Distribution Annual Planning Report

2017 DAPR

Endeavour Energy

December 2017

Endeavour Energy

DISCLAIMER

Endeavour Energy is registered as a Distribution Network Service Provider. This Distribution Annual Planning Report (DAPR) has been prepared and published by Endeavour Energy under clause 5.13.2 of the National Electricity Rules. Its purpose is to notify Registered Participants and Interested Parties of the results of Endeavour Energy's distribution network annual planning review and it should only be used for that purpose.

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1.0 EXECUTIVE SUMMARY

Endeavour Energy is a Distribution Network Service Provider serving some of Australia's largest and fastest growing regional economies.

Endeavour Energy is a 'poles and wires' business, responsible for the safe, reliable and efficient supply of electricity to 974,200 customers or 2.4 million people in households and businesses across Sydney's Greater West, the Blue Mountains, Southern Highlands, Illawarra and the South Coast.

With an estimated regulatory asset value of almost $6 billion, our network spans 24,800 square kilometres and is made up of more than 310,000 power poles, over 200,000 streetlights, 187 major substations and 32,000 distribution substations connected by almost 50,000 kilometres of underground and overhead cables.

The focus of Endeavour Energy is to deliver a safe, reliable and efficient electricity supply to our residential and business customers.

Endeavour Energy is subject to the National Electricity Law (NEL) and National Electricity Rules (NER) which regulate the National Electricity Market. Endeavour Energy is also subject to the statutory and other legal requirements applied to all businesses in NSW. Endeavour Energy operates in the National Electricity Market (NEM) as a licenced distribution network provider (DNSP).

The distributors licence conditions, including the network Reliability and Performance Licence Conditions are imposed by the NSW Minister for Energy. The Independent Pricing and Regulatory Tribunal (IPART - Electricity) is responsible for administering licensing within the energy industry and monitoring compliance with licence requirements on request from the Minister of Energy. The Australian Energy Regulator (AER) is the relevant economic regulator that ultimately adjudges and sets Endeavour Energy's network revenue and network service pricing within each regulatory control period, and this to meet the National Electricity Objectives for economically efficient operation of the business.

This Distribution Annual Planning Report (DAPR) has been prepared to comply with National Electricity Rules (NER) clause 5.13.2. It reflects the outcomes of the annual planning review of Endeavour Energy's network. The aim of the document is to inform network participants and stakeholder groups of the proposed development of Endeavour Energy's network, including potential opportunities for non-network solutions particularly for investments where the AER Regulatory Investment Test for Distribution (RIT-D) applies.

Endeavour Energy has adopted an Asset Owner-Asset Manager-Service Provider model to deliver is asset management strategy and achieve its corporate objectives of Safety, Reliability, and Sustainability. The plans for the distribution network developed to implement the asset management strategy are developed in accordance with the asset management philosophy to achieve the corporate objectives. They are directed and coordinated and through the operation of the Executive Network Asset Management Committee and the Investment Governance Committee.

This Distribution Annual Planning Report outlines the latest plans developed through application of Endeavour Energy's planning processes in accordance with its asset management strategy. Key features of the planning outcomes are:

- Continued strategic focus on asset renewal, prioritised and optimised on the basis of asset condition and network risk, and integrated with growth-related investment needs;
- Demand growth, primarily concentrated in North-West and South-West Sydney which are expected to accommodate over 480,000 new dwellings and land for employment for around 1,000,000 new residents over the next 25 to 30 years, for which Endeavour Energy is planning to provide up-stream supply infrastructure;
- Joint planning with TransGrid for the provision of supply for the proposed Western Sydney Airport at Badgerys Creek, and the Broader Western Sydney Employment Area;
- Continued dependence on Demand Management strategies to defer planned network augmentations where it is economically viable and practicable to do so;
- Maintenance of current reliability performance levels into the future, with planned improvements driven by licence condition requirements and STPIS outcomes;

- A total of 26 network-need driven projects in the next 5 years that require the application of the "RIT-D" regulatory test, including consideration of non-network solutions;
- A total of 2 non- "RIT-D" network-need driven projects in the next 5 years which will also include the consideration of non-network solutions;
- The identification of 252 high-voltage distribution feeders that are currently at or above maximum planned loading level, that require monitoring, remediation through augmentation, load transfers or load reductions, or combination of responses; and
- Ongoing growth in the connection of embedded solar-photovoltaic energy generation technologies and the integration of these and other emerging end-use demand management technologies with Endeavour Energy's distribution and reticulation networks.

This Distribution Annual Planning Report outlines the details of the various investment programs and projects required to fulfil Endeavour Energy's obligation as a licensed DNSP in the National Electricity Market. It is a snapshot of the current understanding of the investment requirements expected over the next five year period, provided in order to inform the market. The details contained in this report will change over time as the consideration of new information in the planning process continues to inform planning outcomes in accordance with meeting of Endeavour Energy's corporate objectives.

2.0 INTRODUCTION

Endeavour Energy is presently a Distribution Network Service Provider serving some of Australia's largest and fastest growing regional economies. Endeavour Energy is a registered electricity Distribution Network Service Provider (DNSP) that owns, develops, operates and maintains electricity distribution assets in NSW, and is subject to the National Electricity Law and National Electricity Rules administered by the Australian Energy Regulator.

The National Electricity Rules requires all registered DNSPs to:

- Conduct an annual planning review and publish a Distribution Annual Planning Report (DAPR);
- Conduct economic assessments of potential project options under a new regulatory investment test for distribution (RIT-D); and
- Implement a Demand Side Engagement Strategy to consult with and engage non-network providers in the development and evaluation of potential solutions to identified network needs.

It is required that the annual planning review includes the planning for all assets and activities carried out by Endeavour Energy that would materially affect the performance of its network. This includes planning activities associated with replacement and refurbishment of assets and negotiated services. The objective of the annual planning review is to identify possible future issues that could negatively affect the performance of the distribution network to enable DNSPs to plan for and adequately address such issues in an appropriate timeframe. This Distribution Annual Planning Report reflects the outcomes of Endeavour Energy's 2017 annual planning review.

Endeavour Energy is required to prepare and publish a DAPR that is compliant with the requirements of National Electricity Rules Schedule S5.8 Distribution Annual Reporting Requirements to:

- Provide transparency to Endeavour Energy's decision making processes and provide a level playing field for all stakeholders in the national electricity market in terms of attracting investment and promoting efficient decisions;
- Include information associated with all parts of the planning process including forecasting demand, identification of network needs and the development of credible options to address network constraints;
- To give third parties the opportunity to offer alternative proposals to alleviate constraints. These proposals may include non-network options such as demand management or embedded generation solutions;
- Set out the results of Endeavour Energy's annual planning review, including joint planning, covering a minimum five year forward planning period for distribution assets;
- Inform registered participants and interested parties of the annual planning review outcomes including asset retirement and network capacity needs for sub-transmission lines, zone substations and transmission-distribution connection points and any primary distribution feeders which are currently present or are expected to emerge within the next two years;
- Provide information on Endeavour Energy 's demand management activities and actions taken to promote non-network initiatives each year including plans for demand management and embedded generation over the forward planning period; and
- Assist non-network providers, TNSPs, other DNSPs and connection applicants to make efficient investment decisions.

The DAPR covers a minimum five year forward planning period for distribution network sub-transmission assets.

2.1 ABOUT ENDEAVOUR ENERGY

Endeavour Energy is responsible for the safe, reliable and efficient supply of electricity to 974,200 customers or 2.4 million people in households and businesses across Sydney's Greater West, the Blue Mountains, Southern Highlands, Illawarra and the South Coast.

With an estimated regulatory asset value of more than $6 billion, our network spans 24,800 square kilometres and is made up of more than 310,000 power poles, over 200,000 streetlights, 187 major substations and 32,000 distribution substations connected by almost 50,000 kilometres of underground and overhead cables.

The focus of Endeavour Energy is to deliver a safe, reliable and efficient electricity supply to our residential and business customers. We are committed to deliver better value for customers by reducing our operating costs without compromising safety or service.

2.1.1 OUR VALUES

Endeavour Energy employees are required to understand and support the Company's corporate values. These five values and their associated behaviours are the basis for everything the Company does.

Safety Excellence

- Put safety as your number one priority
- Do not participate in unsafe acts, and challenge unsafe behaviours
- Think before you act
- Lead by example
- Take responsibility for the health and safety of yourself and others

Respect For People

- Treat all people with respect, dignity, fairness and equity
- Demonstrate co-operation, trust and support in the workplace
- Practise open, two-way communication

Customer and Community Focus

- Deliver value and reliable service to our customers and communities
- Use resources responsibly and efficiently
- Be environmentally and socially responsible

Continuous Improvement

- Look for safer and better ways to do your job
- Improve our financial performance
- Support innovation to add value to our business

Act With Integrity

- Act honestly and ethically in everything you do
- Be accountable and own your actions
- Follow the rules and speak up

2.1.2 OUR OBJECTIVES

Endeavour Energy's purpose is:

> *"To be of service to our communities by efficiently distributing electricity to our customers in a way that is safe, reliable and sustainable."*

Our strategies are designed to promote the long term interests of our customers, shareholders, people and communities by delivering three key strategic goals:

1. **Safety –** deliver best practice safety performance for our employees, contractors and the community.
2. **Reliability –** maintain the reliability, security and sustainability of the network.
3. **Sustainability** – ensure our business is sustainable by making it efficient, affordable and competitive so that it can meet future challenges.

Endeavour Energy's principal activities include:

- The ownership and management of assets which make up the electricity distribution network;
- Infrastructure related construction and maintenance services; and

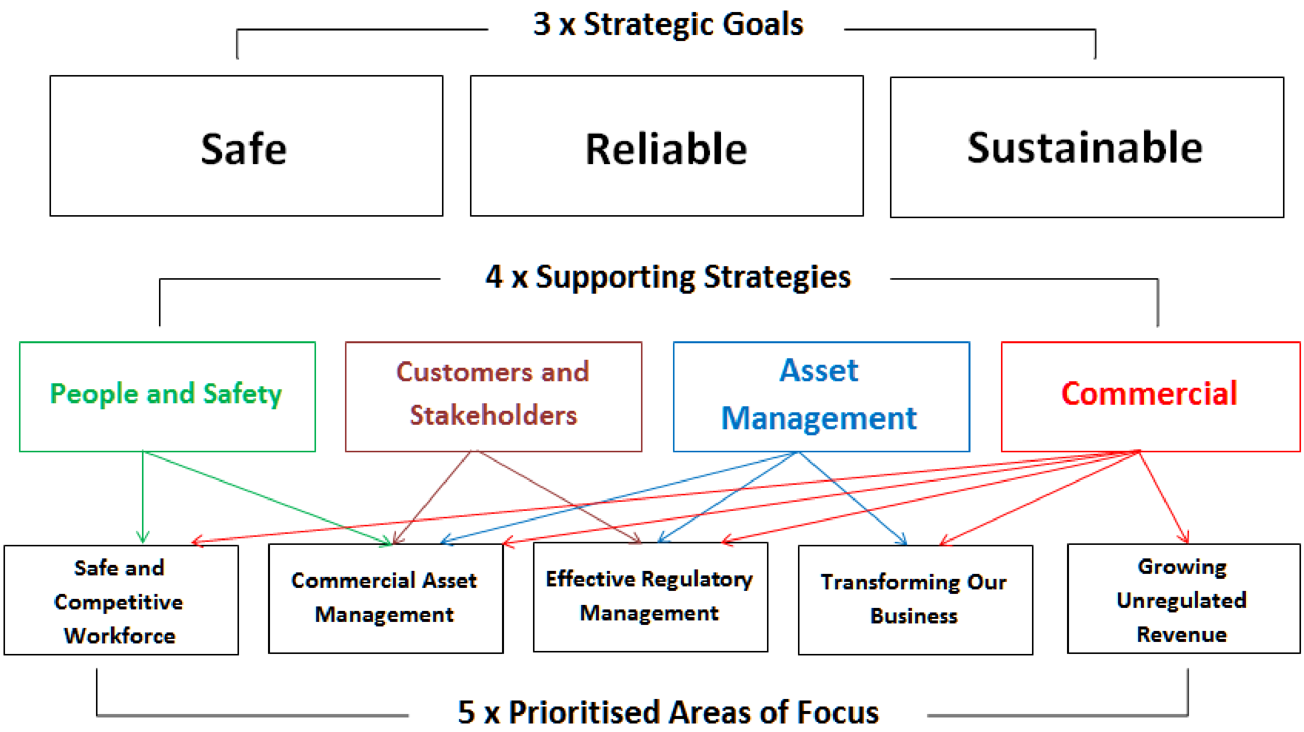
- Street lighting and other services to support the main functions of the business,.

These activities achieve the business purpose through the implementation of four overarching strategic plans that outline the desired outcomes in the following key strategic areas of business operations:

- People and Safety;
- Customers and Stakeholders;
- Asset Management; and
- Commercial.

Each of the four strategic plans supports the three key strategic goals and describes how we are adapting and maintaining relevance in the changing world. From these plans, Endeavour Energy has prioritised five key areas that set the foundation for driving our business forward and capitalising on the opportunities emerging from the transformation occurring in the energy sector. The following graphic depicts the relationship between the goals, strategies and prioritised areas of focus.

FIGURE 1: STRATEGIES AND GOALS



Endeavour Energy's Asset Management Strategy is one of the key plans that support the overall strategic plan. It describes how the priorities drive the short and long term planning of network investment to achieve the overall objective of maintaining a safe, reliable and sustainable network.

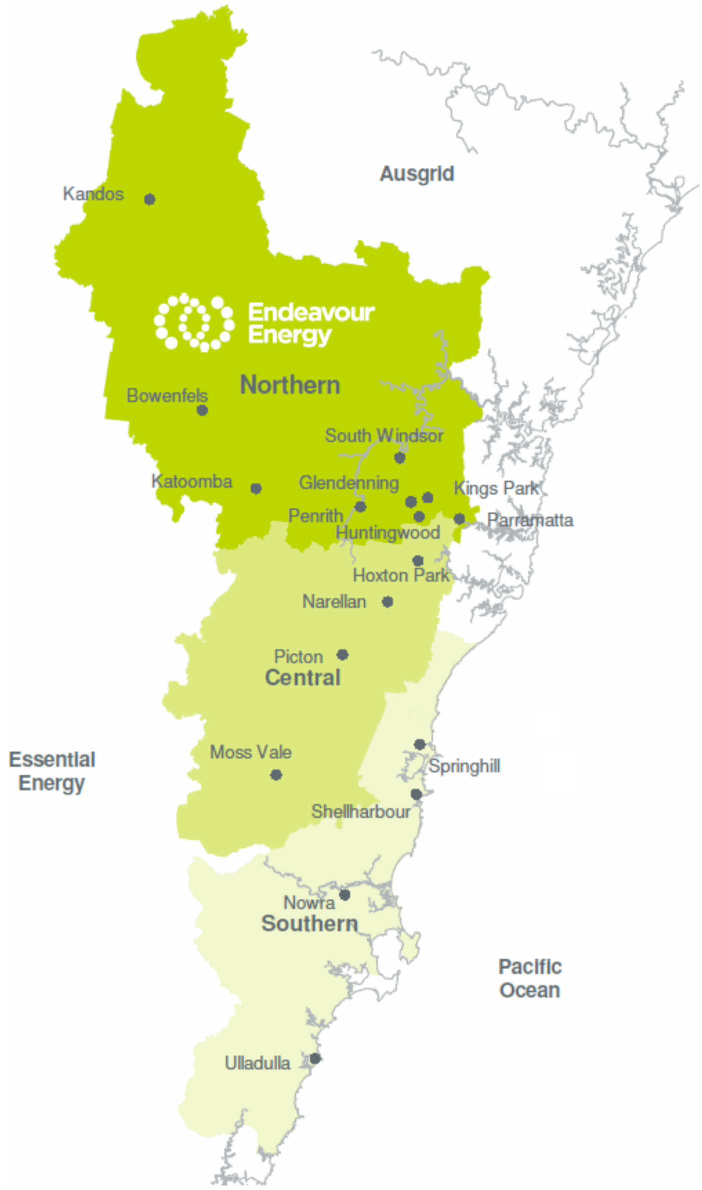
2.2 ENDEAVOUR ENERGY'S NETWORK

Endeavour Energy's network services more than 2.4 million people with a broad-ranging customer base covering rural, urban, residential, industrial and commercial customers, including mining, manufacturing and agricultural industries.

In 2016/17, Endeavour Energy's network supplied 16,700 GWh of electricity to 974,200 network-connected customers. Endeavour Energy's distribution area, shown below, covers an area of 24,800 square kilometres and includes some of the most densely populated and fastest growing areas of NSW. It also supplies customers in Sydney's Greater West, the Illawarra, as far north as the Kandos and as far south as Ulladulla, including the Southern Highlands and the Blue Mountains.

Most of Endeavour Energy's supply of electricity is taken from the generation source through TransGrid's transmission network at 132kV and 66kV. Once the energy is transferred into Endeavour Energy's network, the voltage is transformed through 24 sub-transmission and 163 zone substations and distributed to customers through a 22kV, 11kV or 12.7kV High Voltage network. Distribution substations further reduce the voltage to supply customers with a 230V nominal low voltage supply in accordance with Australian Standards.

FIGURE 2: ENDEAVOUR ENERGY'S NETWORK AREA SHOWING REGIONAL AREAS, HEAD OFFICE, AND FIELD SERVICE CENTRE LOCATIONS



Endeavour Energy's distribution network includes:

- A sub-transmission system of 132kV, 66kV and 33kV assets;
- A high voltage distribution system of 22kV, 11kV and 12.7kV SWER assets;
- A low voltage distribution system of 400V and 230V assets; and
- Over 50,000 km of overhead lines and underground cables.

The elements that make up the electricity network as a whole are shown in Figure 3 below. The elements owned and operated by Endeavour Energy are highlighted in blue. The Transmission network (owned and operated by TransGrid) is located between the output of the Power Station and the Bulk Supply Point. The distribution network generally commences at the output of the Bulk Supply Point and includes Endeavour Energy's entire network to the connection point at the customer's premises. A summary of Endeavour Energy's network and other statistics is given in Table 1.

FIGURE 3: NETWORK LAYOUT DIAGRAM - ENDEAVOUR ENERGY ASSETS SHOWN IN BLUE

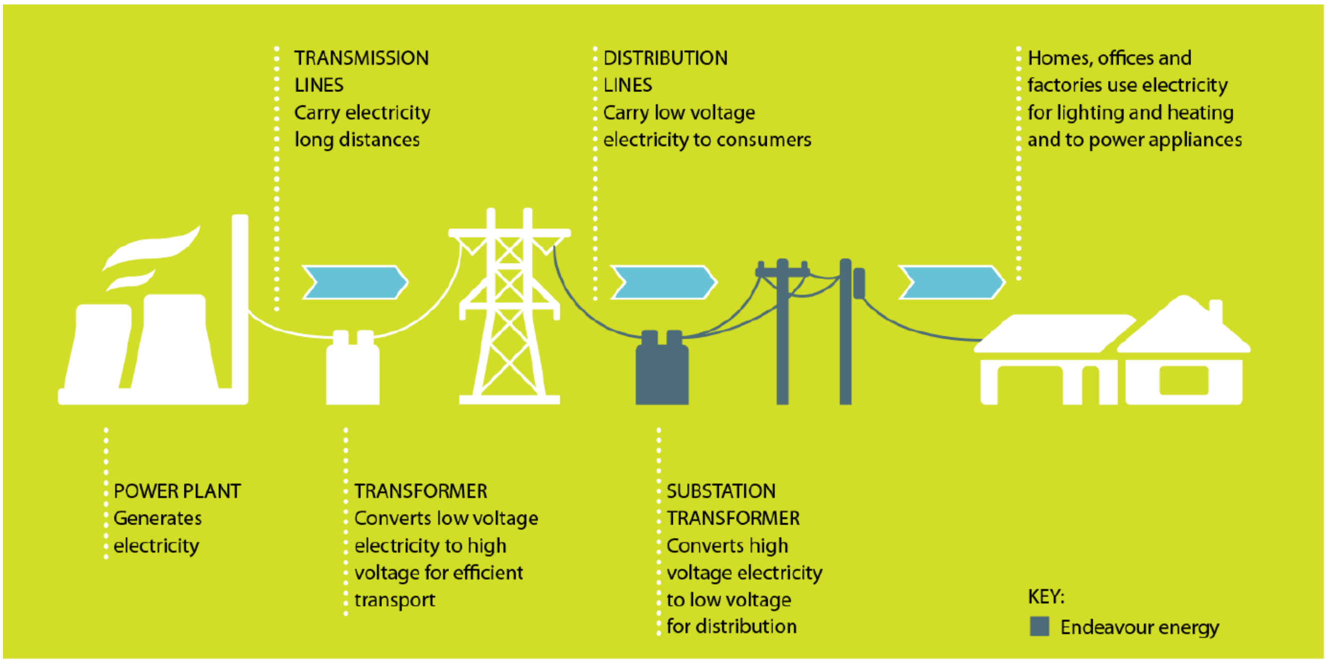


TABLE 1: ENDEAVOUR ENERGY STATISTICS

Statistic	Number
Distribution Customer Numbers (total)	974,200
Maximum Demand (aggregated system MW)	4,100
Feeder Numbers CBD	0
Feeder Numbers Urban	1,078
Feeder Numbers Short Rural	400
Feeder Numbers Long Rural	1
Energy Received by Distribution Network to Year End (GWh)	17,413
Energy Distributed to Year End (Residential) (GWh)	5,877
Energy Distributed to Year End (Non-Residential Including un-metered supplies) (GWh)	10,839
Energy Distributed to Year End (GWh)	16,716
System Losses (%)	4.00
Transmission Substation (Number)	24
Zone Substation (Number)	163
Distribution Substation (Number)	32,000
Sub-Transmission Overhead (km)	3,063
Sub-Transmission Underground (km)	375
High Voltage Overhead (km)	11,379
High Voltage Underground (km)	4,831
Low Voltage Overhead (km)	8,792
Low Voltage Underground (km)	8,540
Streetlighting Overhead (km)	5,194
Streetlighting Underground (km)	3,701

2.3 OPERATING ENVIRONMENT

Endeavour Energy is regulated by statutory and legislative requirements including work health & safety (WH&S), environmental, competition, industrial, consumer protection and information laws, the National Electricity Law Rules, the NSW Electricity Supply Act 1995, the Energy Services Corporations Act, and the requirements of its NSW Distribution Network Service Provider licence. Endeavour Energy ensures compliance with these laws and regulations through its internal policies, procedures, work place instructions and industry codes and standards. We operate a common business control framework across these various instruments that allows us to fulfil our obligations through the development and implementation of plans, delegations of authority and associated controls, instruction and training, audits of compliance, and risk identification and management.

