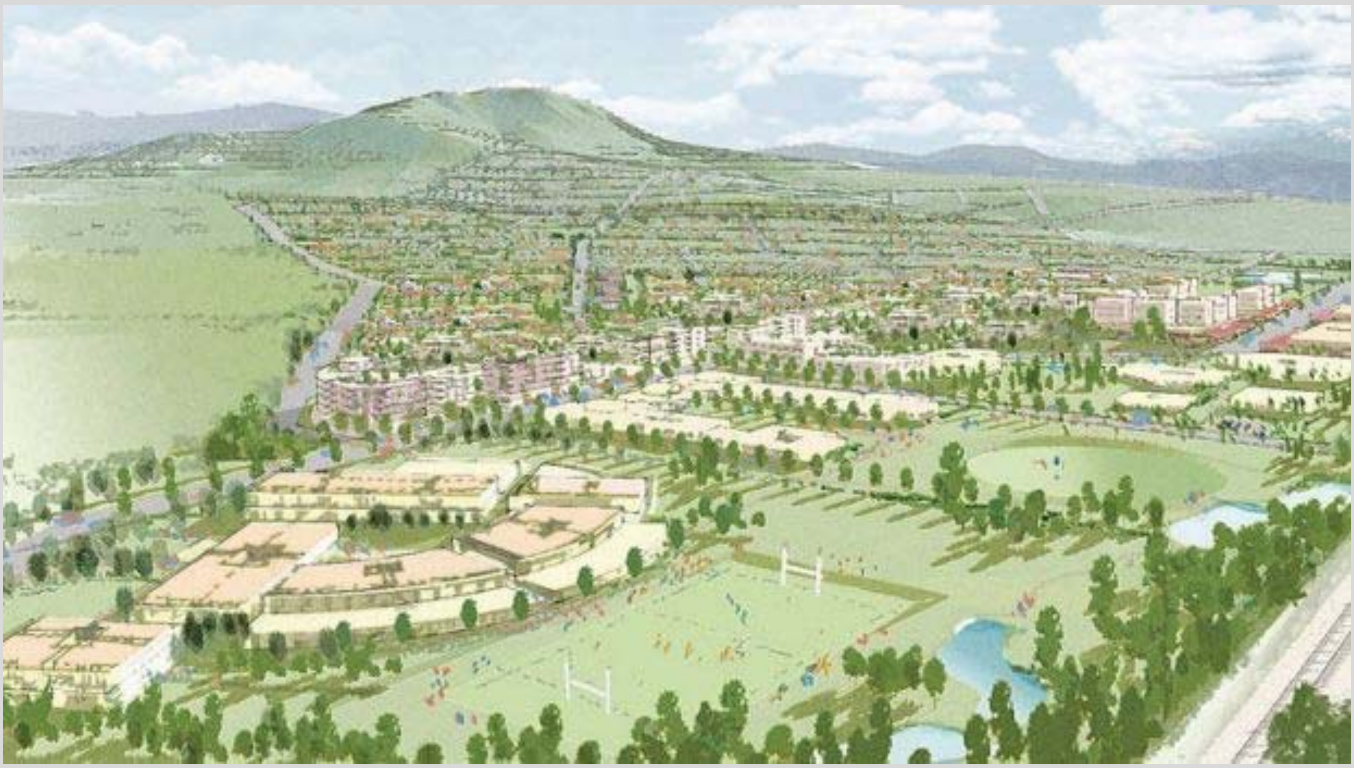
Supporting Document 12.1.15a
Major Project Detailed Options Report

ESS_1030 Googong to Tralee new 132k feeder (South Jerrabomberra Development Supply)



April 2018

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1. Executive Summary

Major Project	ESS_1030 Googong to Tralee new 132k feeder (South Jerrabomberra Development Supply)
Description	Construct a 132kV line from the Googong to Tralee development area which will initially be energised at 11kV.
Drivers for Investment	Customer growth: > Forecast voltage constraint due to expanding residential and commercial development > Maintaining a reliable supply to customers in the South Jerrabomberra area.
Investment Options	The investment options considered include: > Augmentation of the 11kV distribution network to defer major investment > Construction of a 132kV line from Googong to Tralee, initially energised at 11kV
Estimated Expenditure $million	2019/20: $0 2020/21: $0 2021/22: $0 2022/23: $3.0 2023/24: $0

2. Overview

Tralee is a residential and commercial development which forms part of the South Jerrabomberra urban release area which is located to the south east of Canberra. South Jerrabomberra is expected to have 2,200 new dwellings constructed and 130Ha of employment land (commercial/industrial) between 2018 and 2031.

