

South West Priority Growth Area Plan

**Review of the long term electricity infrastructure
requirements in the Sydney South West Priority Growth
Area**

Asset Strategy and Planning

February 2018

REVIEW AND APPROVAL SCHEDULE

Responsibility	Position	Name	Signature	Date
Prepared	Engineering Analyst	Andrew Ma		
Reviewed	Capacity Planning Manager	Jason Lu		
Endorsed	Manager Asset Strategy and Network Planning	Peter Langdon		

DOCUMENT AND AMENDMENT SCHEDULE

Version	Approval date	Comments	Updates

CONTENTS

1.0	Executive Summary	1
2.0	Introduction	3
3.0	South West and Western Sydney Priority Grown Area Precincts	3
4.0	Network Need	5
4.1	Expected Load.....	5
5.0	Study Design Considerations.....	8
6.0	Existing Supply Arrangements.....	9
7.0	Demand Management Strategy	12
8.0	Strategy to Supply the Ultimate Load.....	12
8.1	Proposed Ultimate Network Topology.....	13
8.1.1	Ultimate Configuration	16
9.0	Staging of Investment.....	18
10.0	Stakeholder Issues	18
10.1	Transgrid Works.....	18
10.2	Developers and Landowners.....	19
10.3	General Environmental Considerations	19
11.0	Recommendations	20
12.0	Appendices	21
Appendix 1	Precinct Overlay.....	1
Appendix 2	Contingency Tables – ultimate configuration	2
Appendix 3	Approximate feeder works with Kemps Creek BSP.....	3

1.0 Executive Summary

This report outlines the investment needs and strategy to accommodate the development of an estimated 168,365 residential dwellings and 23.15km² of employment lands in Sydney's South West Area. This area (approximately 160km²) is roughly bounded by Elizabeth Drive to the north, Camden Valley Way (including Gregory Hills and the western part of Denham Court) and the eastern boundary of Austral in the east, Cobbitty Road and Turner Road to the south and Badgerys Creek Road and an area just west of the Northern Road in the west. The last iteration of this plan was published in 2014 as the "South West Sector Area Plan". The ultimate dwelling yield under consideration in the plan has increased significantly by over 35,000 dwellings since that report. This report will review the latest updates to the strategy based on the most recent available data.

It is expected that, fully developed, the South West Growth Area will result in up to 825MVA of load (subject to any future demand management and non-network initiatives) being added to Endeavour Energy's network. The network that is proposed to supply the ultimate load comprises of fourteen zone substations (ZS) and aims to maximise the use of the existing infrastructure currently in place within the development area, which is mostly of 132kV construction. Furthermore, the proposal includes the establishment of a new Bulk Supply Point (BSP) at Kemps Creek that will provide a 132kV injection point to cater for the identified shortfall in network capacity. Consideration is given to staging the implementation of the ultimate network, with short-term (five year) and medium-term (at least ten years) network configurations proposed for supplying the land that is currently zoned or is being planned for development.

The need to continue engagement with various stakeholders, including the NSW Department of Planning & Environment, developers and landowners, is highlighted as critical for the appropriate acquisition of line corridors and zone substation sites.

In summary, the report recommends the following actions:

1. The proposed Ultimate Network Topology outlined within this report be carried forward as the basis for further planning within the South West Priority Growth Area.
2. This strategy has estimated total investment requirements of approximately \$100million over the next decade. Projects proposed to be completed in the 2020-2024 regulatory period with a total investment requirement of \$52m (real \$ FY19) include:
 - Completion of Edmondson Park ZS and North Leppington ZS projects
 - Completion of South Leppington ZS
 - Establishment of Marylands ZS
 - Establishment of Austral ZS (mobile)
 - Establishment of Catherine Park ZS

Projects in the 2025-29 regulatory period that will be considered include:

- Stage 2 investments for zone substations that will have temporary or mobile solutions installed in the 2020-24 period
- Establishment of Catherine Fields North ZS
- Establishment of Rossmore ZS
- 132kV connections works associated with Kemps Creek BSP.

3. Continue Joint Planning with Transgrid on the establishment of 330/132kV Kemps Creek BSP
4. Engage in discussions with the Department of Planning and Environment to ensure that zone substation sites and line corridors are included in the development of master plans for South West Sector precincts.

A staged approach will be taken to minimise present value of costs as well keep pace with growth. Endeavour Energy will develop individual options for each stage of network investment that will reflect the relevant engineering standards applicable at the time of business case development.

2.0 Introduction

This report outlines the strategy for supplying the South West Priority Growth area. This is a greenfield development area within the boundaries of three local government areas: Liverpool, Camden and Campbelltown. The development area is made up of 16 precincts, which are progressively being released and rezoned and are expected to yield 132,678 residential dwellings and 6.26km² of employment lands. The boundaries of the South West Sector are shown in Appendix 1. As the 132kV network is interconnected it is also necessary to consider the possible impact of the adjacent Western Sydney Priority Growth area. The total dwelling yield when these adjacent areas are taken into consideration is 168,365.

This area was the subject of the 2014 South West Sector Area Plan. The strategy contained within that report has been reviewed and updated based on the current state of the network, approved projects, zoning status and expected development yields.

Throughout this report there are occasions where Endeavour Energy may use the term “transmission” to describe some sub-transmission assets due to internal naming convention, however it does not own and operate “transmission” network assets as per the definition in the National Electricity Rules.

3.0 South West and Western Sydney Priority Growth Area Precincts

The (NSW) Department of Planning and Environment has identified 16 precincts within the South West Priority Growth Area. Separate to, but adjacent to the South West Priority Growth Area on the northern boundary is the Western Sydney Priority Growth area which includes the future Western Sydney airport site at Badgerys Creek. The Western Sydney Priority Growth Area includes 81km² of future employment lands which has a potential ultimate load of over 600MVA. This area is an important long term consideration with respect bulk supply point capacity and utilisation of 132kV feeders from Sydney West.

The locations of these precincts are shown in Appendix 1 and their expected dwelling numbers and employment land yields are shown in Table 1 below.

Precinct	Number of Dwellings	Employment land (km ²)
Oran Park	15,498 ¹	0.18 ²
Turner Road	7,506 ¹	0.96 ²
Edmondson Park	10,577 ¹	
Leppington North (SW)	9,070 ¹	
East Leppington (part – C'town & Camden)	4,295 ¹	
East Leppington (part - Liverpool LGA)	2,148 ¹	
Catherine Fields (Part)	4,943 ¹	
Leppington (Stage 1)	3,419 ¹	
Leppington (balance)	6,500 ¹	
Lowes Creek/Maryland PAP	4,000 ¹	
Catherine Fields North	7,614 ¹	0.18 ³
Catherine Fields	12,428 ¹	0.55 ³
Marylands	21,765 ¹	0.57 ³
Lowes Creek	5,065 ¹	1.22 ³
Bringelly (SW)	9,235 ¹	
Rossmore (SW)	8,615 ¹	0.40 ³
Sub-total SWPGA	132,678	4.06
Western Sydney Priority Growth Area (immediately adjacent parts):		
Austral	14,289 ¹	0.15 ³
Leppington North (WS)	8,898 ¹	2.2 ²
Future Industrial (2 precincts)		12 ⁴
North Rossmore	6,500 ²	
Kemps Creek	1,000 ²	4.74 ³
North Bringelly	5,000 ²	
Total	168,365	23.15

Table 1. Precinct yields (dwellings and employment land)

(SW): South West Priority Growth Area

(WS): Western Sydney Priority Growth Area

¹ Source: NSW Department of Planning and Environment – PGA Dwelling forecast

² Source: NSW Government Planning ³ Infrastructure – South West Growth Centre (www.gcc.nsw.gov.au/south+west-22.html accessed 8/11/13)

³ Source: NSW Government Planning ³ Infrastructure – South West Growth Centre Structure Plan (Edition 3) ([www.gcc.nsw.gov.au/media/Pdf/Miscellaneous Amendment/sw_structplan_edn3.pdf](http://www.gcc.nsw.gov.au/media/Pdf/Miscellaneous%20Amendment/sw_structplan_edn3.pdf) accessed 8/11/13)

⁴ Source: NSW Government Planning ³ Infrastructure – Broader Western Sydney Employment Area Draft Structure Plan (http://www.planning.nsw.gov.au/Portals/0/StrategicPlanning/EmploymentLands/DOP_0064_Broader_WSEA_StructurePlan_Artwork_v6-WEB.pdf accessed 26/09/2013)

Table 1 shows that the South West Priority Growth Area and relevant adjacent portions of the Western Sydney Priority Growth Area is expected to have a yield of 168,365 residential dwellings and 23.15km² of employment lands. It should be noted that parts of the original South West Sector have now transferred to the Western Sydney Priority Growth Area. Table 1 does not include the complete load estimate for the Western Sydney Priority Growth Area.