In particular, Endeavour Energy's operations are guided by a number of important policies and codes, including a Code of Conduct, our Safety Policy, Environmental Code of Conduct and our Statement of Business Ethics.

Endeavour Energy is managed by a Board of Directors and a Chief Executive Officer (CEO). The business remains focused on:

- Operating efficiently as any comparable distribution network business;
- Maximising the value of the company to shareholders; and
- Balancing commercial, social, environmental and customer expectations.

Endeavour Energy's CEO reports to the Board, which at present is in turn accountable to shareholders. The Board is responsible for setting the overall strategic direction and performance targets and monitoring the implementation of the strategy by the organisation. The CEO leads the Executive Leadership Team in delivering the approved strategy and achieving the performance targets set by the Board.

Endeavour Energy is subject to the National Electricity Law (NEL) and National Electricity Rules (NER) which regulate the National Electricity Market. As a NSW Statutory State Owned Corporation and NSW Energy Services Corporation, Endeavour Energy is generally subject to the statutory and other legal requirements applied to all businesses in NSW. Endeavour Energy operates in the National Electricity Market (NEM) as a distribution network provider (DNSP). Endeavour Energy is also required to follow government and regulatory direction.

Within NSW, the Network Reliability and Performance Licence Conditions are imposed by the Minister of Energy. The Independent Pricing and Regulatory Tribunal (IPART - Electricity) is responsible for administering licensing within the energy industry and monitoring compliance with licence requirements on request from the Minister. Safety performance and compliance is also administered by IPART in conjunction with WorkCover NSW. The Australian Energy Regulator (AER) is the economic regulator of the distribution and transmission sectors of the national electricity market under the National Electricity Laws and National Electricity Rules.

2.3.1 COMMUNITY SETTING

Electricity consumption within Endeavour Energy increased over the last three years. Growth is driven by population increases in Western Sydney and significant government investment in infrastructure. Wholesale energy prices have increased due to recent closure of major thermal power stations. This in turn has increased retail energy prices despite Endeavour Energy network charges declining in recent years.

The marketplace is increasingly offering Distributed Energy Resource (DER) products that require bidirectional energy flow, the uptake of which may require changes to current network design and construction approaches. These changes further the need for measurement systems and the ability to control the network in new ways in order to continue to provide a cost effective and reliable network. These systems may be the start of a general business model change where networks act more as bi-directional energy trading platform rather than a uni-directional energy delivery system.

Customers are increasingly investing in new technologies as alternate means of energy supply. In recent years there has been a significant growth in solar connections, and it is expected that battery storage systems will increasingly be installed and linked to solar installations to maximise the value and benefit of solar generation as the prices of these energy storage technologies decrease. The use of electric vehicles is another customer technology that may become a viable alternative on a broad scale in the near future. All these changes have the potential to impact the reliability and power quality of the network. This requires further investment in network technologies to better manage the changing electricity network and to continue to provide opportunities for improved operational efficiency.

3.0 ASSET MANAGEMENT

Endeavour Energy's corporate planning framework is updated annually but takes a multi-year view of the strategic objectives and priorities of the business. As noted in Section 2.0, our strategies are designed to promote the long term interests of our customers by targeting three key strategic goals:

- **Safety –** to improve safety performance for employees, contractors and the community;
- **Reliability –** to maintain the reliability, security and sustainability of the network; and
- **Sustainability –** to ensure our business is sustainable by making it efficient, affordable and competitive so that it can meet future challenges.

Asset Management is a key focus area, delivering a suite of initiatives in support of priority actions. These priority actions are assigned to senior managers and implemented in the year ahead.

From an asset management perspective, Endeavour Energy has a strategic objective to "*Apply best-practice asset management principles to ensure value for customers and appropriate returns for our shareholder, without compromising safety and reliability."*

In response to the challenges outlined above, Endeavour Energy has evolved its asset management approach along the lines of "*Asset Owner – Asset Manager – Service Provider"* business model. This model structure is widely accepted as best practice, and the identification of these roles within the business is central to alignment with the requirements of the ISO 55001 Asset Management Framework[1].

3.1 ASSET MANAGEMENT PHILOSOPHY

Endeavour Energy applies a lifecycle approach to managing its network and the assets that comprise it. The lifecycle approach involves two aspects:

- Considering individual assets and asset populations on a whole-of-life basis in order to achieve optimal outcomes across their entire lifecycle e.g. considering how the cost-benefit trade-off between asset management decisions made at the design and procurement stage may later impact the maintenance stage of the asset lifecycle; and
- Considering the network as a whole in all asset management decisions i.e. will the decision made in relation to any individual asset or asset population result in the best outcomes for the network as a whole.

Endeavour Energy's approach captures competing stakeholder requirements in decision making, and is supported by a spectrum of continually improving systems and processes.

This approach has been consolidated through the strategically designed structure of our Asset Management division. In particular, the embedding and integrating of functions such as Network Planning and Asset Performance with other "more operational" asset management functions allows integration of the whole-of-life asset decision processes. Within the industry at large, these longer-term functions are traditionally considered in isolation, yet through their integration Endeavour Energy has created a more holistic life-cycle management approach with benefits in capital efficiency and investment optimisation.

The Asset Management Division is directly responsible for developing network and asset plans, proposed investment programs, developing asset standards and management policies, and strategically monitoring and managing network capability and network performance. Our Network Services division is responsible for implementing the various plans thus developed in accordance with the policies and standards set, and undertaking construction, operating, maintenance, renewal and disposal activities in the field in line with these requirements.

3.2 ASSET MANAGEMENT APPROACH

In adopting this operating model, Endeavour Energy is in the best position to meet the challenges of the future. This alignment with contemporary asset management thinking makes clear the distinctions of

[1] Endeavour Energy is not yet certified to ISO5001, but is currently implementing plan to achieve certification in 2018 as part of its Asset Management Transformation Plan and in accordance with its licence requirements.

responsibility and asset management functions between Asset Owner, Asset Manager and Service Provider. The objective of this is to apply leading asset management principles to optimise practices and subsequent outcomes for the network.

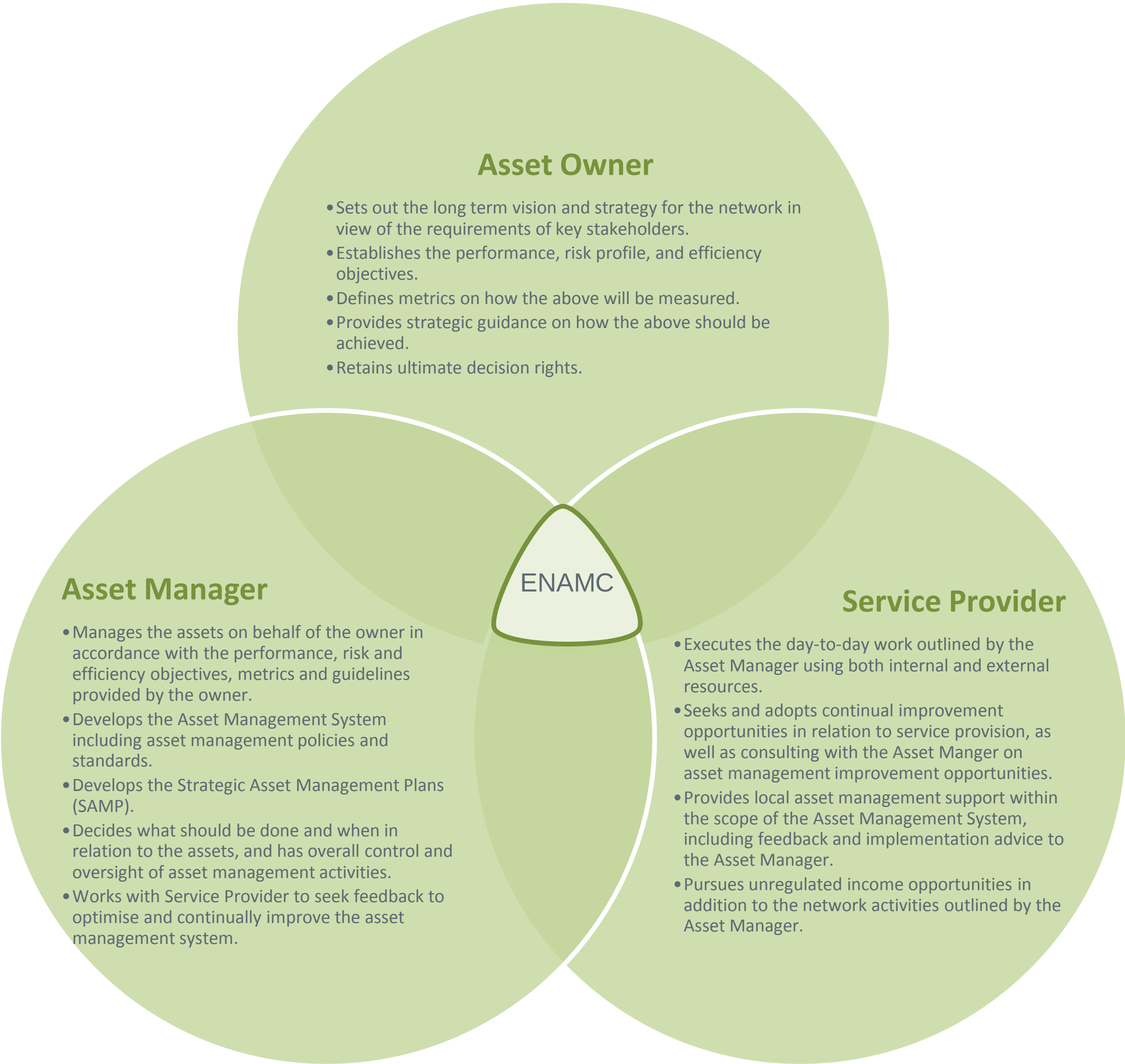
This business model requires the Asset Owner to set the vision for the network, whilst the Asset Manager and Service Provider work in unison to deliver on those objectives. It is a natural evolution of the Endeavour Energy's previous model, combining all delivery functions into a consolidated service delivery group. It removes some duplication present in the previous model, as well as enabling improved ownership and accountability for the expected outcomes, and facilitates the development of "best of breed" delivery practices.

The mechanism by which the Asset Owner receives and provides formal feedback on corporate objectives for the assets and progress in achieving these objectives, as well as setting overall strategic direction, is the Executive Network Asset Management Committee (ENAMC). The Asset Manager and the Service Provider coordinate their respective asset management functions through the operation of this committee in line with the requirements of the Asset Owner.

Figure 4 shows Endeavour Energy's current *Asset Owner – Asset Manager – Service Provider* business model, including roles and responsibilities.

In applying this model within Endeavour Energy, the three functional asset management roles are symbiotic, in that the long-standing culture within the company is to operate on a partnership basis. In this respect, the Asset Owner seeks and takes advice from the Asset Manager and Service Provider on strategic issues and performance objectives, whilst the Asset Manager and Service Provider operate collaboratively to ensure the requirements of the Asset Owner are met and delivered through their respective functions.

FIGURE 4: ENDEAVOUR ENERGY'S *ASSET OWNER – ASSET MANAGER – SERVICE PROVIDER* BUSINESS MODEL.



3.3 ASSET MANAGEMENT STRATEGY

To deliver the desired corporate objectives for asset management, Endeavour Energy develops an Asset Management Strategic Plan (AMSP). This plan provides a framework for aligning Endeavour Energy's asset management related activities to the corporate plan. It is the alignment, or co-ordination of activities, that will realise value from the assets in the delivery of the required outcomes and achievement of the strategic corporate objectives.

The AMSP provides the overarching strategic direction, with a particular focus on asset management and how it can be used to realise value from our assets by achieving the right balance between costs, risks and benefits.

The plan seeks to realise that value through applying better practice, whole of life, asset management principles, including an investment governance framework and risk based prioritisation of investment. Application of these principles will deliver the network performance objectives at least cost and will create value for customers and shareholders.

The AMSP is developed within the context of a number of changing environmental factors that have an impact on the way our network asset is managed.

The strategy is implemented through the plans and programs developed using Endeavour Energy's network planning and management framework, integrated and optimised in the Strategic Asset Management Plan (SAMP). The planning framework itself is embedded in a range of internal procedures, plans, standards and policy documents, overseen and managed by the Executive Network Asset Management Committee (ENAMC). This committee oversees and directs Endeavour Energy's Asset Management Strategy, which is the mechanism by which the overall corporate objectives are achieved.

Endorsement of the funding required to implement agreed plans and programs captured in the SAMP is provided by the Endeavour Energy Investment Governance Committee (IGC) and then approved by the Board or the CEO under delegated authority.

Significant resources are devoted to ensuring timely, relevant and thorough data and information is available to support decisions. For example, Endeavour Energy maintains detailed asset age, location and condition data across the Geographic Information System, Field Inspection System, Asset Management System and Outage Management System. Endeavour Energy also monitors the relationship between planned service performance targets and service outcomes in accordance with current regulatory requirements and our own commitment to service delivery.

Endeavour Energy's network investment planning process develops ensures that network plans are developed annually. This process culminates in the development of Endeavour Energy's Portfolio Investment Plan of required network investments.

3.3.1 SAFETY

Continuing advances in workplace health and safety are driving a more integrated view of contributing factors to workplace safety and the business's obligation to ensure a safe place of work. In this regard, safety considerations including safety in design will be more overtly considered in asset management strategies. Furthermore, Endeavour Energy has a specific strategic plan for Safety and Environment that considers the broader safety and environmental initiatives across the business.

3.3.2 LICENCE CONDITIONS

NSW Design Reliability and Performance licence conditions were introduced in 2007 and required material capital investment to achieve initial compliance over the 2009-2014 regulatory period. A review of the licence conditions in 2014 removed the "deterministic" supply security requirements of the licence conditions, thus facilitating a transition to more "probabilistic" investment planning approaches.

Endeavour Energy has responded to this challenge through the application of a risk-based assessment of the capability versus demand balance, with a clear understanding of the capabilities of its network assessed against the risk profile of its assets. This has enabled a reduction in capital investment to be achieved over the 2015-2019 regulatory period without an undue increase in network risk.

3.3.3 CAPITAL CONSTRAINT

Notwithstanding the reductions in investment noted above, the reduced revenue allowances by the AER during the 2014-2019 regulatory period significantly impacted the Company's ability to fund its approved investment program. This created a need to further reduce capital expenditure in the short-term prior to returning to more sustainable levels, and therefore drove the need to further optimise the risk-based prioritisation of our investment and operating programs.

In this context, Endeavour Energy's asset management approach has transitioned from one of efficient program delivery to that of improved understanding of risks and priorities in a constrained capital environment. To this end, an efficient, consistent and transparent process for assessing and prioritising risks across programs and projects has been implemented. The process, in conjunction with other factors such as revised demand forecasts and less prescriptive licence conditions, has resulted in a significant reduction in Endeavour Energy's forecast capital expenditure in the current and forthcoming regulatory control period compared to historical levels.

3.3.4 CHANGING INVESTMENT PROGRAM

Whilst demand growth has moderated significantly after the global financial crisis there has been a recovery in demand growth in the past three years due to growth in new customer connections. Endeavour Energy connected 23,000 new customers in 2016/17 compared to 10,000 in 2012, and Independent HIA housing construction data shows 29,000 homes commenced construction in the last year. Plans to release large scale greenfield industrial areas are firming, centred around the future Western Sydney Airport and the “third city” in the Sydney as per the Greater Sydney Regional Plan released by the Greater Sydney Commission. Therefore the priority growth areas of Western Sydney will continue to require the provision of substantial amounts of new supply infrastructure, which is a challenge that Endeavour Energy has the demonstrated capability to meet through its various delivery strategies.

Asset renewal is planned on the basis of asset condition and performance criteria. However, a high proportion of aged assets can present a substantial risk to reliability and performance when condition-based or functional failure trends increase, giving rise to coincident asset failure modes. Endeavour Energy’s focus on risk-based asset considers these factors that impact risk levels and risk appetite. This facilitates us developing efficient strategies for mitigating that risk that are proportionate to the magnitude of the risk.

This forms the basis of our strategic approach to asset renewal planning to ensure proposed investment is well targeted and economically efficient. On this basis, we embarked on a program in the period 2004 to 2014 to address the historical under-investment in asset renewal by adopting an efficient strategic asset renewal program optimised and integrated with our growth-driven investment plans. This approach was endorsed through the approved regulatory revenue proposals. Subsequently, financing constraints have required this investment to be curtailed to levels that ultimately may not lead to sustainable network outcomes without future redress.

3.3.5 RESOURCING

Endeavour Energy undertakes regular, robust workforce planning to identify future workforce needs and strategies to fulfil those needs. These needs are satisfied through a combination of existing internal resources, apprentice and graduate programs, and market-sourced resources. In recent times we have established a strategic alliance with a major industry service provider as a means to supplement our internal workforce in an efficient and cost-effective way.

4.0 PLANNING APPROACH

4.1 ANNUAL PLANNING REVIEW

The NER requires that the annual planning review includes the planning for all assets and activities carried out by Endeavour Energy that would materially affect the performance of its network. This includes planning activities associated with the replacement and refurbishment of assets and negotiated services. The objective of the annual planning review is to identify possible future issues that could negatively affect the performance of the distribution network to enable DNSPs to plan for and adequately address such issues in an appropriate timeframe. This Distribution Annual Planning Report (DAPR) is one of the outcomes the annual planning review, and summarises the findings of our planning review processes.

The DAPR provides an insight into the planning process as well as providing information to registered participants and interested parties regarding the nature and location of emerging constraints within Endeavour Energy's sub-transmission and 22kV and 11kV distribution network. The timely identification and publication of emerging network constraints provides an opportunity for the market to identify potential non-network solutions to those constraints and allows Endeavour Energy to develop and implement appropriate and timely solutions.

