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requirements in Sydney's North West Priority Growth Area

Asset Planning & Performance

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Endorsements

Prepared by

Warren Thai

Lead Capacity Planner

Endorsed by

Gavin De Hosson

Acting Network Planning Manager

Approved by

Peter Langdon

Head of Asset Planning & Performance

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1.0 Executive summary

This report outlines the status of the current network configuration and proposed a strategy to continue servicing the North West Priority Growth Area.

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 20 precincts. The growth area is approximately 10,000 hectares and was originally contain about 70,000 new dwellings. This figure has since been revised upwards to approximately 90,000 new dwellings.

This area is currently serviced by six existing zone substations: Riverstone ZS, Mungerie Park ZS, Schofields ZS, Kellyville ZS, Marsden Park ZS and South Marsden Park ZS. Currently, there are projects in progress to establish an additional transformer at Marsden Park and a new zone substation at Box Hill ZS.

As the current network cannot supply the continued growth in this area, further sub-transmission infrastructure investments will be required within the next 10 years. This report proposes a strategy for this network which includes two main projects in the next FY25 to FY29 Regulatory Period.

The first project investigates network options to service the developments in the Riverstone and Riverstone East precincts. Options include either establishing an additional transformer in Schofields ZS and establishing a new zone substation in Riverstone East.

The second project will address the increasing load demand as developments in the Box Hill and Box Hill North precincts continue. This project will investigate the expansion of Box Hill ZS which is currently being constructed.

The projects outlined in this plan will be economically assessed to determine which option is most prudent in addressing risks and has the greatest benefit resulting in the highest NPV. Funding will be sought for each of these projects at the appropriate. Furthermore, for projects above \$6 Million, the RIT-D will be carried out to investigate non network solutions in comparison to network solutions.

Following analysis of future network needs of the NWPGA outlined in this document, it is recommended that the Recommended Supply Strategy outlined within this report is carried forward as the basis for further planning within the North West Priority Growth Area unserved supply area.

2.0 Relationship with Asset Management System

A critical input to the Regulated Asset Base (RAB) Strategies is a series of detailed area plans developed for areas that are expected to require significant investment in the future. The purpose of these area plans is to outline an overarching view of the network infrastructure that will be required to service the identified growth area.

The Area Plans aim to assess the state of the network, identify the critical external influences to determine the likely future network requirements, and identify the high-level needs and opportunities to be refined and options (external to the Area Plan process) through the investment governance process.

The relationship between the Area Plans and the other artefacts within Endeavour Energy's asset management system is illustrated in Figure 1.

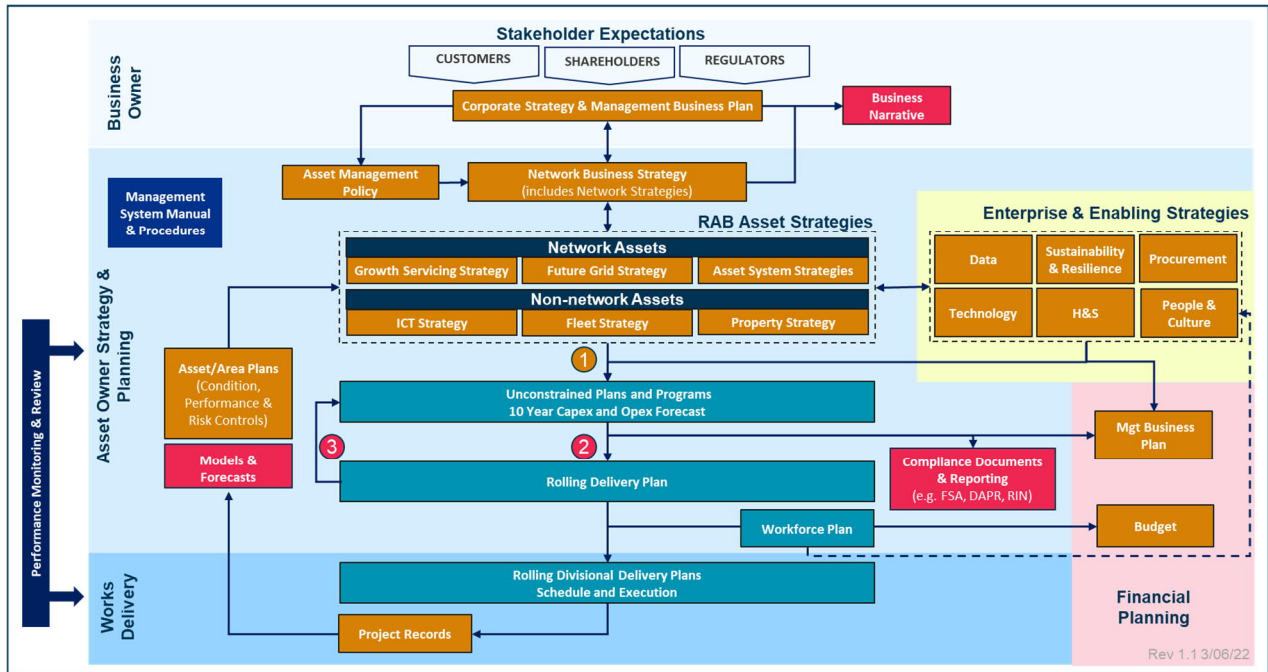


Figure 1 – Endeavour Energy Asset Management System artefact hierarchy

A detailed description of Endeavour Energy's asset management system and its constituent parts is available in the Asset Management System Manual and the Asset Management System Guidelines.

3.0 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 broader precincts of Box Hill, Vineyard, Riverstone, Marsden Park and Schofields as shown in Figure 2 below. Refer to Appendix 10.1 for the corresponding Indicative Layout Plans of each individual precinct.