4.0 Network Need

This report aims to provide a strategy that meets the load requirements of the South West Priority Growth Area while addressing the needs of the network. These needs include the available capacity, the load requirements of adjacent areas and the condition of network assets. Furthermore, the strategy takes into account the development in the nearby Western Sydney Priority Growth Area and the associated load requirements. There are various options for catering for these needs, which are to be assessed in terms of their viability and present value in order to determine a preferred option. This section identifies the needs, whereas the methods for addressing these needs will be explored in sections 6.0, 7.0 and 8.0.

4.1 Expected Load

Based on the projected final dwelling yield and employment land area, the total load for the South West Priority Growth Area has been estimated. Firstly, the load of the residential low-density dwellings was estimated as follows:

$$63,850 \text{ dwellings at } 4\text{kVA per dwelling} = 255\text{MVA}$$

Secondly, the load of the higher density residential (townhouse, terrace, apartment) dwellings was estimated as follows:

$$63,186 \text{ dwellings at } 3\text{kVA per dwelling} = 190\text{MVA}$$

Note these residential ADMD values for the purpose of the area plan also take into account associated loads with residential development (local shopping centre, schools, water infrastructure, community facilities etc.). As such these values are slightly higher than what is effectively included in the summer demand forecast (3.2kVA for houses, 2.4kVA for apartments), as associated loads are often separately accounted for in the forecast. For the purposes of sub-transmission network load flow modelling further diversity factors are taken into consideration to reduce coincident peak load.

The employment lands, consisting of industrial and commercial development, are estimated to have the load shown below:

$$5.3\text{km}^2 \text{ at } 12\text{MVA/km}^2 = 63.6\text{MVA}$$

The total load for the Western Sydney Priority Growth Area was estimated as below. Firstly, the load of the residential low-density dwellings was estimated as follows:

$$27,656 \text{ dwellings at } 4\text{kVA per dwelling} = 111\text{MVA}$$

Secondly, the load of the high density residential (townhouse, terrace, apartment) dwellings was estimated as follows:

$$8,031 \text{ dwellings at } 3\text{kVA per dwelling} = 24\text{MVA}$$

The employment lands, consisting of industrial and commercial development, are estimated to have the load shown below:

$$16.89\text{km}^2 \text{ at } 12\text{MVA/km}^2 = 203\text{MVA}$$

Edmondson Park is considered a part of the South West Priority Growth Area. However, it is supplied by the 33kV network from Liverpool BSP and works outside the scope of this area plan will address increases in demand there.

Another important consideration is the Data Centre at Smeaton Grange. While not a part of the growth defined by NSW Planning and Environment’s plan for the Priority Growth areas, its possible final load of 120MVA will be a significant contribution.

The total load for the South West Priority Growth Area and precincts of the Western Sydney Priority Grown Area formerly known as the South West Sector is therefore estimated as being **808MVA**.

Note that the load per dwelling and the industrial load per square kilometre values are based on historical loads. The load per dwelling in the previous area plan only assumed a single figure of 4kVA for all dwellings, to reflect the trend of increasing mix of density in greenfield for low density residential dwellings the higher density dwellings have been separated out. The load estimate now accounts for high density housing which has a lower average demand per dwelling.

Forecast lot releases for 5 and 10 years from now are shown in Section 9.0 of this document, these forecasts reviewed annually with the most up to date information on lot releases and are a key input into annual spatial demand forecasts. A summary is provided in Chart 1 below.

The vast majority of existing transmission lines in the South West Priority Growth Area are rated to 132kV and work to install 132kV assets has already begun. Therefore, the ultimate network will consist of 132kV assets. Section 6.0 of this report discusses the various 132kV supply options.

Assuming a 132kV transmission network, there are two standard 132kV zone substation sizes (in terms of firm transformer capacity): 45MVA and 90MVA. The number of zone substations required to supply the anticipated load, for each ZS size, is then:

45MVA firm capacity	= $808 / 45 = 18$ zone substations
90MVA firm capacity	= $808 / 90 = 9$ zone substations

A combination of 45 and 90MVA zone substations are planned to be used to service the ultimate requirements of the area formerly known as the South West Sector. The specifics of the planned ultimate supply arrangement are further discussed Section 6.0, with the staging plan shown in Section 9.0.

South West and Western Sydney Priority Growth Area Load Forecast

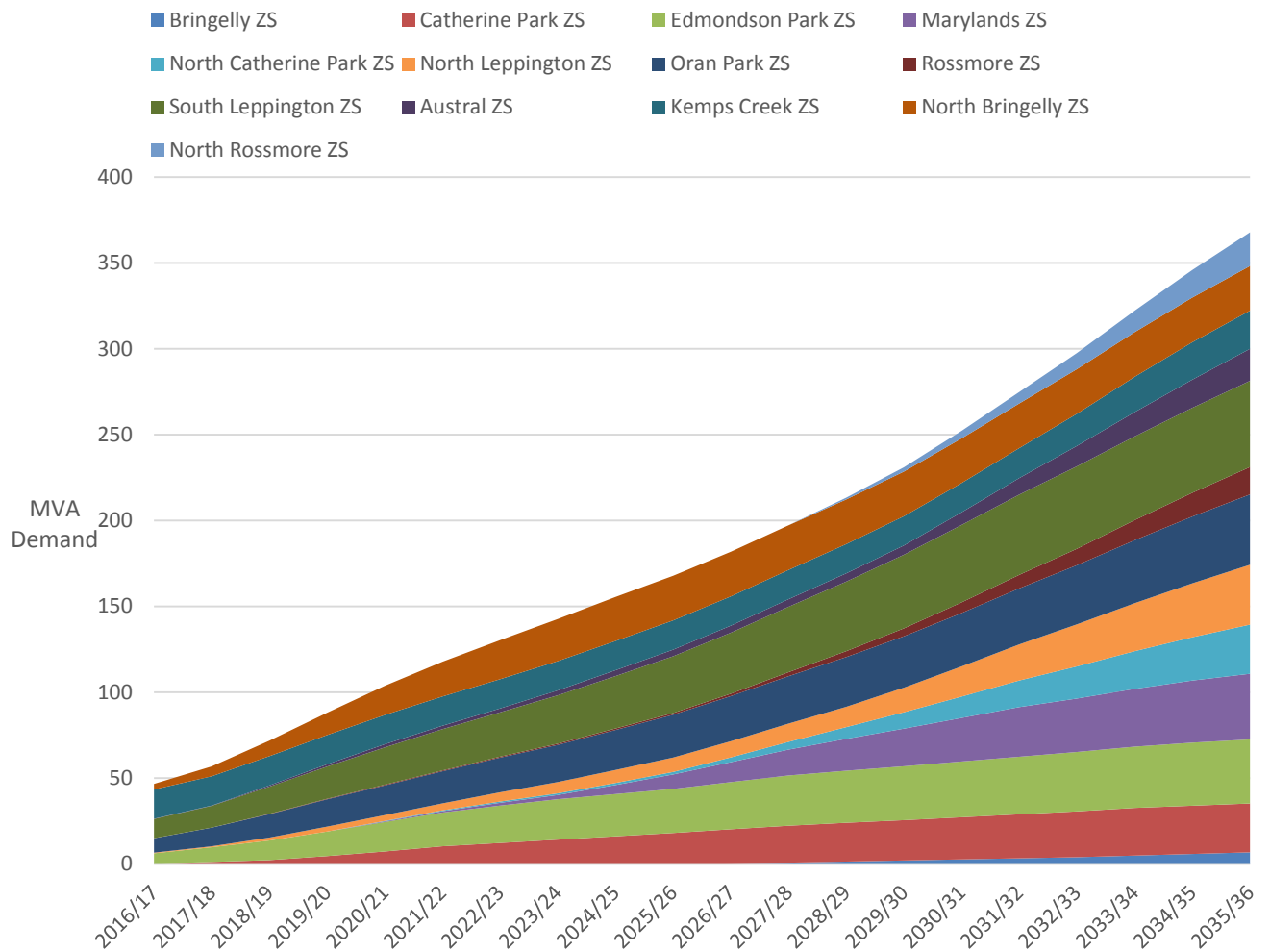


Chart 1 – Demand Forecast for the South West Priority Growth Area

Renewal Needs

The existing zone and transmission substations that supply in and around the South West Sector, as well as their ages and currently identified renewal needs, are listed in the following table.

