

North West Priority Growth Area Plan

Review of the long term electricity infrastructure
requirements in Sydney's North West Priority Growth
Area

Asset Strategy and Planning

March 2018

REVIEW AND APPROVAL SCHEDULE

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1.0 Executive Summary

This report “North West Priority Growth Area Plan 2018” outlines the status of the current network configuration and reviews the existing network sub-transmission strategy with reference to “North West Sector Area Plan (2014)” and the most recent residential and industrial lot release forecasts provided by NSW Planning and Environment.

In April 2014, Endeavour Energy published the “North West Sector Area Plan”. This study was an evolution of previous area plans and refined the supply strategy for the region to provide direction for new major projects.

The North West Priority Growth Area is located within the boundaries of three local government areas of The Hills, Blacktown and Hawkesbury and is comprised of 16 Precincts. The growth area is approximately 10,000 hectares and was estimated in the 2014 report to contain about 70,000 new dwellings. This figure has since been revised upwards to approximately 90,000 new dwellings.

The total load growth of the precincts within the North West Priority Growth Area is estimated to be up to 355MVA with a development timeframe spanning beyond 2036. Since the previous version of this Area Study was published, new zone substations have been established at Marsden Park (Stage 1) and South Marsden Park (Stage 1). The greater Box Hill region has been converted to 22kV with the initial stages of development in the area being supplied via 2 x 22kV feeders from Mungerie Park ZS. South Marsden Park ZS (Stage 2) has recently begun construction, to establish a permanent zone substation and complete the 132kV loop from Vineyard BSP to Schofields ZS in 2020.

Limited supply is currently available to the precincts of Box Hill, Box Hill Industrial, Box Hill North, Riverstone, Riverstone West, Riverstone East and Vineyard where further sub-transmission infrastructure investments will be required within the forecast period. The unserved load in the North West Priority Growth Area is estimated to be in the order of 145MVA within 25 years, based on the latest data from the “Land Use and Infrastructure Implementation Plan” published by NSW Planning and Environment in May 2017. This report outlines the recommended supply strategy to meet future lot release demand growth in the NWPGA.

The recommended supply strategy is a continuation of the preferred option recommended in the previous area plan with a total real 2017/18 cost of \$98.7M. From the basis of the study it is recommended:

- The Supply Strategy option outlined within this report in section 7.0 is carried forward as the basis for further planning within the North West Priority Growth Area unserved supply area. Individual Network Investment Options (NIO) projects based on the principles outlined in this report will be developed separately and funding sought for each of these projects at the appropriate time.
- Projects proposed to be completed in the 2020-2024 regulatory period with a total investment requirement of \$70.3M (real \$ FY19) include:
 - Acquisition of a suitable property near high capacity feeder 938 along Garfield Rd within Riverstone East precinct
 - Establishment of Box Hill zone substation
 - Construction of 132kV feeder from Vineyard bulk supply point to Box Hill zone substation
 - Establishment of Riverstone East zone substation
 - Augmentation of Marsden Park zone substation to firm 45MVA
- Projects estimated to be required in the 2025-2029 regulatory period have a total investment requirement of \$28.4M (real \$ FY19) include:
 - Construction of 132kV feeder from Box Hill zone substation to Riverstone East zone substation
 - Expansion of Schofields zone substation to firm 90MVA
 - Expansion of Box Hill zone substation to firm 90MVA
 - Expansion of South Marsden Park zone substation to firm 90MVA

2.0 Introduction

The aim of this report is to review the current strategy for supplying precincts within the North West Priority Growth Area (NWPGA) with a focus on areas with limited or no supply capacity. This area includes the precincts of Box Hill, Box Hill North, Box Hill Industrial, Riverstone East, Riverstone, Riverstone West and Vineyard. Refer to Appendix 10.1 for the corresponding Indicative Layout Plans of each individual precinct. These are summarised in Figure 1 along with the existing 132kV and 33kV sub-transmission network in the region. Although there are occasions where Endeavour Energy may use the term “transmission” to describe some assets, it does not own and operate “transmission” network assets as per the definition in the National Electricity Rules.

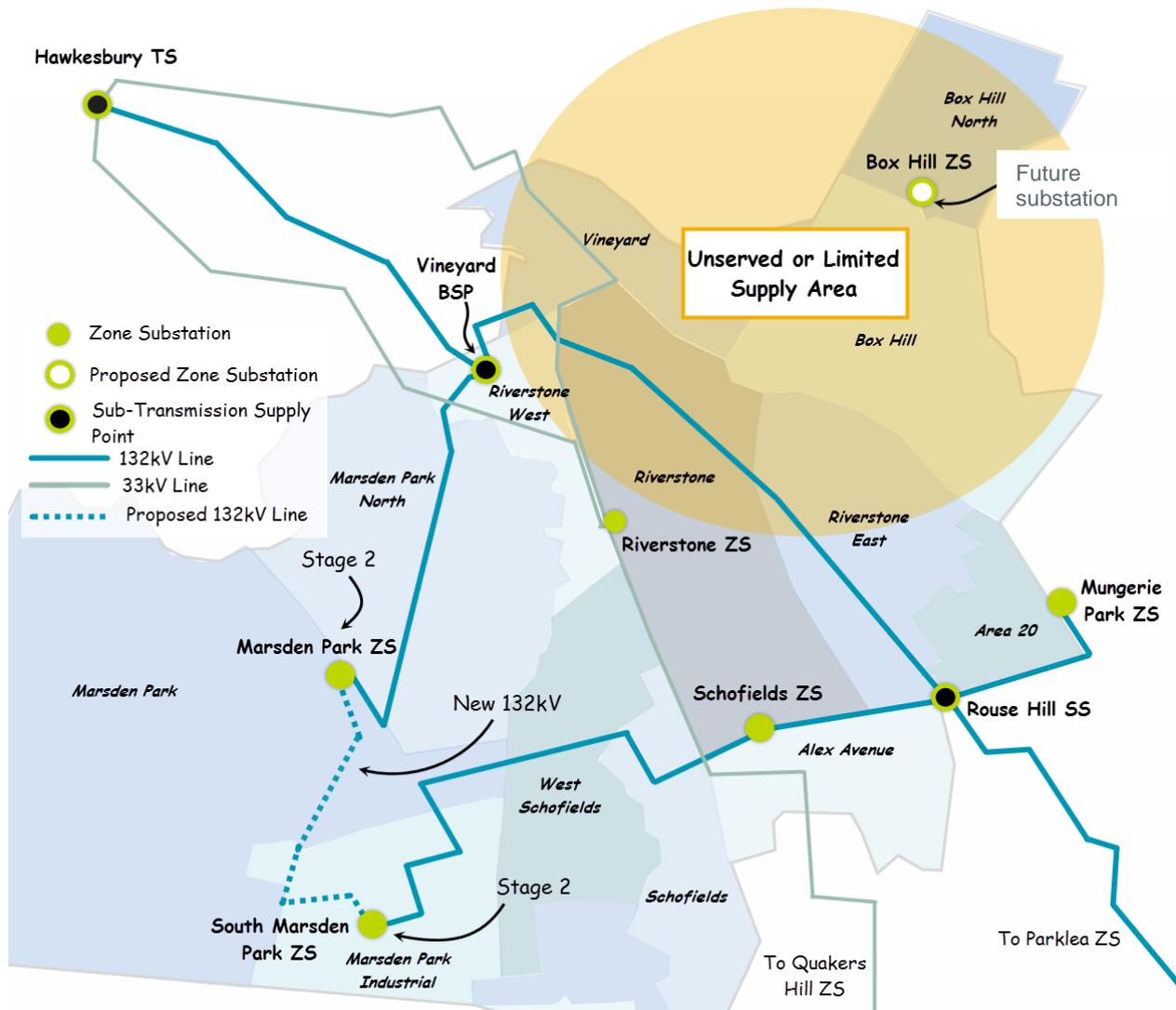


Figure 1 - North West Priority Growth Area Precincts and Sub-Transmission Network

2.1 Previous Area Plan

A supply strategy for the region was presented in the “North West Sector Area Plan” (2014). Various arrangements of 33kV and 132kV infrastructure were explored in the report with 132kV Option 2 being endorsed as the most cost effective solution to satisfying network requirements. A summary of the proposed Option 2 with the various development precinct areas can be seen in Figure 2 below. The coloured areas represent separate precincts within the growth centre as defined by Department of Planning.

This option recommended a 132kV strategy and the acquisition of land for future substations in the Box Hill North and Riverstone East precincts.