There is no spare capacity in the 11kV distribution network from South Queanbeyan 66/11kV Zone Substation (ZS) to supply the Tralee development and limited distribution capacity from the Oaks Estate 66/11kV ZS (Lorn Road 11kV feeder). The distribution capacity will be exceeded when the development area's load reaches 2MVA.

Construction of a new 132kV dual circuit feeder, which will operate initially at 11kV and ultimately as a 132kV source to a future Tralee 132/11kV ZS, is the preferred option to alleviate the distribution constraints and cater for ultimate load developments in South Jerrabomberra area. Essential Energy owns a zone substation site in the Tralee development area.

This report is based on forecasts derived from the Queanbeyan City Council (QCC) paper, "Residential and Economic Strategy 2015 – 2031" for the South Jerrabomberra Region. Essential Energy will continue to liaise with the developers and Council to correctly time and scope the required network augmentations to supply the development area.

3. Network

The closest point of contact between the proposed Tralee development and Essential Energy's electrical infrastructure is the end of the Lorn Rd 11kV feeder which terminates in the vicinity of the Tomsit Rd and Lanyon Drive intersection and is supplied out of the Oaks Estate ZS. The Lorn Rd feeder is comprised of approximately equal lengths of Overhead and Underground line segments and can only provide an additional 2MVA due to voltage constraint. Initial supply to Tralee will be sourced from this feeder via a developer funded underground 11kV extension.

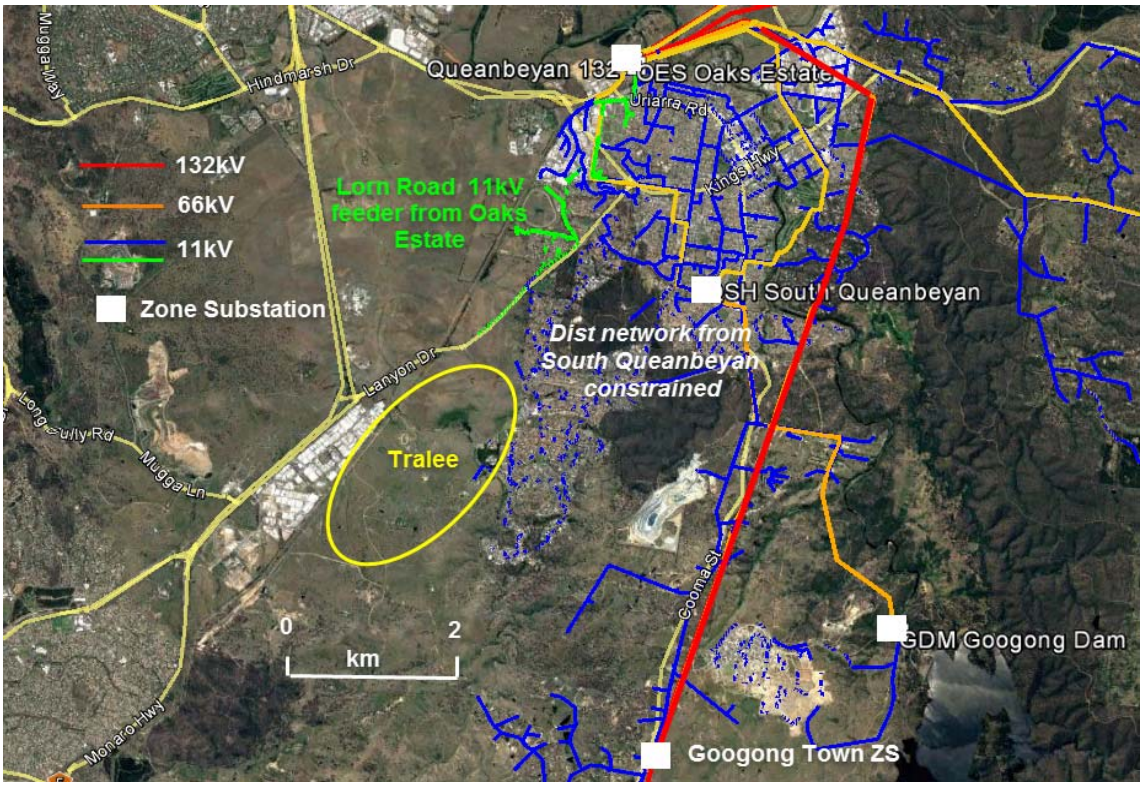

Figure 1 Existing Distribution Network in the vicinity of Tralee

Another potential supply point is the 11kV network supplying Jerrabomberra, sourced from the Queanbeyan South ZS, however due to this feeder being highly loaded there is less than 0.5MVA of additional load available from it. The area has a relatively high annual load growth rate which would further reduce its available load supply to Tralee in the future.