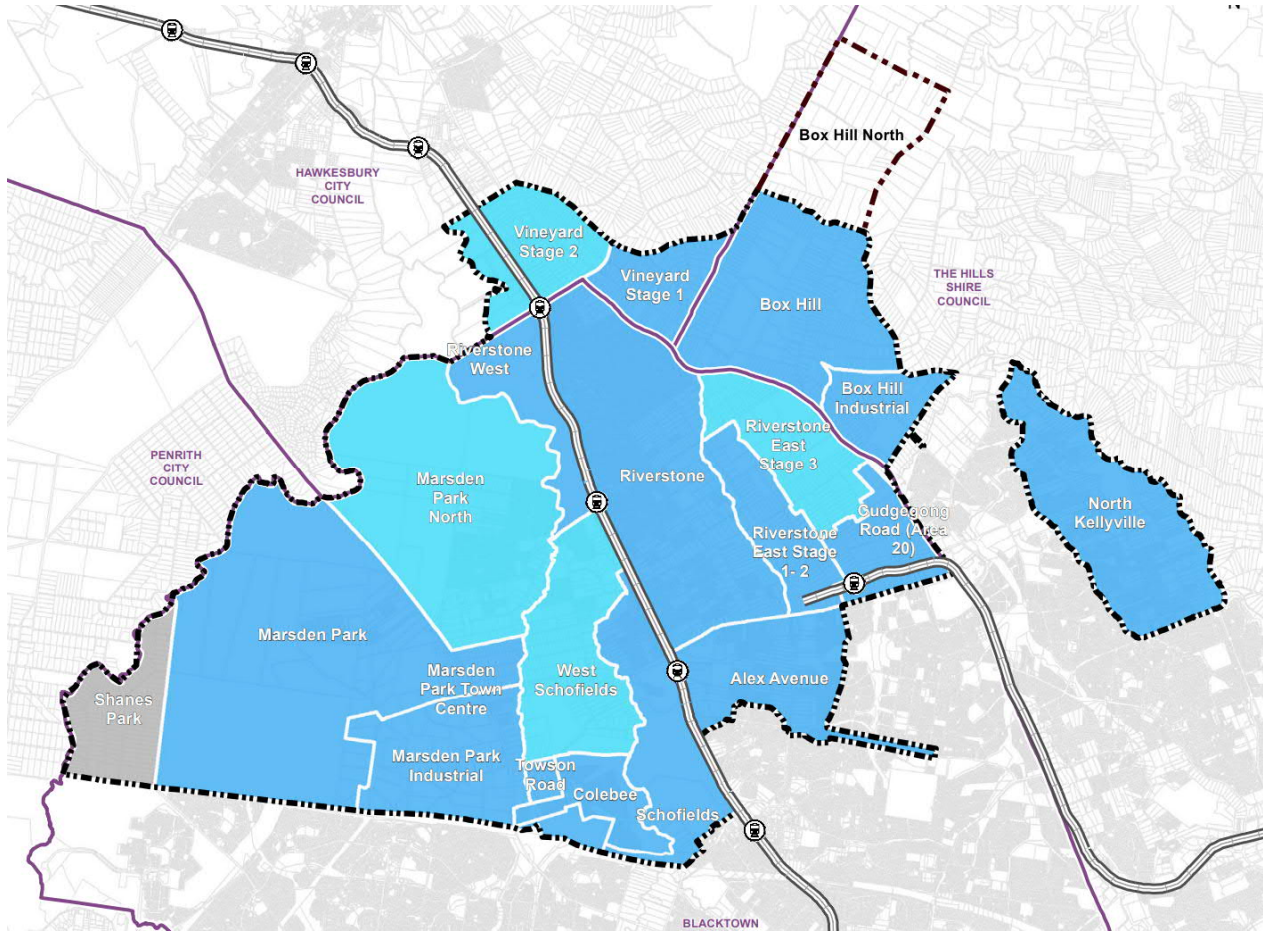


Figure 2 – North West Priority Growth Area Precincts

4.0 North West Priority Growth Area Precincts

The Department of Planning and Environment NSW has identified a number of precincts within the NWPGEA for development. The locations of these precincts are shown in Figure 2 and their expected dwelling numbers, employment land yields and status are shown in Table 1 below. The number of dwellings in this table are based on original estimates totalling 70,000 new homes. However the total number of home for the entire NWPGEA has now been revised to 90,000 [1].

Precinct	New Number of Dwellings	New Employment Area(ha)	Status	Zone Substation Area
Alex Avenue	6,300 [2]	-	Rezoned	Schofields ZS
Cudgegong Road / Tallawong Station / Area 20	4,400 [3]	-	Rezoned	Mungerie Park ZS
Box Hill & Box Hill Industrial	9,600 [4]	133 [4]	Rezoned	Box Hill ZS (Under construction)
Box Hill North	5,500 [5] ¹	-	Rezoned	Box Hill ZS (Under construction)
Colebee	1,000 [6]	-	Rezoned	Quakers Hill ZS
Marsden Park Residential	10,300 [7]	-	Rezoned	Marsden Park ZS
Marsden Park Industrial	-	316 [8]	Rezoned	South Marsden Park ZS
Marsden Park North	4,000 [9]	-	Planning	Marsden Park ZS
North Kellyville	4,500 [10]	-	Rezoned	Mungerie Park ZS
Riverstone	9,000 [11]	-	Rezoned	Schofields ZS Riverstone ZS
Riverstone East (Stage 1 and 2)	3,500 [12]	-	Rezoned	Schofields ZS
Riverstone East (Stage 3)	2,300 [1]	-	Planning	East Riverstone ZS (Future)
Riverstone West	-	100 [13]	Rezoned	Unserviced
Schofields	2,950 [14]	-	Rezoned	Schofields ZS
Shanes Park	500 [15]	-	Future	Werrington ZS (Current) Marsden Park ZS (Future)
Townson Road	336 [16]	-	Rezoned	Schofields ZS
Vineyard (Stage 1)	2,300 [17]	-	Rezoned	South Windsor ZS (Current) Box Hill ZS (Future)
Vineyard (Stage 2)	Unknown	-	Future	East Riverstone ZS (Future)
West Schofields	4,500 [18]	-	Planning	Unserviced

Table 1 – North West Priority Growth Area Precinct summary

¹ Includes 4,000 lots from the DCP with an additional 1,500 lots through a Technical Review Request received by Endeavour Energy.

4.1 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 to the North of the Vineyard precinct and West of the Box Hill precinct have not been included in the NWPGA. The Outer Sydney Orbital [19] is a proposed corridor for a motorway and freight rail line in Western Sydney [19]. The establishment of the Outer Sydney Orbital could stimulate growth in this area. 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.

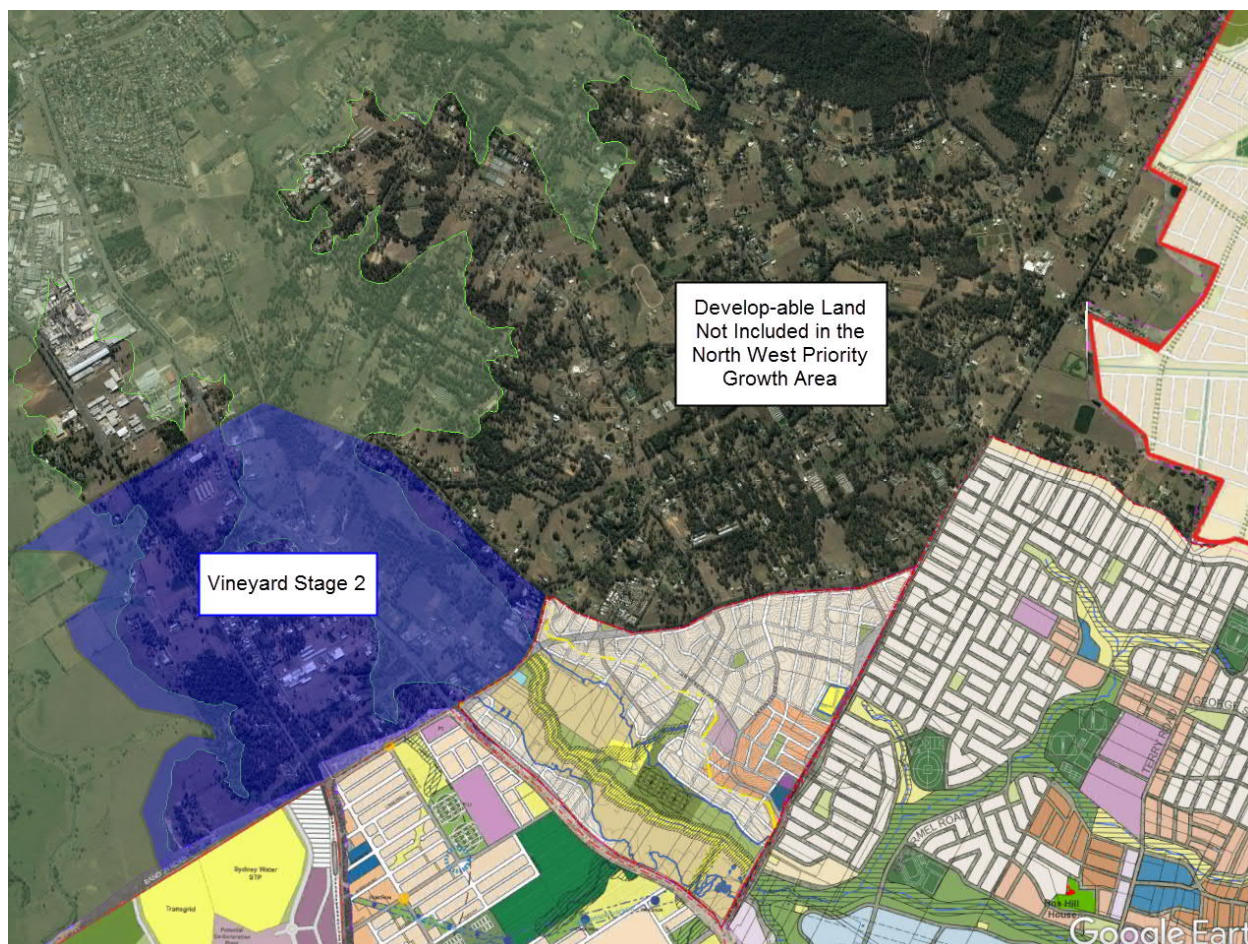


Figure 3 – Location of additional developable land to the NWPGA

The area 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.