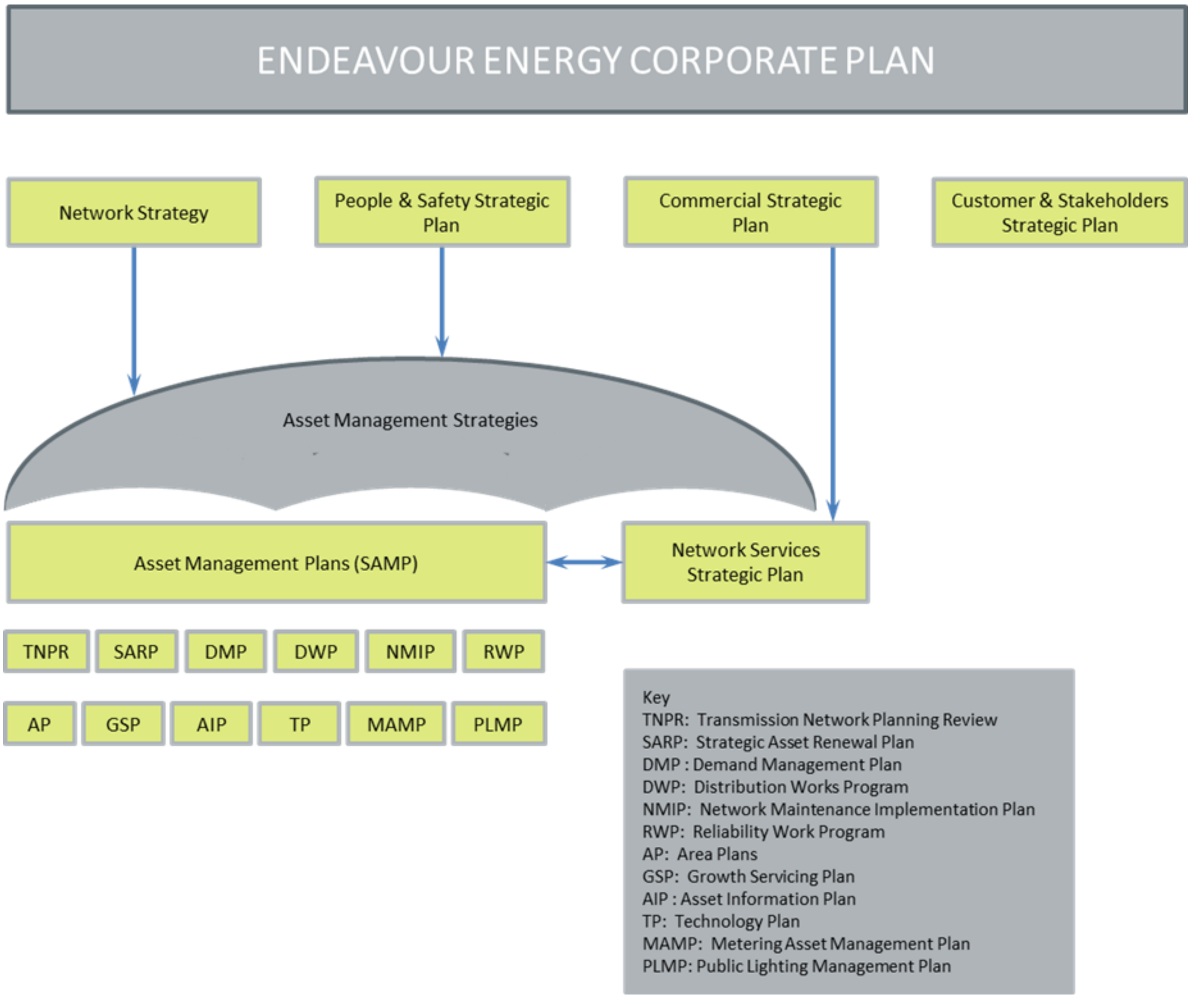
4.2 NETWORK PLANNING PROCESS

The network planning and development process for the distribution network is carried out in accordance with the National Electricity Rules Chapter 5 Part B, Network Planning and Expansion.

Endeavour Energy operates in accordance with the legislative and regulatory framework applicable to electricity DNSPs in NSW.

To this end Endeavour Energy maintains an Electricity Network Safety Management System (in accordance with the requirements of AS 5577). This system provides for the planning, recording and reporting of network and safety performance. The various investment needs of the electrical network required to fulfil the requirements of the Safety Management System as well as other licence requirements a identified and captured in various supporting plans, as outlined in Figure 5 below.

FIGURE 5: ASSET MANAGEMENT PLAN STRUCTURE



Endeavour Energy carries out network planning at both a strategic and a project level. Endeavour Energy's investment governance process provides continuous review and ongoing assurance that the Company's capital investment is both prudent and efficient as well as being consistent with the longer term strategic planning objectives.

Endeavour Energy's planning process is designed to identify the most efficient ways of ensuring the network business meets its network performance obligations. The Company places great emphasis on the planning and project identification stage, assessing our customer's short term and longer term supply needs, and coordinating these with asset renewal requirements. We are then able to identify and select the optimal solution to meet all of those needs in a coordinated, risk-optimised way.

All credible potential options, including non-network and non-capital alternatives, are considered in determining how best to meet our network performance obligations and the objectives of the National Electricity Law. There is a robust selection process that explicitly trades off alternative expenditure options using quantified estimates of credible option costs and benefits to identify the optimum solution to address network constraints.

In accordance with NER obligations, network investment and non-network (demand management) options are assessed impartially, using a consistent process for reviewing cost effectiveness. Demand management options are evaluated for the extent to which they can facilitate the deferral of a network investment need, or obviate it altogether. This allows various combinations of demand management and deferred investment options to be assessed.

The first stage of the planning process involves gathering the data required to inform the investment process. This includes: recorded actual electricity demand; the preparation of demand forecasts; the examination of network capacity limits; the assessment of asset condition and asset performance data; the forecast of new customer connection requirements and the consideration of applicable statutory and regulatory obligations.

The capability of the network is assessed against key criteria which include:

- Meeting statutory and regulatory requirements relating to the safe operation of the network and to environmental impact;
- Addressing capacity constraints to achieve a level of supply security commensurate with reasonable customer expectations;
- Reliability performance against the reliability performance standards set out in the Licence Conditions;
- Asset condition; and
- Customer connection requirements.

When emerging network needs are identified, a range of feasible options are developed to address the network need and thus to ensure that supply security levels are maintained at levels appropriate to ensure that reliability of supply is maintained. Options considered include both network and non-network solutions. A review including public consultation with interested stakeholders then selects the most economic option (or options). Each major investment is required to be consistent with Endeavour Energy's longer term network plans and network standards and the National Electricity Objective.

This document forms part of the public consultation and provides notification of the expected future network requirements. It also indicates the required timeframe to address these needs to allow for appropriate corrective network investment or non-network alternatives or modifications to connection facilities to be developed and undertaken.

Capital investment requirements in the distribution network are forecast in line with network needs and constraints across the network area.

The spatial demand forecast is a critical process which supports the planning and development of the capital program. The forecasting process is carried out twice a year and is a critical input into the planning process to identify and understand the investment needs of the network. The summer and winter loading conditions are analysed to provide understanding of the seasonal variations which are important for identifying optimal network solutions.

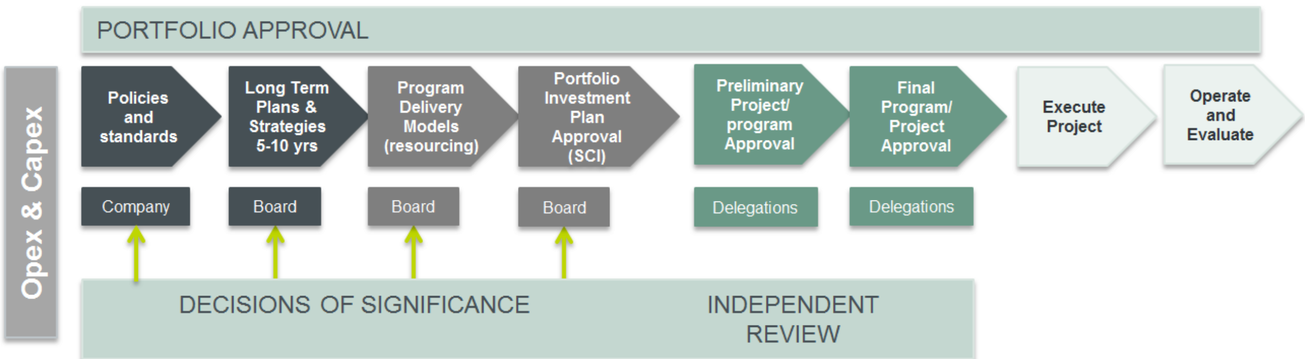
Losses are considered when comparing credible options. Endeavour Energy complies with RIT-D guidelines and assesses the cost of losses for each option where the losses are materially different between the options. An increase in network losses makes a negative contribution to the market benefits of a credible option, while a decrease in network losses makes a positive contribution.

4.3 APPROACH TO INVESTMENT DECISION MAKING

All investment decisions are governed by the Network Investment Governance Framework. This is a robust process that provides the basis for transparently and efficiently making investment decisions by taking into account a full life cycle approach to network investments.

The framework is shown in Figure 6 below.

FIGURE 6: NETWORK INVESTMENT GOVERNANCE FRAMEWORK



Network investment decisions made to achieve customer and business objectives will be focused on one or more of three key focus areas of our network strategy of Safety, Reliability, and Sustainability.

4.3.1 PLANNING AND INVESTING FOR GROWTH

Growth in Endeavour Energy's network is being driven principally by new customer connections arising from greenfield development in Sydney's north-west and south-west priority growth areas. Augmenting the network to provide for the growth in demand in these areas at the right time is important to ensure that development can proceed and that significant infrastructure investment by the State Government in water, roads and rail in greenfield areas are not left stranded.

Since the removal of the deterministic planning requirements of the NSW distributor licence conditions, Endeavour Energy is managing this risk by evaluating lower cost options for network augmentation and/or extension in response to developer requests for supply. Further augmentation is undertaken when load growth projections are realised. In some cases, the minimum viable solution may involve a temporary mobile substation that can be moved on to the next greenfield development when its capacity has been outgrown.

Endeavour Energy has plans in place to utilise mobile or temporary substations where appropriate. The ability to stage investment in infrastructure for growth depends on the rate of growth. In an area which is expected to see a rapid increase in new load (e.g. a large new town centre) a staged option may not be economically efficient. Conversely an area with a lower projected rate of growth (low-density residential only), the onset of the risk of insufficient capacity can take longer thereby facilitating the exploration of lower-cost operational and non-network options to manage this risk.

In general Endeavour Energy identifies limitations in its network capability against an "N-1" level of supply security at the sub-transmission and zone-substation level, however small or temporary substations (noted above) may operate in a "non-secure" manner. This approach only serves to identify preferred future network development options should future limitations be unable to be mitigated through operational response (such as load transferring) or demand management initiatives.

The actual investment timing is confirmed through a probabilistic assessment of the network risk and the optimisation of the economic benefits of any proposed development.

Demand management strategies play a significant role in Endeavour Energy's plans to service the growth in demand, especially in constrained supply areas. Demand management has a higher likelihood of success in brownfield development locations compared with greenfield release areas due the potential to reduce load from the existing customer base.

4.3.2 PLANNING AND INVESTING FOR ASSET RENEWAL

Endeavour Energy takes a strategic approach to asset renewal planning that matches the investment in the network to the business risk posed by individual assets or groups of assets approaching the end of their useful lives. Risks to the safety of personnel and property and the reliability of the network as a result of asset failures are taken into consideration, as is the risk to operational management of the network arising from multiple asset failures occurring during a short period of time.

These considerations lead to an approach where an asset group that has relatively few individual assets, with non-catastrophic failure modes and an adequate level of network redundancy are more likely to be renewed if and when failure is imminent or should it occur. Other asset groups that are pro-actively and strategically planned to be renewed are those where failure modes present safety or unacceptable supply security risks, or where the cost of reactive replacement significantly outweighs the cost of planned replacement.

Further, some individual programs and projects within the overarching asset renewal investment program are informed by advanced condition monitoring technology so that targeted replacement programs can be developed more effectively. This has resulted in some significant reductions in historical programs and improved risk and performance outcomes for the assets impacted.

4.3.3 PLANNING AND INVESTING FOR RELIABILITY

Endeavour Energy has adopted a Reliability Strategy of maintaining existing levels of reliability, and rectifying poor-performance outliers that have been identified as per Endeavour Energy's Licence Conditions. Targeted investment leverages new technology such as distribution feeder automation schemes, where analysis shows that these can be a cost effective way of improving the Company's response to faults. Investment for reliability improvement is intrinsically linked to achieving a neutral position with respect to Endeavour Energy's Service Targets Performance Incentive Scheme (STPIS) outcomes as agreed with the AER.

4.4 RECENT CHANGES IN THE PLANNING PROCESS

Endeavour Energy applies probabilistic planning techniques to assess supply security constraints. Deterministic (N-1) criteria are used only as a trigger for further investigation. The probabilistic planning approach includes:

- An assessment of likelihood of failure of network elements;
- An assessment of consequence in the event of failure. This includes expected outage duration and expected unserved energy. The unserved energy can be monetised by applying a Value of Customer Reliability;
- Consideration of back-up capacity at other voltage levels (for example HV distribution feeder capacity when analysing zone substation contingencies);
- A sensitivity analysis for key parameters such as load growth, cost and Rate of Return; and
- A determination of economic timing for network augmentation and the net present value of options based on demand forecasts.

For greenfield development, probabilistic techniques tend to result in a staged approach to provision of supply capacity including the use of distribution feeders, single transformers and temporary and mobile substations being adopted.

Significant changes to planned projects compared to the previous DAPR are detailed in Table 2 below. The biggest changes are addition of new greenfield projects, most notably the industrial areas of the recently announced Western Sydney Priority Growth Area anchored by the proposed Western Sydney Airport.

TABLE 2: SIGNIFICANT CHANGES TO PLANNED PROJECTS COMPARED TO THE PREVIOUS DAPR

RIT-D project	Change	Comments
Nepean ZS	Deferred	Lower Demand Forecast / Cyclic Rating
Mt Gilead ZS	New Greenfield Residential Project Added	Recently announced Greater Macarthur South release area
North Bomaderry ZS	New Greenfield Residential Project Added	New land release area by Shoalhaven Council
Western Sydney Employment Lands ZS	New Greenfield Industrial Subdivision Added	Recently announced Western Sydney Priority Growth area and the “Third city”
Science Park ZS	New Greenfield Industrial Subdivision Added	Recently announced Western Sydney Priority Growth area and the “Third city”
Southpipe ZS	New Greenfield Industrial Subdivision Added	Originally part of Broader Western Employment Area. Within scope of recently announced Western Sydney Priority Growth area and the “Third city”

5.0 NETWORK PERFORMANCE

5.1 NETWORK RELIABILITY OVERVIEW

Reliability of supply is a key measure of the performance of the electrical network. System Average Interruption Duration Index (SAIDI) is the measure of the number of minutes on average that Endeavour Energy's customers are without electricity each year due to unplanned events (but excluding storms and other major events).

While Endeavour Energy's normalised SAIDI performance exhibits a slightly deteriorating trend over the longer term, performance has improved more recently from 91.3 minutes in 2014/15 to 73.5 minutes in 2016/17. Climactic conditions continue to introduce significant volatility in reliability outcomes.

Major Event Days and the number of days where SAIDI is above one minute are typically associated with adverse weather conditions. Figure 7 and Figure 8 below shows the relationship between these days and the overall SAIDI and SAIFI performance of the network including underlying performance (days over one minute excluded). Endeavour Energy's underlying SAIDI and SAIFI performance exhibits a slightly improving trend.

FIGURE 7: ORGANISATIONAL SAIDI TREND (AER NORMALISED)

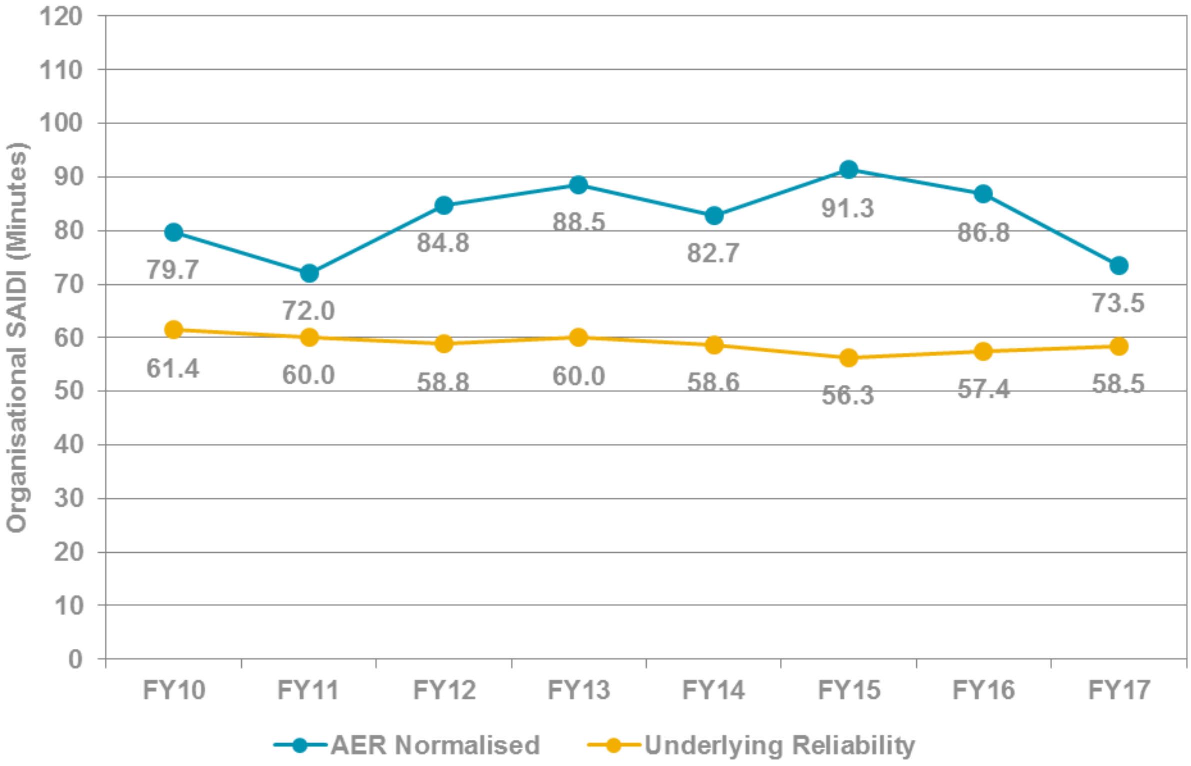
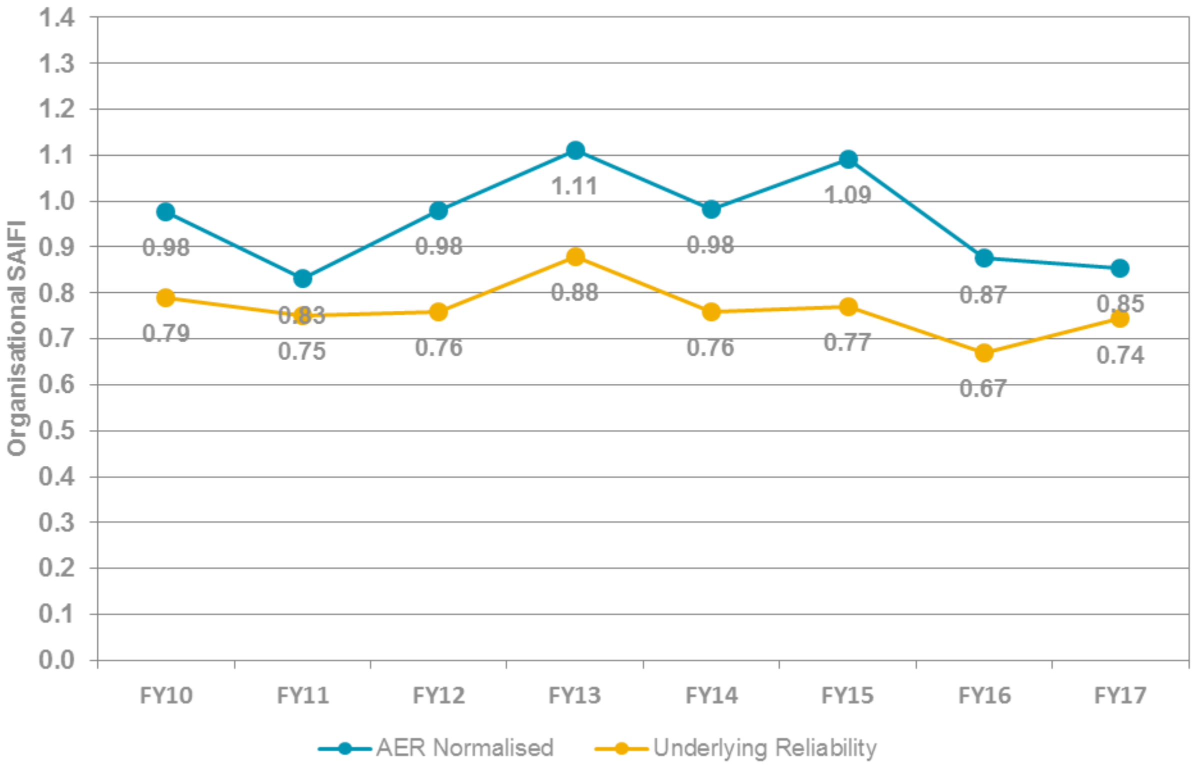


FIGURE 8: ORGANISATIONAL SAIFI TREND (AER NORMALISED)



5.1.1 TRENDS IN RELIABILITY TARGET PERFORMANCE

The NSW Minister for Energy first imposed licence conditions for the distribution network service providers on 1 August 2005 covering design planning standards, reliability, individual feeder and customer service standards. The conditions were designed to give guidance to the distributors regarding the performance levels expected by the NSW Government.