The Queanbeyan Subtransmission network shown in Figure 2 shows the Googong Town and Oaks Estate ZS's have full alternate supply available. The Googong Town ZS currently has a single 132/11kV transformer however a 2nd transformer will be installed by 2020 to provide full redundancy.

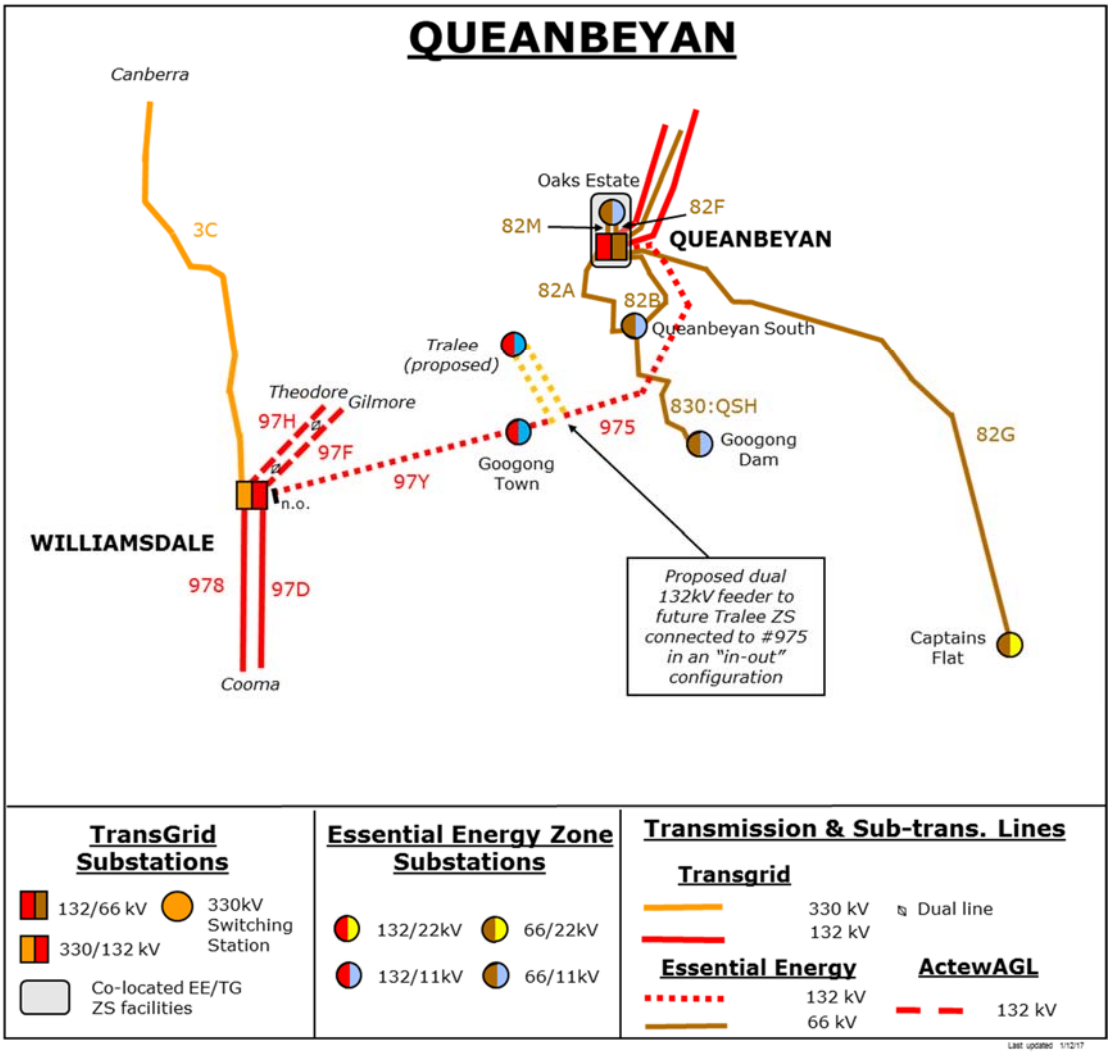

Figure 2 Queanbeyan Subtransmission Network

4. Load Forecast

The long term strategic plan for the South Jerrabomberra region based on the QCC publication "Residential and Economic Strategy 2015-2031" indicates a total of 2,200 residential lots and 130Ha of employment land are required by 2031.