4.2 North West Rail Link Corridor Development

In 2013, the North West Rail Link Corridor (NWRL) strategy was approved. 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 3. One of the eight precincts is covered under the precincts of the NWPGA. Although the remaining NWRL precincts do not directly impact the NWPGA, they may impact the sub-transmission network which supplies it.

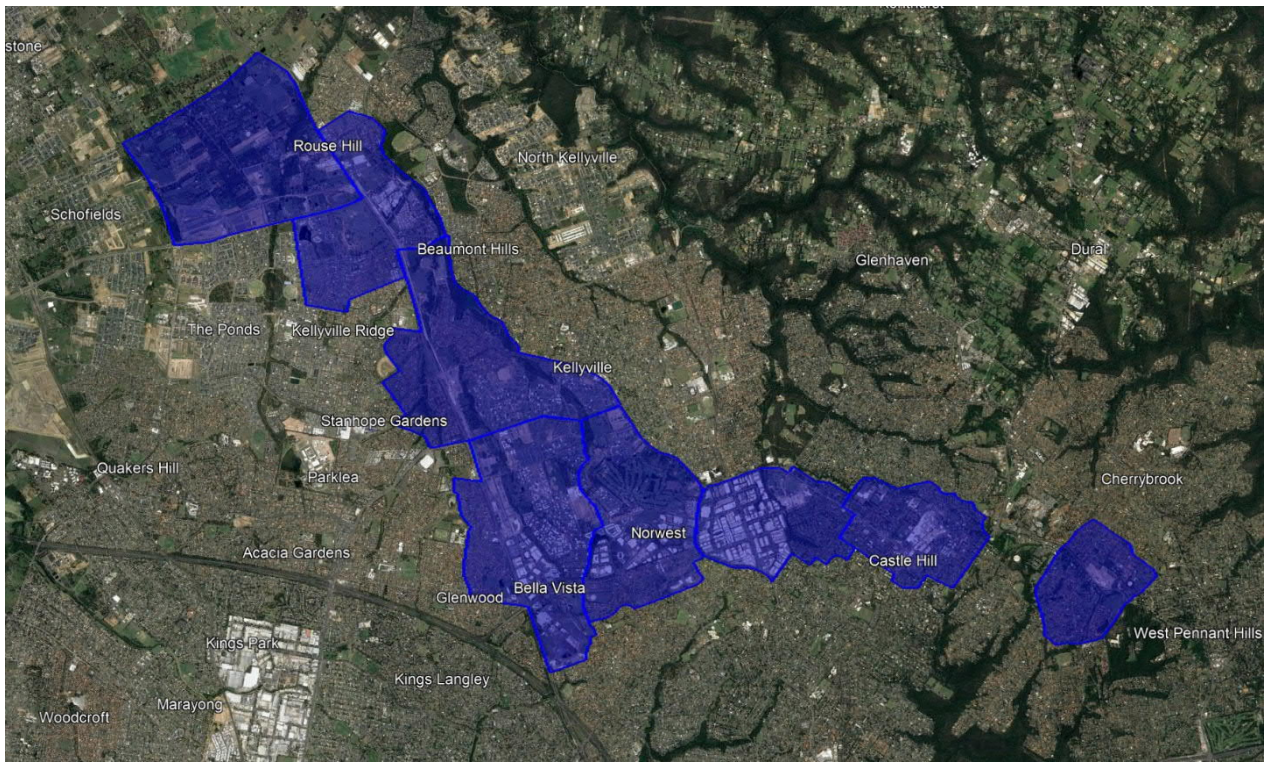


Figure 4 – North West Rail Link Corridor

5.0 Network Need

The figures provided by the Department of Planning and Environment NSW for anticipated residential and industrial lot yields have been used as inputs into load forecasts. An After Diversity Maximum Demand (ADMD) of 5.4kVA per dwelling and 3.3kVA per apartment have been used to calculate residential demand. Note these residential ADMD values typically have an 80% diversity factor applied to them when included in demand forecasts at zone substation levels. For the purposes of sub-transmission network load flow modelling, further diversity factors are taken into consideration to reduce coincident peak load.

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. The table below shows the 10 year load forecasted for each zone substation.

Zone Substation (Existing firm capacity)	Supplying Precinct	ZS Firm Capacity (MVA)	ZS Total Capacity (MVA)	Year 10 Load (MVA)
Riverstone ZS	Riverstone (Partial)	25	50	40.8
	Riverstone West			
Kellyville ZS ²	North Kellyville (Partial)	25	50	27.8
Schofields ZS	Alex Avenue	45	90	98.4
	Riverstone (Partial)			
	Riverstone East (Stage 1 and 2)			
	Schofields			
	Townson Road			
Mungerie Park ZS	Area 20	90	135	102.4
	North Kellyville (Partial)			
Quakers Hill	Colebee	50	95	42.8
Marsden Park ZS ³	Marsden Park Residential	0 (Current) 45 (Future)	45 (Current) 90 (Future)	59.6
	Marsden Park North			
	Shanes Park			
South Marsden Park ZS	Marsden Park Industrial	45	90	40.9
Box Hill ZS ⁴	Box Hill	0 (Future)	45 (Future)	44.7
	Box Hill Industrial			
	Box Hill North			
	Vineyard (Partial)			

Table 2 – Zone substations, precincts and loads

² Kellyville ZS is constrained by upstream transmission feeder ratings.

³ 2nd transformer expected to be commissioned in FY2024.

⁴ ZS expected to be commissioned in FY2024.

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- It can be seen from Table 2 there are zone substations which exceed both firm and total capacity in the next 10 years. As a result, projects are being investigated and assessed to address the risks associated with exceeding capacity.
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6.0 Existing Supply Arrangements

6.1 Description of the network

The majority of the zone substations are supplied at 132kV from the TransGrid owned Vineyard Bulk Supply Point (BSP) within the NWPGA. Vineyard BSP supplies the majority of the NWPGA through a mesh network as shown in Figure 5.

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. Feeder 229 also provides a tie to a neighbouring BSP via Carlingford TS but is currently open bonded at West Castle Hill ZS. This feeder was considered for removal due to easement encroachment issues along its alignment. An investigation was carried out to assess the best course of action for this feeder. The outcome of that investigation determined that reconnecting this feeder as a tee connection to Feeder 21C from West Castle Hill ZS to Cheriton Avenue ZS would improve contingency capacity to the Vineyard sub-system.

Existing 33kV Zone Substations also exists 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.