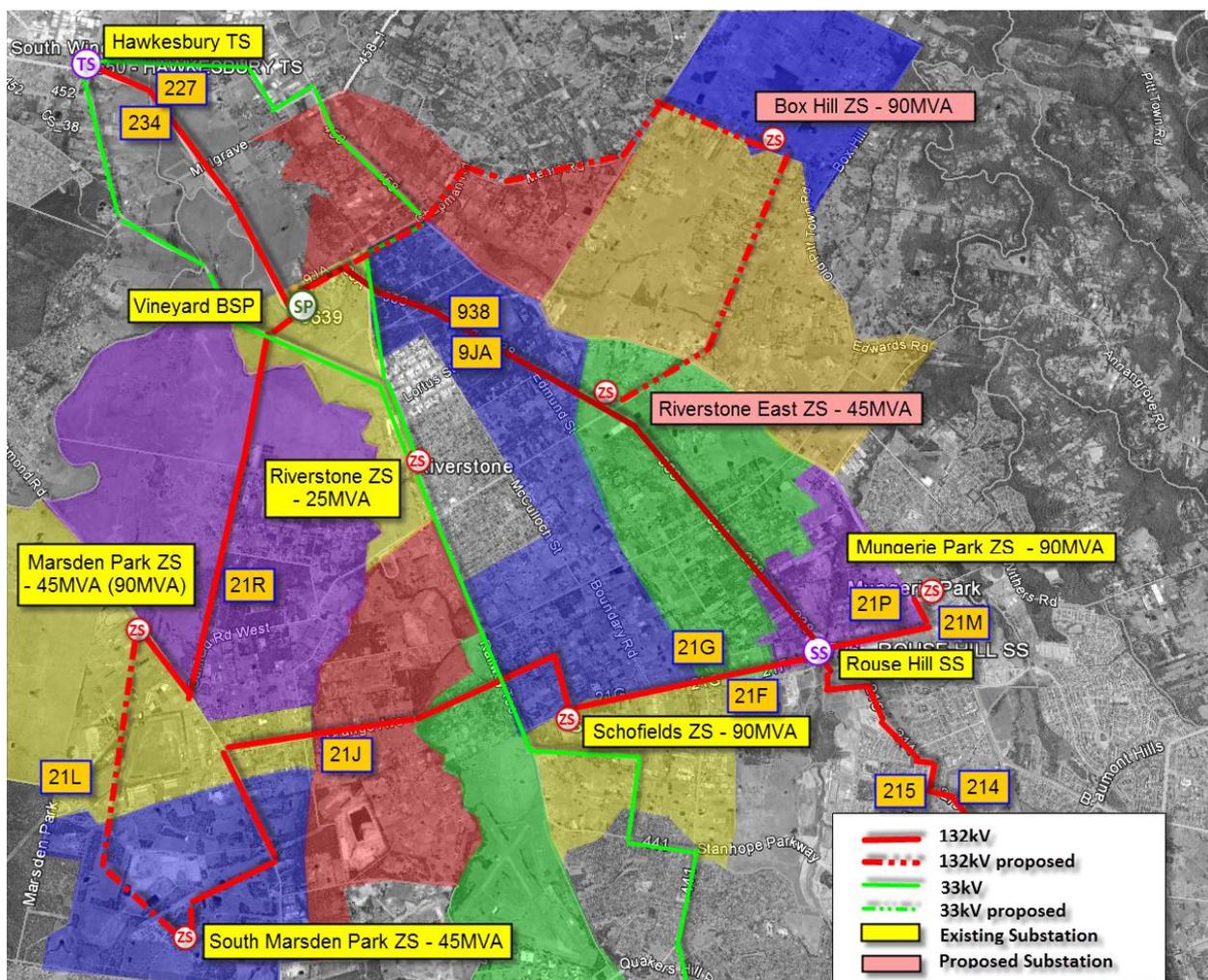


Figure 2 - Proposed Option 2 (2014) Sub-Transmission Network and Priority Growth Area Precincts

A site for Box Hill Zone Substation has been acquired in close proximity to Old Pitt Town Rd in the North Box Hill precinct. Endeavour Energy currently owns a site in the Riverstone East precinct along Guntawong Rd, which was originally acquired to enable the duplication and augmentation of feeder 9JA. However, this site has since been deemed an unsuitable location for a new zone substation due to distance to the northern sections of the Riverstone and Vineyard precincts. In addition, the sub-transmission line easement splits the site down the middle requiring a non-standard zone substation layout. A more suitable site, along Garfield Rd East is now being investigated and discussions are underway to have this site zoned for infrastructure as part of the Riverstone East - Stage 3 Indicative Layout Plan.

A RIT-D project was raised for the establishment of Box Hill ZS in 2015. The result of this process was to defer the establishment of Box Hill ZS by converting the Box Hill area from 11kV to 22kV and to supply the initial stages of the development via 2 x new 22kV feeders from Mungerie Park ZS. The conversion works were completed in 2017, allowing for approximately 18MVA of initial supply to the Box Hill and North Box Hill precincts.

This report will use the latest forecast lot release and industrial lot release numbers provided by the Department of Planning and Environment NSW to assess the future needs of the NWPGA. The existing network configuration will be considered and the most suitable strategy for network development will be recommended.

3.0 North West Priority Growth Area Precincts

The Department of Planning and Environment NSW has identified a number of precincts within the NWPGA for development. The locations of these precincts are shown in Figure 1 and their expected dwelling numbers, employment land yields and status for the next 25 years are shown in Table 1 below.

Precinct	Number of Dwellings	Employment (ha)	Status	Zone Substation Area
Alex Avenue	8,600	-	Rezoned	Schofields ZS
Cudgegong Road (Area 20)	5,000	-	Rezoned	Mungerie Park ZS
Box Hill/Box Hill Industrial	13,200	122	Rezoned	Mungerie Park ZS (limited supply)
Box Hill North	4,100	-	Rezoned	Mungerie Park ZS (limited supply)
Colebee	1,100	-	Rezoned	Quakers Hill ZS
Marsden Park Residential	12,800	-	Rezoned	Marsden Park ZS
Marsden Park Industrial	1,200	317	Rezoned	South Marsden Park ZS
Marsden Park North	4,000	-	Exhibition	Marsden Park ZS
North Kellyville	7,800	-	Rezoned	Mungerie Park ZS
Riverstone	14,000	-	Rezoned	Schofields ZS Riverstone ZS (limited supply)
Riverstone East (Stage 1 and 2)	3,500	-	Rezoned	Schofields (limited supply)
Riverstone East (Stage 3)	2,700	-	Investigation	Riverstone ZS (limited supply)
Riverstone West	0	100	Investigation	Unserviced
Schofields	4,000	-	Rezoned	Schofields ZS
Shanes Park	1000	-	Future	Marsden Park
Townson Road	400	-	Rezoned	Quakers Hill ZS
Vineyard (Stage 1)	2,800	-	Rezoned	Unserviced
West Schofields	4,100	-	Released	Unserviced
Total	90,300	540		

Table 1 North West Priority Growth Area Precinct lot number totals and status

3.1 Developable Land not included in the North West Priority Growth Area

There is a significant portion of land not included in the NWPGA with the potential to ultimately be developed. Land in Stage 2 of the Vineyard precinct is affected by the Outer Sydney Orbital study area and has not yet been released for planning. As a result, no estimates for future lot numbers or employment land yields have been released and the area has not been included in Table 1 above.

Land to the north of the Vineyard and Box Hill precincts have not been included in the NWPGA. The development of infrastructure in the NWPGA as well as the establishment of the Outer Sydney Orbital could stimulate growth in these surrounding areas. The area is shown in Figure 3 along with the 1 in 100 flood level. Areas above this level have generally been zoned for urban development in the rezoned precincts of the NWPGA.

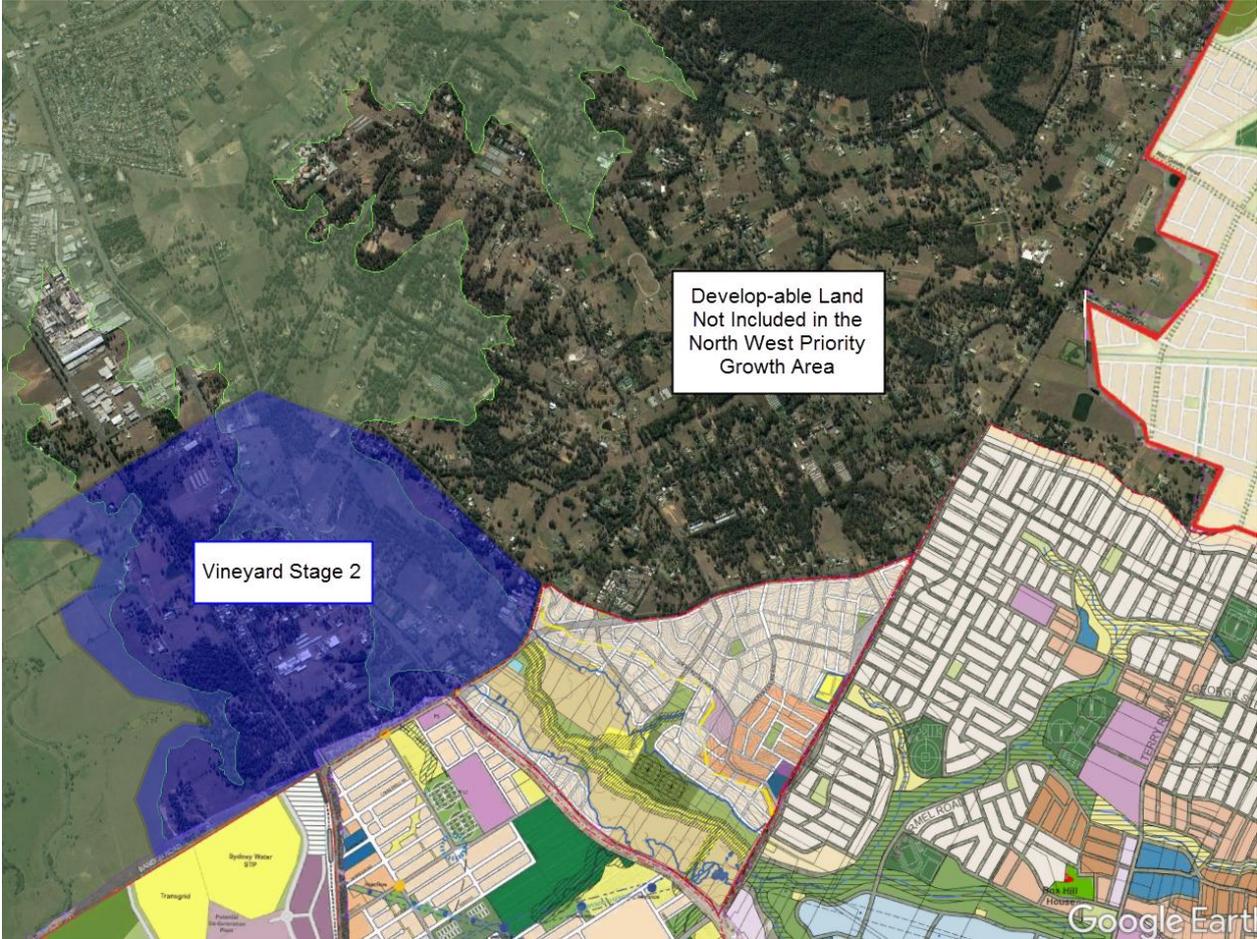


Figure 3 - Location of Vineyard Stage 2 and additional developable land to the NWPGA

The areas mentioned above have not been directly included in the scope of this study. However, the potential for future growth in these areas has been considered for long term viability and flexibility of the recommended strategy.