Using an average load of 3.5kVA per household and the existing load/Ha of existing light industrial land such as at Fyshwick and Hume in the ACT suggests corresponding loads of 8MVA and 13MVA, for a total of 21MVA, will be required. This level of load would require a dedicated zone substation hence there is a high degree of likelihood for the need for the Tralee ZS within the next 13 years.

Tralee is forecast to commence construction in 2019 and is expected to contain a total of 1500 lots constructed in three stages, as outlined in Figure 3 for a total of 1500 lots including both residential and commercial usage. Table 1 indicates the proposed schedule details for each stage.

Stage	Lots	Construction commencement date	Land Use
1	500	2019	Residential + Commercial
2	500	2021	Residential Only
3	500	2023	Residential Only

Table 1 Tralee Development Stage Size

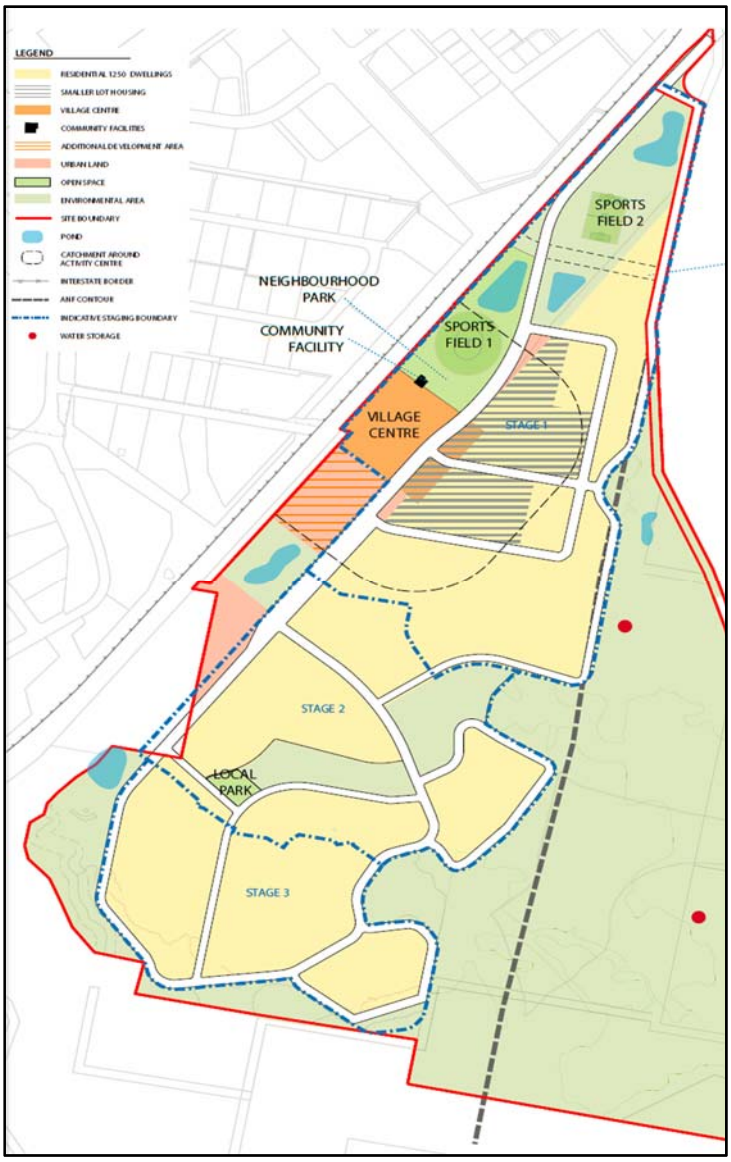

Figure 3 Tralee Staging Boundaries

The growth rate is expected to be between 150 – 200 houses/year based on the current housing demand and historic growth rates experienced in neighbouring developments which equates to an annual load growth of 450 – 600kVA.