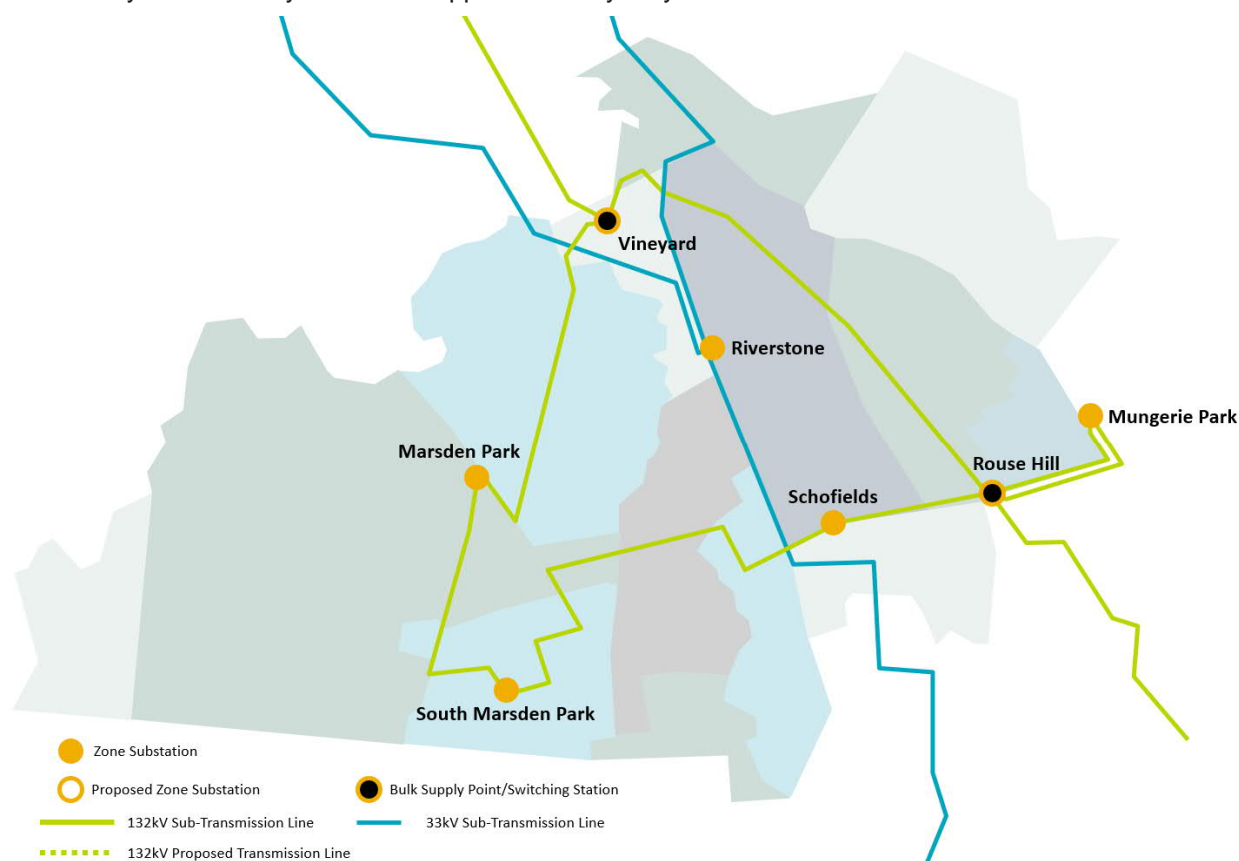


Figure 5 – Sub-Transmission Network within the North West Priority Growth Area

6.2 Substation Capacities

Table 3 below shows the zone substations currently supplying the NWPGA, their 10th year load forecast and their capacities.

Zone Substation	ZS Firm Capacity (MVA)	ZS Total Capacity (MVA)	Year 10 Load (MVA)
Riverstone ZS	25	50	40.8
Kellyville ZS	25	50	27.8
Schofields ZS	45	90	98.4
Mungerie Park ZS	90	135	102.4
Quakers Hill	50	95	42.8

Marsden Park ZS	0 (Current) 45 (Future)	45 (Current) 90 (Future)	59.6
South Marsden Park ZS	45	90	40.9
Box Hill ZS	0 (Future)	45 (Future)	44.7

Table 3 – Zone substation capacities

6.3 Transmission Feeder 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 4 shows each sub-transmission line in the area along with the contingency demand and the associated rating.

Feeder Designation and Destination	Voltage (kV)	Contingency Demand (MVA)	Rating (MVA)
Vineyard BSP			
227 & 234 Vineyard BSP to Hawkesbury TS	132	207	230
938 & 9JA Vineyard to Rouse Hill	132	494	495
21F & 21G Rouse Hill to Schofields	132	104	172
21M & 21P Rouse Hill to Mungerie Park	132	105	172
214 & 215 Rouse Hill to Parklea	132	149	172
213 Parklea to Bella Vista	132	157	172
230 Parklea to West Castle Hill	132	154	145
21C West Castle Hill to Cheriton Ave	132	100	172
216 Bella Vista to Cheriton Ave	132	90	172
212 Baulkham Hills to Bella Vista	132	98	172
21R Vineyard to Marsden Park	132	100	145
21L Marsden Park to South Marsden Park	132	67	145
21J South Marsden Park to Schofields	132	105	145
Hawkesbury TS			
444 Hawkesbury to Riverstone	33	42	42
441 Quakers Hill to Riverstone	33	20	19
458 Hawkesbury to Tee	33	47	46
458 Tee to Riverstone	33	13	19
Baulkham Hills TS			
469 Jasper Road to Kellyville	33	13	21
473 Baulkham Hills to Tee	33	16	32
473 Tee to Kellyville	33	16	21
Sydney North BSP			
221 Sydney North to Kenthurst	132	61	128
476 Kenthurst to Kellyville	33	23	19

Table 4 – Sub-transmission feeder loadings and ratings

7.0 Recommended Supply Strategy

7.1 Projects in Progress

Projects are currently in progress to address some of the network needs in the NWPGA.

Box Hill ZS is to be commissioned in FY2024 and will ultimately supply all of Box Hill and Vineyard Stage 1 developments. This project will relieve load from Mungerie Park ZS that is currently supplying Box Hill.

Marsden Park ZS will have a second transformer installed by FY2024 which will improve backup capacity for the residential developments in the Marsden Park area.

7.2 NWPGA Supply Strategy

Figure 6 below shows the strategy for the next 10 years to service the continual development of the NWPGA.

The following sections discuss strategies for the broader areas of Riverstone, Box Hill and Vineyard as these are the focus areas of network investment in the next 10 years.

For the remaining areas, augmentation needs will be investigated as growth across the NWPGA materialises.