Asset	Year Built	Age (years)	Renewal Needs
Bow Bowing ZS	1986	31	Nil renewal needs
Bringelly ZS	1991	26	Nil renewal needs
Hinchinbrook ZS	2007	10	Nil renewal needs
Kemps Creek ZS	1972	45	Nil renewal needs
Luddenham ZS	1966	51	Renewal needs which are included in the SARP 2017/18 for consideration within the next 10 years include: TS173 – 2021/22 – Replace 11kV switchboard truck replacement – 8 oil-insulated CB TS009 – 2018/19 – 11 kV auxiliary switchgear replacement
Narellan ZS	2001	16	Nil renewal needs
Nepean TS	1970	47	Renewal needs which are included in the SARP 2017/18 for consideration within the next 10 years include: TS004 – 132kV HPF512A/2F CB replacement – 4 TS055 – 66kV HLC72.5/1600 CB replacement – 9 TS016 – 2020/21 – VT and CT replacement
Prestons ZS	2001	16	Nil renewal needs
West Liverpool TS	1967	50	Renewal needs which are included in the SARP 2017/18 for consideration within the next 10 years include: TS016 – 2020/21 – VT and CT replacement TS179 – 33kV wall bushing replacement
West Liverpool ZS	2013	4	Nil renewal needs
Feeder 512			Nil renewal needs

Table 2. Zone and transmission substation renewal needs

The above table shows that there are limited renewal needs in the network in the area of the South West Priority Growth Area and that these needs have minimal impact on determining the ultimate supply strategy for increased capacity. As there is little scope for installing new capacity based on the condition of the existing assets, at least in the short to medium term, the installation of new assets is anticipated to be driven by capacity constraints.

5.0 Study Design Considerations

The majority of the existing electricity infrastructure in the study area is of a light, rural nature and is limited in its ability to supply any load arising from redevelopment of the South West Priority Growth Area. In other words, items of major infrastructure will need to be established prior to developments being completed. It may not be possible to provide supplies to initial phases of development from the existing infrastructure.

Due to the difficulties in establishing overhead electricity infrastructure, particularly high capacity lines, the following basic design considerations have been used in the determination of a suitable network topology:

- Lines should be to the current Endeavour Energy standards, namely single pole lines with line post insulators using a single conductor wherever possible.
- Mesh 132kV is preferred, but changeover schemes are acceptable.

- c) The use of standard capacity overhead feeders will allow standard underground installations where required.
- d) Existing lines and easements should be used wherever practicable. Both 93X (Sydney West to Nepean tee Bringelly) and 93Y (West Liverpool to Nepean) traverse part of the development area. In addition, parts of 33kV feeder 512 (Kemps Creek to Luddenham tee Bringelly) are constructed at 132kV and should be used for this purpose where possible.
- e) The use of 11kV as the distribution voltage. Although a majority of the existing 11kV in the area is of light, rural design, there are enough assets in place to make any conversion to an alternative distribution voltage difficult, involving complex changeover procedures and possibly lengthy and multiple interruptions to customers.

6.0 Existing Supply Arrangements

The South West Priority Growth Area is currently serviced by a largely rural overhead 11kV network with sparsely located rural standard zone substations. The existing network cannot service the significant step change in loads that will ultimately materialise as a result of wholesale rezoning of land by the NSW State Government.

The existing transmission and sub-transmission network within the South West Priority Growth Area is shown in Figure 1.. Denham Court Transmission Substation is being installed with a primary purpose of supplying the South West Rail Link.

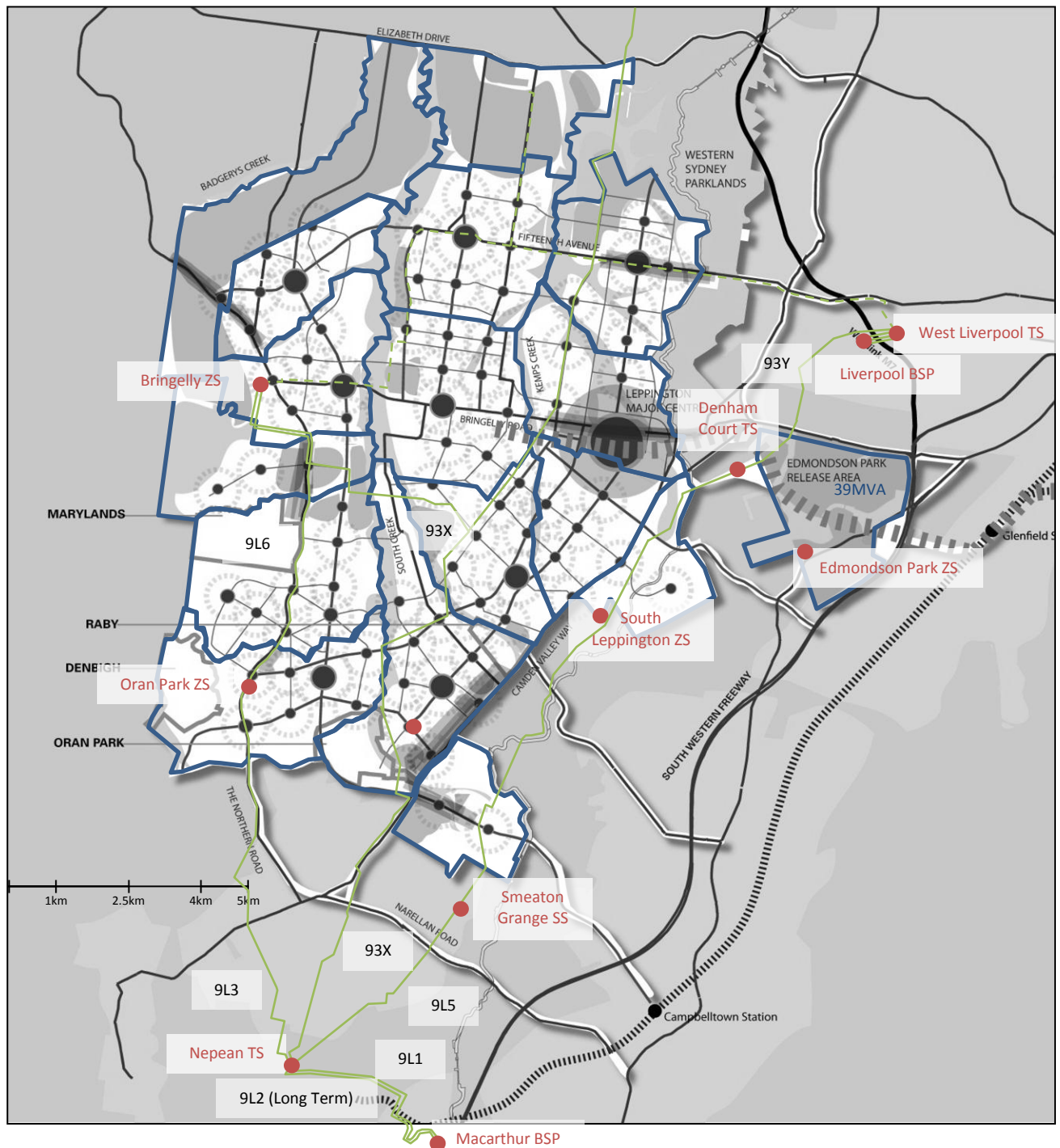


Figure 1. Existing Network (including approved projects)

Sub-transmission Line Capacity

The sources that supply the 132kV network shown in Figure 1 are ultimately connected by feeders 93X (Sydney West BSP to Nepean TS tee Bringelly ZS), 93Y (West Liverpool TS to Denham Court TS) and the proposed 9L1 (Macarthur BSP to Nepean TS). These feeders have ratings that limit the ability of the existing 132kV network to supply the ultimate load of the South West Priority Growth Area as well as Nepean TS. The ratings of the feeders are shown in Table 3 below, these ratings include emergency rating where available.