Other proposed future developments in the South Jerrabomberra region are indicated in Fig 4 and include;

1) The Poplars – area designated for employment use and sporting facilities could commence development in 2021,
2) Environa/Robin – area designated for employment use of up to 2500 lots could commence development in 2026,
3) Tralee Station – area designated for residential and commercial use of up to 7000 lots could commence development in 2028,
4) North Tralee – are designated for employment use of up to 500 lots could commence development in 2022.

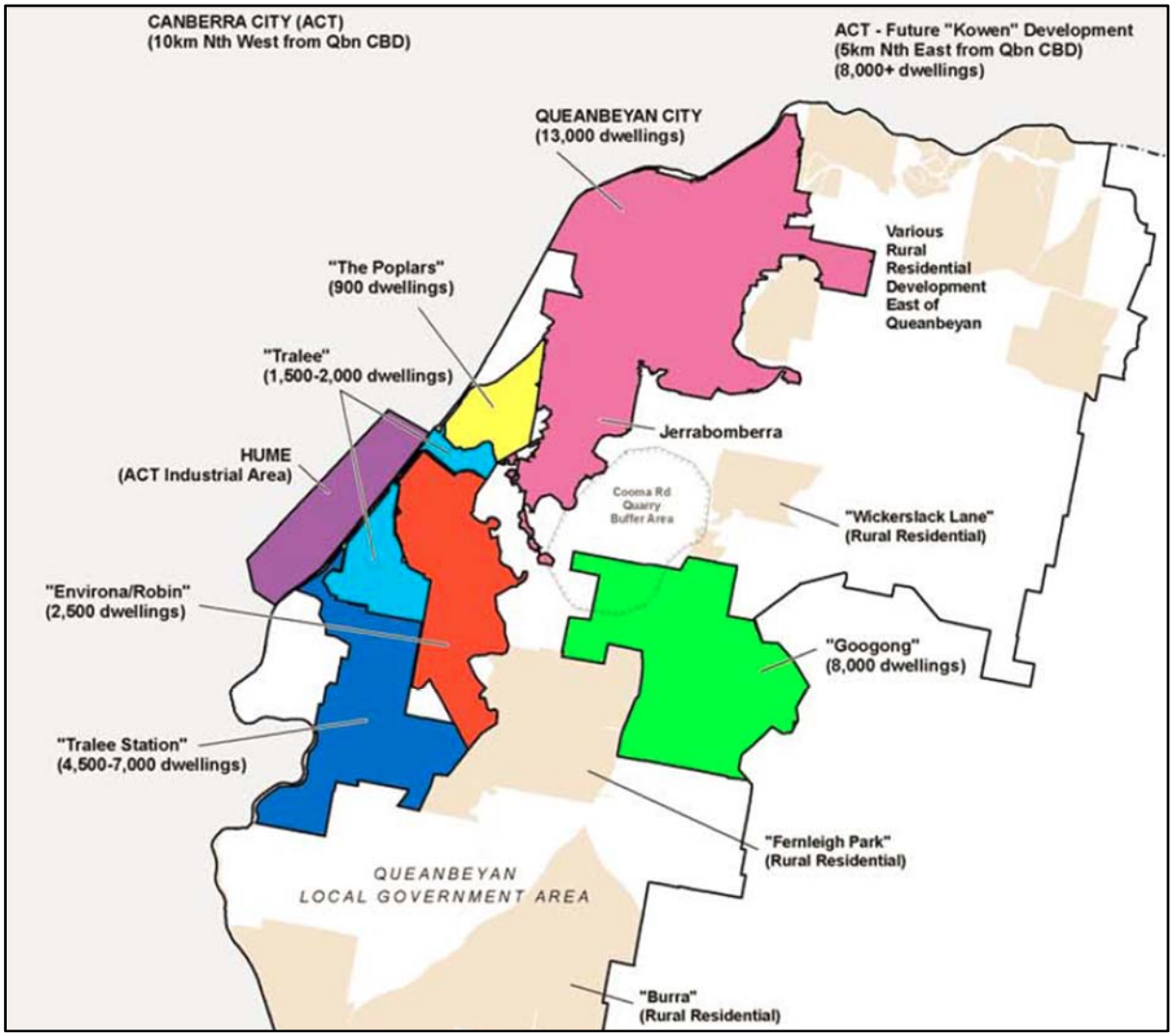

Figure 4 South Jerrabomberra Regional Developments

The forecast growth rate of the South Jerrabomberra region based on these other developments is given in Table 2 and indicated in Figure 4 for the scenarios of low, moderate and high growth rates. These three scenarios are mostly dependant on when these other proposed developments commence and their property construction uptake rate.