The current licence conditions were imposed on 7 July 2017. Table 3 provides the reliability performance information required by licence conditions 18.2 and 18.3 including:

- Performance against the SAIDI average standards and SAIFI average standards by feeder type, disregarding excluded interruptions; and
- Reasons for any non-compliance by the licence holder with the reliability standards and plans to improve performance.

The data listed in Table 3 is the 'normalised' data set i.e. the overall data with 'excluded' interruptions deducted. 'Excluded' interruptions are defined in Schedule 4 of the licence conditions and are primarily outages of less than one minute duration or outages caused by directed load shedding, planned maintenance, failure of the shared transmission system or 'major event day' outages.

TABLE 3: ANNUAL NETWORK RELIABILITY PERFORMANCE

		Whole Network and Feeder Category				
		Network*	CBD[2]	Urban	Rural Short	Rural Long
Customer Numbers (Average over Year to Date)		996,702	N/A	835,885	160,503	314
SAIDI	Actual	78.4	N/A	57.8	182.3	1,762
	Standard from Licence Conditions	N/A	N/A	80	300	N/A
SAIFI	Actual	0.87	N/A	0.73	15.9	10.71
	Standard from Licence Conditions	N/A	N/A	1.2	2.8	N/A

*Refers to the average performance of the Endeavour Energy's network overall. This measure does not form part of the licence conditions but is needed to calculate the overall NSW result.

2 The definition of a "CBD" area is a formal technical definition in the Reliability and Performance Standards against which Endeavour Energy is required to report. Key commerce centres at Parramatta, Liverpool, and Penrith which are supplied by Endeavour Energy do not fall into the official "CBD" category and hence there are no statistics against this category.

SAIDI is calculated from the sum of the duration of each sustained customer interruption (measured in minutes), divided by the total number of customers (averaged over the year) of the licence holder.

SAIFI is calculated from the total number of sustained customer interruptions divided by the total number of customers (averaged over the year) of the licence holder.

The Australian Energy Regulator (AER) introduced a Service Target Performance Incentive Scheme (STPIS) for NSW electricity distributors in 2014/15. This scheme encourages continuous improvement in reliability performance by offering financial incentives or penalties based on improvements or deterioration in performance from benchmark levels set in a prior period. From 2014/15 Endeavour Energy's reliability performance began to be measured against performance achieved in the 2009 - 2014 period.

Endeavour Energy has a corporate objective of maintaining reliability at current average levels over the course of the next regulatory period as defined by the expected target under the AER's STPIS incentive scheme.

More specifically, Endeavour Energy has a reliability plan intended to achieve the objectives of:

- Stable reliability performance;
- Performance levels that prevent the Company incurring efficiently avoidable penalties under the AER's STPIS scheme;
- Ensuring that the performance experienced by those customers who currently experience worse than average reliability on the Endeavour Energy network does not materially deteriorate;
- Continued compliance with the licence condition reliability objectives;
- Ensuring that the reliability impact of equipment defects is managed to a level consistent with or better than historic performance;
- Raising the profile of reliability as a key indicator of corporate performance and in so doing encourage a culture that observes, identifies and learns from issues on the network that may impact asset life, reliability performance or safety standards;
- Improving data analysis, reliability performance reporting and explanation through better data gathering and statistical analysis tools; and
- Levering new technology.

5.1.2 SERVICE TARGET PERFORMANCE INCENTIVE SCHEME

Management of reliability under a STPIS regime requires consideration of desired reliability outcomes as well as the interactions between expenditure and STPIS bonuses or penalties and the overall impact of these on customer prices. Therefore, where operational efficiencies can be made that also result in improved reliability outcomes, or at least do not result in worse outcomes, customer outcomes in terms of reliability and pricing are optimised. Endeavour Energy's approach to the STPIS scheme is to focus efforts on operational efficiency initiatives rather than continued capital investment to improve the reliability of the network.

The SAIDI and SAIFI unplanned performance results (excluding major events) compared to the STPIS targets for Endeavour Energy are shown in the Table 4 below.

TABLE 4: SAIDI & SAIFI STPIS TARGETS VS 2016/17 ACTUALS

Category	SAIDI Actual	SAIDI Target	SAIFI Actual	SAIFI Target
Urban	54.6	60.3	0.720	0.794
Rural	168.5	175.9	1.522	1.798

5.2 QUALITY OF SUPPLY

Quality of supply refers to the performance of the network in terms of steady state voltage, sags and swells, voltage unbalance, harmonic distortion and rapid voltage variation (or flicker).

The quality of supply performance of the network is impacted primarily by the characteristics of customer loads as well as by network events and by the configuration of the network. To manage these impacts, significant customer load applications, particularly commercial/industrial loads and other high voltage customers are formally assessed and provided power quality allocations in accordance with the National Electricity Rules, relevant Australian Standards and ENA Guidelines. Provided customers maintain their emissions within these allocations, the power quality performance of the network can be maintained within established planning levels and the risk of adverse impacts on other customer's equipment is minimised.

There are some loads on Endeavour's network which were connected prior to the implementation of the National Electricity Rules and associated formal power quality allocation processes. These loads can cause planning levels to be exceeded. In such cases, Endeavour Energy assesses the materiality of the performance level on customer equipment and monitors any associated complaints from affected customer that may arise. To date, no significant or widespread complaints have arisen as a result of these legacy loads.

5.2.1 QUALITY OF SUPPLY STANDARDS

Endeavour Energy's technical service standards are published in its Customer Service Standards for Connection Customers (the Customer Service Standards) which has been prepared in accordance with the NSW Electricity Service Standards Code of Practice. The Customer Service Standards include descriptions of the power quality that customers can expect to receive and the disturbances that may occur on the network.

A copy of the Customer Service Standards for Connection Customers can be downloaded from the Endeavour Energy website. Refer to section 3.2 in particular.

The limits and requirements for the management of power quality in Endeavour Energy's network, limits and connection guidelines for the management of connected load, generation and/or transmission network service providers and/or their equipment is published in Endeavour Energy's MDI 0050 Network Power Quality Limits and Levels. This is available on Endeavour Energy's standards website.

5.2.2 QUALITY OF SUPPLY CORRECTIVE ACTION

Endeavour Energy's power quality monitoring and rectification process resulted in all substantive issues relating to identified power quality non-compliances being addressed in the 2016/17 year. Outstanding matters pertain to incidents where non-compliances were unable to be clearly identified and/or validated.

5.2.3 COMPLIANCE PROCESSES

Endeavour Energy is required to design, maintain and operate its network in a cost effective manner to provide reliable power supply to its connected customers. The objectives of power quality fall within this overall framework.

Power quality issues are frequently related to specific loads connected to the network. In order to appropriately manage these effects, Endeavour Energy places requirements on connected customers to ensure that power quality is maintained. These requirements are stated in Company Policy 9.6.1 – Network Connection, the Customer Service Standards for Connected Customers and the Service and Installation Rules of NSW. Customers are advised of these requirements by reference to the Customer Service Standards for Connected Customers and the Service and Installation Rules of NSW.

5.2.4 SURVEY AND AUDIT

Endeavour Energy takes part in the national Power Quality Compliance Audit run annually by the Australian Power Quality and Reliability Centre. This audit uses data from power quality monitors in Endeavour Energy's substations and from smart meters on customer's switchboards to assess the Company's performance and compliance levels compared to accepted limits (such as the planning levels).

Endeavour Energy has supplied data from sites at low voltage (LV) as follows:

- 3524 sites for voltage variation;
- 1626 site for unbalance;
- 2764 sites for harmonics;

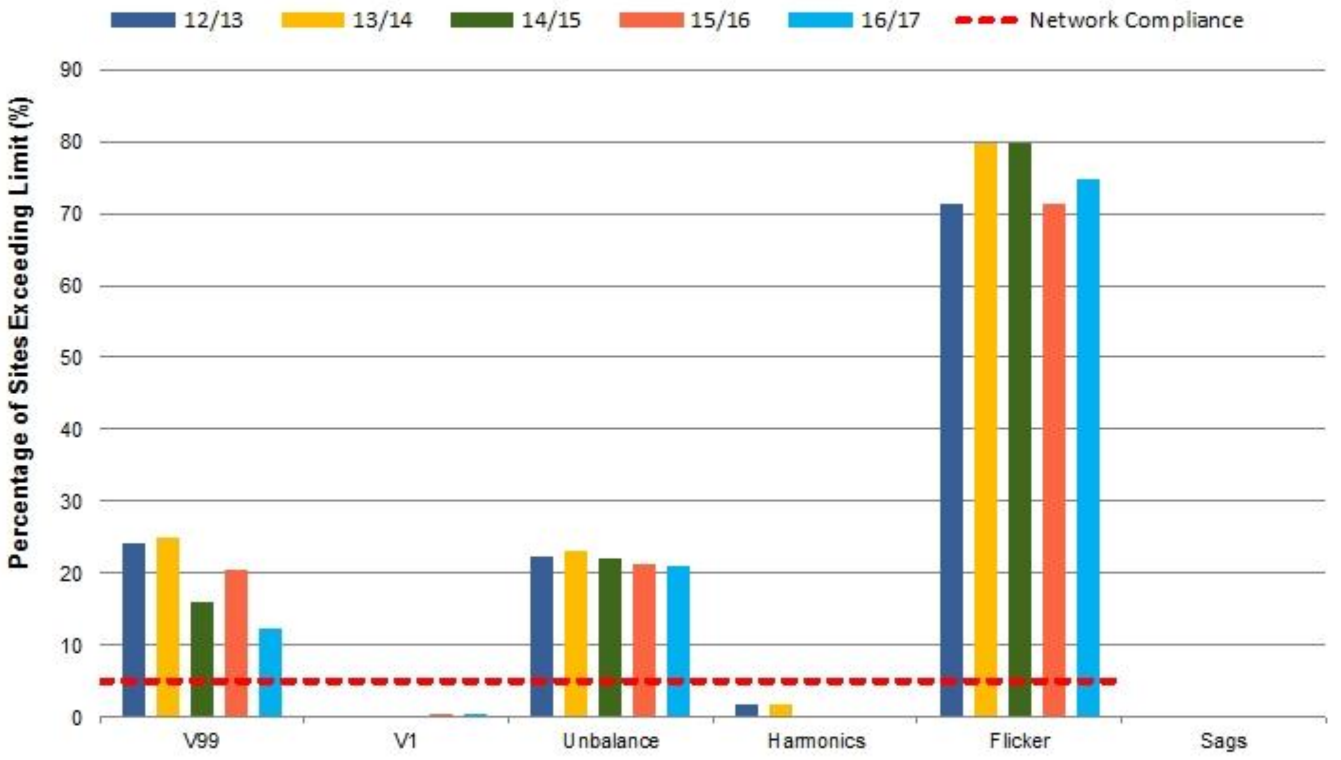
- 8 sites for flicker; and
- 53 sites for voltage sags.

Endeavour Energy has supplied data from sites at medium voltage (MV 22kV and 11kV – also called “HV” in this document) as follows:

- 150 sites for voltage variation and unbalance;
- 151 sites for harmonics;
- 148 sites for flicker; and
- 155 sites for voltage sags.

The results of the Power Quality Compliance Audit of Endeavour Energy’s network in 2015/16 for the low voltage network are shown in Figure 9 and for the medium voltage network in Figure 10.

FIGURE 9: POWER QUALITY - MEASURED LV NETWORK COMPLIANCE



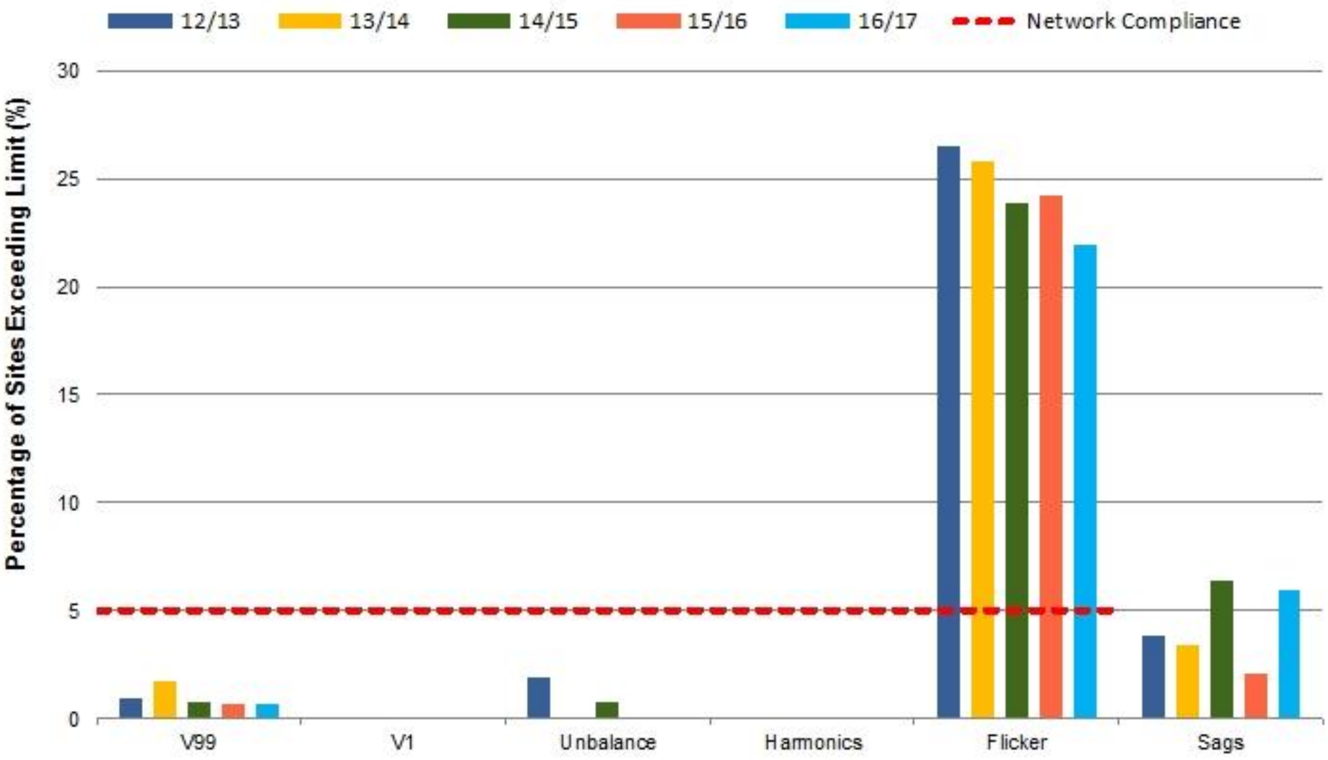
Endeavour Energy’s steady state voltage V_{99} (upper limit) performance exceeded the compliance limits for some 12% of sites in 2016/17. As discussed in Section 5.3.2, this is a known issue where network voltage levels are generally too high which is currently being addressed through low cost approaches such as the adjustment of voltage float settings at zone substations and the re-tapping of distribution transformers where appropriate. Some 40 zone substations have had target voltage adjustments to date, primarily during 2015/16 and 2016/17. This is expected to continue to significantly improve voltage compliance levels in future years.

Voltage unbalance exceeded planning levels for some 22% of sites however there appears to be a slight improving trend. Performance is expected to be particularly poor at weaker sites towards the end of LV feeders with significant line impedance coupled with significant single phase loads. In such scenarios relevant standards allow for more generous unbalance limits than have been utilised in this Audit.

A high percentage of sites continue to exceed Flicker limits. However, these results are not considered representative of the network performance as a whole due to the limited number of LV power quality monitors that are capable of measuring flicker that are predominantly located in a supply area influenced by a large arc-furnace which produces high levels of flicker. Historically however, these high flicker levels have not led to significant customer complaints relating to perceptible light flicker or other disturbance of other equipment.

Harmonics (THD) and voltage sags are both within accepted network compliance limits.

FIGURE 10: POWER QUALITY - MEASURED MV NETWORK COMPLIANCE



Endeavour Energy's performance at the medium voltage (also referred to as "HV") level is compliant for voltage, unbalance, harmonic distortion (THD) and sags.

Flicker significantly exceed limits, however, as noted above, these results are influenced by a large arc-furnace and are not representative of the network as a whole and further, have not led to significant customer complaints in the past.

5.3 OTHER FACTORS AFFECTING NETWORK PERFORMANCE

5.3.1 FAULT LEVELS

Fault levels in the network are controlled primarily by managing the number of network elements (lines and transformers as well as local generation) which are in service in parallel at any given time. Fault levels across the network are studied on a regular basis, including during planning for the establishment of new or augmented or redeveloped network elements and for the connection of new load or generation. These studies inform the management of network configuration to ensure that the fault ratings of the affected network element are not exceeded. Alternatively, these studies identify the requirement to upgrade elements to appropriate fault ratings.

Further, Endeavour Energy participates in regular joint planning exercises with TransGrid to ensure that any effect on Endeavour Energy's network by changes in the fault level within TransGrid's network are understood allowing solutions to be developed in an efficient and timely manner.

The majority of new generation connecting to Endeavour Energy's network in recent years has been rooftop solar photovoltaics (PV) connected through an inverter. Solar PV does not contribute to fault currents beyond the rating of the inverter and therefore does not generally contribute to fault rating exceedance of network equipment. Furthermore, detailed assessment of the impacts of embedded synchronous generation is undertaken as a matter of course as part of the connection process.

5.3.2 VOLTAGE LEVELS

Voltage levels are managed primarily through appropriate network design and operational configuration.

The voltages within the sub-transmission and HV distribution networks are managed by local control routines in the SCADA systems controlling the on-load tap-changers on the transformers in transmission and zone substation. Taps on distribution transformers are fixed at levels selected on the basis of typical voltage drops on the type of LV network being supplied as well as the HV distribution feeder regulation and supplying zone substation voltage regulation characteristics.

In certain situations, load growth in weaker parts of the network can lead to complaints of low voltage. This has traditionally been resolved by adjusting the distribution transformer tap setting to the upper end of the voltage range.

In recent years however, the proliferation of solar PV has reduced daytime demand significantly and in some cases reversed power flows which has contributed to voltages outside of the standard range. As a result, complaints of high voltage have now become more significant that complaints of low voltage.

Endeavour Energy is actively managing this issue through the assessment of clustered customer complaints data, available smart meter data and load flow voltage studies to better align zone substation target voltage and distribution transformer tap settings to improve voltage compliance and improve voltage headroom to accommodate solar PV.

5.3.3 POWER SYSTEM SECURITY

Power system security requirements are defined in the National Electricity Rules. The need to comply with these requirements may result in a need to invest in the network. Examples of these requirements include obligations to implement under-frequency load shedding, to operate within prescribed limits for the 132kV network and to comply with critical clearance times to maintain power system stability.

Projects that are affected by these requirements include:

- PR427 North Leppington ZS including the establishment of communications links to provide compliance with critical clearance times in the South West Sector 132kV network.

These issues are managed through the joint planning process with TransGrid, outlined in Section 7.1

5.3.4 AGEING AND POTENTIALLY UNRELIABLE ASSETS

There are a numerous projects and programs that are being undertaken or are proposed to be undertaken during the forward planning period that retire assets that have reached the end of their serviceable life. Details of these projects and programs are provided in Section 9.7.

6.0 DEMAND FORECASTS FOR THE FORWARD PLANNING PERIOD

Summaries of the peak demand conditions experienced during the previous summer and winter are provided in Appendix A, covering the peak demand forecast by season for the 2016 – 2020 period. The peak demand forecasts provide Endeavour Energy with the basis for identifying network limitations and commencing the RIT-D process and other demand management investigations to identify and evaluate the credible network and non-network options to address those limitations. They also feed into the strategic asset management plan (SAMP) which documents the capital and operating investment expected to be required for a rolling ten year period.

Growth in peak demand is a key driver of network-capability related capital investment. In the previous decade the growth in demand was fundamentally driven by an increased penetration of residential air-conditioning units. The increased uptake of air-conditioning, in existing dwellings in particular, caused peak demand to increase significantly across both our existing and expanding network. In recent years the penetration of air-conditioning appears to have reached saturation point in some areas of our network. As a consequence, peak demand growth from existing connections no longer presents a significant driver of network expenditure. Furthermore, demand in recent years has seen a decline due to the effect of energy efficiency measures, the roll-out of roof-mounted photovoltaic systems and reductions in the demand from large industrial customers. It is further expected the energy efficiency measures and the installation of photovoltaic systems will continue to influence a reduction in demand over the forecast horizon.