Feeder	Rating (
93X	148.6MVA
93Y	148.6MVA
9L1	334MVA
Firm Rating	297MVA

Table 3. Existing 132kV feeder ratings.

Although the second feeder 132kV feeder 9L2 has already been constructed between Macarthur BSP and Nepean TS it will be operated at 66kV initially (known as 85L) to provide supply security for the single 330kV/66kV transformer at Macarthur. Converting to this feeder to 132kV operation will be triggered by load growth and will need to be accompanied by duplication of the existing single 330/132kV and 330/66kV transformers at Macarthur.

To determine whether the existing network has sufficient capacity to supply the long term needs of the South West Priority Growth Area, the network capacity can be compared to the expected demand on the network. The demand on the subject network will come from Nepean TS, Denham Court TS and the South West Priority Growth Area. Note that, as mentioned previously, Edmondson Park will be normally supplied by the 33kV West Liverpool TS and, therefore, will only impact of 132kV feeder 93Y under contingency conditions on the 33kV network. The expected ultimate load on the 132kV network is shown in Table 4 below, including the loads that the network supplies outside of the defined South West Priority Growth Area boundaries.

Location	Expected Ultimate Load
South West Priority Growth Area	509MVA
Western Sydney Priority Growth Area	337MVA
Edmondson Park	-38MVA
Nepean TS	152MVA
Total Load	960MVA

Table 4. 132kV ultimate load estimate

Tables 3 and 4 show that the expected demand is significantly greater than the firm rating of the existing network. Therefore, additional 132kV capacity is required to supply the ultimate needs of the South West Priority Growth Area.

7.0 Demand Management Strategy

In accordance with Company Policy 9.2.8 Demand Management, Endeavour Energy investigates demand management (DM) options for all major projects meeting the criteria as stipulated in the National Electricity Rules (NER) Chapter 5 Part B – Network Planning & Expansion. The Rules state all distribution network limitations with a credible network option greater than \$5 million must be screened for non-network (demand management) options and, if feasible, investigate non-network alternatives via a RIT-D consultation process.

The screening test is applied to ascertain whether it is feasible to expect that the number and type of electricity customers driving the identified electricity network limit will respond to demand management initiatives. Generally, demand management can be effective in deferring network augmentation where demand growth is organic as part of normal customer behaviour. Where the area is a substation “green field” site, demand management has to change the demand of future customers to be effective. This is the case with the SWPGA, which mainly consists of the conversion of rural lands to urban and industrial use. Demand management will not avoid the need to establish electricity connection assets in order to supply the SWPGA but may have the potential to defer future network augmentation.

No submissions have been received from interested parties or non-network providers for recent projects progressing through the RIT-D process, including North Leppington ZS, South Leppington ZS Stage 2, Catherine Park 11kV feeders.

Demand management's ability to postpone the need to augment the electricity network in the future depends on the type of demand management program and the uptake by customers. Programs may be either permanent or temporary demand reducing initiatives. Permanent demand reduction is preferred in the early stages of the program where temporary demand reduction initiatives may be utilised as the peak demand is approaching network capacity limits. Examples of temporary demand reducing initiatives include peak time rebate and air conditioning cycling in the residential sector and load curtailment programs in the industrial/commercial sectors. Permanent demand reduction initiatives may include dynamic pricing in the residential sector and efficient appliances and lighting in the industrial/commercial sectors.

8.0 Strategy to Supply the Ultimate Load

This section outlines the strategy options that have been developed to establish the major electrical infrastructure that is required to service the expected ultimate demand of the South West Priority Growth Area. This major infrastructure includes zone substations (132/11 and 33/11kV), sub-transmission network (132 and 33kV feeders) and bulk supply points (owned and operated by Transgrid). The existing network is presented as well as options to modify it in order to meet the network need. Note that the strategy for the distribution network (11kV) is not discussed within this document as it will be planned for and established as part of individual developments. The topology of the distribution network is contingent on the upstream network, the plan for which is to be addressed within this area study.

8.1 Proposed Ultimate Network Topology

Given the anticipated load of the South West and Western Sydney Priority Growth Area, and the geographical spread of this load across the various precincts, a network topology has been developed in order to service the development by best utilising the existing assets. Further, the proposed network is broadly based on the design requirements of Section 5.0 and Endeavour Energy's Network Configuration Standard.

Transgrid had established Macarthur BSP for the purposes of supplying growth in the South West Priority Growth Area. There is a plan to augment Macarthur BSP to duplicate the existing single 375MVA transformer and correspondingly duplicate 132kV feeder 9L1 from Macarthur to Nepean by establishing feeder 9L2.

However Macarthur BSP will not have sufficient capacity to manage all new development in the South West and Western Sydney Priority Growth Area, noting that Macarthur BSP will also supply the Greater Macarthur South Area (at 66kV). In joint planning to date with Transgrid the preferred option to address the future shortfall in BSP capacity is to establish a new 132kV BSP at Kemps Creek.

It has been determined that it will be possible to service the development with a total of fourteen zone substations, thirteen of which are to be supplied at 132kV (nine 45MVA and four 90MVA substations). Two of the existing zone substations (Bringelly and Kemps Creek) are supplied, or backed up, at 33kV and will be required to be augmented and converted to 132kV as appropriate. The ultimate loads on each zone substation have been estimated in Table 5 below.

Zone Substation	Supplying Precinct	Residential Load (MVA)	Employment Load (MVA)	ZS Load (MVA)
Kemps Creek ZS	Kemps Creek	4.0	39.8	43.8
Oakey Creek ZS	Future Industrial (2 precincts)	0.0	90.5	90.5
	Kemps Creek			
North Bringelly ZS	North Bringelly	20.0	70.6	90.6
	Future Industrial (2 precincts)			
North Rossmore ZS	North Rossmore	28.8	0.0	28.8
	Rossmore (SW)			
Rossmore ZS	Rossmore (SW)	38.4	5.2	43.6
	Austral			
	Catherine Fields North			
Austral ZS	Austral	40.4	1.4	41.8
North Leppington ZS	Leppington North (SW)	63.7	26.4	90.1
	Leppington North (WS)			
Bringelly ZS	Bringelly (SW)	43.9	11.7	55.6
	Lowes Creek			
Marylands ZS	Marylands	80.3	8.7	89.1
	Lowes Creek			
	Lowes Creek/Maryland PAP			
Oran Park ZS	Oran Park	43.2	2.3	45.5
	Marylands			
North Catherine Park ZS	Catherine Fields North	43.0	2.2	45.2
	Leppington (balance)			
	Catherine Fields			
Catherine Park ZS	Catherine Fields	81.9	7.5	89.4
	Oran Park			
	Catherine Fields (Part)			
	Turner Road			
South Leppington ZS	East Leppington (part – C'town & Camden)	54.4	0.0	54.4
	East Leppington (part - Liverpool LGA)			
	Leppington (balance)			
	Emerald Hills			
	Gledswood Hills			
	Leppington (Stage 1)			
Edmondson Park ZS*	East Leppington (part – C'town & Camden)	37.7	0.0	37.7
	Edmondson Park			
Data Centre**		0	120	120

Table 5. ZS ultimate loads

* Edmondson Park is considered part of the South West Priority Growth area but is supplied by the existing Edmondson Park ZS connected to Liverpool BSP.