3.2 North West Rail Link Corridor Development

In October 2013, the North West Rail Link Corridor (NWRL) strategy was approved by the Minister of Planning and Infrastructure. This included increasing residential and commercial building density (brownfield development) around the proposed North West Rail Link with a potential yield of an additional 27,000 dwellings by 2036. The study covered eight precincts across suburbs such as Cherrybrook, Castle Hill, Kellyville, Bella Vista and Rouse Hill and can be seen in Figure 4.

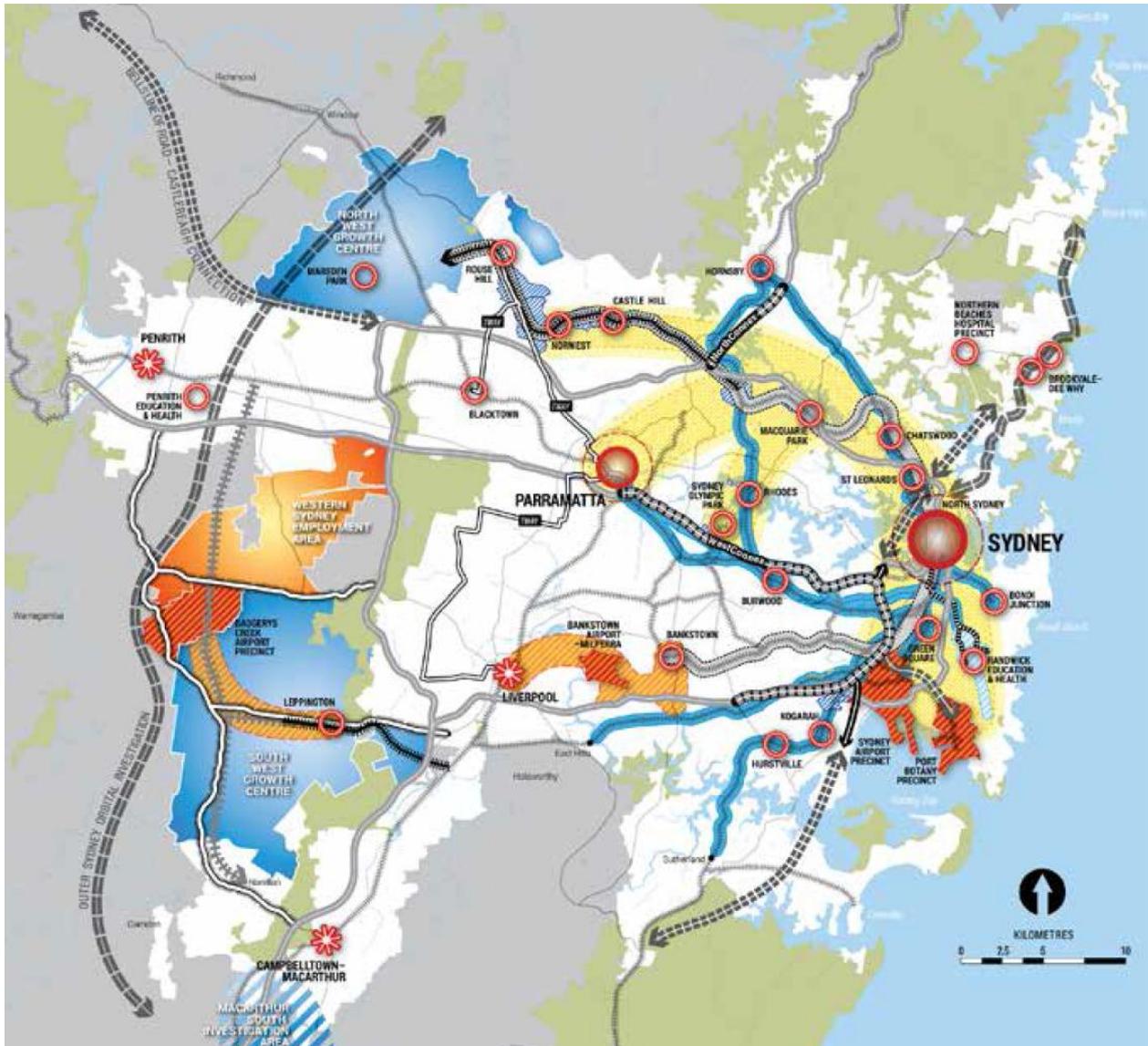


Figure 4 - Location of the North West Growth Centre and the North West Rail Link Corridor

At the time of development of the “North West Sector Area Plan (2014)”, the NWRL strategy was in early stages of planning and as a result, the impact of the NWRL Corridor strategy was not included in the scope of the study. The implications of the strategy are now better understood and will be considered in this report. Although the NWRL strategy does not directly impact the immediate areas of consideration, the overall impact of changes to the sub-transmission network has been carefully considered as this could impact the ability to supply the NWRL Urban Activation Precincts from Vineyard BSP.

4.0 Network Need

The figures provided by the Department of Planning and Environment NSW for anticipated residential and industrial lot yields have been used to calculate load forecasts for each precinct in the NWPGA. An After Diversity Maximum Demand of 4.0kVA per dwelling has been used to calculate residential demand. Note the 4.0kVA 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, libraries etc.). As such, these values are slightly higher than what is effectively included in the summer demand forecast at zone substation level (3.2kVA), 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 previous area plan used a value of 5.2kVA/dwelling. The lower value reflects a reduction in the power demand of new residential developments due to BASIX energy efficiency requirements, solar PV generation and more efficient appliances. In addition, there is an increased ratio of unit style developments compared to stand alone houses. An individual demand per area has been calculated for each employment load where a standard figure of 12MVA/km² was previously used for all areas. A diversity factor of 0.8 has also been applied to all new loads for the purpose of load flow analysis.

The demand for each precinct has been attributed to the appropriate zone substation in order to present a “do nothing” result of the anticipated load demand on the existing network over the next 25 years. Although it is not yet established, Box Hill ZS is included in this analysis since a site has already been acquired for the establishment of a 132/22kV firm 45MVA zone substation. The results are shown in Table 2 below.

Zone Substation (Existing firm capacity)	Supplying Precinct	New Residential Load (MVA)	New Employment Load (MVA)	Total New Load (MVA)	Ultimate ZS Load (MVA)	Unserviceable Load (MVA)
Riverstone ZS (25MVA)	Riverstone (Northern)	40	13	53	64	39
	Riverstone West					
	Riverstone East (Northern)					
	Vineyard					
Schofields ZS (45MVA)	Alex Avenue	72	-	72	89	44
	Riverstone (Southern)					
	Riverstone East (Southern)					
	Schofields					
West Schofields (East)						
Mungerie Park ZS (90MVA)	Area 20	36	-	36	86	-
	North Kellyville					
Quakers Hill (50MVA)	Colebee - Stonecutters	2	-	2	38	-
	Colebee Extension					
Marsden Park ZS (Stage 1 45MVA non-firm)	Marsden Park Residential	56	-	56	57	12
	Marsden Park North					
	Shanes Park					
South Marsden Park ZS (45MVA)	Marsden Park Industrial	11	38	48	54	9
	West Schofields (West)					
Box Hill ZS (PR184 – 45MVA)	Box Hill	55	28	83	84	39
	Box Hill Industrial					
	Box Hill North					
Total		270	79	349	472	143

Table 2 Zone Substations, Precincts Ultimate Loads

It can be seen from Table 2 there is insufficient capacity to supply precincts surrounding Riverstone, Schofields, Marsden Park, South Marsden Park and Box Hill zone substations. Some of the shortfall in capacity can be provided with the establishment of a third transformer at South Marsden Park, Schofields and Box Hill zone substations, increasing their firm capacity to 90MVA. Unserved load would remain at Riverstone ZS, where additional network investment is required.

4.1 Renewal Needs

The only zone substation with identified material renewal requirements within the NWPGA in the next 10 years is Riverstone Zone Substation. Renewal requirements for Riverstone 33/11kV Zone Substation are outlined below:

- TS173 – 11kV circuit breaker replacement - \$500k
- PS012 – 11kV relay replacement, 11kV cable replacement - \$700k
- TS005 – 33kV circuit breaker changes – \$650k
- TS177 – Battery duplication - \$100k
- AU004 – SCADA refurbishment - \$130k

The 2 x 33/11kV 25MVA power transformers at Riverstone Zone Substation were both manufactured in 1971, putting their present age at 47 years. If their condition degrades over the next five years, they may enter into consideration for replacement, although their current condition does not indicate this is likely within the next 10 years.

The total cost of renewal works is \$2.1M. All viable options considered in this study retain the 33/11kV zone substation. As such, the renewal works are essential to the supply strategy for the area.

Since there are no additional major renewal requirements identified for existing sub-transmission lines and zone substations in the NWPGA for the foreseeable future, the ultimate supply strategy for the NWPGA will be driven by capacity constraints alone.

5.0 Existing Supply Arrangements

5.1 Description of the network

Endeavour Energy is supplied at 132kV from the TransGrid owned Vineyard Bulk Supply Point (BSP) within the NWPGA. Vineyard BSP supplies the majority of the NWPGA via Rouse Hill Switching Station (SS). Rouse Hill SS supplies Mungerie Park ZS, Parklea ZS, West Castle Hill ZS, Cheriton Avenue ZS, Bella Vista ZS, Schofields ZS and South Marsden Park ZS.