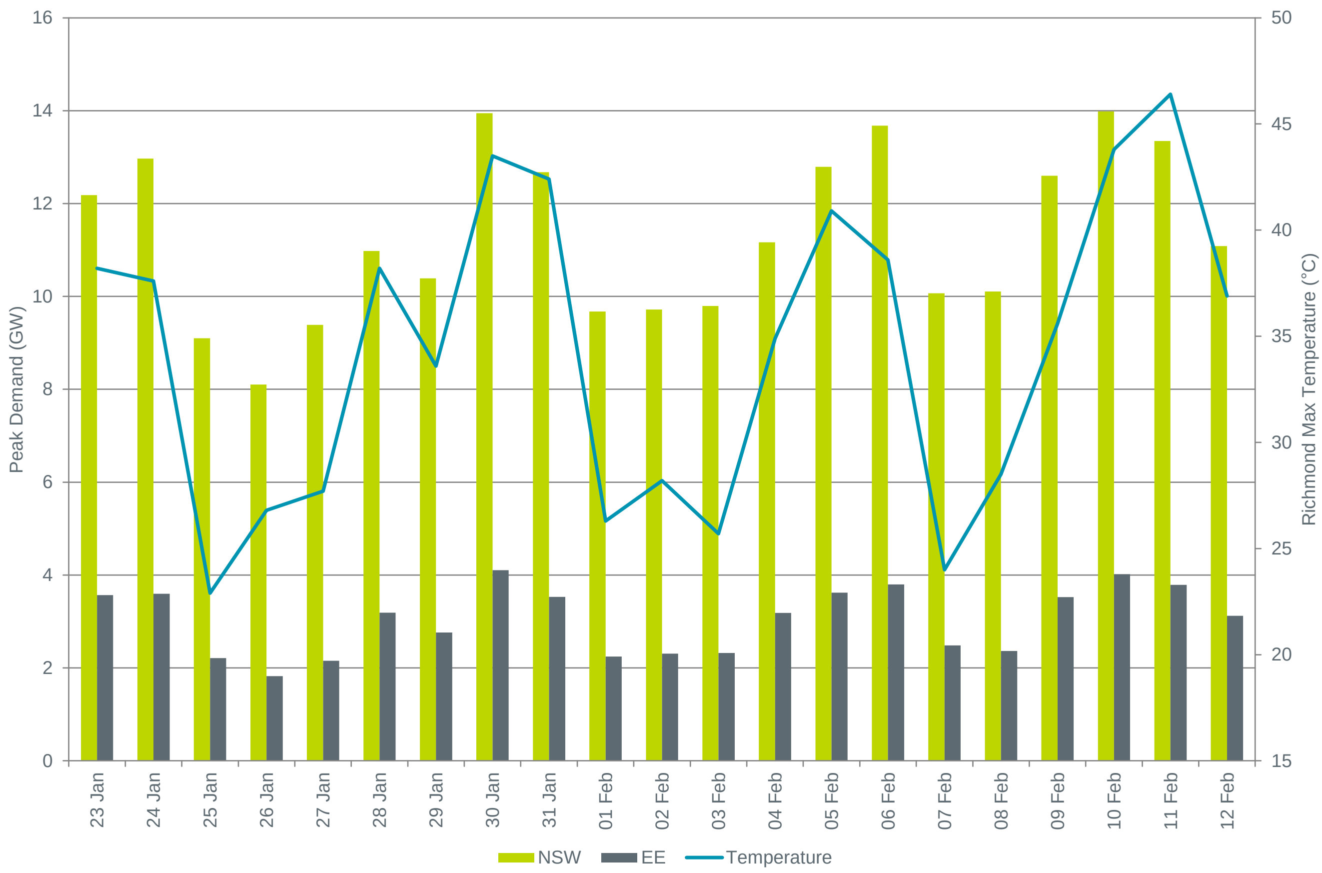
Demand growth is primarily concentrated in North-West and South-West Sydney. Widely regarded as the fastest-growing corridor in the state, priority growth areas in Western Sydney are expected to accommodate up to 480,000 new dwellings and land for employment for around 1,000,000 new residents over the next 25 to 30 years. Strong economic growth is expected in the growth centres over the forecast period, with a series of major transport, health and education projects planned for the region. Recent announcements by the Federal Government on the siting of Sydney's second airport at Badgerys Creek within Western Sydney will drive further demand growth in the years to come. The North West Rail Link, currently under development, will also create new high density residential and commercial development in the North-West Growth Sector.

There have been two record breaking events of peak demands in 2016/2017 summer. The Endeavour Energy Network total demands for the 2017 summer peaked at 4,107 MW at 5:15 pm on 30 Jan 2017 (Monday) while the maximum temperature at Richmond recorded 43.5 ºC on that day. This set a new record of maximum peak demand at Endeavour Energy total network and exceeded by a margin of 105 MW on the previous highest peak demand of 4,002 MW made on 1 Feb 2011. The 2016/17 figure was an increase of 252 MW on the 2015/16 summer peak demand of 3,855 MW. The peak demand of 3,789 MW on 11 Feb 2017 (Saturday) set another new record for the highest demand for a non-working day when the maximum temperature at Richmond was 46.4 ºC on that day. The previous highest peak demand for a non-working day was 3,676 MW made on 5 Feb 2011 (Saturday).

These record breaking peak demands were attributed to the heatwaves during January/February 2017 when Western Sydney had the hottest summer on record for both maximum and mean temperatures. Richmond recorded its highest daily maximum temperature of 46.4 ºC on 11 February 2017.

Figure 11 shows the time series of the daily maximum temperatures at Richmond and the peak demands on the Endeavour Energy network and NSW during the 2017 summer peak demand period. Endeavour Energy peak demand and maximum NSW daily peak demand for the 2017 summer occurred on the same day of 30 Jan 2017. We experienced hotter days later that summer, but were able to constrain demand to below this recorded peak through working with major customers to reduce demand in response to AEMO's call for load reductions on those days.

FIGURE 11: DAILY PEAK DEMAND FOR ENDEAVOUR ENERGY AND NSW BETWEEN 23 JAN AND 12 FEBRUARY 2017



6.1 FORECASTING METHODOLOGY

Peak demand forecasts are prepared for both the summer and winter season. Summer is defined as the five month period between November and March while winter consists of the four month period from May to August. The forecast method is based on a bottom-up approach and provides maximum MVA, MW and MVAr loads and the power factor expected for the summer and winter peak periods.

The forecasts are prepared for each zone substation and major customer substation, each transmission substation and TransGrid's Bulk Supply Points (BSPs) that supply Endeavour Energy's network as well as for the Endeavour Energy network as a whole.

The forecasts consider planned load transfers, expected spot loads, land releases and re-development in the area under consideration. Loads supplied by generation embedded in the network are also incorporated into the calculation of the maximum demand forecasts.

Historical and forecast peak demands at the Endeavour Energy total, bulk supply point transmission load area, transmission substation and zone substation levels are corrected to normalised figures that represent a specific weather condition. Temperature Corrected Maximum Demand (TCMD) is the estimate of the likely peak demand that could be expected in the reference conditions with 10% and 50% Probability of Exceedance (PoE).

Weather correction is applied to the peak demands at substations where there is a strong relationship between demand and temperature. Summer demands at zone substations in the Blue Mountains and demands of all high voltage customers are not subject to any weather normalisation.

A weather normalisation methodology based on a simulation approach is used to normalise peak demand forecasts for Endeavour Energy's network area. Two reference weather stations are employed for temperature correction of the maximum demand for summer. A weather station at Nowra is used for the South Coast area which covers the Dapto BSP Region and the Richmond weather station is used for the remainder of the network. The temperature correction method utilises two steps:

- Development and updating of a regression model for estimating the relationship between demand, weather and periodic pattern (calendar effects) of demand; and
- Simulation of the demand using multi-years of historical weather data to produce 10% and 50% normalised demand values.

For the summer peak, the regression model uses the most recent six years of daily maximum demand and temperature values to determine the relationship between demand, weather and periodic patterns of demand. Various input parameters are employed in the model. Day-of-the-week variables account for the difference between the daily peak by day of the week and by workday/non-workday. A set of holiday variables are included to describe the load reductions associated with holiday periods. Separate variables are used for special days such as: New Year's Day, Australia Day, and Christmas Day. In addition, a school holiday variable captures the reduced loads which occur in residential Western Sydney during the school holiday period in December and January and the commensurate increase in demand seen in some south coast zone substations during the same period. Monthly and bi-monthly variables captured the key seasonal demand variations. Year variables describe the changes in base load level for each year. Previous hot day effect variables are also included to explain the impacts of successive hot days on the daily peak demand.

From the regression model, daily demands are estimated using 24 years of daily weather data available from the reference weather stations. Annual seasonal maximum demands are derived from the calculated daily demands. The 10% and 50% demand values are computed from the distribution of annual seasonal maximum demands to give the 10% and 50% PoE TCMD values. The TCMD values for the latest year are the starting points for the peak demand forecasts.

The peak demand forecast considers the growth from the existing customers as well as the new customer connections. The forecasting process has two major steps:

- Incorporating the network planner's inputs into the base level forecast.

  The inputs include new developments planned to occur (lot releases), new load increases expected from customer applications (spot loads) and also information regarding the transfer of load between zone or sub-transmission substations (load transfers).

- Applying post model adjustments (PMA).

  PMAs are applied to each year of the forecast for each zone substation based on the zone substation's residential, commercial and industrial customer mix and its peak demand for the season. PMAs are designed and used to capture future changes in the peak demand which may not be considered fully by the energy forecasts PMAs include the demand impacts from solar generation and emerging electric vehicles and from different state and national energy policies/ programs, such as the Minimum Energy Performance Standards (MEPS), NSW Energy Savings Scheme (ESS) and changes to the building code.

The final forecasts for all zone substations are reviewed for consistency with expected demand growth based on local knowledge of load transfers, embedded generation, proposed spot-loads and lot release information.

The forecast at transmission substations and bulk supply points is based on the rolled up zone substation forecast and calculated using the corresponding historical diversity factors.

The diversity factor is considered to be the ratio between the summation of the individual peak demands of the lower level substations connected to the higher level substation and the measured peak demand at the higher level substation for the same period.

6.2 FORECAST INPUT INFORMATION SOURCES

Demand and temperature data is sourced from Endeavour Energy's Network Load History (NLH) database. Data from the SCADA system is used as a substitute where gaps existed in the metering data available from NLH. Where neither metering nor SCADA data is available, current flow is read from the current transformers on individual circuit breakers.

6.3 ASSUMPTIONS APPLIED TO FORECASTS

The following probability of exceedance (PoE) parameters have been adopted:

- 1 in 10 year event (corresponding to 10% PoE); and
- 1 in 2 year event (corresponding to 50% PoE).

A 10% PoE figure is estimated to be exceeded once in every ten seasons on average whilst a 50% PoE figure is likely to be exceeded every two years on average.

The firm capacity of the substations and capacity of the sub-transmission system shown in the forecast tables are indicated by a single figure. This figure is the summer rating for the sub-transmission system and for substations and represents the worst case scenario.

The determination of the load transfer capability for each substation involves the analysis of individual distribution feeders and their ability to carry additional load after network switching occurs. Consequently, this is only performed for substations that are experiencing limitations and may need to be offloaded. The analysis involves determining the load that could potentially be transferred away from the constrained network on a permanent basis.

6.4 DEMAND FORECASTS

Appendix A lists details of the capacity, forecast demand and any capacity constraints on each of the transmission and zone substations on the Endeavour Energy network and on the associated sub-transmission networks.

Limitations are referenced to the design level of supply security at each substation. In general Endeavour Energy assesses its network capability on the basis of providing an “N-1” level of supply security at the sub-transmission and zone-substation level, however small or temporary substations may operate in a non-secure manner and these are marked as limited to N. Generally these have maximum demands of less than 10 MVA. This approach serves to identify preferred future network development options should future limitations be unable to be mitigated through Demand Management initiatives. The actual investment timing is confirmed through a probabilistic assessment of the network risk and the optimisation of the economic benefits of any proposed development.

The substation total capacity is the maximum load able to be carried by the substation with all elements in service.

The secure capacity of a substation is the capacity with one major element (such as a power transformer) out of service. This is often referred to as its “Firm” or N-1 rating. Transmission substations are considered to be constrained when the load exceeds the secure capacity. Suburban zone substations are considered to be constrained when the demand exceeds the secure capacity by more than 1% of the year annually (88 hrs) or when the load is greater than 120% of the secure capacity. The exception are substations whose rating is limited by underground feeders or where exceeding secure capacity will result in the thermal rating of apparatus being exceeded in its normal configuration. In these situations, the load may not exceed the secure capacity of the substation for any period of time.

The voltage levels of Endeavour Energy’s sub-transmission substations (termed “Transmission substations”) are nominally 132kV on the primary and either 66kV or 33kV on the secondary.

The voltage levels of Endeavour Energy zone substations are nominally 132kV, 66kV or 33kV on the primary and 22kV or 11kV on the secondary.

The forecast is prepared following the end of each peak season. The zone substation rating changes have only been included where the associated project(s) which are influencing the rating have been given approval and are committed at the date of preparation of the forecast.

The forecast power factor readings correspond to the power factor at time of peak load. A dash in this field indicates that the particular transformer was either not commissioned at the time of measurement or is normally unloaded.

Forecast demands for the sub-transmission feeder network are based on its ‘N’ rating, summer or winter, and the ‘N-1’ loading, that is, the worst condition load that would appear on the feeder with an adjacent feeder out of service compared to the thermal rating of the smallest conductor or cable on that feeder.

The ‘95% Peak Load Exceeded (hours)’ figure in the Transformer Rating and Substation Details table represents the number of hours the load is above the 95% level of actual peak demand. It is an indication of how peaky the load profile is which is important for designing an effective non-network option.

The ‘Actual (MVA)’ figure that appears in the summer and winter demand forecast tables is not temperature corrected. It is the actual recorded load. The forecast loads are based on temperature corrected actuals.

The ‘Embedded Generation’ figure that appears in the Transformer Rating and Substation Details table in each forecast area provides the estimated aggregate level of embedded generation connection to the network supplied from that substation. It includes residential and commercial PV and customer generation. Customer details are withheld for privacy reasons.

The summer 2017 refers to the 2016/17 summer.

The transmission-distribution connection points are termed Bulk Supply Points (BSP) and are owned by TransGrid, the NSW transmission company.

Endeavour Energy evaluates the capability of its sub-transmission network on the basis of load flows modelling, different contingencies and network operating configurations. The sub-transmission forecast tables in this document are desktop estimates derived from zone substation load forecasts and are based on an assumed operating configuration and on the present day network. The loads presented are indicative of the load on the stated feeder in the event of the most likely contingency. Hence, the sub-transmission forecast tables should therefore be treated as indicative loading data in the event of a probable contingency event.

6.5 ANALYSIS AND EXPLANATION OF FORECAST CHANGES

There have been minor changes occurring within the customer groups that has an effect on demand on the network and the demand forecast. These include:

- An increase in the projects for residential lot releases in the North West and South West Growth Sectors; and
- A stabilisation of the decline of demand in the established industrial sector.

Certain areas in the North West and South West Growth Sectors have accelerated their lot release projections resulting in increased levels of demand growth. However, all lot release projections are diversified to account for the lag in housing development.

A review of established industrial areas has identified a stabilisation in the decline in demand in those areas. This trend will be closely monitored over the coming years to determine if growth in demand in these established industrial areas re-emerges.

7.0 PLANNING COORDINATION

7.1 JOINT PLANNING WITH TRANSGRID

Joint planning is carried with TransGrid on a biannual basis or as required. Agreed actions are minuted and action plans developed by each company as required.

Areas where network limitations and/or network developments affect the electricity networks of Endeavour Energy jointly with TransGrid are discussed below.

7.1.1 PROCESS AND METHODOLOGY

Endeavour Energy confers with TransGrid on technical matters relating to Endeavour Energy's connections with TransGrid at bulk supply points (TransGrid connection points). These matters include:

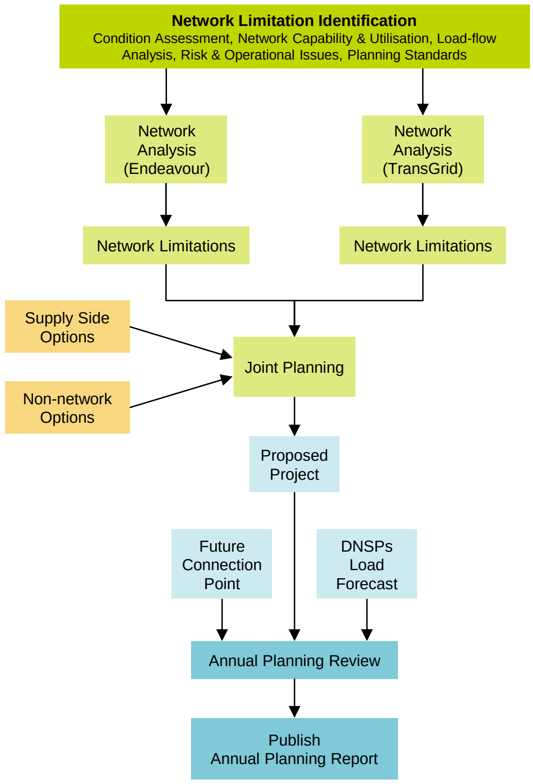
- Forecast loads for all BSP's supplying Endeavour Energy's network;
- Supply capability at all BSP's supplying Endeavour Energy's network;
- Exchange of system modelling data;
- Coordination of loading requirements on individual BSP's and across other BSP's;
- New BSP requirements and connection arrangements;
- Coordination of communication, protection and control requirements; and
- Coordination of other operational requirements.

Clause 5.14.1 of the NER sets out the planning process and consultation requirements and includes requirements on forecasting, annual reviews, regulatory tests and consultations. The principal inputs to the planning process are:

- DNSP supply point load forecasts;
- Review of network capacity and utilisation;
- Planning criteria and indicators;
- Condition, operational and risk assessments;
- Transmission network load-flow analysis; and
- TransGrid planning reviews.

The relationship between the various elements in the planning process is shown in Figure 12.

FIGURE 12: JOINT PLANNING PROCESS WITH TRANSGRID



Note that Endeavour Energy does not have any assets that are classed as "dual function assets" under the NER.

7.1.2 OVERVIEW OF BULK SUPPLY INVESTMENTS

7.1.2.1 TOMERONG BULK SUPPLY POINT (DEFERRED)

The proposed TransGrid Bulk Supply Point has been deferred indefinitely with the implementation of a project by Endeavour Energy. Until the need arises, this project will not be listed in future editions of the DAPR.

7.1.2.2 VINEYARD 132KV SWITCHBAY (BOX HILL SUPPLY)

A project requiring a switchbay at Vineyard Bulk Supply Point for supply to Box Hill will now be required by 2022.

7.1.2.3 VINEYARD 132KV SWITCHBAY (MARSDEN PARK SUPPLY)

A project requiring a switchbay at Vineyard Bulk Supply Point has been implemented to facilitate the connection of the new Marsden Park Zone Substation which will be connected via Feeder 21R.

7.1.2.4 MACARTHUR 66KV SWITCHBAY (MENANGLE PARK SUPPLY)

A 66kV switchbay is required at Macarthur Bulk Supply point by 2020 to supply the proposed Menangle Park Zone substation. The project is development driven and is still being scoped.

7.1.2.5 MACARTHUR 66KV SWITCHBAY (MT GILEAD SUPPLY)

A 66kV switchbay will be required at Macarthur Bulk Supply point to supply the proposed Mt Gilead Zone Substation by 2023. The project is development driven.

7.1.2.6 MACARTHUR 66KV BSP AUGMENT

A study commissioned by Endeavour Energy has confirmed the need to augment Macarthur 66kV Bulk Supply Point with a second 330/66kV transformer to alleviate constraints associated with the Nepean 66kV supply area. This is an existing constraint and it is expected that Transgrid will deliver on this project by 2022.

7.1.2.7 KEMPS CREEK BSP/SWITCHING STATION

Joint planning has determined that an initial 132kV switching station is required at Kemps Creek by 2024 to facilitate the supply to the Western Sydney Priority Growth Area, the Western Sydney Airport and surrounding developments. This switching station will be turned into a Bulk Supply Point at the appropriate time.

7.1.2.8 OTHER FUTURE INVESTMENT REQUIREMENTS

Discussions are continuing with TransGrid in relation to:

- Timing for the augmentation of Macarthur 132kV BSP with the augmentation of a second 330/132kV transformer. A joint planning project will be developed when this is required; and
- Initial discussions have taken place in relation to the utilisation of an existing 132kV switchbay at Sydney West Bulk Supply Point to supply a zone substation in the Oakdale Industrial Precinct.