** Data Centre – Major customer connection not under priority growth plans

Note that standard 132/11kV 45 and 90MVA zone substations are limited to 106% of the power transformer rating by the transformer circuit breakers (from Section 5.7.3.4 and 5.7.3.5 of Network Configuration SDI 501). Higher ratings will be required for equipment, such as the transformer circuit breakers, transformer cables, etc., in instances where the required capacity is greater than that specified within SDI 501.

In selecting a ZS site, particularly for a 90MVA ZS, consideration should be given to providing sufficient site frontage such that the cables to be connected to the ZS do not limit the firm capacity. Consideration needs to be given to not just the de-rating resulting from cables within the same ducts bank, but also the de-rating caused by adjacent duct banks.

8.1.1 Ultimate Configuration

In order to cater for the shortfall in supply capacity outlined in Section 6.0, it is proposed that a new 330/132kV BSP be established, with two 375MVA transformers, at the existing Kemps Creek 500/330kV Substation. The proposed network topology, with this new BSP established, is shown in Figure 2, below.

The proposed network topology, shown in Figure 2, splits the South West and Western Sydney Priority Growth Area load over three BSPs: Kemps Creek, Liverpool and Macarthur. Note that the Western Sydney Airport and Broader Western Sydney Employment area zones are not shown. The loads placed on each of these supply points from the South West Priority Growth Area, as well as the expected ultimate loads (including load from established areas), are shown in Table 6 below.

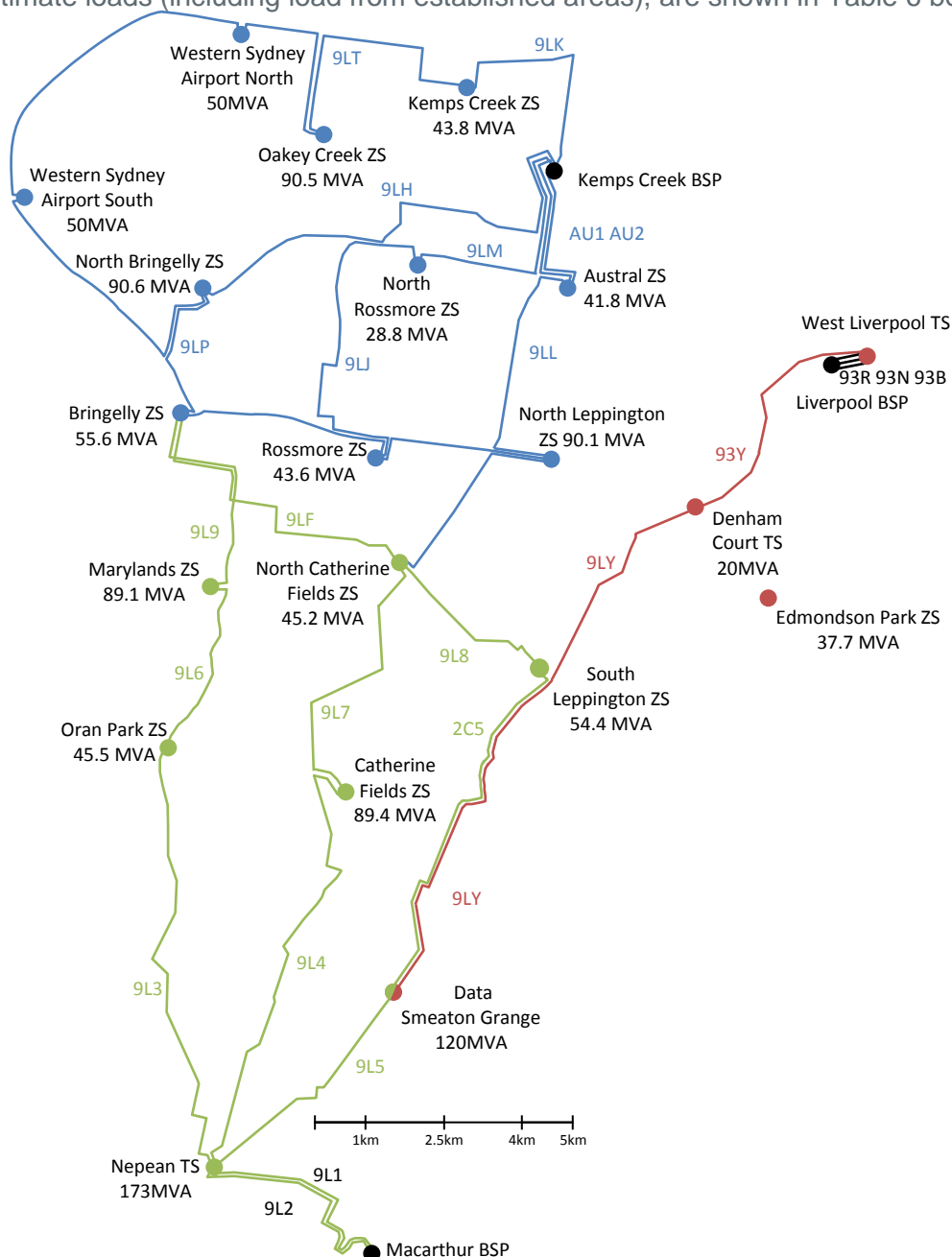


Figure 2. Ultimate network topology - Kemps Creek BSP

Bulk Supply Point	Firm Capacity (MVA)	South West Priority Growth Area Load (MVA)	Ultimate Load (MVA)	Diversified Ultimate Load (MVA)
Kemps Creek	400 ¹	189.3	827.8.6 ²	792.2
Liverpool	750	37.731	555.7 ³	640.2
Macarthur	400 ¹	323.5	535.5 ⁴	417.1
Total	1550	550.5	1918.9	1849.5

Table 6. BSP ultimate loads with Kemps Creek BSP

¹ Rating allows for cyclic rating of a 375MVA transformer

² Load is the addition of the South West Priority Growth Area, Western Sydney Priority Growth Area and Broader Western Sydney Employment area load.

³ Load is the addition of the South West Priority Growth Area load and the expected ultimate load on Liverpool BSP due to West Liverpool TS, Liverpool TS, Denham Court TS and Abbotsbury ZS.

⁴ Load is the addition of the South West Priority Growth Area load, Data Centre and the expected ultimate load at Nepean TS. Diversity factors for Summer 2017 from the Summer 2018 forecast were used to calculate the diversified ultimate loads. Macarthur - 0.779; Liverpool - 1.152; Sydney West diversity factor was used for Kemps Creek - 0.957.

The diversified ultimate loads shown in Table 6 exceed the installed capacity at both Kemps Creek and Macarthur. Should diversity not be sufficient to keep the load on these supply points below their firm rating, reactive support and/or changeover routines may be required for the loss of a BSP transformer. For example, South Leppington and North Catherine Park can be transferred to Liverpool BSP during N-1 scenarios at Kemps Creek BSP.

A contingency analysis was undertaken for the network shown in Figure 2 in order to determine the efficacy of the proposed network. The analysis showed that there are several instances where lines need to be augmented and reactive support installed in order to provide sufficient capacity to supply the ultimate load of the South West Priority Growth Area under normal and single contingency conditions. The approximate quantity of line works required to overcome these constraints, as well as the new lines required to achieve the proposed network topology, are itemised in Appendix 3 and approximated to total 58km.

In addition to these feeder works and depending on the power factor of the loads that eventuate on the network, it may be necessary to install reactive support at Leppington, North Bringelly and North Catherine Fields zone substations. Modelling has shown that the installation of 10MVar at Leppington will prevent the feeder between Leppington ZS and Denham Court TS from becoming constrained. Further, modelling has shown the reactive support at North Catherine Fields ZS will prevent the voltage at the ZS from deviating outside of the targeted range under contingency conditions. Some further studies are recommended when final load details are clear to optimise the amount of reactive compensation required.

9.0 Staging of Investment

Endeavour Energy minimises the present cost of servicing green field development by taking a staged approach to zone substation construction. This strategy involves considering options for establishing a 132kV relocatable or interim ZS as the first stage of ZS establishment, which will defer the cost of constructing a full zone substation, minimising the net present value, and provide flexibility in managing areas with uncertain growth rates. It is proposed that this strategy will be employed in establishing zone substations for the South West Priority Growth Area where it is economic. In some cases where there are firm plans for a large step change in load, such as a new town centre with high density housing (as in the case of North Leppington) the RIT-D economic modelling has favoured no staging of the zone substation.