It has been assumed that up until 2021 all load growth is due to the Tralee development itself, from 2021 onwards development of The Poplars is assumed to commence, and afterwards the other developments with their corresponding commencement dates as given above are assumed to commence.

In the worst case scenario, the 2MVA trigger point requiring augmented supply could occur as early as 2021 however is more likely at 2023 and if particularly slow growth occurs out to 2024. Similarly, the 11MVA trigger point for construction of the new Tralee ZS could occur as early as 2025 if growth was strong but is more likely by 2031.

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Residential Lots	0	150	300	450	600	750	900	1050	1200	1350	1500
Industrial (Ha)	0	0	0	0	13	26	39	52	65	78	91
Load (kVA)	0	525	1050	1575	3400	5225	7050	8875	10700	12525	14350

Table 2 Tralee Forecast Lots and Load Growth

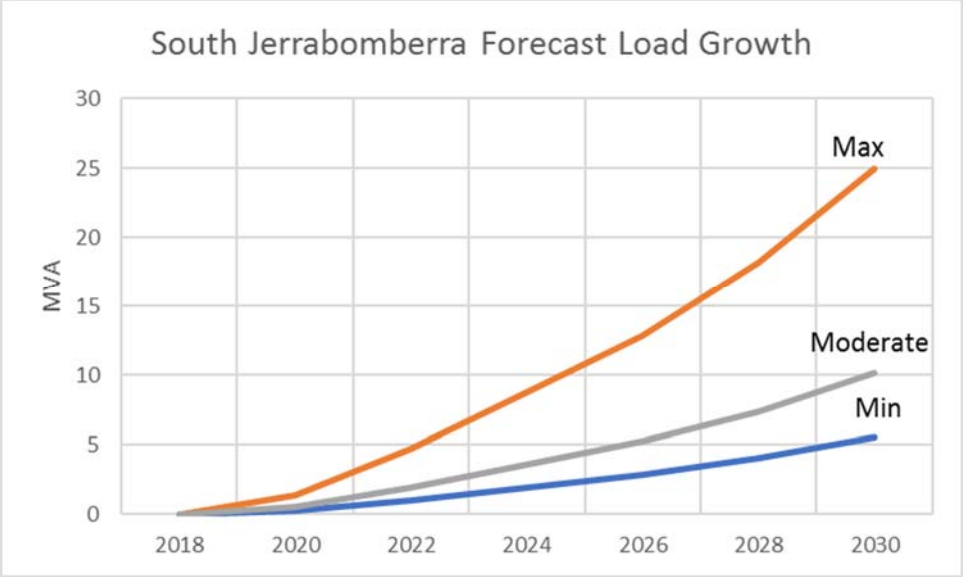

Figure 5 South Jerrabomberra Regional Load Forecast

If these other proposed developments in the South Jerrabomberra area commence earlier or experience higher than expected growth, then since they would utilise the same supply as Tralee this would bring forward any augmentation works required (either the new Googong Town ZS 11kV feeder or Tralee ZS) base load forecast used in the analysis of this report is shown in Table3. The peak demand load growth for Tralee in terms of lot release is based on a 150-lot p.a. growth rate at 3.5kVA load per lot.

5. Constraint

The proposed Tralee development requires supply from EE's network which will be achieved by utilising the Lorn Road 11kV feeder supplied out of the Oaks Estate ZS. This feeder is currently voltage constrained to 2MVA. The following options were investigated to alleviate these constraints.

6. Options

The following network options were compared via Net Present Value (NPV) analysis. Beyond capital and operational costs, a key consideration is the value of 'unsupplied' energy

Initially the development will be supplied by the existing 11kV network, until the 2MVA capacity of this network is exceeded. Once exceeded some customer energy cannot be supplied. This 'unsupplied' energy can be equated to

an annual $/MWH value of Value of Unserved Energy (VUE) based on the amount of energy not supplied and a Value of Customer Reliability (VCR[1]). As the demand increases annually the VUE will increase.

Although the network augmentations are outgoing (-ve) costs, the NPV analysis takes into account the saving (+ve value) of the augmentation supplying the 'unsupplied' energy based on the annual VUE. The network augmentations over time prove to have a NPV positive benefit and the option with the greater NPV benefit is generally the preferred option.