7.1.3 ADDITIONAL INFORMATION

Endeavour Energy and TransGrid have formalised the joint planning arrangements between the two companies. The joint planning arrangements have been expanded to include an executive steering committee as well as the current working group. For additional information, refer to contact details under the disclaimer at the beginning of this document.

7.2 JOINT PLANNING WITH OTHER DNSPS

Joint planning between Endeavour Energy and Ausgrid and Endeavour Energy and Essential Energy follow the same principles as applied to the joint planning process with TransGrid. However, due to the limited number of dependencies between the companies' networks, joint planning meetings are generally conducted on a needs basis.

7.2.1 PROCESS AND METHODOLOGY

Formal joint planning meetings between the planning groups of the companies form the basis of the joint planning process as per the planning process with TransGrid.

7.2.2 JOINT DNSP PLANNING COMPLETED IN PRECEDING YEAR

Endeavour Energy has continued joint planning with Ausgrid to:

- Develop a project to supply Ausgrid's Auburn and Lidcombe Zone Substations from Endeavour Energy's Camellia Transmission Station following a cost benefit analysis conducted by Ausgrid.

Endeavour Energy has had no need to carry out joint planning with Essential Energy during the year.

7.2.3 PLANNED DNSP JOINT NETWORK INVESTMENTS

There are currently no other planned joint network investments with other DNSPs.

7.3 DEMAND MANAGEMENT PROCESS

The National Electricity Rules (NER) requires Distribution Network Service Providers (DNSP) to investigate non-network options by utilising a thorough consultation process as part of the planning for major network investments. The NER calls for a Regulatory Investment Test for Distribution (RIT-D) process to be used in identifying the most cost effective solution to address the network need for all projects where the most expensive credible option exceeds $5 million. These network investment projects are classified as RIT-D projects. This provides opportunity to all interested parties and the community to submit options and ideas allowing for the development of cost effective demand management and other system support options.

Endeavour Energy conducts a planning review of the network on an annual basis to identify emerging network needs and to identify any non-network solutions which could effectively manage demand and defer or replace investment in the augmentation of the network

As part of the RIT-D process, the timing of the need and the level of demand reduction required to address the requirement and credible options to do so are assessed.

Network options are developed first to determine if the estimated cost of the most expensive credible option is above $5 million in which case the project is classified as a RIT-D project. The network need is then screened to identify if a non-network option is feasible. A positive outcome of the screening test initiates a non-network option investigation consultation process. The goal of this process is to find the most cost effective solution that meets the required standards for network security and reliability.

The non-network option investigation process is comprised of six separate stages:

- A planning review to identify the emerging network needs and credible network options;
- Screening of the non-network options;
- Issue of a Non-Network Options Report as part of the community consultation process to obtain proposals from interested parties where a demand management approach appears to be feasible. This process is run as a Request for Proposal (RFP) for probity and due diligence reasons and is subject to internal approval;
- Evaluation of submissions to identify the most cost effective credible non-network option;
- A RIT-D evaluation on all options to identify the most cost effective option or combination of options; and
- Negotiations with proponents of the successful proposal to implement the program if a non-network option is identified as the most cost effective approach.

All parties registered on Endeavour Energy's register of interested parties are notified when a Screening Report or a Non-Network Options Report is issued. This is performed in accordance with Endeavour Energy's Demand Side Engagement Document.

7.4 EMBEDDED GENERATION CONNECTIONS

Endeavour Energy currently has no plans for the installation of new generation facilities. However, the non-network option consultation process will provide an opportunity for embedded generation proposals to be submitted and considered for each constrained location assessed.

During the 2016/17 financial year there were 3,985 new embedded generators connected to Endeavour Energy's network all of which were PV systems. The total PV capacity of these generators was 22.3 MW. Of these connections, 133 were non-micro embedded generation installations with a total combined capacity of 16.3MW.

At the end of the 2016/17 year there was a total of 110,575 PV generators connected to Endeavour Energy's network.

There were no significant issues recorded as arising from the connection of these generators to Endeavour Energy's network.

Endeavour Energy did not receive any large embedded generation enquiries or connection applications for the 2016/17 financial year.

8.0 IDENTIFIED NETWORK NEEDS

A key element of the planning process is the determination of network needs through:

- network analysis using the latest demand forecasts to identify upcoming network capacity or supply security limitations; and
- asset condition or performance assessments to identify assets approaching their end-of-life.

The Replacement Expenditure Planning Arrangements rule change, commencing 1 January 2018, requires DNSPs to evaluate retirement and de-rating projects using the RIT-D process together with augmentation projects.

The process identifies whether a corrective action is required to address the network need. A network need is declared to be a "RIT-D project" if there is sufficient evidence that the network need will be realised within the time required to initiate corrective action. If action is required, the RIT-D process is initiated if the most expensive feasible remediation option exceeds the RIT-D trigger threshold (currently $5 million). Endeavour Energy will then proceed with a RIT-D process to determine the most cost effective solution to address the network need.

Non RIT-D projects (those that do not meet the RIT-D criteria) also undergo analysis to identify credible network and non-network options using a similar but less formal process.

Those projects identified as being subject to the RIT-D process are outlined in Table 6 and Table 7 given in Section 8.2.

The National Electricity Rules requires DNSPs to investigate non-network options through market consultation as detailed in the RIT-D investigation process. This process forms an integral part of planning for major network investment proposals and provides opportunity for interested parties and the community to submit concepts and ideas for the development of cost-effective demand management and other non-network system support options.

The RIT-D process requires a 'screening test' to be performed for all RIT-D projects to determine if a non-network option is feasible and should be investigated further. If the screening test determines that a non-network option is feasible, Endeavour Energy will conduct a detailed investigation to determine the objective and targets for a non-network option to be successful and publish this information in a Non-Network Options Report. The publication of this report forms part of the process whereby Endeavour Energy invites interested stakeholders to make submissions for non-network options to be evaluated against network options. It also provides instructions on how to make a submission. The Non-Network Options Report is an alternative to the request for proposals (RFP) process for the purposes of tendering for DM services.

Whilst not required under the National Electricity Rules, non-network option investigations are also conducted for selected projects that do not meet the $5 million trigger threshold (non RIT-D projects). An alternative demand management investigation process (such as an in-house investigation) may be adopted to identify a suitable non-network option for these projects, or the formal RIT-D process may be used if considered appropriate. An in-house demand management investigation is generally adopted where there are a few major customers within the constraint area that could provide the demand reduction required to cost effectively defer or avoid the identified network need.

The Non RIT-D projects that Endeavour will investigate for non-network options are listed in Table 9.

Future network needs have also been identified as those that are heavily dependent on forecast load growth and the proposed greenfield development that underpins this proceeding as forecast. These limitations will be investigated when demand growth and network needs are more certain and may develop into RIT-D projects if the RIT-D criteria are met. Future needs are listed in Table 11.

Details of projects which Endeavour Energy expects to commence within the next 5 years are discussed in sections 8.2, 8.3 and 8.4 below for RIT-D, Non RIT-D and future limitations respectively.

8.1 NOTES ON INDICATIVE NETWORK SOLUTIONS

The following notes shown in Table 5 below provide an explanation of the terms used in the Identified System Limitations tables in sections 8.2, 8.3 and 8.4 below.

TABLE 5: TERMS USED IN IDENTIFIED NETWORK NEEDS

Term	Definition
Critical Season	The season of most critical peak demand (summer or winter) in terms of network limitation.
Existing Capacity (firm)	The firm capacity that the network element can supply. In the case of the 11kV network it is the firm capacity whilst preserving the appropriate level of backup.
Demand Forecast	The following year forecast demand for the most critical season.
Capacity Limitation Rating Reached	Indicates that the load at risk has reached unacceptable limits being either cyclic or emergency rating exceeded or the expected energy at risk is above acceptable limits in the next year.
Need Date	Indicates when both the firm rating of the network supplying the load (F) and its corresponding capacity limitation rating (C) is exceeded.
RIT-D Start Date	The year in which Endeavour Energy anticipates options investigation to commence. Investment decisions can take up to 3 years to finalise the agency and regulatory approvals. Given this, RIT-D start is timed to meet capacity limitations.
Load Transfer Potential	The load in MVA that could potentially be transferred away from the constrained network, through the existing network, on a permanent basis. This analysis is performed for constrained assets only.
Required Load Reduction	The required level of load reduction to achieve a one year deferral of the network limitation.
Potential Solutions	The currently identified credible options to resolve the network limitation including network and non-network solutions (subject to public consultation). Network limitations where power factor correction could be a viable and effective solution will be investigated in-house and implemented with customer consultation.
Asset Retirement	The removal of an asset from service due to the asset reaching its end of life or a condition where the asset can no longer service the network due to performance or safety risks.

8.2 RIT-D INVESTIGATIONS

This section details the RIT-D augmentation and replacement projects in the 5 year planning period that Endeavour Energy will investigate. Endeavour Energy reviews its network needs annually and the dates shown below may be adjusted accordingly.

Listed below in Table 6 are the identified Augmentation RIT-D projects and Table 7 details the Retirement or De-Rating RIT-D Projects. A screening test is required for each of these projects to determine the potential for non-network solutions.

TABLE 6: IDENTIFIED NETWORK NEED – AUGMENTATION RIT-D PROJECTS

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2018/19 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	RIT-D Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Menangle Park	S	1.5*	1.0	No	(F) Nov 21 (C) Nov 21	Nov 2017	0	1.5	1. DM 2. New ZS
Feeder 308 Rebuild	S	1.5*	1.0	No	(F) Nov 21 (C) Nov 21	Nov 2017	0	1.5	1. DM 2. New ZS
Calderwood ZS	S	5.4*	3.8	No	(F) Nov 21 (C) Nov 21	Dec 2017	0	1.8	1. DM 2. New ZS
Box Hill ZS	S	18.0*	8.0	No	(F) Nov 22 (C) Nov 22	Feb 2018	0	4.0	1. DM 2. New ZS
South Penrith ZS	S	52.0	54.8	Yes	(F) Nov 20 (C) Nov 20	Feb 2018	3.0	3.2	1. DM 2. New ZS
Southpipe ZS	S	22.5*	27.0	No	(F) Nov 19 (C) Nov 19	Nov 2018	0	4.5	1. DM 2. New ZS
Marsden Park (stage 2)	S	10.0*	14.4	Yes	(F) Nov 18 (C) Nov 18	Nov 2018	0	5.7	1. DM 2. Augment ZS
Science Park ZS	S	4.5*	3.8	No	(F) Nov 21 (C) Nov 21	Nov 2018	2.0	8.0	1. DM 2. New ZS
Feeders 214 / 215	S	172	304	Yes	(F) Nov 17 (C) Nov 17	Nov 2020	108	24.0	1. DM 2. Augment Fdr
Parklea ZS	S	90	90	No	(F) Nov 20 (C) Nov 20	Nov 2018	8	2.2	1. DM 2. Augment ZS
Maryland ZS	S	5.2*	7.2	Yes	(F) Nov 20 (C) Nov 20	Jan 2019	0	2.0	1. DM 2. New ZS
West Dapto ZS	S	5.3*		No	(F) Nov 21 (C) Nov 21	Nov 2019	0	2.0	1. DM 2. New ZS
Western Sydney Airport 132kV Supply	S	TBD	TBD	No	(F) Nov 23 (C) Nov 23	Nov 2020	0	TBD	1. DM 2. New ZS

Endeavour Energy

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2018/19 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	RIT-D Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Riverstone East ZS	S	12.0*	4.0	No	(F) Nov 21 (C) Nov 21	Nov 2019	0	4.7	1. DM 2. New ZS
Mt Gilead ZS	S	9.0*	9.0	No	(F) Nov 23 (C) Nov 23	Nov 2020	0	2.0	1. DM 2. New ZS
West. Sydney Employment Lands	S	TBD	TBD	No	(F) Nov 23 (C) Nov 23	Nov 2020	0	TBD	1. DM 2. New ZS
North Bomaderry ZS	S	3.0*	2.2	No	(F) Nov 20 (C) Nov 20	Feb 2019	0	0.4	1. DM 2. New ZS
Catherine Park ZS	S	TBD	TBD	No	(F) Nov 23 (C) Nov 23	Feb 2022	0	TBD	1. DM 2. Augment ZS
Termeil ZS	S	3.0*	4.7	No	(F) Nov 24 (C) Nov 24	Nov 2021	1.0	0.5	1. DM 2. New ZS

* Based on the existing 11kV back- up capacity.

TABLE 7: IDENTIFIED NETWORK NEED – RETIREMENT OR DE-RATING PROJECTS

RIT-D Project Name	Existing Capacity (firm) (MVA)	2018/19 Demand Forecast (MVA)	Retirement or De-Rating Date	Original Retirement or De-Rating Date	RIT-D Start Date	Retirement or De-Rating Details
Marayong ZS	50	40.0	2021	2021	Nov 2017	End of life of the 11kV switchboard, transformers, switchgear and associated equipment.
Carlingford TS	360	2017	2022	2022	Nov 2017	End of life of the control building and associated equipment.
Sussex Inlet ZS	15	8.0	2021	2021	Nov 2017	End of life of the 11kV busbar and associated equipment.
Feeder 7028 - Bellambi TS to Helensburgh ZS	44.4	10.1	2020	2020	Nov 2017	End of life of the steel structures.
West Wollongong ZS	22.5	12.5	2023	2023	Nov 2019	End of life of the 11kV busbar and associated equipment.
Unanderra ZS	24	13.0	2024	2024	Mar 2020	End of life of the control building,11kV busbar and associated equipment.
Greystanes ZS	25	18.0	2026	2026	Mar 2022	End of life of the 11kV busbar and associated equipment.

Table 8 provides detail of the timeline for the RIT-D process for each augmentation or retirement / de-rating project. Additional details of these RIT-D projects are provided in Appendix B and Appendix C.

For each identified project details of the need and the areas where demand reduction opportunities may exist are discussed, including the time frame over which a non-network investigation and program implementation would be expected to operate to successfully address the need.

If a screening test identifies that a non-network option is feasible Endeavour Energy will issue a Non-Network Options Report. All registered participants on Endeavour Energy's register of interested parties' database will be notified of the release of the document.

If a screening test identifies that non-network options are not feasible Endeavour Energy will publish a notice of the results on its website and all registered participants will be notified.

TABLE 8: RIT-D PROJECTS TIMETABLE

RIT-D Project Name	Constraint Driver	Timetable		Constraint
RIT-D Augmentation Projects				
Menangle Park ZS	New residential release area - Development dependent project	Investigate Results Decision	Nov 2017 Mar 2018 Apr 2018	Nov 2019
Feeder. 308 Rebuild	New residential release area - Development dependent project	Investigate Results Decision	Nov 2017 Mar 2018 Apr 2018	Nov 2019
Calderwood ZS	New residential release area - Development dependent project	Investigate Results Decision	Nov 2017 Mar 2018 Apr 2018	Nov 2021
Box Hill ZS	New residential release area - Development dependent project	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2022
South Penrith ZS	Continual development of the commercial and residential areas - Development dependent project	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2022
Southpipe ZS	New industrial release areas - Development dependent project	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2022
Marsden Park ZS (Stage 2)	New industrial release areas - Development dependent project	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2021
Science Park ZS	New Industrial release area - Development dependent project	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2022
Feeders 214 / 215	Contingency driven	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2021
Parklea ZS	Development driven by rezoning	Investigate Results Decision	Nov 2018 Mar 2019 Apr 2019	Nov 2020
Maryland ZS	New residential and commercial release area - Development dependent project	Investigate Results Decision	Nov 2019 Mar 2020 Apr 2020	Nov 2019
West Dapto ZS	New residential and commercial release area - Development dependent project	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
Western Sydney Airport 132kV Supply	Large spot load and associated employment lands	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
Riverstone East ZS	New residential and commercial release area - Development dependent project	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
Mt Gilead ZS	New residential release area - Development dependent project	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
West. Sydney Employment Lands	Large spot load and associated employment lands	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
North Bomaderry ZS	New residential and commercial release area - Development dependent project	Investigate Results Decision	Nov 2020 Mar 2021 Apr 2021	Nov 2024
Catherine Park ZS	New residential and commercial release area - Development dependent project	Investigate Results Decision	Nov 2021 Mar 2022 Apr 2022	Nov 2024
Termeil ZS	New residential release area - Development dependent project	Investigate Results Decision	Nov 2021 Mar 2022 Apr 2022	Nov 2024

RIT-D Project Name	Constraint Driver	Timetable		Constraint
RIT-D Retirement or De-Rating Projects				
Marayong ZS	End-of-life Replacement	Investigate Results Decision	Nov 17 Mar 18 Apr 18	Nov 2021
Carlingford TS	End-of-life Replacement	Investigate Results Decision	Nov 17 Mar 18 Apr 18	Nov 2022
Sussex Inlet ZS	End-of-life Replacement	Investigate Results Decision	Nov 17 Mar 18 Apr 18	Nov 2021
Feeder 7028 - Bellambi TS to Helensburgh ZS	End-of-life Replacement	Investigate Results Decision	Nov 17 Mar 18 Apr 18	Nov 2020
West Wollongong ZS	End-of-life Replacement	Investigate Results Decision	Nov 19 Mar 20 Apr 20	Nov 2023
Unanderra ZS	End-of-life Replacement	Investigate Results Decision	Mar 20 Aug 20 Sept 20	Nov 2024
Greystanes ZS	End-of-life Replacement	Investigate Results Decision	Mar 22 Aug 22 Sept 22	Nov 2026

8.3 NON RIT-D PROJECTS

Endeavour Energy also seeks to investigate non-network options for network needs that are below the RIT-D trigger threshold, but are driven by network capacity limitations being reached. Typically these projects require significant potential network investment but are below $5 million and are therefore outside by the RIT-D evaluation process. These are shown in Table 9.

If a non-network investigation identifies that a demand management option is feasible for a Non RIT-D project, Endeavour Energy may issue a public tender document to provide interested stakeholders and service providers the opportunity to submit proposals to address the need. All registered participants on Endeavour Energy's database of interested parties will be notified if and when a tender document is issued.

Alternatively, an in-house demand management investigation may be conducted to identify a suitable non-network option where it is identified that one customer or a small number of customers are able to provide sufficient demand reduction to defer or avoid network augmentation or asset replacement. The implementation of a non-network solution in these instances is negotiated directly between Endeavour Energy and the relevant customer(s). The dates associated with these projects are shown in Table 10. Endeavour Energy reviews its demand forecast annually and the dates shown below may be adjusted accordingly. For each identified constraint, details of the limitation and possible demand reduction opportunities are discussed in Appendix D.

TABLE 9: IDENTIFIED NETWORK NEEDS – NON-RIT-D PROJECTS

RIT-D Project Name	Critical Season	Existing Capacity (firm) (MVA)	2016/17 Demand Forecast (MVA)	Capacity Limitation Rating Reached	Limitation Date	RIT-D Start Date	Load Transfer Potential (MVA)	Required Load Reduction (MVA)	Potential Solutions
Austral ZS	S	4.9*	2	No	(F) Nov 22 (C) Nov 22	Nov 2019	0	1	1. Demand Management 2. ZS augmentation

* Based on the existing 11kV back- up capacity

TABLE 10: TIMETABLE FOR THE INVESTIGATION OF NON RIT-D PROJECTS

Project Name	Constraint Driver	Timetable		Constraint
Austral ZS	New Interim ZS	Investigate Results Decision	Nov 2017 Mar 2018 Apr 2018	Nov 2022

8.4 FUTURE NETWORK NEEDS

A future network need is one that occurs beyond the 5 year planning period and where there is uncertainty regarding the timing of the need. Such network needs may become RIT-D projects if the criteria are met and when the need is more certain due to load applications and/or subdivisions being submitted or when asset condition and end-of-life actors become more evident.

In the early stages of development applications, the proposed timing is often not firm but the need date is estimated based on the best available information. On this basis the identified future network needs are shown in Table 11.

TABLE 11: FUTURE NETWORK NEEDS

Project Name	Description	Estimated Constraint Date
South Gilead	New residential release area – Development dependant project	Nov 2025
Holsworthy ZS	New residential release area – Development dependant project	Nov 2026
Eschol Park ZS	New residential release area – Development dependant project	Nov 2026
Penrith Lakes ZS	New residential release area – Development dependant project	Nov 2024
Kemps Creek BSP Works	New residential release area – Development dependant project	Future
Austral Permanent ZS	New residential release area – Development dependant project	Nov 2026
North Catherine Fields ZS	New ZS to supply South West Sector– Development dependant project	Nov 2025
Culburra Beach ZS	New residential release area – Development dependant project	Future
Cheriton Ave ZS	New commercial – Development dependant project	Nov 2026
Bringelly ZS	New residential release area – Development dependant project	Nov 2027
Western Sydney University employment lands	New industrial release area – Development dependant project	Nov 2027
132kV Kemps Creek Conversion	New residential, commercial and industrial release area – Development dependant project	Nov 2025

8.5 IMPACT ON TRANSMISSION - DISTRIBUTION CONNECTION POINTS

Table 12 details constraints in the network which impact on the capacity of transmission – distribution connection points.