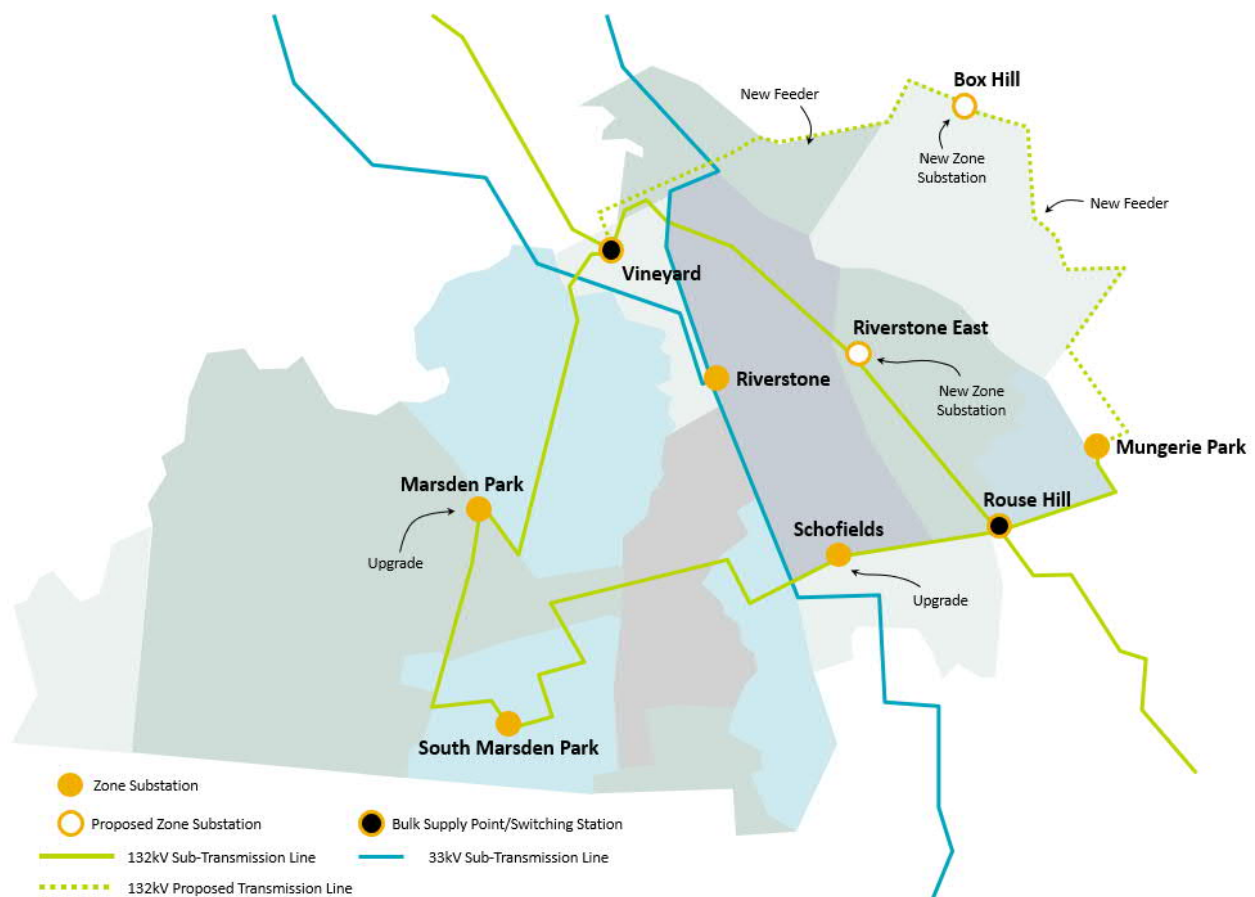


Figure 6 – Proposed North West network

7.3 Riverstone and Riverstone East Precincts

The precincts of Riverstone and Riverstone East will drive the need for the next major zone substation works at either Schofields ZS or establishment of East Riverstone ZS. Initial supply to these areas provided from both Riverstone ZS and Schofields ZS.

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- 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.
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Economic analysis is being carried out and continually updated and monitored to determine which of these two projects will proceed first and defer the other.

It is expected that Riverstone East ZS location will be built around the corner block of 263 Garfield Road, Riverstone.

Connection of Riverstone East ZS to the transmission network can be achieved using one of the following options:

- **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.

7.4 Box Hill & Vineyard

The Box Hill and Box Hill Industrial precincts are currently being supplied by Mungerie Park ZS. Supply will be switched over to the new Box Hill ZS once it is commissioned in FY2024. Both precincts will deliver approximately 10,000 new homes, employment lands and a new town centre.

Box Hill North is being developed by a single private developer and initially planned to deliver approximately 4,000 new homes with a new town centre. Recently, the developer has informed that rezoning will lead to 1,500 additional dwellings to this area.

The combined developments will cause the demand to exceed the 36 MVA of firm capacity from Box Hill ZS and the surrounding 22kV distribution feeders in 2027 and exceed the total capacity of 45 MVA from Box Hill ZS by 2029.

A project will be required to increase the capacity of Box Hill ZS in the next regulatory period. This project will also investigate options for a backup 132kV transmission feeder outlined as follows:

- **A new feeder from Mungerie Park ZS**

There is a spare 132kV circuit breaker at Mungerie Park to connect a new feeder. This feeder will pass the vicinity of a large industrial customer in Rouse Hill and thus enable their connection.

- **A second feeder from Vineyard BSP**

This option will result in a shorter route however space constraints may result in constructability difficulties.

Furthermore, the Vineyard Stage 1 precinct will deliver 2,300 new homes. This area is currently being supplied at 11kV from South Windsor ZS. Once Box Hill ZS is commissioned, this area and some remaining 11kV areas of Box Hill will be converted to 22kV in order to supply those areas from Box Hill ZS.

7.5 Proposed Projects

A summary of projects for the next 10 years to service the NWPGA are shown in Table 5. It is noted that the Need Year identified for these projects are indicative only and will be further refined as they are assessed.

Project Number	Project	Description	Need Year (FY)	Status	Cost (\$M)
NPR-000048	Capacity Increase for Riverstone East Residential Precinct	Supply to the Riverstone East precinct developments by either establishing a 3rd transformer at Schofields ZS or establishing a new Riverstone East ZS.	2028	Investigating	18.6
NPR-000019	Supply to Box Hill Development Area	Supply to the Box Hill development area by establishing a new ZS supplied by a single 132kV feeder from Vineyard BSP.	2024	Executing	13.5
NPR-000070	Box Hill ZS Load Constraint	Augmentation of Box Hill ZS to cater for the continual growth of the Box Hill and Vineyard development precincts.	2029	Investigating	18.3
NPR-000023	Feeder 214/215 constraints	Addressing the safety risks of Feeder 229 associated with easement encroachments against unserved energy risks due to the constraints of feeders 214/215	2023	Investigating	0.6
NPR-000017	Marsden Park ZS Capacity Constraint	Establishment of a second transformer at Marsden Park ZS to cater for continual residential developments in the area.	2024	Executing	5.1
NPR-000056	Mungerie Park & Parklea ZS Constraints	Investigate potential to transfer loads supplied at 22kV from Mungerie Park ZS and Parklea ZS to Bella Vista ZS by establishing 22/11kV auto transformers at Bella Vista ZS.	2023	Investigating	2.0

Table 5 – Proposed cost of network strategy

8.0 Electrification and our customers changing energy needs

Customer energy needs continue to evolve within the wider context of the energy transition. There is a growing bias from both customer groups and developers to transition or move away from gas, increase energy efficiency (e.g., building standards and heat pump heating systems), adopt low emission transportation options, and increase the penetration and capability of distributed energy resources (DERs) such as solar generation and storage.

Endeavour Energy continues to adapt to changing needs. The extended roll out of distributed automation, latest technology substation control systems, the provision for grid scale storage on many zone substation sites, amongst other initiatives provides enabling options in this transition. The deployment of the Advanced Distribution Management System (ADMS), continued developments in Distributed Energy Resource Management System (DERMS), TimeScale Databases, and Next Generation Planning Systems (NGPS) will provide data platforms to underpin an ability to inspect, understand and forecast changing customer behaviours and continue to adapt.

Continuously investigating alternative, new technology and non-network options and integrating these into the network planning process represent important enablers of energy transition. In addition to strategic investment initiatives such as load transfers (Mungerie Park and Parklea) and staged transformer deployment (Marsden Park), Endeavour Energy will seek innovative methods to provide for network capacity both through the New Technology Master Plan screening tool (NTMP, refer to Growth Servicing Strategy) and the Regulatory Investment Test – Distribution framework.