The new projects listed in Table 7 below will have separate business case documentation that will include demand forecasts and the justification for timing.

Project	Scope	Year Required	Project Status
2020-2024 Regulatory Period – Completion of Projects Under Construction			
Edmondson Park ZS	Complete 2 nd 33kV feeder to Edmondson Park ZS	2020	Under construction
North Leppington ZS	Establish 132/11kV ZS	2020	Under construction
South Leppington ZS	Augment from single transformer interim substation to 2 transformers (132/11kV)	2021	Under construction
2020-2024 Regulatory Period – New Projects			
Austral ZS	Mobile substation	2021	Planning
Catherine Park ZS	Interim ZS	2024	Planning
Maryland ZS	132/11kV ZS Stage 1	2023	Planning

Table 7 Staging of Investment

10.0 Stakeholder Issues

10.1 Transgrid Works

Transgrid are the Transmission Network Provider in NSW. They provide the main “grid injection points” in the form of Bulk Supply Points that supply Endeavour Energy’s network, and, as such, the two organisations conduct joint planning in relation to these connection points. The provision of supply to an estimated 810MVA of load in the South West Priority Growth Area is to be ultimately met by capacity provided by Transgrid. Macarthur BSP was established (in 2009) by Transgrid to provide support to the Campbelltown 66kV network as well as to the 132kV network supplying Nepean TS and the South West Priority Growth Area. Further, Transgrid have an existing 500/330kV substation that is located at Kemps

Creek, towards the northern perimeter of the subject land release area. This is the proposed location for the 330/132kV BSP put forward in Ultimate Network Topology Option 1. It is expected that this proposed BSP can be accommodated on the existing 500/330kV substation site. Initial joint planning has commenced with Transgrid in relation to establishing this BSP, and the issues concerning this option will be progressively explored in future joint planning meetings between the two organisations.

10.2 Developers and Landowners

In order to obtain the appropriate land to build each ZS and the corridors for the connecting feeders, it is important that Endeavour Energy is involved in the subdivision planning stage of the developments. The manner in which developments take place is important from a land acquisition and corridor development perspective. Areas with fragmented land ownership can make the delivery of major infrastructure to large development risky, costly, time inefficient and difficult to achieve. Past experience has shown that these issues can be exacerbated by negotiations with private landowners that have either no vested interest in the development requiring supply or that have no long term view of the infrastructure servicing needs. However, areas of fragmented land ownership are also less likely to develop at a fast pace. It is critical that the following issues be considered and addressed where appropriate based on learnings from past experience:

- Endeavour Energy needs to actively support Department of Planning & Infrastructure in their efforts to coordinate development in areas of fragmented land ownership.
- Early discussions need to be held to determine options for incorporating existing and future infrastructure into precinct master plans (involving the NSW Department of Planning and Environment). This should incorporate the need for relocation and the identification of feasible options where required.

Zone substation sites and line corridors should be identified on precinct master plans from the outset where appropriate.

- Early strategic acquisition of zone substation sites and transmission line corridors can be advantageous due to lower land prices (pre-rezoning) and fewer environmental constraints (not surrounded by existing residential dwellings). It is also necessary to compare the cost of easement acquisition for overhead transmission lines versus undergrounding or use of the road reserve.
- Transmission line design and construction has a longer lead time than zone substations due to the ability to secure appropriate line routes. Consideration should be given to issuing projects for transmission line design and easement acquisition ahead of approval for final construction of the transmission lines and zone substations.

There is a need to have a consistent process by which the necessary properties and line easements can be acquired. The preferred option would be that suitable substation locations and line corridors are identified at an early stage and these included on precinct master plans. As design work on the development proceeds, final details of sites and corridors can be determined in discussions between developers and Endeavour Energy. Upon finalisation of the infrastructure location, Endeavour Energy will make arrangements with the developer to acquire the appropriate tenure over the agreed locations. NSW Department of Planning and Environment have established a policy level reference group for “Corridor Preservation and Management Review”. Endeavour Energy will be an active participant in this reference group.

10.3 General Environmental Considerations

The construction and upgrading of zone substations and the connecting lines will be assessed under the Environmental Planning and Assessment Act (1979) (the Act). Reviews of Environmental Factors (REFs) will be prepared for all activities and depending on the impacts of the proposals,

Environmental Assessments may be required for some of the works and therefore extensive community involvement and community consultation would be required. Depending on the complexity

of a project, the Environmental Assessment process can take between 12 – 24 months before environmental approval is obtained and construction of a project can commence. Allowance of sufficient forward planning time is therefore essential. The planning process needs to ensure that electrical infrastructure can be installed in strategic locations and be located adjacent to suitable compatible land uses to minimise the impacts to the environment and the community.

11.0 Recommendations

It is recommended that the following points be adopted:

1. The proposed Ultimate Network Topology – (Kemps Creek BSP) outlined within this report be carried forward as the basis for further planning within the South West Priority Growth Area. Individual projects based on the principles outlined in this report will be developed separately and funding sought for each of these projects at the appropriate level and time.
2. This strategy has estimated total investment requirements of approximately \$100million over the next decade. Projects proposed to be completed in the 2020-2024 regulatory period with a total investment requirement of \$52m (real \$ FY19) include:
 - Completion of Edmondson Park ZS and North Leppington ZS projects
 - Completion of South Leppington ZS
 - Establishment of Marylands ZS
 - Establishment of Austral ZS (mobile)
 - Establishment of Catherine Park ZS

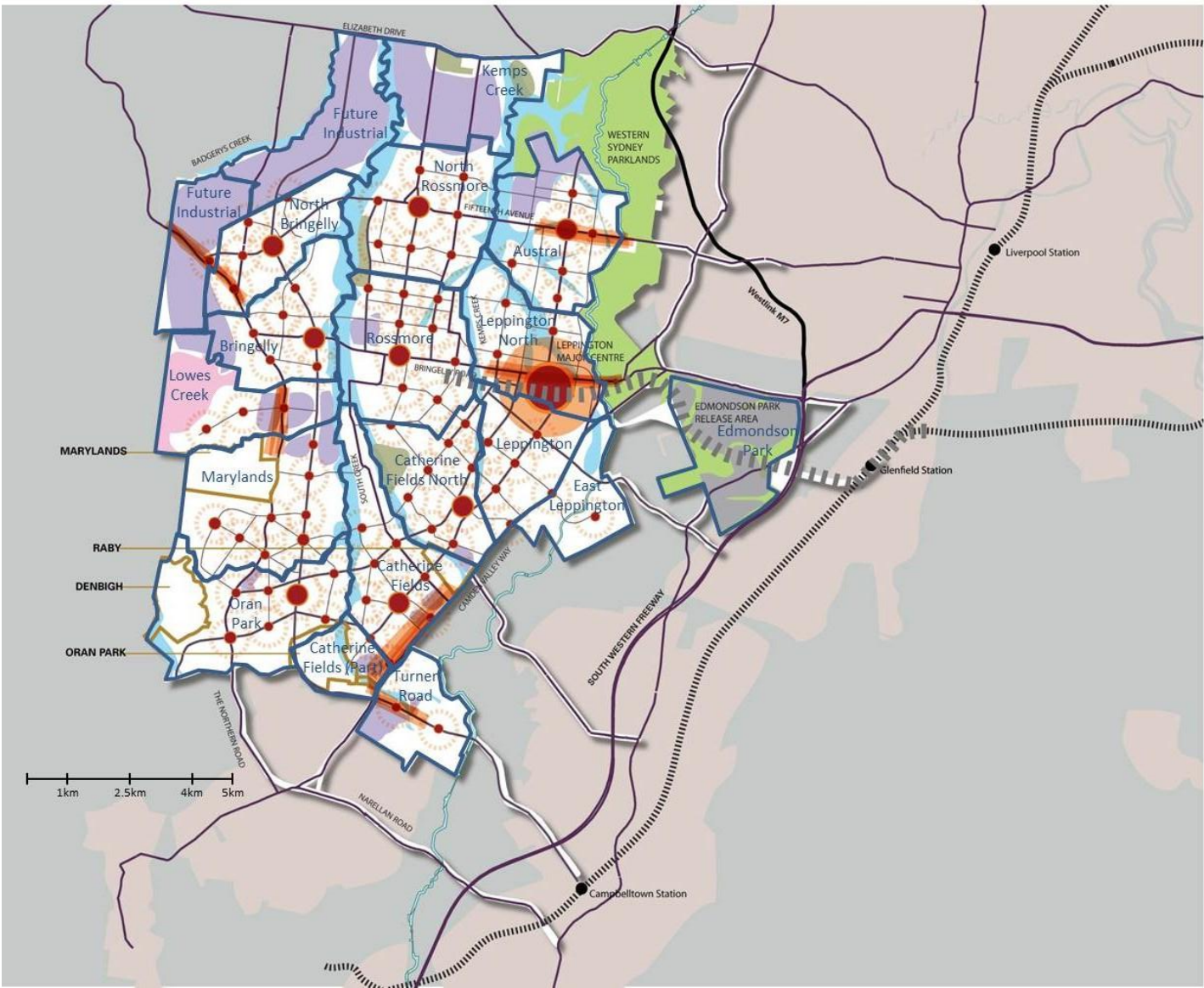
Projects in the 2025-29 regulatory period that will be considered include:

- Stage 2 investments for zone substations that will have temporary or mobile solutions installed in the 2020-24 period
 - Establishment of Catherine Fields North ZS
 - Establishment of Rossmore ZS
 - 132kV connections works associated with Kemps Creek BSP.
3. Continue Joint Planning with Transgrid on the establishment of 330/132kV Kemps Creek BSP
 4. Engage in discussions with the Department of Planning and Environment to ensure that zone substation sites and line corridors are included in the development of master plans for South West Priority Growth Area precincts.
 5. Continue discussions with the Department of Planning and Environment on an ongoing basis to ensure that Endeavour Energy's staging for the establishment of major infrastructure is in line with projected development timing.

It is noted that demand management initiatives and changes in electricity demand may modify the ultimate load of the South West Priority Growth Area as well as the timing of the required infrastructure. This will be assessed at the RIT-D stage of each project.

12.0 Appendices

SOUTH WEST GROWTH CENTRE STRUCTURE PLAN (EDITION 3)



LEGEND

DISCLAIMER: The Structure Plan is an indicative regional land use plan that will guide the detailed planning for Precincts when they are released.

- MAJOR CENTRES
- TOWN & VILLAGE CENTRES
- WALKABLE NEIGHBOURHOODS
A key element of the urban form is the walkable neighbourhood which is the area within a 400 metre radius from a local shop (or group of shops) or from another community focus (eg a community centre with a bus stop). Walkable neighbourhoods are clustered around mixed use main street retail centres shown as red on the plan. These centres include housing, community facilities, shops for daily convenience etc.
- SOUTH WEST RAIL LINK
As part of the Government's commitment to deliver better, sustainable new communities a new rail line will be constructed to serve the new communities. The Government is currently considering the preferred alignment.
- FLOOD LIABLE LAND & MAJOR CREEKS
- CONSERVATION / OPEN SPACE
- HERITAGE CURTILAGES
- TRANSITIONAL LANDS
- INDUSTRIAL / EMPLOYMENT LANDS
- MIXED USE EMPLOYMENT CORRIDORS