Only one 132kV tie from the Vineyard BSP catchment area currently exists to a neighbouring BSP catchment area. This is Feeder 212 from Bella Vista ZS to Baulkham Hills TS. However, Feeder 229 also provides a tie from Carlingford TS but is open bonded at West Castle Hill ZS. PR732 will investigate reconnecting this feeder as a tee connection to Feeder 21C from West Castle Hill ZS to Cheriton Avenue ZS in order to improve contingency capacity to the Vineyard sub-system.

Marsden Park ZS has recently been commissioned with supply via a new 132kV Feeder 21R from Vineyard BSP. PR292 will establish 132kV Feeder 21L between Marsden Park ZS and South Marsden Park ZS, creating a 132kV loop from Vineyard BSP – Marsden Park ZS – South Marsden Park ZS – Schofields ZS – Rouse Hill SS.

Existing 33kV Zone Substations also exist in the NWPGA. Riverstone ZS and Kellyville ZS both supply the established network in their respective areas. Riverstone ZS is supplied from Vineyard BSP via Hawkesbury TS and Kellyville ZS is supplied from Sydney North BSP via Kenthurst ZS.

A summary of the sub-transmission network in the NWPGA can be seen in Figure 5.

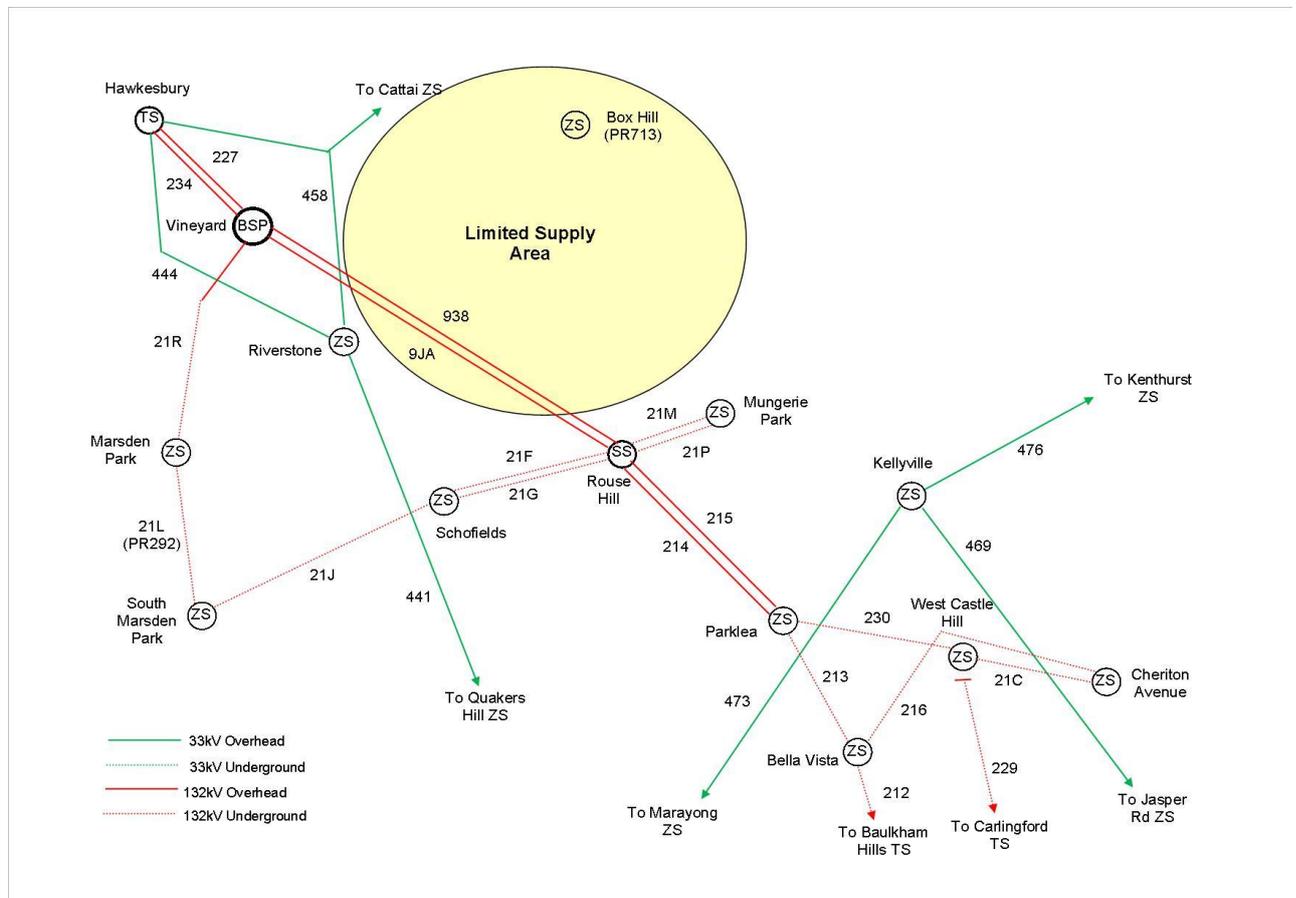


Figure 5 - Sub-Transmission Network within the North West Priority Growth Area

- The network shown in Figure 5 includes :
 - 1 x 330/132kV Bulk Supply Point (TransGrid);
 - 1 x 132kV Switching Station
 - 2 x 132/22kV Zone Substations;
 - 6 x 132/11kV Zone Substations;
 - 1 x 132/33kV Sub-Transmission Substation;
 - 1 x 33/11kV Zone Substation;
 - 1 x 33/11/22kV Zone Substation;

5.2 Transmission Capacities

Vineyard Bulk Supply point has 3 x 375MVA 330/132kV transformers, providing firm capacity of 750MVA. This capacity is sufficient to supply the long term load projections of the NWPGA and Hawkesbury Sub-Transmission Substation. Table 3 shows each sub-transmission line in the area along with the contingency demand and the associated rating. These results are as reported in the Transmission Network Planning Review (TNPR) 2017-2026.

Feeder Designation and Destination	Voltage (kV)	2027 Contingency Demand (MVA)	Rating (MVA)
227 & 234 Vineyard BSP to Hawkesbury TS	132	189	230 ¹
938 & 9JA Vineyard to Rouse Hill	132	540²	495
21F & 21G Rouse Hill to Schofields	132	85	172
21M & 21P Rouse Hill to Mungerie Park	132	105	172
214 & 215 Rouse Hill to Parklea	132	304²	189 ¹
213 Parklea to Bella Vista	132	172²	172
230 Parklea to West Castle Hill	132	173²	172 ¹
21C West Castle Hill to Cheriton Ave	132	112	172
216 Bella Vista to Cheriton Ave	132	108	172
212 Baulkham Hills to Bella Vista	132	-	172 (232 ³)
21R Vineyard to Marsden Park	132	72	172
21L Marsden Park to South Marsden Park	132	43	172
21J South Marsden Park to Schofields	132	71	172
444 Hawkesbury to Riverstone	33	39	42
441 Quakers Hill to Riverstone	33	17	16
458 Hawkesbury to Tee Riverstone and Cattai	33	36	46
458 Tee to Riverstone	33	20	23 ¹
469 Jasper Road to Kellyville	33	7	21
473 Baulkham Hills to Tee Marayong and Kellyville	33	20	32
473 Tee to Kellyville	33	11	21
476 Kenthurst to Kellyville	33	18	19

Table 3 Sub-Transmission Feeder Loadings and Ratings

Notes: 1. Indicates emergency rating

2. PR732 is being investigated to mitigate this constraint. In high load periods, Feeder 212 is utilised to supply Bella Vista ZS, Cheriton Ave ZS and West Castle Hill ZS from Sydney West BSP via Baulkham Hills TS

3. Indicates 2HR emergency rating

5.3 Substation Capacities

Table 4 below shows the zone substations currently supplying the NWPGA, their transformer arrangement, 2027 summer demand forecast load and their firm nameplate capacities.

Substation	Voltage (kV)	Transformer arrangement	2027 Demand (MVA)	Firm transformer nameplate capacity (MVA)
Vineyard BSP	330/132kV	3 x 375MVA	742	750
Hawkesbury TS	132/33	3 x 120MVA	183	240
Marsden Park ZS (Stage 1)	132/11	1 x 45MVA	39	45 (non-firm)
South Marsden Park ZS (Stage 2)	132/11	2 x 45MVA	31	45
Mungerie Park ZS	132/22	3 x 45MVA	94	90
Schofields ZS	132/11	2 x 45MVA	77	45
Kellyville ZS	33/11	2 x 25MVA	17	25
Riverstone ZS	33/11	2 x 25MVA	39	25
Box Hill ZS	132/22		34	N/A

Table 4 Zone and Sub-Transmission Substation Capacities

Schofields Zone Substation is expected to exceed firm in the forecast period. Expansion of the zone substation with a third 45MVA transformer will allow for anticipated load growth in the catchment area. Riverstone Zone Substation is also expected to reach firm rating in 2022. Demand growth is due to greenfield lot releases in the surrounding Riverstone, Riverstone West, Riverstone East and Vineyard precincts. To supply the precincts, new sub-transmission infrastructure is required.

Additional lots adjoining Riverstone Zone Substation have been purchased according to the recommendation given in Special Report S073 “North West Sector Transmission needs study”. However, there is insufficient space to redevelop the substation to a larger 132kV type substation. If the capacity need arises it would be possible to augment the existing transformer capacity, keeping the sub-transmission feeders operating at 33kV.

The initial stages of the Marsden Park Industrial and Marsden Park Residential precincts are underway after being rezoned as accelerated precincts in 2010 and 2013 respectively. The existing network at the time of rezoning was rural in nature and not sufficient to service the predicted growth in the area.

PR674 – South Marsden Park Stage 1 and PR596 - Marsden Park Stage 1 were commissioned in 2016 and 2017 respectively. PR292 - South Marsden Park Stage 2 has secured gate 3 approval and has recently begun construction. Load at risk constraints will require a second power transformer at Marsden Park ZS within 2-4 years. The NIO process for Marsden Park Stage 2 has not yet begun.