TABLE 12: TRANSMISSION – DISTRIBUTION CONNECTION POINT CONSTRAINTS

Network Constraint	Year	Impact on Transmission-Distribution Connection Point
The two Nepean TS 132/66kV transformers are overloaded for an outage on the single 330/66 kV transformer at Macarthur BSP.	2017	This constraint limits the firm capacity of the 66kV system supplied from the single 330/66kV transformer at Macarthur BSP.

8.6 PRIMARY DISTRIBUTION FEEDERS

For any primary distribution feeders for which Endeavour Energy has prepared forecasts of maximum demands and which are currently experiencing an overload situation, or are forecast to experience an overload within the next two years, Endeavour Energy must set out:

- The location of the primary distribution feeder;
- The extent to which demand exceeds, or is forecast to exceed, 100% of the normal cyclic rating (240A) of the feeder (or a lesser percentage of the cyclic rating of the feeder where maximum utilisation factors[3] are employed), under normal conditions during the in summer and/or winter periods;
- The types of potential solutions that may address the constraint or forecast constraint; and
- Where an estimated reduction in forecast demand would defer the constraint for a period of 12 months, including:
    - An estimate of the year and month in which the constraint is forecast to occur;

[3] Endeavour Energy employs a utilisation factor of 80% for the distribution feeder cables exiting a zone substation to allow 20% of the thermal rating of the feeder to be available for transfer of load from an adjacent feeder under first level emergency conditions.

- A summary of the location of relevant connection points at which the estimated reduction in forecast demand would defer the constraint; and
- The estimated reduction in demand required to defer the forecast constraint.

Options that are considered for all forecast constraints include:

- Non-network solutions such as customer power factor correction;
- Augmentation the network;
- Rearranging the network by switching and load transfers; and
- Monitoring the situation if the forecast constraint is not significant.

Details of Endeavour Energy's primary distribution feeders which are currently overloaded are given in Appendix E.

8.7 OTHER NETWORK ISSUES IMPACTING IDENTIFIED NETWORK NEEDS

Endeavour Energy faces several challenges and opportunities in relation to managing network assets in the face of changing demands on those assets. The key issues in the short-term include the assessment of asset ratings and the impact of rooftop solar photo-voltaic installations whilst longer term issues include energy storage systems and the increasing use of electric vehicles. These issues are being addressed through network investigations, participation in industry committees and through the development of appropriate network connection and management standards.

Each of these emerging issues are further discussed below.

8.7.1 ASSET RATINGS

Endeavour Energy investigates potential cyclic or emergency rating of assets to identify the actual capacity of the network and to accurately forecast the emergence of constraints. This ensures optimal utilisation of existing network assets and presents opportunities for deferral of investment in augmentation of the network.

8.7.2 SOLAR PHOTOVOLTAIC (PV) GENERATION

The growth in embedded photovoltaic generation has continued steadily since 2010 despite reductions in feed-in tariffs and continues to challenge the performance of the distribution network.

Endeavour Energy continues to monitor the impacts of solar panels which, in some areas, have materially reduced peak demand. PV generation has little impact on peak demand in those areas of the network where demand peaks later in the day. What it does do is to reduce the duration of the peak and improve the thermal capacity of some parts of the network during the day.

PV systems also impact the quality of supply. Traditionally, distribution networks were designed to accommodate voltage drops arising from the flow of power from the high voltage system through to the low voltage system and connected customers. However, the large volumes of rooftop solar PV connected at customer's premises in some locations results in power flows in the reverse direction from the LV to HV at times of peak solar generation and overall low system demand. This reverse power flow situation is often not predictable and can lead to both voltage rise and voltage drop situations in various parts of the network having to be managed simultaneously to ensure voltage at the customer's premises remains within statutory voltage limits.

8.7.3 FUTURE IMPACTS OF BATTERY ENERGY STORAGE SYSTEMS

It is expected that there will be an increasing trend of PV customers installing battery energy storage systems to optimise the generation output from their PVs for their internal consumption.

This may result in a reduction in high voltage complaints as the exporting of energy from customers with PV installations reduces during periods of low system demand. . It is also likely to result in a reduction in the level of peak demand on the network as batteries allow customers to shift their solar generation to better match their electricity consumption profile and to make use of time-of-use tariffs to reduce their overall electricity consumption charges.

Battery systems may also provide opportunities for Endeavour Energy to utilise the stored energy during critical peak times to defer investment in the augmentation of the network.

8.7.4 ELECTRIC VEHICLES

Electric Vehicles (EV) are an emerging technology with potential for significant impact on the electricity network both due to the very large demand when the vehicles are being recharged and also for the potential for the batteries in the vehicles to be used to support the electricity network during periods of peak network demand.

Endeavour Energy is a member of the Australian Standards Electric Vehicle Committee which is developing standards for the connection of EVs to the electricity network and for the associated charging/discharging control systems. The committee is also exploring strategies for vesting the control of the charge and discharge of EV batteries with the DNSP for load management purposes. Such an approach will require regulations and technical standards to be developed that balance the need to maintain network security with customer's needs and also enable different providers to offer controlled EV charging services.

Network pricing signals will also play a key role in encouraging efficient EV charging behaviour by customers and influencing the take up of demand side participation products.

9.0 NETWORK INVESTMENTS

9.1 DEMAND MANAGEMENT ACTIVITIES IN THE PRECEDING YEAR

9.1.1 SCREENING FOR NON-NETWORK OPTIONS

The purpose of the screening for non-network options is to determine if investment in network augmentation or replacement to address a network need has a reasonable opportunity of being deferred or avoided. Screening includes investigating the feasibility of initiatives that reduce the demand on that part of the network by the required amount and at the appropriate time of day or that provide an alternative source of energy that addresses the need.

When screening for non-network options Endeavour Energy considers the following:

- Any measure or program targeted at reducing peak demand, including:
  - Improvement to or additions of automatic control schemes such as direct load control and pool pump usage during off-peak times;
  - Energy efficiency programs that target appliances that contribute to peak demand;
  - The installation of smart meters to accommodate a demand response program;
  - Existing load transfer capacity; and
  - Installation of technology capable of reducing peak demand.
- Increased local or distributed generation/supply options including:
  - Capacity for standby power from existing or new embedded generation;
  - Capacity of micro embedded generation; and
  - Capacity of energy storage systems.

Endeavour Energy understands that credible solutions may include a variety of different measures combined to form one integrated program when determining whether a non-network option could constitute or be part of a credible option.

In evaluating the feasibility of a non-network option the analysis focuses on the following areas:

- The ability to address the identified need in terms of the level and timing of demand reduction;
- Commercially feasibility;
- Technical feasibility; and
- Implementation timeframe to meet the network need.

9.1.2 SCREENING TESTS

The network limitations screened for non-network options during 2017 are shown in Table 13 below.

TABLE 13: SCREENING TEST RESULTS

Network Connection Point	Constrained Area	Summary of Constraint	Screening Test Result	Notice date
South Leppington ZS	New release residential and commercial areas	Distribution network capacity	Not feasible	November 2017
South Marsden Park ZS (stage 2)	New release residential and commercial areas	Distribution network capacity	DM Feasible issue Non-network Options Report	May 2017
Marayong ZS	Existing supply area of Marayong ZS	Retirement of end of life assets	DM Feasible issue Non-network Options Report	October 2017

9.1.3 SCREENING TEST RESULT DETAILS

9.1.3.1 SOUTH LEPPINGTON ZS

The proposed South Leppington ZS (stage 2) is required to cater for residential developments in the Leppington, East Leppington and surrounding precincts. The current single transformer supply, with limited back-up results in network limitation being experienced when the demand exceeds 10 MVA. This is forecast to occur in 2018. To supply the release areas and cater for an ultimate load of 45 MVA the stage one development of South Leppington ZS will need to be upgraded to 45 MVA firm capacity.

The investigation into the demand reduction found that potentially 2.6 MVA is attainable on the 11kV network supplying the South Leppington ZS supply area and the 11kV back-up feeders. This fell far short of the required demand reduction of 11.7 MVA for a one year deferral and 16.7 MVA for a two year deferral. The number of events will also increase from 5 to 6 per year on a pre-emptive basis to 16 events in 2019 and 53 events in 2020.

As a result, it was concluded that a non-network option to overcome the constraints in this area was not feasible.

9.1.3.2 SOUTH MASDEN PARK (STAGE 2)

The Marsden Park Industrial precinct is experiencing significant development. Located within the North West Growth Centre, it is designated to contain a total of 316 hectares of commercial, bulky goods retail and industrial land as well as 1,200 dwellings. The precinct will create approximately 10,000 jobs, house 3,500 people and place an estimated 50 MVA of demand on the network over 20 years. South Marsden Park ZS (stage 1) was constructed as an interim substation with a 15 MVA transformer and a single 132 kV subtransmission feeder to supply the recently released Marsden Park Industrial precinct.

South Marsden Park ZS has limited back-up supply via the 11kV network from the surrounding zone substations. This 11kV back-up capacity is being restricted as the developments on the surrounding zone substations continue to expand. The Marsden Park Industrial precinct load growth is expected to average around 3 MVA per year for the next twelve years. Analysis has identified that there is insufficient back-up capacity available to supply the industrial precinct under outage conditions from 2018/19.

Screening identified that a non-network option was feasible and a Non-network Options Report was issued in May 3017 to obtain submissions for non-network options. The DM program objectives were:

- Reduce peak demand by 13.1 MVA in 2021 to achieve a one year deferral;
- Reduce the peak demand between the hours of 11:00 to 20:00 all year round; and
- Permanent demand reduction would be required as exceedance occurs on a daily basis.

The Non-network Options Report tender closed on 31 August 2017. No submissions were received.

9.1.3.3 MARAYONG ZS

Marayong ZS major equipment has reached its end-of-life and further repair or maintenance is not warranted. A project has been developed to build a new substation adjacent the existing substation as a replacement. Replacement of power transformers will be like-for-like, being 3 x 25 MVA. An opportunity exists to install one less transformer if sufficient demand can be removed on a permanent basis.

The peak demand on Marayong ZS is currently 40 MVA with 85% being industrial load, reaching 35 MVA during the peak. The residential demand accounts for the remaining 5 MVA of the total peak demand. Consequently, the industrial load will need to be targeted to achieve a useful reduction in demand. To enable a 25 MVA firm substation to be built, 13.5 MVA of demand at peak time must be removed on a permanent basis.

Screening identified that a non-network option was feasible and a Non-network Options Report was issued in October 2017 to invite submissions for non-network options. The demand management program objectives are:

- Reduce peak demand by 13.5 MVA in 2021 to achieve a saving of $1.38 million;
- Industrial sector will need to be targeted as it contributes 85% to the peak demand; and
- Permanent demand reduction will be required and must be reliable.

The Non-network Options Report closing date for submission is 12 January 2018.

9.2 DETAILS OF IMPLEMENTED NON-NETWORK PROGRAMS

Endeavour has not implemented any non-network options during 2016/17. All major projects have been driven from greenfield development converting rural areas into residential subdivisions. Endeavour has implemented two demand management trials being:

- *Solar*Saver - Battery Energy Storage; and
- *Cool*Saver - using 3G DRED Air Conditioning control.

9.2.1 BATTERY ENERGY STORAGE SYSTEM TRIAL

A Battery Energy Storage System (BESS) trial was implemented in early 2017 targeting residential customer sites. The focus of this trial is to investigate how Endeavour could use and manage the technology to provide on-call demand reduction, reduce peak demand, improve power quality and defer or avoid capital investment. The BESS will be evaluated in terms its technical and financial viability for and will also be used to determine any potential conflicts between stakeholders (including electricity retailers) and methods to resolve these.

Homeowners with existing PV installation have been approached to participate in the trial. The BESS utilises existing PV installations, storing their energy output during the day and returning the energy to the participating customers as required. During peak demand response events (DR Event), the BESS will be utilised to provide network support at its maximum capability. The trial is proposed to run for two summer periods ending on 31 March 2019.

9.2.2 AIR CONDITIONING CONTROL TRIAL

This trial is being conducted to determine the ability and reliability of the 3G Demand Response Enabled device (3G DRED) to control the energy consumption of air conditioners during peak periods. The 3G DRED is a new technology that provides a higher level of interactive control and management of air conditioners. Endeavour Energy will share the learnings from this trial to assist the aggregation market develop to provide cost-effective demand response programs. The trial was implemented in mid-2017 and will end on 31 March 2019.

9.3 PROMOTION OF NON-NETWORK OPTIONS

The promotion of non-network options occurs predominantly through the public consultation process which includes the issuing of the following reports:

- Non-Network Options Report;
- Draft Project Assessment Report; and
- Final Project Assessment Report.

Listed below are the actions taken to promote non-network proposals from the preceding year.

9.3.1 SUMMARY OF NON-NETWORK OPTIONS REPORTS

The network needs where a Non-network Options Report was issued during 2016/17 are shown below in Table 14 below.

TABLE 14: NON-NETWORK OPTIONS REPORTS

Network Connection Point	Constrain Area	Summary of Constraint	Non-Network Options Issue Date	Timing of Constraint	Est. Load Reduction (kVA)	Defer Years
South Marsden Park ZS	Industrial and residential	New release areas	May 2017	Nov 2021	13.1	1
Marayong ZS	Industrial and residential	End-of-life asset replacement	October 2017	Nov 2021	13.5	Permanent

9.3.2 SUMMARY OF DRAFT PROJECT ASSESSMENT REPORTS

One Draft Project Assessment Report was issued during 2016/17 in accordance with the RIT-D cost thresholds. This project is detailed in Table 15 below.

TABLE 15: DRAFT PROJECT ASSESSMENT REPORTS

Network Connection Point	Constrained Area	Summary of Constraint	Status	Notice Date
North Leppington	New release residential and commercial areas	Distribution network capacity	Issued	Nov 2016

9.3.3 SUMMARY OF FINAL PROJECT ASSESSMENT REPORTS

Two Final Project Assessment Reports were issued during 2016/17 in accordance with the RIT-D cost thresholds. These projects are detailed in Table 16 below.

TABLE 16: FINAL PROJECT ASSESSMENT REPORTS

Network Connection Point	Constrained Area	Summary of Constraint	Status	Notice Date
North Leppington	New release residential and commercial areas	Distribution network capacity	Issued	May 2017
Catherine Fields	New release residential and commercial areas	Distribution network capacity	Issued	Nov 2017

9.3.3.1 NORTH LEPPINGTON ZS

The North Leppington Zone Substation Draft Project Assessment Report was issued in November 2016. A Final Project Assessment Report was issued and placed on Endeavour Energy's web site in March 2017. The reports detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test that found demand management not to be feasible in this greenfield development area due to the weak existing network and the high demand growth rate as well as the low potential for demand reduction. The assessment results conclude the following:

- The preferred option involves the development of a 2 x 45 MVA transformer zone substation with a simplified control building.
- The estimated cost of the preferred option is $24 million;
- The net economic benefit of this option is $47 million over a 15 year evaluation period;
- This investment is required by 2019/20; and
- The estimated capital expenditure of $24 million is part of the overall approved capital program and consequently will have no effect of connections charge or distribution use of system charges.

9.3.3.2 CATHERINE PARK ZS

The Catherine Park ZS Final Project Assessment Report was issued and placed on Endeavour Energy's web site on October 2017. A Draft Project Assessment Report was not prepared for this project as the projects is the below $10 million trigger threshold that requires a draft report to be prepared prior to a final. The report detailed the network development plans resulting from the new release areas. It also details the result of the non-network screening test that found demand management not to be feasible in this greenfield development area due to the weak existing network and the high demand growth rate as well as the low potential for demand reduction. The assessment results conclude the following:

- The preferred option involves the development of 3 x 11kV feeders from Oran Park Zone Substation.
- The Stage 1 project allows for the deferment of the construction of the zone substation and allows the development to proceed in a timely manner;
- The estimated cost of the preferred option is $3.24 million;
- The net economic benefit of this option is $93.4 million over a 15 year evaluation period;
- This option is required by 2020; and
- The estimated capital expenditure of $3.24 million is part of the overall approved capital program and consequently will have no effect of connections charge or distribution use of system charges.

A non-network option screening will be re-performed when the Catherine Park ZS is planned to be constructed.

9.4 PLANS FOR DEMAND MANAGEMENT

Endeavour Energy produces a demand management plan that includes all identified network needs that are subject to a non-network options investigation and potentially the release of a Non-Network Options Report. The principal factor affecting the investigation timetable is the forecast load growth or the asset retirement timeframe. In many situations the load growth is driven by spot load applications and projected development whereas retirements are driven by the condition and performance of the network assets in question. Endeavour Energy closely monitors the level of demand that appears on the network and the condition of assets identified for retirement to ensure network needs are accurately forecast and solutions implemented in a timely manner.

Details of the network needs that are currently RIT-D projects or non RIT-D projects and will be screened or investigated for non-network options during 2018 are shown in Table 17 below. These details have been extracted from Table 6, Table 7 and Table 9. An indicative timetable of investigation is provided but this may change due to changes to development programs, to the trend of demand growth and to changes in the condition and performance of the network assets.

TABLE 17: RIT-D AND NON RIT-D NON-NETWORK PROGRAMS INVESTIGATIONS

Network Connection Point	Load Type	Screening/DM Investigation	Constraint Year	Decision Deadline
RIT-D Augmentation Projects				
RIT-D Investigations for 2017/18				
South Leppington ZS	90% residential, 10% commercial – greenfield dev.	Nov 2017	Nov 2019	Apr 2018
Menangle Park ZS	90% residential, 10% commercial – greenfield dev.	Nov 2017	Nov 2019	Apr 2018
Feeder 308 Rebuild	30% residential, 20% commercial, 50% industrial.	Nov 2017	Nov 2019	Apr 2018
Calderwood ZS	60% Commercial, 25% Industrial, 15% Residential	Nov 2017	Nov 2021	Apr 2018
RIT-D Investigations for the next two to three years				
Box Hill ZS	90% residential, 10% commercial – greenfield dev.	Nov 2018	Nov 2022	Apr 2019
South Penrith ZS	20% residential, 50% commercial, 30% industrial.	Nov 2018	Nov 2022	Apr 2019
Southpipe ZS	100% industrial.	Nov 2018	Nov 2022	Apr 2019
Marsden Park (stage 2)	95% residential, 5% commercial – greenfield dev.	Nov 2018	Nov 2021	Apr 2019
Science Park ZS	100% industrial.	Nov 2018	Nov 2022	Apr 2019
Feeders 214 / 215	80% residential,10% commercial,10% industrial.	Nov 2018	Nov 2021	Apr 2019
Parklea	90% residential,10% commercial.	Nov 2018	Nov 2020	Apr 2019
Non RIT-D Investigations beyond the next three years				
Maryland ZS	80% residential,10% commercial – greenfield dev.	Nov 2019	Nov 2020	Apr 2019
West Dapto ZS	80% residential,10% commercial,10% industrial.	Nov 2020	Nov 2024	Apr 2021
Western Sydney Airport 132kV Supply	50% commercial, 50% industrial – greenfield dev.	Nov 2020	Nov 2024	Apr 2021
Riverstone East ZS	90% residential,10% commercial – greenfield dev.	Nov 2020	Nov 2024	Apr 2021
Mt Gilead ZS	90% residential,10% commercial – greenfield dev.	Nov 2020	Nov 2024	Apr 2021
West. Sydney Employment Lands	100% industrial.	Nov 2020	Nov 2024	Apr 2021

Network Connection Point	Load Type	Screening/DM Investigation	Constraint Year	Decision Deadline
North Bomaderry ZS	90% residential,10% commercial – greenfield dev.	Nov 2020	Nov 2024	Apr 2021
Catherine Park ZS	90% residential,10% commercial – greenfield dev.	Nov 2021	Nov 2024	Apr 2022
Termeil ZS	90% residential,10% commercial – greenfield dev.	Nov 2021	Nov 2024	Apr 2022
RIT-D Retirement or De-Rating Projects				
Non RIT-D Investigations for 2017/18				
Marayong ZS	20% residential, 80% industrial.	Nov 2017	Nov 2021	Apr 2018
Carlingford TS	90% residential,10% commercial.	Nov 2017	Nov 2024	Apr 2018
Sussex Inlet ZS	90% residential,10% commercial.	Nov 2017	Nov 2021	Apr 2018
Feeder 7028 - Bellambi TS to Helensburgh ZS	90% residential,10% commercial.	Nov 2017	Nov 2020	Apr 2018
RIT-D Investigations for the next two to three years				
West Wollongong ZS	90% residential,10% commercial.	Nov 2019	Nov 2023	Apr 2020
Non RIT-D Investigations beyond the next three years				
Unanderra ZS	75% residential, 5% commercial, 20% industrial	Nov 2019	Nov 2022	Apr 2020
Greystanes ZS	90% residential,10% commercial.	Nov 2022	Nov 2025	Apr 2023
Non RIT-D Projects				
Non RIT-D Investigations for 2017/18				
Austral ZS	90% residential,10% commercial – greenfield dev.	Nov 2017	Nov 2022	Apr 2018
RIT-D Investigations for the next two to three years				
Nil entry.				
Non RIT-D Investigations beyond the next three years				
Nil entry.				