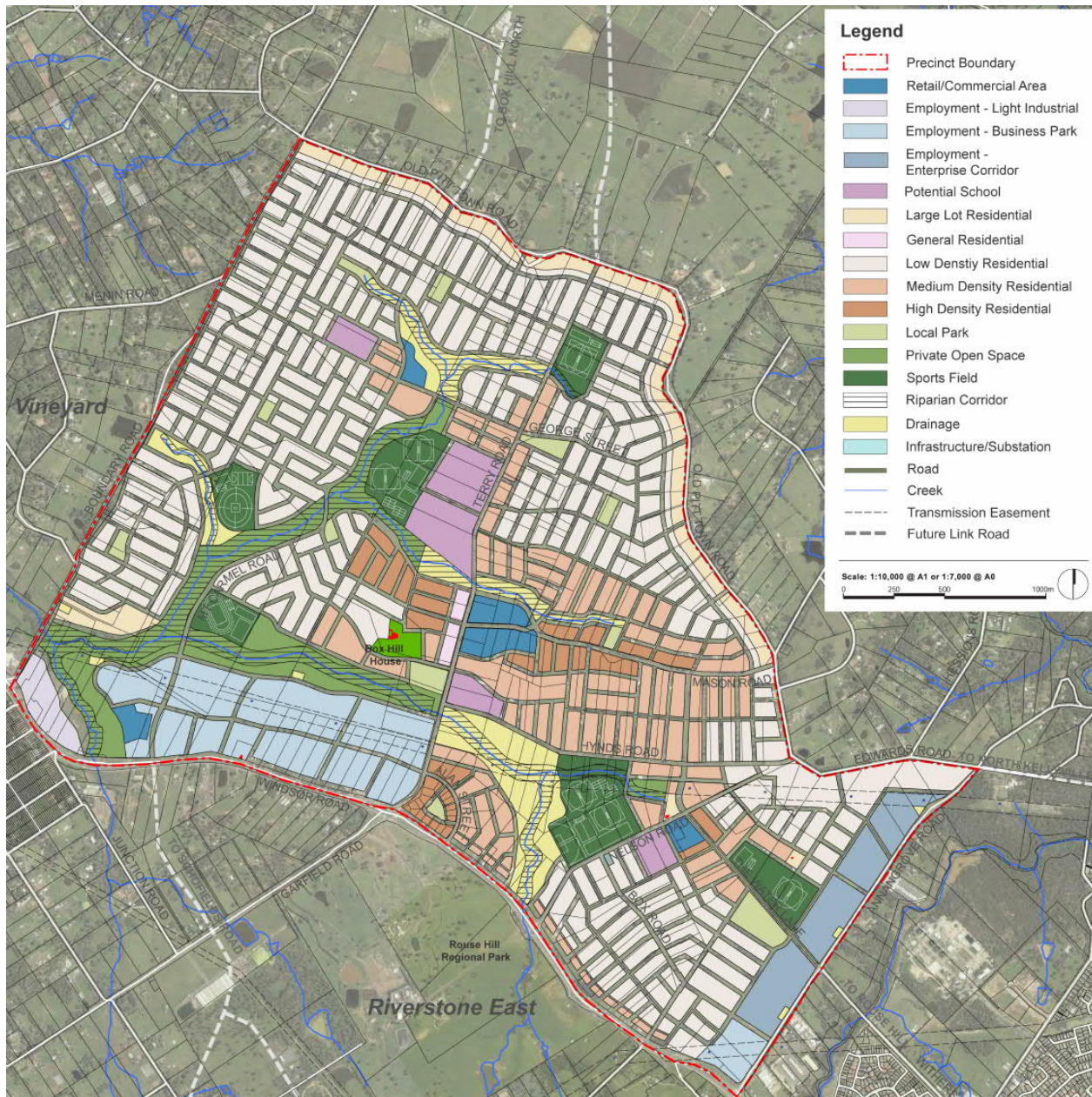
9.0 Recommendation

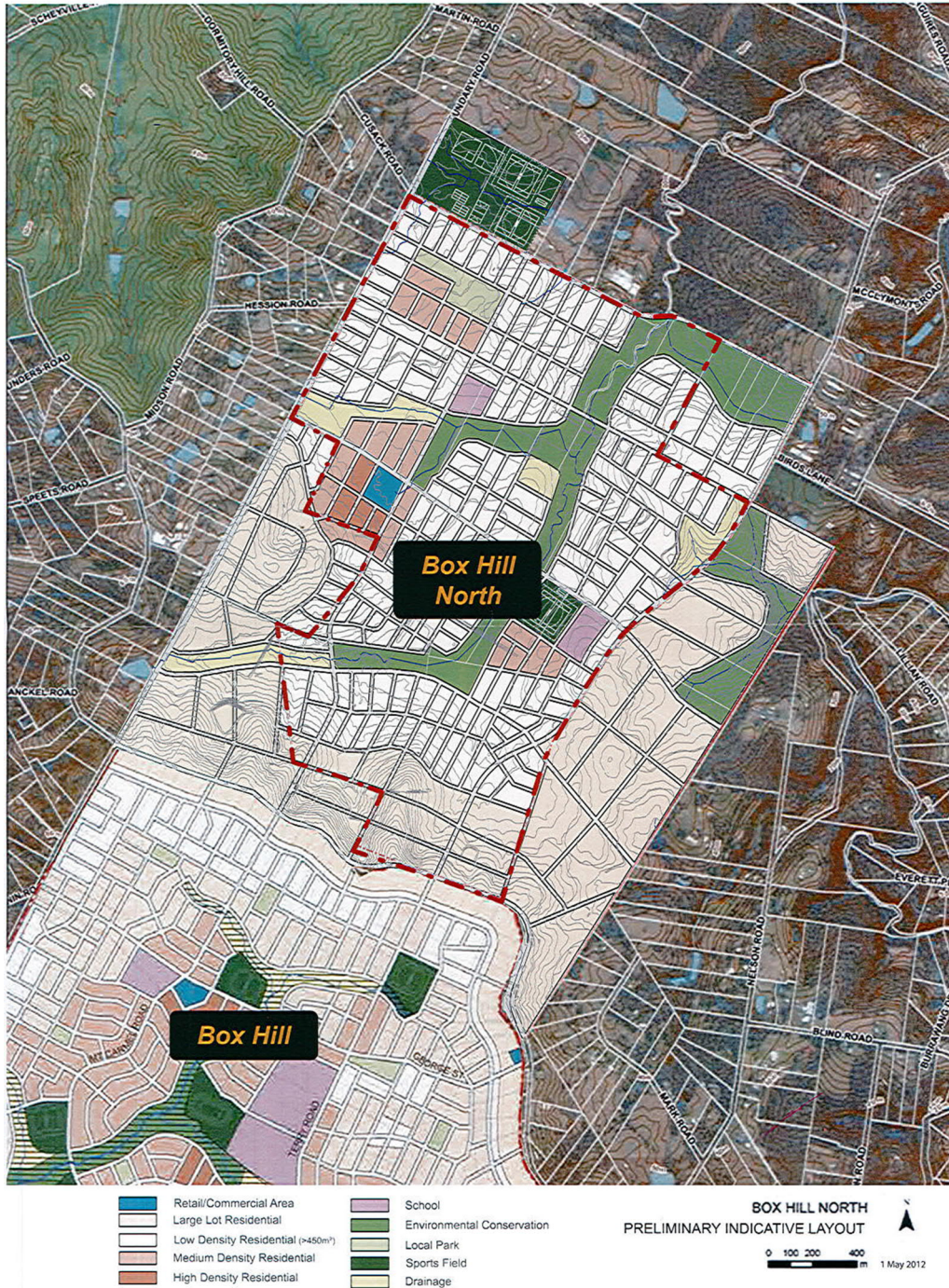
Following analysis of future network needs of the NWPGA, it is recommended that the Recommended Supply Strategy outlined within this report in section 7.0 is carried forward as the basis for further planning within the North West Priority Growth Area unserved supply area.