NIO	Project Description	Status
PR292	Establishment of South Marsden Park Stage 2	Under Construction
PR698	Establishment of Marsden Park Stage 2	SNN Complete

Table 5 Committed projects within the North West Priority Growth Area

5.4 22kV Distribution Network Conversion of Box Hill

The establishment of a zone substation in the Box Hill/North Box Hill area was deferred by the establishment of 22kV feeders from Mungerie Park ZS and the associated 22kV conversion works. A site has been acquired in the Box Hill North precinct for the proposed zone substation.

Figure 6 shows the existing 22kV region in red and the developed 11kV regions in blue. The remaining areas of the Box Hill and North Box Hill precincts, shown in yellow, will also be converted to 22kV in the near future with new developments in these regions being constructed at 22kV but operated at 11kV initially. Distribution Works Program (DWP) items will be raised for the conversion of these areas at the appropriate times.

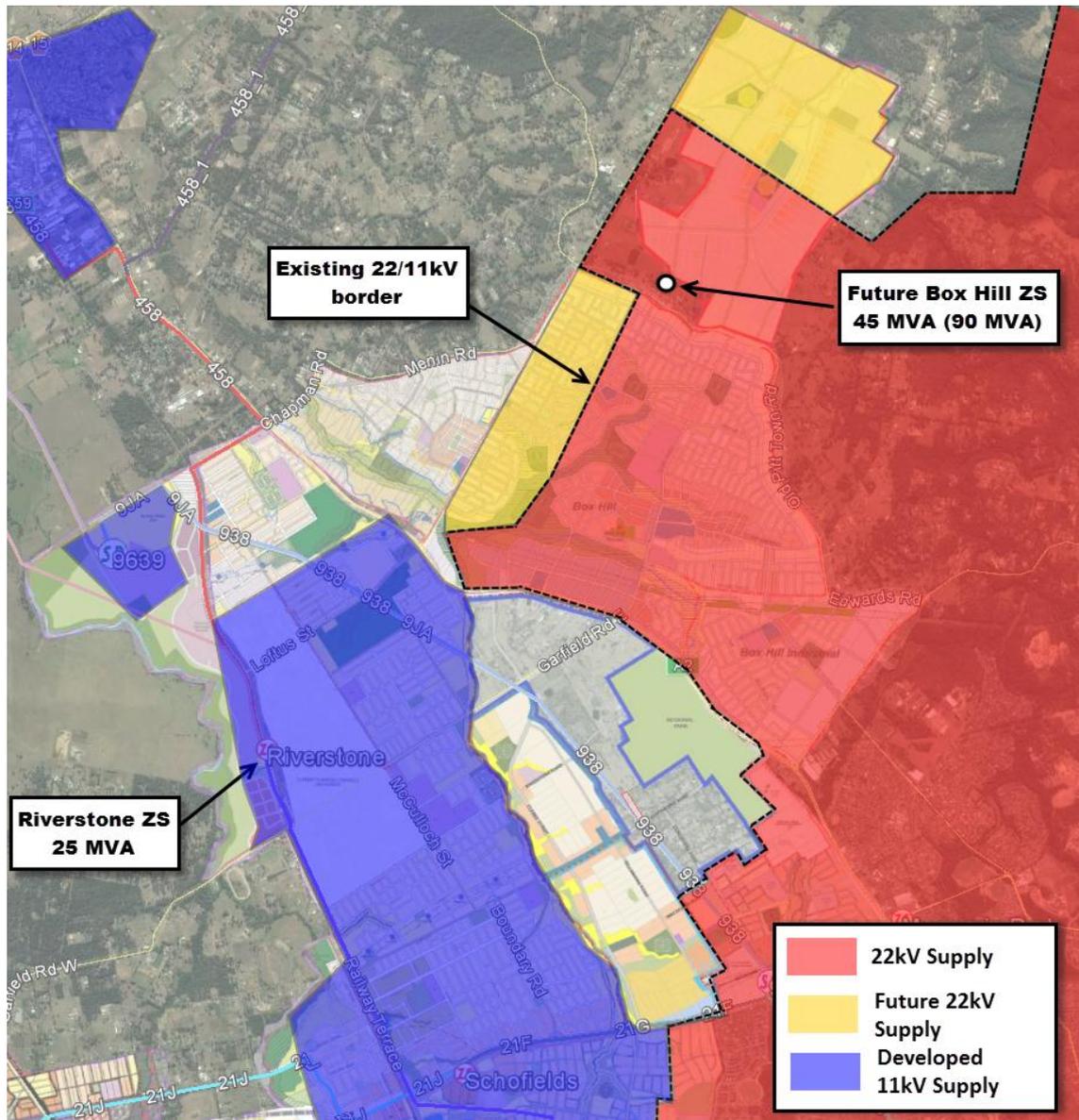


Figure 6 - Existing Location of 22kV and Developed 11kV Supply Areas

The un-highlighted areas shown in Figure 6 are rural areas, currently supplied at 11kV. These areas include Vineyard, Riverstone East and northern sections of the Riverstone precinct. Existing electrical infrastructure in these areas are of a light, rural nature and it may be cost effective to implement projects similar to the Box Hill 22kV conversion for these sections of network. This has been considered in detail as part of this study.

6.0 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 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 NWPGA, which mainly consists of the conversion of rural lands to urban and industrial use. Demand management will not avoid the need to establish or augment electricity assets in order to supply the NWPGA but may have the potential to defer future network augmentation.

The market was engaged via open tender to provide non-network options for deferral of South Marsden Park (Stage 2) in 2017. No submissions were received for non-network options.

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.

7.0 Recommended Supply Strategy

Various supply arrangements were considered in this study. Options included both 132kV and 33kV sub-transmission arrangements to supply the expected ultimate demand of the NWPGA. Several distribution network arrangements were also considered, allowing for an expansion of the 22kV network. These options were compared across a variety of factors including cost, reliability, flexibility and risk of implementation and operation. This section will outline the aspects of the favoured option – a continuation of the preferred option recommended in the previous area plan.

Summary of Supply Strategy

Initial supply to the development areas of Riverstone, Riverstone East and Vineyard will be provided from both Riverstone ZS and Schofields ZS. Although Schofields ZS can be expanded to 90MVA firm, capacity will not be available at Riverstone ZS to service the anticipated load to the northern regions of these precincts. As a result, a new zone substation will be required in the area.

Establishing a new 45MVA 132/11kV Riverstone East Zone Substation allows Riverstone East, Riverstone and Vineyard precincts to develop without exceeding firm capacity at Riverstone ZS. Riverstone ZS can also be offloaded in order to service the Riverstone West employment lands. Although the new zone substation will have provision to be expanded to 90MVA firm, it is not envisaged this will be required.

The new zone substation would be located along Garfield Rd East near high capacity 132kV feeders 938 and 9JA, allowing for connection to one or both of the feeders. The site would provide a connection point for the second 132kV feeder to Box Hill ZS. As a result, the timing of this connection would be linked to the establishment of firm capacity at Box Hill ZS. There are three possible configurations of connection for the new zone substation to the high capacity feeders;

- **A ring-in to Feeder 938:** This would require a high capacity 132kV busbar at the new ZS to match the capacity of the high capacity lines. This would also have a negative impact on the symmetry of the load sharing of the two high capacity feeders when the Box Hill sub-system is supplied through this connection.
- **A double tee-off to Feeders 938 and 9JA:** This would not require any new high capacity assets but would require significant protection upgrades allowing for three ended differential protection schemes. The benefit of this option would be maintaining symmetry when the Box Hill sub-system is supplied through this connection.
- **A single tee-off to Feeder 938:** This would be similar to the double tee-off option but would have a negative impact on the symmetry of the load sharing of the two high capacity feeders when the Box Hill sub-system is supplied through this connection. This option would require the least amount of 132kV equipment. It would also allow the establishment of the second Box Hill ZS supply prior to the establishment of the zone substation at this location. A single tee-off connection could be established from the high capacity feeders to Box Hill ZS before the new Riverstone East ZS is rung-in to the connection at a later date.

At this stage, all options for the connection of the new Riverstone East Zone Substation are considered viable and roughly similar in cost. The actual method of connection will be determined during the NIO process for the project.

As the new zone substation would be required to flexibly transfer load to and from Riverstone ZS, reticulation at 11kV will be required for the catchment area. Therefore, there will be no expansion of the 22kV reticulation area beyond the Box Hill region.

As growth across the NWPGA materialises, expansion of South Marsden Park ZS, Schofields ZS and Box Hill ZS will also be required.

The proposed network topology is shown in Figure 7. The feeder routes shown are indicative only and may not portray the ultimate feeder location. Each new feeder will be subject to a Feeder Route Options Report either in conjunction with or prior to the standard NIO process.