Appendix 2 Contingency Tables – ultimate configuration

		Contingency Loading (MVA)																																		
Circuit	From To	None	AU1	AU2	9LL	9LN	9LY	2C5	93Y	93R	93N	93B	9L1	9L2	9L3	9L4	9L5	9L6	9L7	9L8	9LF	9L9	9LB	9LG	9LH	9LJ	9LK	9LM	9LP	9LT	WSAS	WSAN	WSA-LINK	Rating S (MVA)	Rating I (kA)	
AU1	KempsCreek BSP to Austral ZS	67.6	X	124.5	22.2	67.7	67.6	80.0	80.0	67.6	67.6	67.6	X	X	80.0	108.1	80.0	67.6	67.6	67.6	67.6	67.8	71.9	103.0	69.7	67.8	80.8	82.5	71.7	64.5	69.3	67.5	144.5	0.632		
AU2	KempsCreek BSP to Austral ZS	63.7	123.6	X	20.9	63.8	63.7	75.4	75.4	63.7	63.7	63.7	X	X	75.4	101.8	75.4	63.7	63.7	63.7	63.7	63.9	67.7	97.1	65.7	63.9	76.1	77.7	67.5	60.8	65.3	63.6	199.8	0.874		
9LL	Austral ZS to North Leppington ZS	88.2	80.3	81.1	X	88.3	88.2	112.2	112.2	88.2	88.2	88.2	X	X	112.2	166.7	112.2	88.2	88.2	88.2	88.2	88.5	96.5	156.7	92.3	88.6	113.6	117.0	96.0	82.2	91.5	88.0	199.8	0.874		
9LN	North Leppington ZS to North Catherine Fields ZS	0.9	0.9	0.9	0.9	X	0.9	46.6	46.6	0.9	0.9	0.9	X	X	46.6	153.0	46.6	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	192.5	0.842		
9LY_1	Denham Court TS to Tee	60.3	60.3	60.3	60.3	60.3	X	60.3	36.2	60.3	60.3	60.3	X	X	60.3	60.3	121.9	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	60.3	199.8	0.874	
9LY_3	Smeaton Grange SS to Tee	60.2	60.2	60.2	60.2	60.2	X	60.2	36.2	60.1	60.1	60.1	X	X	60.2	60.2	121.1	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	60.2	199.8	0.874	
2C5	Smeaton Grange SS to South Leppington ZS	72.8	72.8	72.8	72.8	72.8	59.8	X	1.4	72.8	72.8	72.8	X	X	118.8	56.1	1.4	116.3	93.9	57.9	70.3	70.2	72.8	72.8	99.1	99.1	99.1	72.8	72.8	72.8	72.8	72.8	72.8	192.5	0.842	
93Y	West Liverpool TS to Denham Court TS	95.4	95.4	95.4	95.4	95.4	36.2	95.4	X	95.3	95.3	95.3	X	X	95.4	95.4	158.0	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	95.4	148.6	0.65	
93R	Liverpool BSP to West Liverpool TS	188.6	188.6	188.6	188.6	188.6	168.4	188.6	158.1	X	283.5	283.4	X	X	188.6	188.6	209.7	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	188.6	375.0	1.64	
93N	Liverpool BSP to West Liverpool TS	190.9	190.9	190.9	190.9	190.9	170.5	190.9	159.9	285.8	X	287.4	X	X	190.9	190.9	212.2	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	190.9	375.0	1.64	
93B	Liverpool BSP to West Liverpool TS	190.8	190.8	190.8	190.8	190.8	170.4	190.8	159.8	285.5	287.2	X	X	X	190.8	190.8	212.1	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	190.8	375.0	1.64	
9L1	Macarthur BSP to Nepean TS	294.9	294.9	294.9	294.9	294.9	324.2	272.1	318.2	294.9	294.9	294.9	X	X	275.1	222.2	243.9	295.9	295.1	295.7	294.9	295.3	294.9	294.9	324.6	324.6	324.6	294.9	294.9	294.9	294.9	294.9	294.9	294.9	232.7	1.018
9L2	Macarthur BSP to Nepean TS	294.9	294.9	294.9	294.9	294.9	324.2	272.1	318.2	294.9	294.9	294.9	X	X	275.1	222.2	243.9	295.9	295.1	295.7	294.9	295.3	294.9	294.9	324.6	324.6	324.6	294.9	294.9	294.9	294.9	294.9	294.9	294.9	232.7	1.018
9L3	Nepean TS to Oran Park ZS	137.1	137.1	137.1	137.1	137.1	142.2	147.6	147.4	137.1	137.1	137.1	X	X	X	142.5	147.5	49.2	151.9	143.9	142.7	143.7	137.1	137.1	142.6	142.6	142.6	137.1	137.1	137.1	137.1	137.1	137.1	145.0	0.634	
9L4	Nepean TS to Catherine Park ZS	140.5	140.5	140.5	140.5	140.5	147.6	156.7	155.8	140.5	140.5	140.5	X	X	189.8	X	156.5	186.7	106.2	151.3	137.9	137.8	140.5	140.5	168.3	168.3	168.3	140.5	140.5	140.5	140.5	140.5	140.5	199.8	0.874	
9L5	Nepean TS to Smeaton Grange SS	132.8	132.8	132.8	132.8	132.8	180.3	60.0	155.0	132.8	132.8	132.8	X	X	179.5	116.1	X	177.2	154.7	117.7	130.1	130.0	132.8	132.8	159.5	159.5	159.5	132.8	132.8	132.8	132.8	132.8	132.8	171.9	0.752	
9L6	Oran Park ZS to Marylands ZS	86.8	86.8	86.8	86.8	86.8	91.7	97.1	96.8	86.8	86.8	86.8	X	X	49.3	92.1	96.9	X	101.4	93.3	92.3	93.3	86.8	86.8	92.3	92.3	92.3	86.8	86.8	86.8	86.8	86.8	86.8	145.0	0.634	
9L7	Catherine Park ZS to North Catherine Fields ZS	37.0	37.0	37.0	37.0	37.0	44.9	52.0	51.9	37.0	37.0	37.0	X	X	83.0	106.1	51.8	81.4	X	46.1	33.9	33.9	37.0	37.0	63.6	63.6	63.6	37.0	37.0	37.0	37.0	37.0	37.0	192.5	0.842	
9L8	North Catherine Fields ZS to South Leppington ZS	17.5	17.5	17.5	17.5	17.5	7.5	57.8	57.2	17.5	17.5	17.5	X	X	62.2	4.2	57.3	59.4	37.4	X	15.8	15.6	17.5	17.5	42.9	42.9	42.9	17.5	17.5	17.5	17.5	17.5	17.5	192.5	0.842	
9LF	Bringelly ZS to North Catherine Fields ZS	6.5	6.5	6.5	6.5	6.5	3.1	7.7	6.9	6.5	6.5	6.5	X	X	143.7	0.4	7.3	93.0	9.2	6.4	X	0.4	6.5	6.5	58.5	58.5	58.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	229.8	1.005
9L9	Bringelly ZS to Marylands ZS	6.6	6.6	6.6	6.6	6.6	2.8	7.4	6.5	6.6	6.6	6.6	X	X	142.7	2.9	6.9	93.2	9.1	6.0	2.5	X	6.6	6.6	2.5	2.5	2.5	6.6	6.6	6.6	6.6	6.6	6.6	145.0	0.634	
9LB	Rossmore ZS to Bringelly ZS	6.4	7.7	7.3	62.6	6.2	6.4	17.0	17.0	6.4	6.4	6.4	X	X	17.0	54.0	17.0	6.4	6.4	6.4	6.4	6.4	X	9.4	137.4	50.2	6.0	59.2	58.5	18.4	12.7	10.5	4.6	192.5	0.842	
9LG	North Leppington ZS to Rossmore ZS	8.4	16.0	15.2	96.0	8.5	8.4	31.3	31.3	8.4	8.4	8.4	X	X	31.3	84.2	31.3	8.4	8.4	8.4	8.4	8.4	8.0	X	60.9	4.2	8.0	17.2	20.9	1.0	14.1	5.0	8.6	133.3	0.583	
9LH	KempsCreek BSP to North Bringelly ZS	198.2	202.0	201.6	241.2	198.3	198.2	209.9	209.9	198.2	198.2	198.2	X	X	209.9	235.8	209.9	198.2	198.2	198.2	198.2	198.2	199.0	194.4	X	192.6	227.0	238.7	159.8	243.2	163.7	217.3	197.4	192.5	0.842	
9LJ	North Rossmore ZS to Rossmore ZS	53.7	56.0	55.8	80.6	53.7	53.7	60.8	60.8	53.7	53.7	53.7	X	X	60.8	76.9	60.8	53.7	53.7	53.7	53.7	53.7	54.0	51.3	123.0	X	54.1	30.0	82.7	61.5	47.7	57.0	53.5	145.0	0.634	
9LK	KempsCreek BSP to KempsCreek ZS	209.1	209.9	209.8	217.7	209.1	209.1	212.0	212.0	209.1	209.1	209.1	X	X	212.0	217.6	212.0	209.1	209.1	209.1	209.1	209.1	209.2	208.3	211.7	208.6	X	217.1	201.3	46.3	231.3	140.7	211.0	192.5	0.842	
9LM	KempsCreek BSP to North Rossmore ZS	83.7	86.0	85.8	110.5	83.7	83.7	90.8	90.8	83.7	83.7	83.7	X	X	90.8	106.8	90.8	83.7	83.7	83.7	83.7	83.7	84.0	81.3	153.0	30.0	84.1	X	112.7	91.5	77.6	87.0	83.5	192.5	0.842	
9LP	North Bringelly ZS to Bringelly ZS	57.2	62.6	62.0	118.9	57.2	57.2	73.2	73.2	57.2	57.2	57.2	X	X	73.2	110.0	73.2	57.2	57.2	57.2	57.2	57.2	58.5	51.7	138.5	48.0	11.0	115.6	X	41.9	69.0	50.7	57.3	192.5	0.842	
9LT	KempsCreek ZS to Oakey Creek ZS	164.6	165.3	165.3	173.1	164.6	164.6	167.5	167.5	164.6	164.6	164.6	X	X	167.5	173.1	167.5	164.6	164.6	164.6	164.6	164.6	164.7	163.8	167.3	164.2	46.2	172.5	156.9	X	186.7	96.7	166.6	192.5	0.842	
WSAS	North Bringelly ZS to Western Sydney Airport South	49.8	48.2	48.4	30.8	49.8	49.8	45.6	45.6	49.8	49.8	49.8	X	X	45.6	34.5	45.6	49.8	49.8	49.8	49.8	49.8	49.2	51.5	45.9	53.4	137.3	31.6	66.5	109.8	X	75.3	48.5	192.5	0.842	
WSAN	Oakey Creek ZS to Western Sydney Airport North	70.2	70.9	70.9	78.7	70.2	70.2	73.2	73.2	70.2	70.2	70.2	X	X	73.2	78.9	73.2	70.2	70.2	70.2	70.2	70.2	70.3	69.4	73.1	69.9	140.5	78.1	62.5	96.8	92.2	X	72.3	192.5	0.842	
WSA-LINK	Western Sydney Airport North to Western Sydney Airport South	15.5	15.2	15.2	20.5	15.4	15.5	15.3	15.3	15.5	15.5	15.5	X	X	15.3	17.7	15.3	15.5	15.5	15.5	15.5	15.5	13.5	16.1	7.8	16.5	92.8	19.6	24.4	66.4	48.2	33.5	X	192.5	0.842	

Table 7. Loads (MVA) - Contingency analysis with Kemps Creek BSP.

Appendix 3 Approximate feeder works with Kemps Creek BSP

Feeder	From To	New (km)	Augment (km)	Rebuild to 132kV / Augment (km)	Total Works (km)
9LJ	North Rossmore ZS to Rossmore ZS	9.0			9.0
9LH	Kemps Creek BSP to North Bringelly ZS	8.9			8.9
2C5	Smeaton Grange SS to South Leppington ZS	7.3			7.3
9LT	Kemps Creek ZS to Oakey Creek ZS	4.8			4.8
9LK	Kemps Creek BSP to Kemps Creek ZS	4.8			4.8
9LB	Rossmore ZS to Bringelly ZS	4.2	0.5		4.7
9LM	Kemps Creek BSP to North Rossmore ZS	4.5			4.5
9LP	North Bringelly ZS to Bringelly ZS	4.0			4.0
9LG	North Leppington ZS to Rossmore ZS	3.4			3.4
9L8	North Catherine Fields ZS to South Leppington ZS	3.4			3.4
AU1	Kemps Creek BSP to Austral ZS	1.5			1.5

Table 8. Approximate feeder works with Kemps Creek BSP