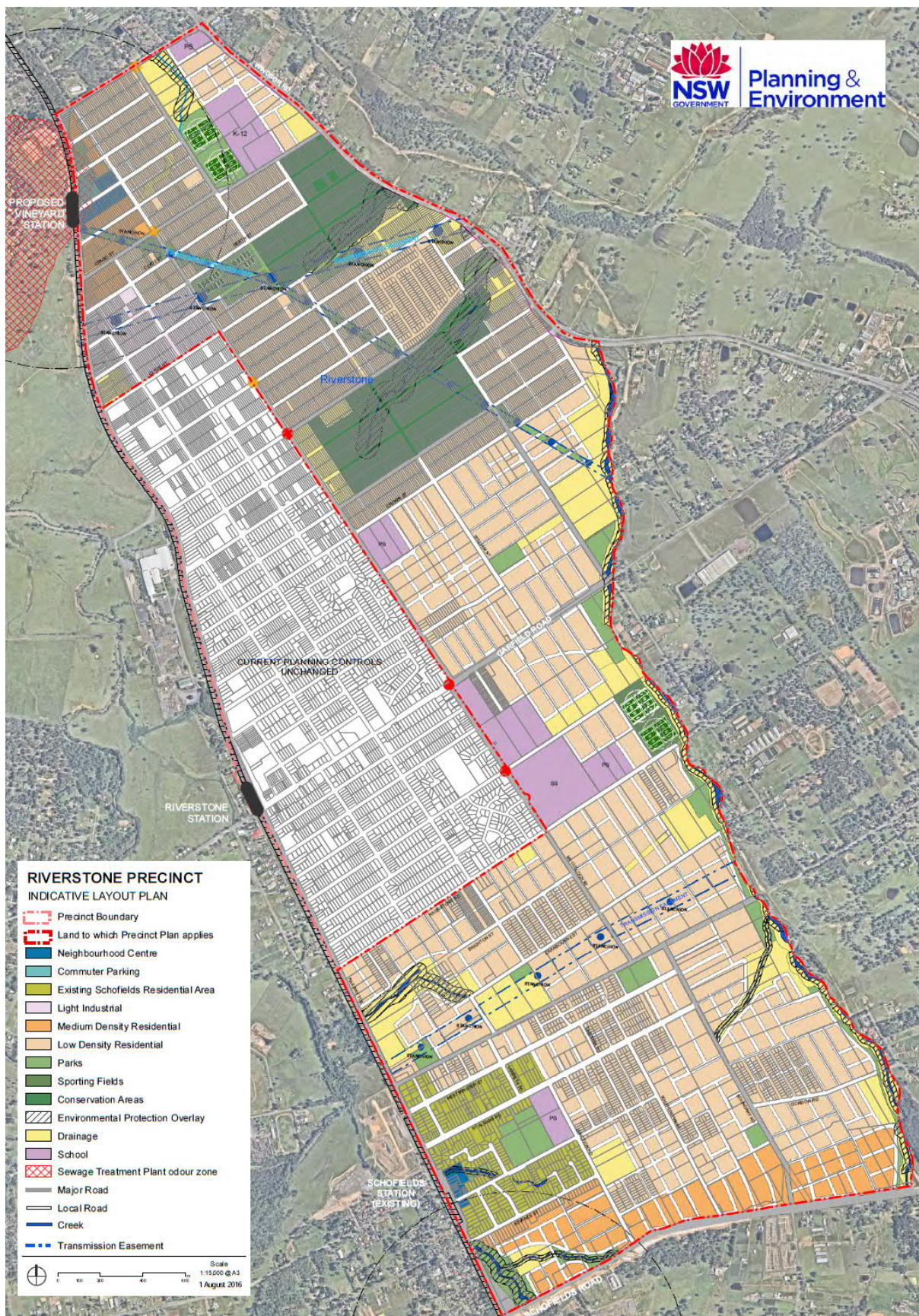
Furthermore, individual Network Investment Options (NIO) are to be carried out for the projects in Section 7.5 based on the principles outlined in this report will be developed separately. Options will be economically assessed to determine which option is most prudent in addressing risks and has the greatest benefit resulting in the highest NPV. Funding will be sought for each of these projects at the appropriate time.

