation on the Sorell-Triabunna 110 kV line as well as the end of life of the Triabunna 110/22 kV transformers (2056)


110 kV
66 kV
22 kV
Proposed works
Triabunna
To
Lindisfarne
Sorell
Lewisham
Dodges Ferry
Primrose
Sands
Dunalley

Ultimate

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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