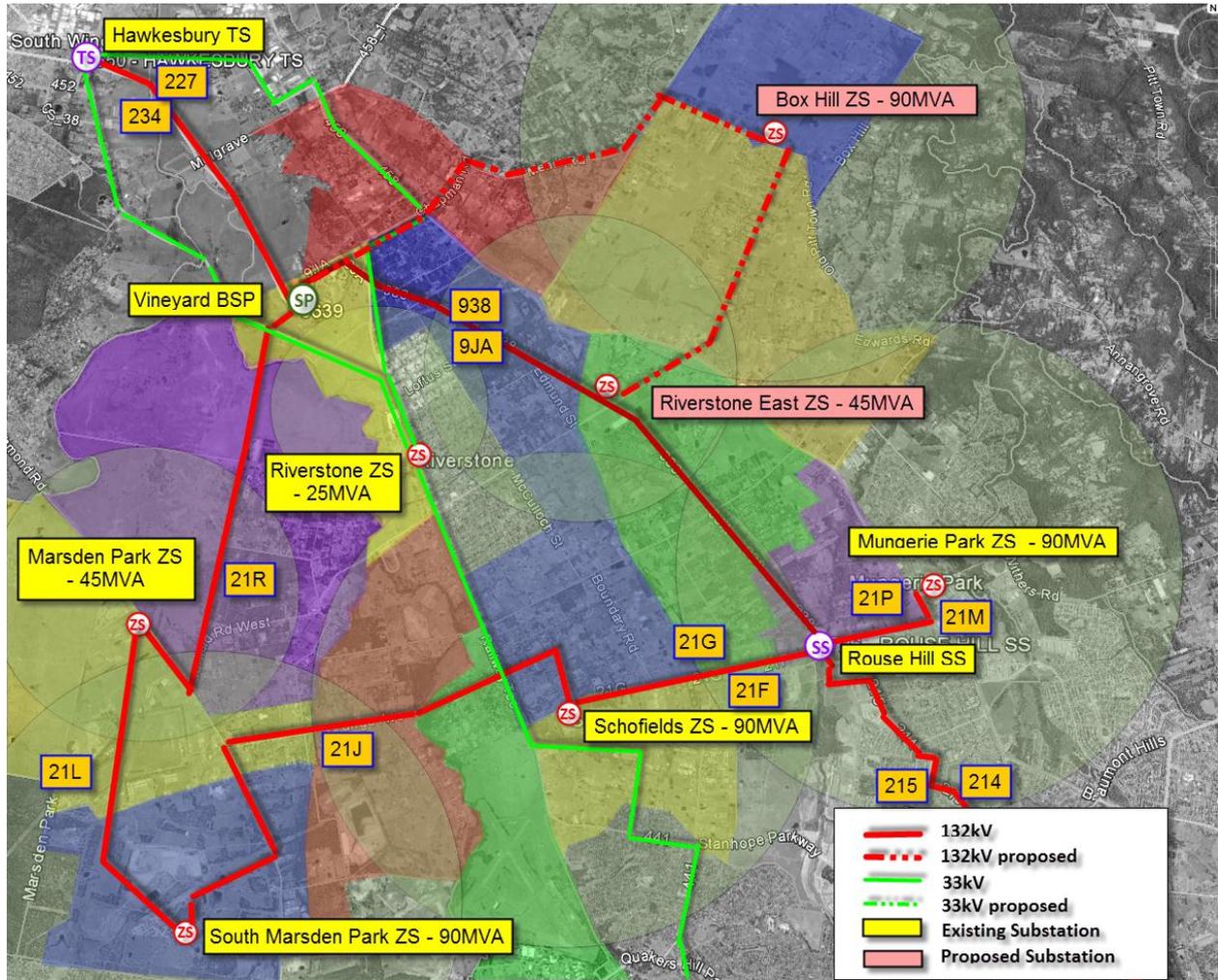


Figure 7 - Proposed Sub-Transmission Network and Priority Growth Area Precincts

Proposed network costs are shown in Table 6. The year required for each project is based on analysis of this area plan and may not be indicative of actual project times. Projects may be deferred based the results of a risk analysis performed at the time of the corresponding NIO process.

Substation	Configuration	Year Required	NPV Cost (\$M)
2020-2024 Regulatory Period			
Riverstone East ZS	Site Purchase	2019	\$5.3
Box Hill ZS	2 x 45MVA 132/22kV TX, 2 TR FDR's	2020	\$16.7
Box Hill ZS	132kV Feeder from Vineyard BSP to Box Hill ZS	2020	\$11.9
Riverstone East ZS	2 x 45MVA 132/11kV TX, 3 TR FDR's	2022	\$14.9
Marsden Park ZS	Second 45MVA 132/11kV TX	2023	\$6.0
2025-2029 Regulatory Period			
Riverstone East ZS/ Box Hill ZS	132kV Feeder from Riverstone East ZS to Box Hill ZS	2025	\$6.2
Schofields ZS	Third 45MVA 132/11kV TX	2026	\$3.3
Box Hill ZS	Third 45MVA 132/22kV TX	2027	\$3.1
South Marsden Park ZS	Third 45MVA 132/11kV TX	2029	\$2.7
Total			\$70.1

Table 6 Proposed cost of Network Strategy

Potential Issues

- Securing property in a suitable location within Riverstone East precinct
- Impact on load sharing of high capacity feeder 9JA and 938
- Timing of Riverstone East ZS could be linked with establishment of firm capacity at Box Hill ZS
- Long geographical distance to northern regions of Vineyard from Riverstone East ZS

25 Year Load Forecasts

Zone Substation	Supplying Precinct	Load (MVA)	Capacity (MVA)	Spare Capacity (MVA)
Riverstone ZS	Riverstone West	25	25	0
Schofields ZS	Alex Avenue	79	90	11
	Riverstone (Southern)			
	Schofields			
	West Schofields (East)			
Mungerie Park ZS	Area 20	86	90	4
	North Kellyville			
Quakers Hill ZS	Colebee -Stonecutters	38	50	12
	Colebee Extension			
Marsden Park ZS	Marsden Park Residential	57	45	-12 ¹
	Marsden Park North			
	Shanes Park			
South Marsden Park ZS	Marsden Park Industrial	54	90	36
	West Schofields (West)			
Box Hill ZS	Box Hill	84	90	6
	Box Hill Industrial			
	Box Hill North			
Riverstone East ZS	Riverstone East	49	45	-4 ²
	Riverstone (Northern)			
	Vineyard			
Total		472	525	53

Table 7 Forecast 25 Year Load and Capacity of Recommended Supply Strategy

1. Excess capacity at South Marsden Park ZS can be utilised to supply capacity shortfall at Marsden Park ZS
2. Excess capacity at Schofields ZS can be utilised to supply capacity shortfall at Riverstone East ZS

8.0 Stakeholder Issues

8.1 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. Vineyard BSP was established by TransGrid to service growth in the NWPGA and has a firm transformer capacity of 750MVA, which is sufficient to supply the ultimate load of the NWPGA. Joint planning with TransGrid has identified the need for installation of 132kV feeder bays for connection works and this will continue to be discussed in future joint planning meetings between the two organisations.

8.2 Developers and Landowners

In order to obtain the appropriate land to build each zone substation and the corridors for the connecting feeders, it is important that Endeavour Energy is involved in the subdivision planning stage of 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. It is critical that the following issues be considered and addressed where appropriate based on learnings from past experience:

- Endeavour Energy must actively support NSW Planning and Environment in their efforts to coordinate development in areas of fragmented land ownership.
- Early discussions must be held to determine options for incorporating existing and future infrastructure into precinct master plans (involving the NSW Department of Planning and Infrastructure). 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 sub-transmission line corridors can be advantageous due to lower land prices (pre-rezoning) and fewer environmental constraints (not surrounded by existing residential dwellings). However, the Foreign Investment Review Board (FIRB) now mandates a maximum five year period between the land acquisition and commencement of construction works by Endeavour Energy. This is a major limitation on any new land acquisition and must be carefully considered during the planning process.

It is also necessary to compare the cost of easement acquisition for overhead sub-transmission lines versus undergrounding or use of the road reserve.

- Sub-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 lead times and final commissioning dates when issuing projects with significant sub-transmission line design and easement acquisition.

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 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 developers to acquire the appropriate tenure over the agreed locations.

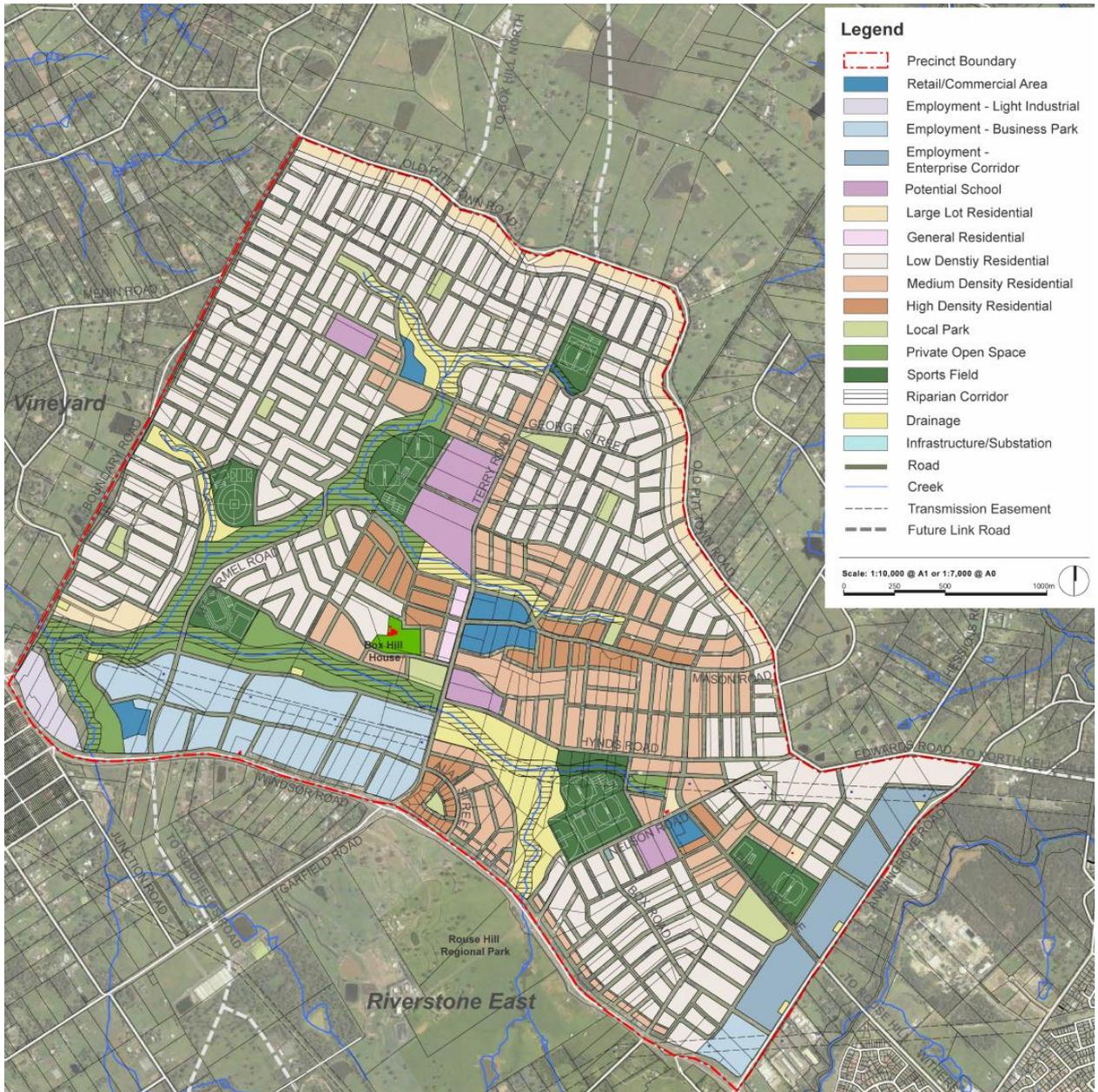
9.0 Recommendation

Following analysis of future network needs over a 25 year period, it is recommended the following points be adopted for forward planning purposes:

- The Recommended Supply Strategy outlined within this report in section 7.0 is carried forward as the basis for further planning within the North West Priority Growth Area unserved supply area. Individual Network Investment Options (NIO) projects based on the principles outlined in this report will be developed separately and funding sought for each of these projects at the appropriate time.
- Projects to be completed in the 2020-2024 regulatory period with a total investment requirement of \$70.3M (real \$ FY19) include:
 - Acquisition of a suitable property near high capacity feeder 938 along Garfield Rd within Riverstone East precinct
 - Establishment of Box Hill firm 45MVA zone substation
 - Construction of 132kV feeder from Vineyard bulk supply point to Box Hill zone substation
 - Establishment of Riverstone East firm 45MVA zone substation
 - Expansion of Marsden Park zone substation to firm 45MVA
- Projects to be completed in the 2025-2029 regulatory period with a total investment requirement of \$28.4M (real \$ FY19) include:
 - Construction of 132kV feeder from Box Hill zone substation to Riverstone East zone substation
 - Expansion of Schofields zone substation to firm 90MVA
 - Expansion of Box Hill zone substation to firm 90MVA
 - Expansion of South Marsden Park zone substation to firm 90MVA

10.0 Appendices

10.1 North West Priority Growth Area Precinct Maps



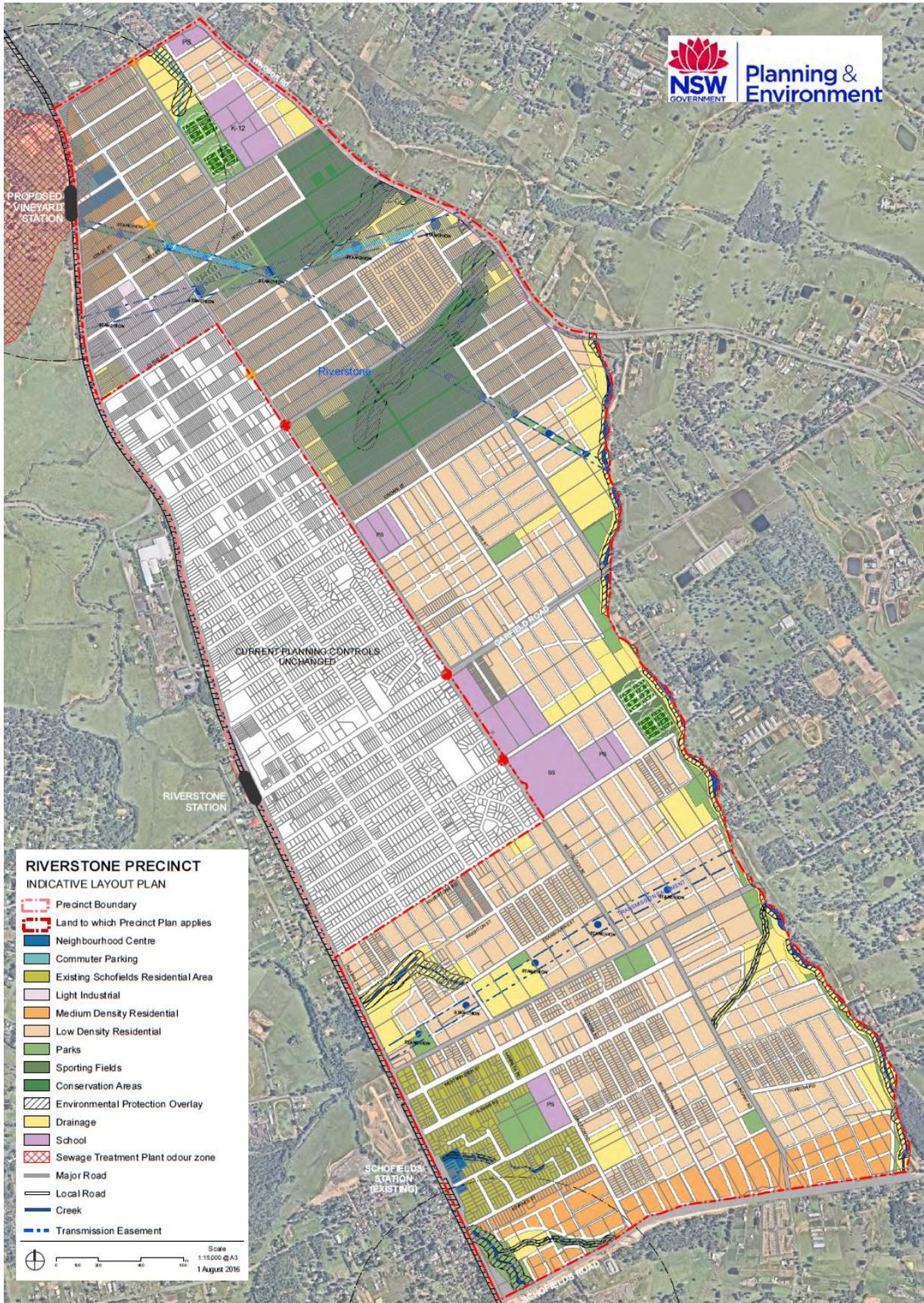


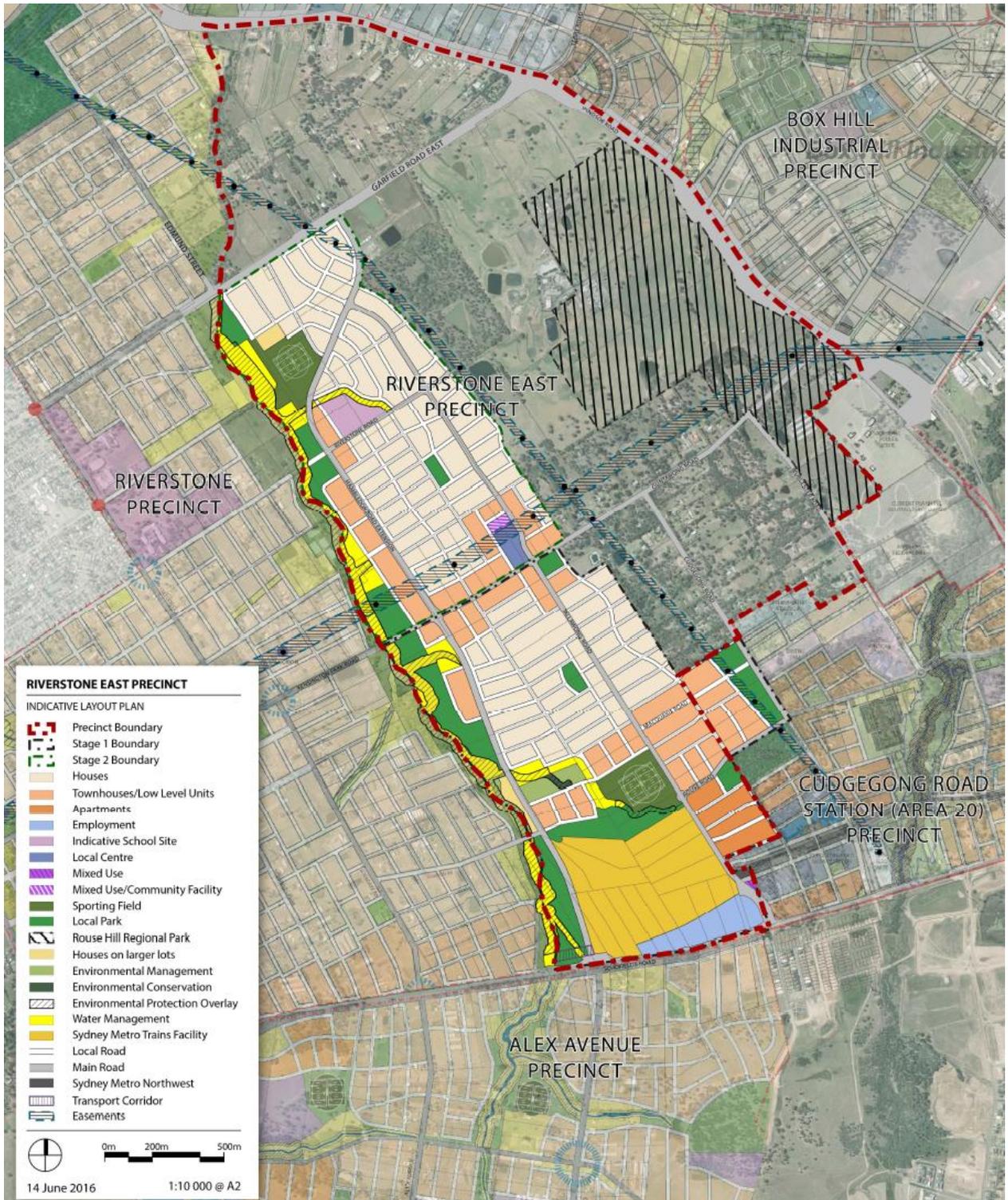
- | | | | |
|---|---|---|----------------------------|
|  | Retail/Commercial Area |  | School |
|  | Large Lot Residential |  | Environmental Conservation |
|  | Low Density Residential (>450m ²) |  | Local Park |
|  | Medium Density Residential |  | Sports Field |
|  | High Density Residential |  | Drainage |