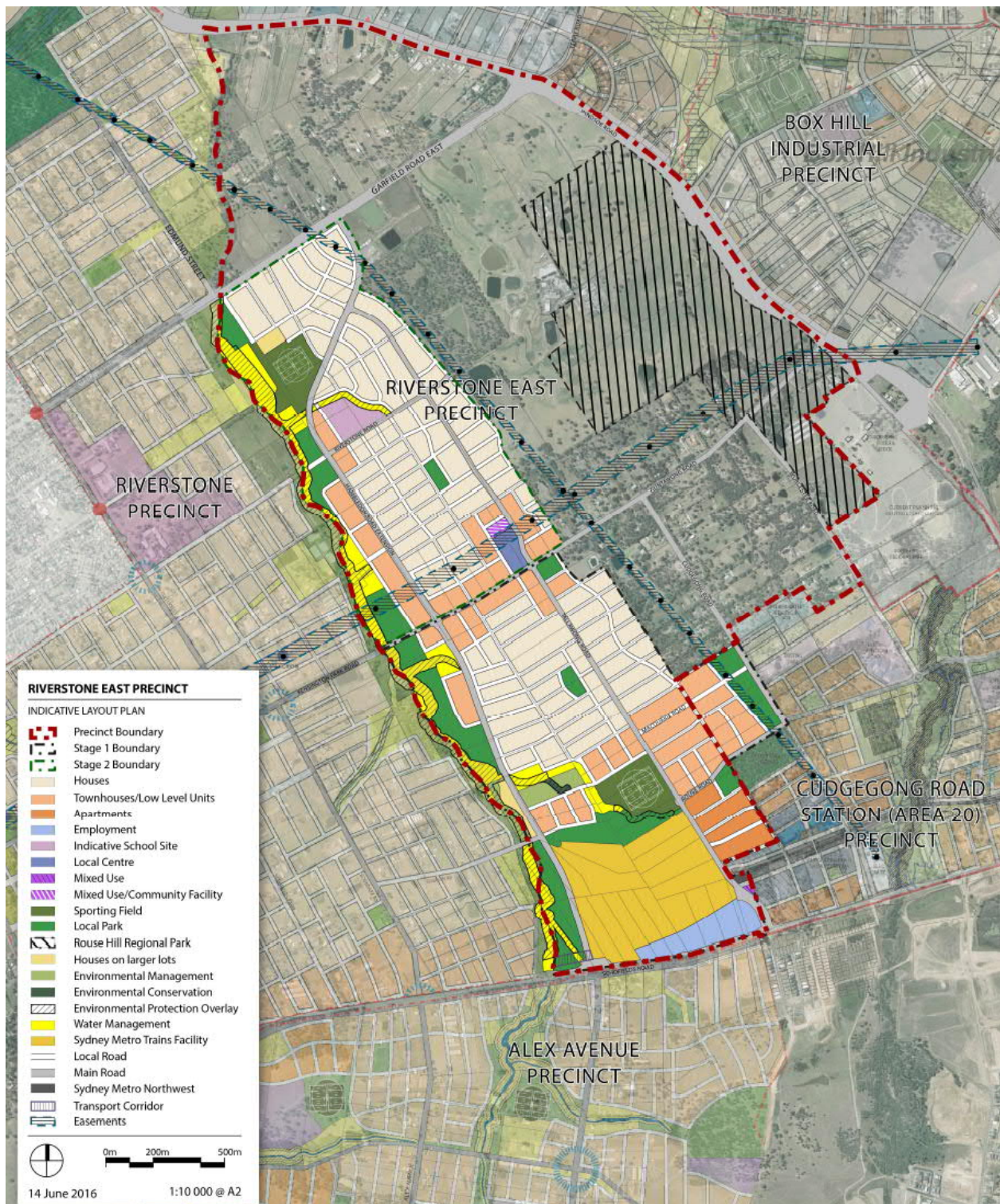
10.0 Appendices

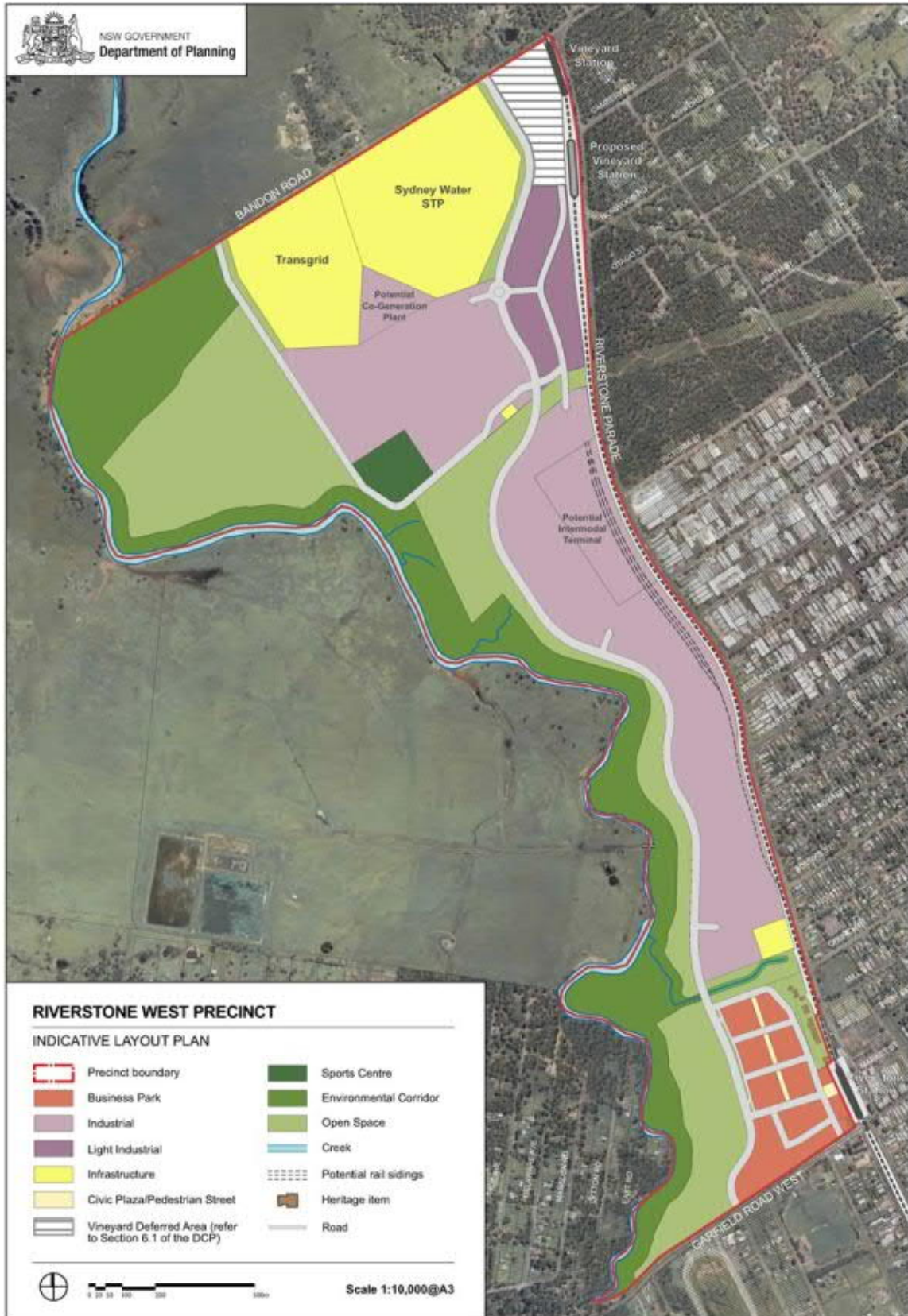
10.1 North West Priority Growth Area Precinct Maps

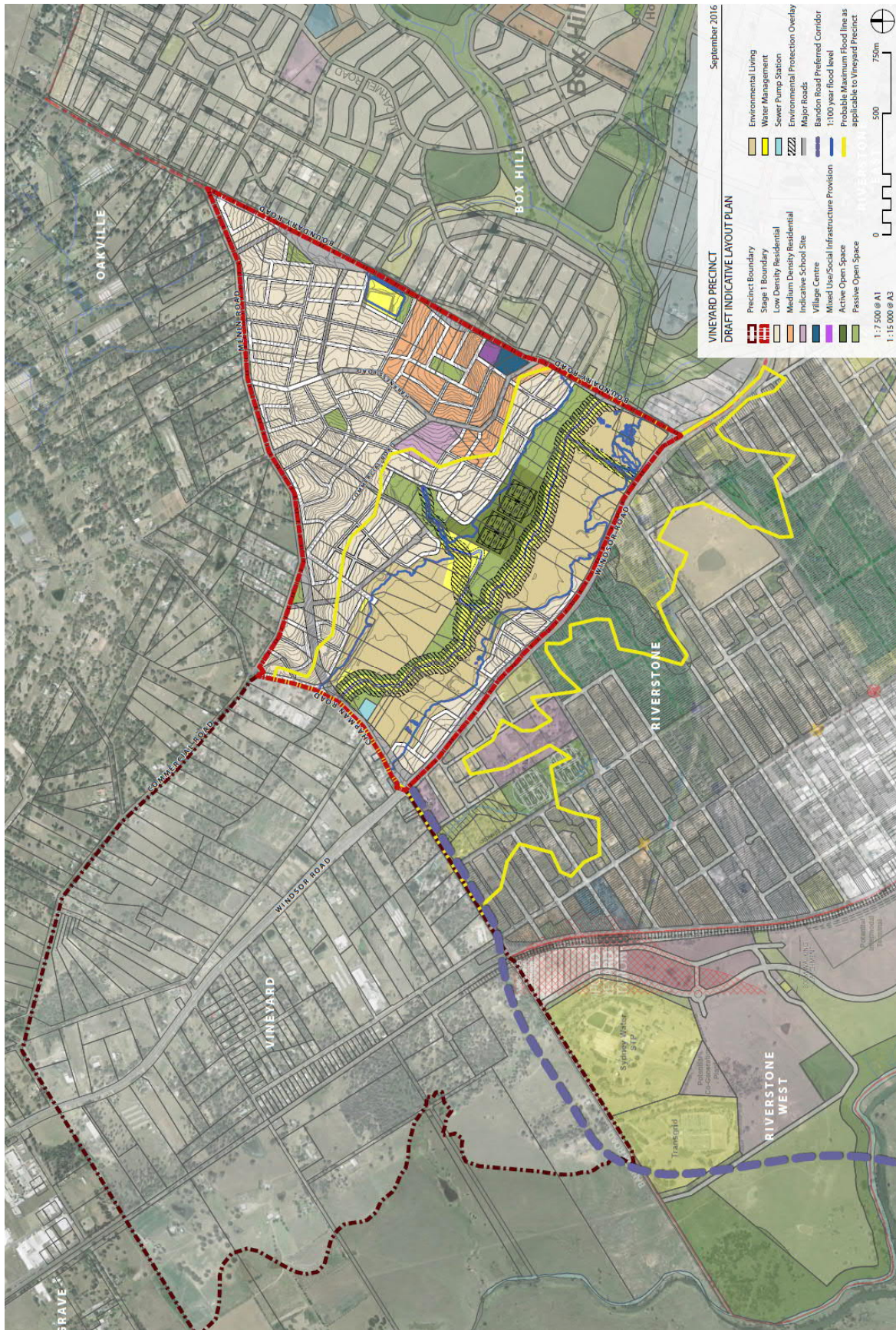












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W Endeavourenergy.com.au
E news@endeavourenergy.com.au
T 131 081



ABN 11 247 365 823