Do Nothing

Without augmentation or demand management load above the 2MVA voltage limit would be lost. The resulting annual VUE would be significant given the level of development forecast in the area. This annual VUE has not been included as a cost in the NPV analysis in the do-nothing option but has been included as a saving in both Options 2 and 3. The do-nothing option has not been included in NPV analysis.

Option 1. Upgrade Distribution Network

When the Tralee demand exceeds the 2MVA limit, supply would need to be augmented. Due to the significant length of underground segment in the Lorne Road feeder it would not be cost effective to undertake upgrade work on the feeder to mitigate this constraint. The installation of a regulator could extend the load available up to 4MVA before the cable thermal constraint is reached. This would delay the need for a new dual 11kV Tralee distribution feeder supplied from Googong Town ZS by up to 4 years compared to Option 3.

Additional load to the South Jerrabomberra Development would require augmentation with the least cost option being the construction of a dedicated dual 11kV feeder supplied from the Googong Town ZS. This feeder would have a firm rating of 8.4MVA which, when combined with the 4MVA available from the Lorne Road feeder would provide firm supply to South Jerrabomberra up to a rating of 12.4MVA.

This new feeder would use an existing UG 11kV line that runs northward from the Googong Town ZS to a point under the #975 line near the future Dunns Creek Road entrance. From this point a new OH line would be constructed to a new switching station located where the proposed future Tralee ZS would be built. This feeder would be constructed of dual 11kV Nitrogen conductor to 85°C thermal rating which has a firm rating of 8.4 MVA.

The next augmentation stage occurs when the South Jerrabomberra load reaches 12.4MVA which would then require construction of the Tralee ZS and a dual circuit 132kV feeder to support further load.

Option 1 has estimated capital cost $11.16M and 40-year NPV benefit of $40.33M

Option 2. Upgrade Subtransmission Network

Given the high forecast future demand at Tralee a subtransmission extension will be needed eventually. This option evaluates a staged upgrade of the Subtransmission network, with a dual circuit 132kV line constructed from Googong to Tralee, initially energised at 11kV. The next augmentation stage occurs when the South Jerrabomberra load reaches 10.4MVA which would then require construction of the Tralee ZS.

Option 2 has estimated capital cost $10.00M and 40-year NPV benefit of $40.66M

A summary of the results of the NPV is shown below in Table 3 with Option 2 – Upgrade Subtransmission Network showing the greater benefit in all sensitivities.

	Base Dis. Rate	Discount Rate Sensitivity		Capital Sensitivity		VUE Sensitivity	
Option	3.45%	1.45%	5.45%	+25%	-25%	+25%	-25%
1	$40.33	$44.54	$36.55	$38.59	$42.07	$52.43	$28.22
2	**$40.66**	**$45.30**	**$36.56**	**$39.00**	**$42.32**	**$52.77**	**$28.56**

[1] Value of Customer Reliability – based on rates CPI to 2017 from AEMO Value of Customer Reliability – Application Guide Dec 14

Further detail of the NPV analysis is shown in Attachment A.

7. Non-Network Options

With all network augmentation investigations Essential Energy examines the opportunities to alleviate network constraints with non-network solutions. Non-network options generally consist of either demand management or embedded generation.

Demand management requires the peak demand to be reduced to a level which removes or defers the network constraint. The reduction in demand can be achieved by a number of methods, mainly load curtailment or fuel substitution.

With load curtailment, customers agree to provide a significant reduction in their demand (switch off air-conditioning, hot water, manufacturing plant etc) when requested during high peak demand periods. It is generally cost effective with large individual commercial/industrial customers or substantial numbers of existing residential customers. With fuel substitution, customers are given incentives or are provided with appliances that use alternate energy sources to electricity; gas stove replace electric stove etc.

In the case of Tralee with newly established residential lots, with no or a very low base of existing demand, achieving a significant reduction in peak demand is not possible in the short – medium term.

Embedded generation involves installing generation sources to supply the load during peak periods and reduce the peak demand to a level which removes or defers the network constraint. The generation could come from various sources; diesel, gas, solar or wind etc. In this case, as the demand exceeds the network constraint, more generation capacity would be required and would operate for extended periods to a point where it would operate 24 hours/day. Generation is costly with average install costs around $1M/MW.