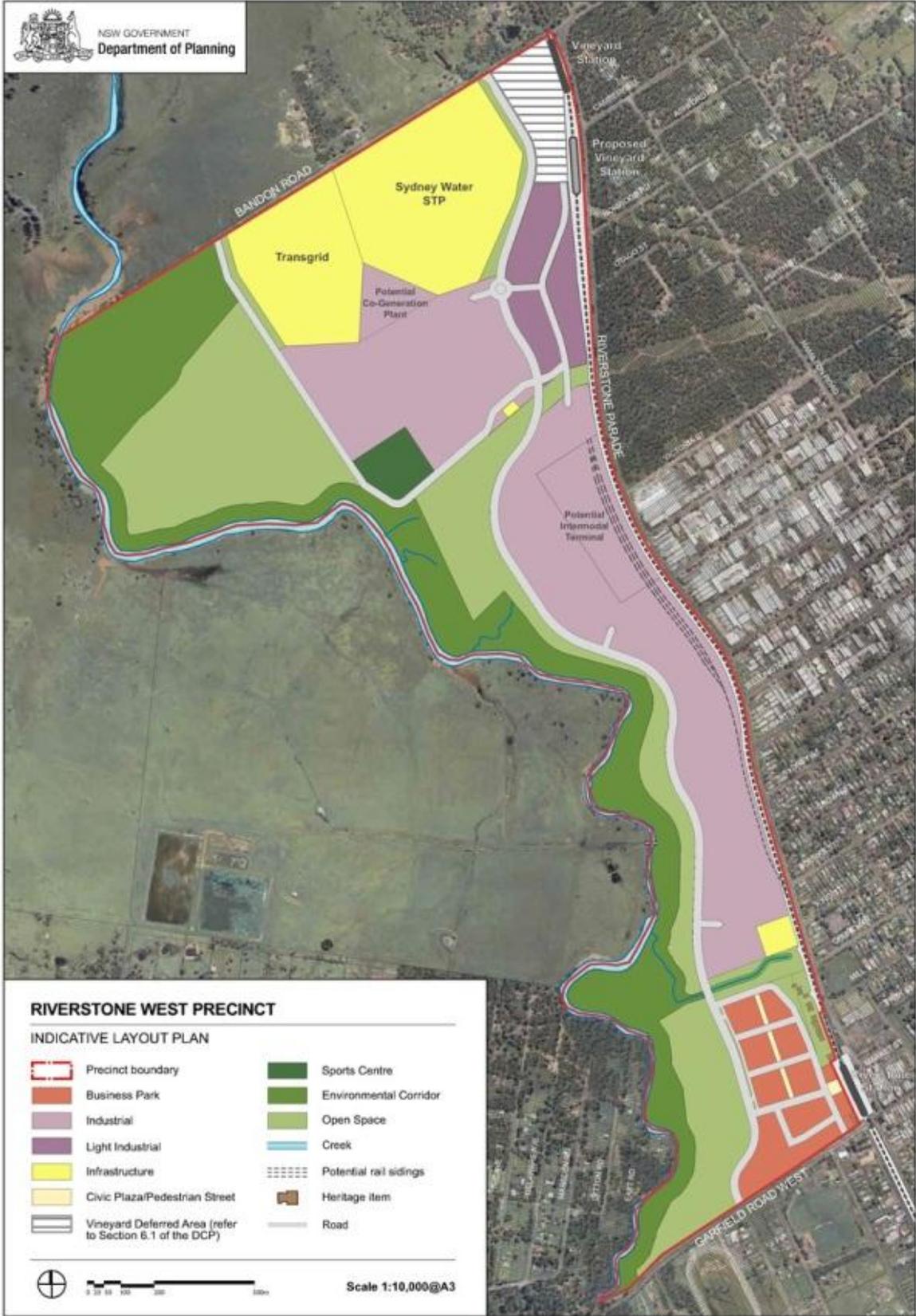
BOX HILL NORTH
 PRELIMINARY INDICATIVE LAYOUT

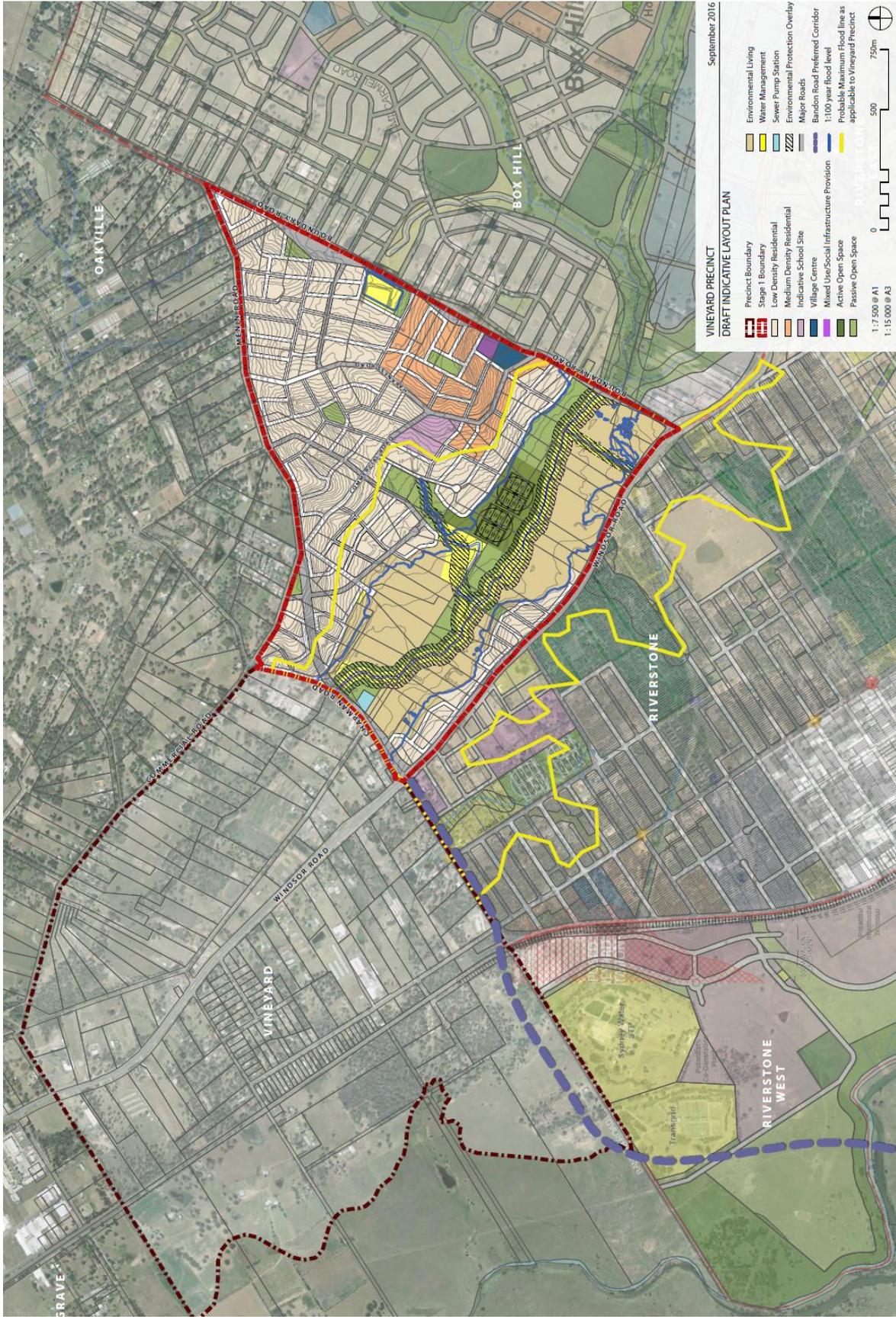
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10.2 Recommended Supply Strategy Contingency Analysis

Faulty -->	None	9JA ¹	938A ¹	214 ¹	215 ¹	21M	21P	21F	21G	21L	21R	TR-A	TR-B	Rating
9JA Vineyard BSP to Rouse Hill	257	x	363	184	184					289	319	300	274	495
938 Vineyard BSP to Tee	257	363	x	184	184					289	319	364	298	495
938 Tee to Rouse Hill	248	363	x	184	184					289	319	212	237	495
938 Tee to Riverstone East	N/O		x									146	56	230 ²
214 Rouse Hill to Parklea	150	76	76	x	159									172
215 Rouse Hill to Parklea	150	76	76	159	x									172
212 Baulkham Hills to Bella Vista	N/O	141	141	141	141									172
21M Rouse Hill to Mungerie Park	46					x	94							172
21P Rouse Hill to Mungerie Park	47					94	x							172
21F Rouse Hill to Schofields	46							x	92	72	103			172
21G Rouse Hill to Schofields	46							92	x	72	103			172
21J Schofields to South Marsden Park	N/O									54	115			172
21L South Marsden Park to Marsden Park	53									x	60			172
21R Marsden Park to Vineyard BSP	112									58	x			230 ³
TR-A Vineyard BSP to Box Hill	151											x	94	230 ³
TR-B Box Hill to Riverstone East	57											91	x	172

Table 8 Transmission Network Planning Review Results for summer 2044

Note 1: Bella Vista, Cheriton Ave and West Castle Hill 132kV Sect 2 supplied from Sydney West BSP via FDR 212

Note 2: Rating of tee section not yet known, has been modelled to match rating of other sections of Box Hill 132kV loop

Note 3: Feeder 21R, TR-A contingency rating of 230MVA. Peak load would only be expected for a maximum of 8 hours a day for a total of 20-30hours per year.