With the release of residential lots as noted by the developer, the estimated increasing peak demand, the low level of network constraint and the ultimate demand levels in excess of 20MVA, residential demand management or installation of embedded generation would not significantly defer the preferred network option to a point where implementing these strategies are cost effective.

8. Recommendation

It is recommended that Option 2 – Upgrade Subtransmission Network be accepted as the network solution for future supply constraints in the South Jerrabomberra Region. Option 2 has the least cost NPV and provides a robust long-term solution for providing reliable supply to the Tralee development.

9. References

Doc No.	Document Name	Relevance
1	NPV Tralee development NPV V1.xlsx	Net Present Value Analysis calculations
2	Residential and Economic Strategy 2015-2031.pdf	Queanbeyan City Council strategy document

10. Key Terms and Definitions

Term	Definition
NPV	Net Present Value
FY	Financial Year
VUE	Value of Unserved Energy

Appendix A – NPV Summary

Project:	South Jerrabomberra development supply
Company Tax Rate	30%
Discount Rate after Tax:	3.45%

NPV Summary	Total Capital Costs	10 Yr NPV	20 Yr NPV	30 Yr NPV	40 Yr NPV	50 Yr NPV	60 Yr NPV
OPTION 1: Distribution dual 11kV line + 132kV line	-	40,255,318	40,288,460	40,312,068	40,328,886	-	-
OPTION 2: Subtransmission dual inc 132kV line	-	40,595,333	40,625,030	40,646,184	40,661,253	-	-

		FY19	FY20	FY21	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29
Timeline (Year)	Book Life Yrs	0	1	2	3	4	5	6	7	8	9	10
OPTION 1: Distribution dual 11kV line + 132kV line	Depreciation Age											
Capital Expenditure:												
1 x 11kV 200A regulator	40			-	-	(200,000)	-	-	-	-	-	-
1 x 4km dual 11kV line	40	-	-	-			(960,000)	-	-		-	-
1 x 132/11kV ZS	40	-	-	-	-	-	-	-	-	-	-	(7,000,000)
1 x 14km single 132kV line	40	-	-	-	-	-	-	-	-	-	-	(3,000,000)
Cash Outflows - Risk												
O&M		-	-	-	-	(2,000)	(11,600)	(11,600)	(11,600)	(11,600)	(11,600)	(111,600)
Total:		-	-	-	-	(2,000)	(11,600)	(11,600)	(11,600)	(11,600)	(11,600)	(111,600)
Cash Inflows - Benefits												
Total:		-	-	-	-	-	-	-	-	-	-	-
VUE SAVED						22,301	11,080,109	47,859,759				
Undiscounted Cashflow:		-	-	-	-	(179,099)	10,113,489	47,860,339	580	580	580	(10,069,420)
Discounted Cash Flow		-	-	-	-	(156,376)	8,535,884	39,047,461	457	442	427	(7,172,978)
Cumulative Discounted Cash Flow (Option 1)		-	-	-	-	(156,376)	8,379,508	47,426,969	47,427,427	47,427,869	47,428,296	40,255,318
		10 Yr NPV	20 Yr NPV	30 Yr NPV	40 Yr NPV							
NPV (Option 1)		40,255,318	40,288,460	40,312,068	40,328,886							
OPTION 2: Subtransmission dual inc 132kV line	Depreciation Age											
Capital Expenditure:												
1 x 4km dual 132/11kV line	40					(3,000,000)						
1 x 132/11kV ZS	40			-			-	-	-		(7,000,000)	-
Cash Outflows - Risk												
O&M		-	-	-	-	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(100,000)	(100,000)
Total:		-	-	-	-	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(100,000)	(100,000)
Cash Inflows - Benefits												
Total:		-	-	-	-	-	-	-	-	-	-	-
VUE SAVED						22,301	11,080,109	47,859,759	-	-		
Undiscounted Cashflow:		-	-	-	-	(2,998,699)	11,081,609	47,861,259	1,500	1,500	(7,047,500)	5,000
Discounted Cash Flow		-	-	-	-	(2,618,248)	9,352,987	39,048,212	1,183	1,144	(5,193,506)	3,562
Cumulative Discounted Cash Flow (Option 2)		-	-	-	-	(2,618,248)	6,734,739	45,782,951	45,784,134	45,785,277	40,591,771	40,595,333
		10 Yr NPV	20 Yr NPV	30 Yr NPV	40 Yr NPV							
NPV (Option 2):		40,595,333	40,625,030	40,646,184	40,661,253							