9.5 RIT-D'S COMPLETED OR IN PROGRESS

9.6 PROJECTS IN PROGRESS

Table 18 below provides a summary of the RIT-D projects which are currently in progress. Refer to Section 9.1.3 for more information.

TABLE 18: RIT-D PROJECTS IN PROGRESS – SUMMARY

RIT-D Project	RIT-D Status	Cost of Preferred Option ($m)	Construction Timetable	Credible Options
South Leppington ZS	Screening complete	$26.1	2018/19 to 2020/21	1. Construct stage 2 with 2nd 45 MVA 132/11kV transformer and control building.
South Marsden Park ZS (stage 2)	Non-network options complete	$24.6	2018/19 to 2019/20	1. Construct stage 2 with 2x45 MVA 132/11kV transformers and 2nd 132kV feeder. 2. Demand Management
Marayong ZS	Non-network options open	$18.8	2017/18 to 2020/21	1. Renewal of entire substation. 2. Demand Management to install one less transformer

9.6.1 PROJECTS COMPLETED

The consultation process for projects where a Final Project Assessment Report was issued in the preceding year is considered to be complete. These projects are detailed in Table 19. Refer to Section 9.3.3 for more information.

TABLE 19: RIT-D PROJECTS COMPLETED – SUMMARY

RIT-D Project	Cost of Preferred Option ($m)	Construction Timetable	Credible Options	Net economic Benefit ($m)
North Leppington ZS Stage 2	$24.0	2017/18 to 2020/21	1. Construct a 2x45 MVA 132/11kV ZS and simplified control building. 2. Construct a 2x45 MVA 132/11kV ZS and modular control building	$47.0
Catherine Park ZS	$3.24	2018/19	1. Establish a new zone substation 2. Extend 11kV network from adjacent zone substations	$93.4

9.7 ASSET RETIREMENTS AND POTENTIAL REGULATORY INVESTMENT TESTS

9.7.1 ASSET RETIREMENTS (PROJECT BASED)

Endeavour Energy has a range of project based planned asset retirements which will result in a system limitation or de-rating. Table 20 below summarises these planned asset retirements for the forward planning period. Some of these needs may be addressed by options that are yet to be determined and which could trigger the requirement to undertake a RIT-D assessment.

TABLE 20: ASSET RETIREMENTS (PROJECT BASED)

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTM028	132kV oil insulated cable	Guildford/Merrylands/ Parramatta	• Sheath oil leaks and dissolved gas levels indicating end of life of the cable(s)	2027/28	N/A
RTM030	33kV Feeder 7028 on 132kV steel towers	Bellambi/Helensburgh	• Corrosion of towers and conductors with risk of failure • Safety risk for the public and electricity workers	2023/24	N/A
RTM134	Wollongong - Port Kembla copper pilot cables	Wollongong – Port Kembla	• Increased experience of failures at joint boxes leading to failures of the high speed 33kV feeder protection schemes • Risk to public safety due to slow clearing of feeder faults	2027/28	N/A
RTS146	Marayong Zone Substation: 11kV switchgear, 33kV power transformers, protection and control and auxiliaries	Marayong	• Safety risks of oil CB failure • Circuit breakers with high contact resistance and low insulation resistance • Transformers with low paper strength, poor oil quality, low insulation resistance and oil leaks	2019/20	N/A
RTS155	Sussex Inlet Zone Substation: 11kV switchgear, protection and control and control building	Sussex Inlet	• Safety issues associated with busbars with poor clearances and in poor condition • Poor condition of control building	2020/21	N/A
RTS163	Unanderra Zone Substation 11kV switchgear and control building	Unanderra	• Safety issues in cable basement, 11kV oil insulated switchgear and P&C tunnel board • Poor condition of control building	2023/24	N/A
RTS165	Greystanes Zone Substation: Power transformers and 33kV switchgear	Greystanes	• Transformer noise compliance issues • Constrained 33kV switchyard	2025/26	N/A
RTS174	West Wollongong Zone Substation 11kV switchboard	Wollongong	• End of life of 11kV switchboard • Safety risks of oil CB failure	2022/23	N/A

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTS167	Carlingford Transmission Substation control building replacement	Carlingford	• Failure of roof of control building • Deterioration of protection and control services • Asbestos contamination of control building • Risk of loss of protection and control of the substation • WH&S risks	2021/22	N/A
RTS615	Gerringong ZS 33kV No 2 transformer	Gerringong	• End of life of the power transformer evidenced by low insulation resistance and high winding dielectric dissipation factor	2018/19	N/A
RTS617	Prospect ZS power transformer	Prospect	• Oil leaks • Poor oil condition • Poor paper condition • Risk of failure	2018/19	N/A
RTS618	Albion Park ZS power transformer	Albion Park	• Oil leaks • Poor oil condition • Poor paper condition • Risk of failure	2018/19	N/A
RTS701	North Rocks ZS 11kV switchboard	North Rocks	• Safety issues relating to aging oil insulated circuit breakers • Safety issues relating to deteriorated paper cable terminations	2018/19	N/A
RTS702	Kellyville ZS 11kV switchboard	Kellyville	• Safety issues relating to aging oil insulated circuit breakers • Safety issues relating to deteriorated paper cable terminations	2018/19	N/A
RTS703	Horsley Park ZS 11kV switchboard	Horsley Park	• Safety issues relating to aging oil insulated circuit breakers • Safety issues relating to deteriorated paper cable terminations	2018/19	N/A
RTS704	Port Central ZS 11kV switchboard	Port Central	• Safety issues relating to aging oil insulated circuit breakers • Safety issues relating to deteriorated paper cable terminations	2018/19	N/A

9.7.2 ASSET RETIREMENTS (PROGRAM BASED)

The following list of programs will result in the retirement of various asset types across the Endeavour Energy network. The rationale for the retirement of these assets is defined by Endeavour Energy Standards which set out conditions and health indices used to determine the need for the retirement of assets.

TABLE 21: ASSET RETIREMENTS (PROGRAM BASED)

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RAU004	Substation SCADA Remote Terminal Units	Zone and sub-transmission substations	• Increased likelihood of failures leading to loss of control of the substation	2018/19 - 2027/28	N/A
RDS005	Distribution poles	Across the network	• Failure of inspection and test criteria with risk of failure • Safety risk to the public	2018/19 - 2027/28	N/A
RDS006	LV CONSAC distribution cables	Across the network	• Failures of joints in pillars and columns and of the CONSAC cable • Shock hazards to the public and electricity workers	2018/19 - 2027/28	N/A
RDS007	LV service wires	Across the network	• Deterioration of insulation • Safety risks to public and electricity workers	2018/19 - 2027/28	N/A
RDS011	HV distribution steel mains	Bushfire prone areas	• Corrosion of steel conductor • Risk of initiating a bushfire • Risk of failure causing safety risks for the public and electricity workers	2018/19 - 20227/28	N/A
RDS014	LV underground cable network	Across the network	• Failures of in-ground joints • Shock hazards to customers and electricity workers	2019/20 - 2027/28	N/A
RDS301	Distribution ground substations	Across the network	• Poor condition of the substation assets • Safety risks due to exposure of conductors and inadequate clearances	2018/19 - 2027/28	N/A
RDS302	Distribution transformers	Distribution substations across the network	• Poor condition of transformer due to crack bushings, oil leaks and corrosion • Risk to safety, environment and reliability	2018/19 - 2027/28	N/A
RDS305	Compact brand LV switchgear	Distribution substations across the network	• Deterioration of epoxy encapsulated busbar • Risk of flash-over and substation fire • Safety risk to the public and electricity workers	2018/19 - 2027/28	N/A
RDS307	MD4 epoxy switchgear	Distribution substations across the network	• Discharge over surface of resin • Risk of flash-over and substation fire • Safety risk to the public and electricity workers	2018/19 - 2027/28	N/A
RDS308	HV RGB12 switchgear	Distribution substations across the network	• Mechanical failures resulting in operational failure • Partial discharge • Safety risk to the public and electricity workers	2018/19	N/A
RDS315	Low voltage switchgear	Distribution substations across the network	• Insulation deterioration leading to arc-flash incidents • Safety risk to electricity workers	2018/19 - 2027/28	N/A
RDS405	Air break switch	Across the network	• Failure of switchgear resulting in inability to be operated • Safety risks to electricity workers and the public	2018/19 - 2027/28	N/A

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RDS414	Copper distribution mains	Across the network	• Corrosion of conductor • Fatigue of material • Risk of conductor failure • Safety risk to the public and electricity workers	2018/19 - 2027/28	N/A
RDS415	LV mains	Across the network	• Deterioration of insulation • Safety risk to public and electricity workers	2018/19 - 2027/28	N/A
RDS416	Asbestos containing service fuses	Switchboards across the network	• Friable asbestos present in fuse • Safety risk to the customer and electricity workers	2018/19 - 2019/20	N/A
RPS008	Substation electro-mechanical, electronic and early numerical protection relays	Zone and sub-transmission substations	• Increased risk of malfunction • Technological redundancy • Non-conformance to current standards	2018/19 - 2027/28	N/A
RTM012	Sub-transmission poles	Across the network	• Failure of inspection and test criteria with risk of failure • Safety risk to the public	2018/19 - 2027/28	N/A
RTM015	Sub-transmission steel towers	Across the network	• Corrosion of steel structures • Risk of failure • Safety and reliability risk	2018/19 - 2027/28	N/A
RTM171	Corroded overhead steel earthwires	Across the network	• Corrosion of steel earthwire • Risk of failure • Safety risk to the public • Reliability risk	2018/19 - 2027/28	N/A
RTM174	Hardex earthwires	Across the network	• Risk of burn-down during faults • Pilot failure • Loss of high speed protection • Safety risk due to the public due to slow clearing of the fault and due to conductors down	2019/20 - 2027/28	N/A
RTS004	132kV circuit breakers	Zone and sub-transmission substations	• Poor diagnostic test results • Poor circuit breaker performance • Defect history • Risk of failure	2018/19 - 2027/28	N/A
RTS005	33kV circuit breakers	Zone and sub-transmission substations	• Poor diagnostic test results • Poor circuit breaker performance • Defect history • Risk of failure	2018/19 - 2027/28	N/A
RTS007	11kV circuit breakers	Zone and sub-transmission substations	• Poor diagnostic test results • Poor circuit breaker performance • Defect history • Risk of failure	2020/21 - 2021/22	N/A
RTS008	Substation batteries	Zone and sub-transmission substations	• Deteriorating test results • Failure of performance criteria • Risk of failure and loss of protection systems at the substation • Reliability risk as substation is remotely switched off until battery is replaced and control restored	2018/19 - 2027/28	N/A

Reference	Asset	Location	Rationale for Retirement	Retirement Date	Change to Retirement Date
RTS009	Auxiliary switchgear	Zone and sub-transmission substations	• Risk of catastrophic failure • Safety risk to electricity workers • Reliability risk	2018/19 - 2024/25	N/A
RTS015	Surge arresters	Zone and sub-transmission substations	• Breakdown of seals on porcelain housing • Moisture ingress leading to failure • Exposure to surge currents diminishes future surge protection ability • Safety and reliability risk	2018/19 - 2027/28	N/A
RTS016	VT and CT's	Zone and sub-transmission substations	• Oil leaks • Degradation of seals • Corrosion • Risk of destructive failure • Safety and reliability risk	2018/19 - 2027/28	N/A
RTS050	Circuit breakers for capacitor banks	Zone and sub-transmission substations	• Switching of capacitor banks with conventional circuit breakers causes transients resulting in damage to customer's sensitive electronic equipment • Customer impact risk	2022/23	N/A
RTS055	66kV circuit breakers	Zone and sub-transmission substations	• Poor diagnostic test results • Poor circuit breaker performance • Defect history • Safety and reliability risk	2018/19 - 2027/28	N/A
RTS086	Busbars, disconnectors and/or support structures	Zone and sub-transmission substations	• Corrosion of reinforcing steel • Cracking of support insulators • Risk of failure • Safety and reliability risk	2018/19 - 2027/28	N/A
RTS128	Capacitor banks	Sub-transmission substations	• Leaking of capacitor cans • Risk of failure • Safety and reliability risk	2018/19	N/A
RTS173	11kV oil circuit breaker trucks	Zone substations	• Risk of failure to clear faults leading to catastrophic failure • Safety risk for electricity workers • Reliability risk	2018/19	N/A
RTS179	33kV wall bushings	Sub-transmission substations	• Degradation of insulation due to pollution • Risk of failure leading reliability risk	2018/19 - 2027/28	N/A
RTS600	Power transformers	Zone and sub-transmission substations	• Poor paper insulation • Poor bushing and tap changer condition • Poor oil condition • Risk of loss of capacity	2018/19 - 2027/28	N/A
RTS700	11kV zone substation switchboards	Zone substations	• Risk of failure to clear faults leading to catastrophic failure • Safety risk for electricity workers • Reliability risk • Safety risks for workers in the cable basement due to failure of deteriorated paper cable terminations	2018/19 - 2027/28	N/A

9.8 FUTURE NETWORK NEEDS AND POTENTIAL REGULATORY INVESTMENT TESTS

This section provides details of future network needs and an estimate of the expected timeframe for commencing options investigation. The planning investigation will identify viable options and dictate if the network need is to be classified as a RIT-D project.

Table 22 shows the identified future network needs. The majority of these projects will service new housing and employment development areas. The timeframes are estimates only due to current uncertainties surrounding the pace of development in each area. Investigation dates will become more firm once the trend of development take-up and the subsequent forecast of needs within the existing network become more certain.

TABLE 22: RIT-D PROJECTS IDENTIFIED FOR FUTURE ANALYSIS

RIT-D Project	Need	Estimated RIT-D Commencement	Potential Credible Options
South Gilead	New release area – Existing 11kV capacity exceeded	2020/21	• Establish new ZS • Demand Management
Holsworthy ZS	New release area – Existing 11kV and ZS capacity exceeded	2023/24	• Augment ZS and distribution network • Demand Management
Eschol Park ZS	New release area – Existing11kV and ZS capacity exceeded	2023/24	• Establish new ZS • Extend existing distribution network • Demand Management`
Penrith Lakes ZS	New release area – Existing 11kV and ZS capacity exceeded	2021/22	• Establish new ZS • Extend existing distribution network • Demand Management
Kemps Creek BSP Works	New release area – Subtransmission system capacity exceeded	2024/25	• Develop 132 kV subtransmission network
Austral Permanent ZS	New release area – Existing 11kV and ZS capacity exceeded	2022/23	• Augment ZS • Demand Management
North Catherine Fields ZS	New release area – Existing 11kV capacity exceeded	2022/23	• Establish new ZS • Extend existing distribution network • Demand Management
Culburra Beach ZS	New release area – Existing 11kV and ZS capacity exceeded	2024/25	• Augment ZS • Demand Management
Cheriton Ave ZS	New release area – Existing ZS capacity exceeded	2023/24	• Augment ZS • Extend existing distribution network • Demand Management
Bringelly ZS	New release area – Existing 11kV and ZS capacity exceeded	2023/24	• Augment ZS • Extend existing distribution network • Demand Management
Western Sydney University employment lands	New release area – Existing 11kV and ZS capacity exceeded	2024/25	• Establish new ZS • Demand Management
132kV Kemps Creek ZS Conversion.	New release area – Subtransmission system capacity exceeded	2022/23	• Augment ZS • Extend existing distribution network • Demand Management

9.9 URGENT AND UNFORSEEN INVESTMENTS

There are currently no issues which are sufficiently urgent or unforeseen that they have not been able to be addressed through the normal investment planning process.

TABLE 23: URGENT AND UNFORSEEN NETWORK ISSUES

Project Number	Project Name	Description Purpose	Estimated Cost ($m)	Approval Date	Completion Date	Alternative Options
Nil entry						

9.10 INFORMATION TECHNOLOGY INVESTMENT

Table 24 provides information on the investment in information technology systems within the network for the preceding year and that proposed for the forward planning period.

TABLE 24: INFORMATION TECHNOLOGY PROGRAM

Project Name	Period	Description
ICT Transformation	2017/18 onwards	This program includes a refresh of the enterprise platform, streamlining applications, improving asset condition data and expanding customer & employee self service.
Field Computing Program (Field Mobility)	2016/17 and 2017/18	The program’s purpose is to improve data quality and increase productivity by reducing the need for manual data entry from paper forms completed in the field. Projects within this program will deliver field mobility solutions for a number of inspections and asset maintenance processes including distribution maintenance activities, asset and substation inspections and updating geographical asset information from the field. The Enhanced Mobility Support Project will meet current support needs and be scalable to accommodate the expected increase in the digitalisation of asset management processes.
Metering System Program	2016/17	This program of work is to complete the Power of Choice framework.
Workforce Scheduling	2017/18 onwards	The workforce scheduling program will facilitate work planning processes to increase resource utilisation and reduce manual and duplicated work. It also intends to provide visibility of all projects and jobs in a single repository for consolidated and forward load planning This solution will provide work packets to the field that will then be managed by the field mobility program.
Security Improvement Program	2017/18 onwards	The Security Improvement Plan includes a number of key initiatives to improve Endeavour’s overall information security and to ensure ongoing compliance with the proposed new licence conditions.
Distribution Management System	2017/18 onwards	This program aims to provide Endeavour Energy with a Distribution Management System (DMS) providing a number of functionalities including: an electronic pin-board; Network Analysis Tools; Field Crew Mobile Dispatch; and integration of an electronic network model with feeder automation.

APPENDICES

APPENDIX A: DEMAND FORECASTS

A.1 BAULKHAM HILLS TRANSMISSION SUBSTATION

A.1.1 BAULKHAM HILLS TS CONNECTION POINTS

Baulkham Hills TS is supplied by Sydney West BSP via Blacktown TS on feeders 9J3 and 9J4. This system has a firm rating for one circuit outage of 512/618MVA summer/winter based on the line ratings. The 2400A switchgear at Baulkham Hills TS limits the winter rating to 548 MVA. The Baulkham Hills 132kV busbar supplies the Baulkham Hills 132/11kV supply point and Carlingford TS. Baulkham Hills TS has four 60 MVA 132/33kV transformers, providing a firm capacity of 180MVA.

TABLE 25: BAULKHAM HILLS TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Jasper Rd ZS	33/11kV	3 x 25	75	50	5.75	3.04
Northmead ZS	33/11kV	2 x 25	50	25	7.75	1.38
North Rocks ZS	33/11kV	2 x 25	50	25	4.25	1.35
Seven Hills ZS	33/11kV	3 x 25	75	50	7.75	1.16
Westmead ZS	33/11kV	2 x 35	70	35	16.25	2.24
Baulkham Hills TS	132/33kV	4 x 60	240	180	11.75	-

TABLE 26: BAULKHAM HILLS TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Jasper Road ZS	0.966	34.4	41.3	32.6	34.4	36.0	36.8	37.4
Northmead ZS	0.980	22.9	24.7	21.0	21.0	21.0	20.9	20.8
North Rocks ZS	0.998	20.4	21.6	18.7	18.7	18.6	18.6	18.5
Seven Hills ZS	0.983	23.9	27.2	31.3	31.7	31.6	31.6	31.5
Westmead ZS	0.979	25.3	25.1	26.0	28.0	31.2	34.9	37.9
Baulkham Hills TS	0.954	134.1	141.4	129.8	134.1	138.7	143.1	146.4

TABLE 27: BAULKHAM HILLS TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Jasper Road ZS	0.988	27.1	27.6	27.2	27.6	28.1	29.5	30.3
Northmead ZS	0.990	19.0	18.9	18.0	18.1	18.2	18.2	18.2
North Rocks ZS	0.998	16.5	16.8	15.6	15.5	15.5	15.5	15.5
Seven Hills ZS	0.995	20.3	21.6	23.6	24.1	24.1	24.0	24.0
Westmead ZS	0.962	19.7	18.9	18.0	20.4	22.8	26.3	29.8
Baulkham Hills TS	0.989	108.0	123.1	100.5	103.7	106.6	111.2	115.3

A.1.2 BAULKHAM HILLS TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Baulkham Hills TS operates at 33kV.

Baulkham Hills TS is supplied by Sydney West Bulk Supply Point via 132kV feeders 9J3 and 9J4, Refer Sydney West BSP.

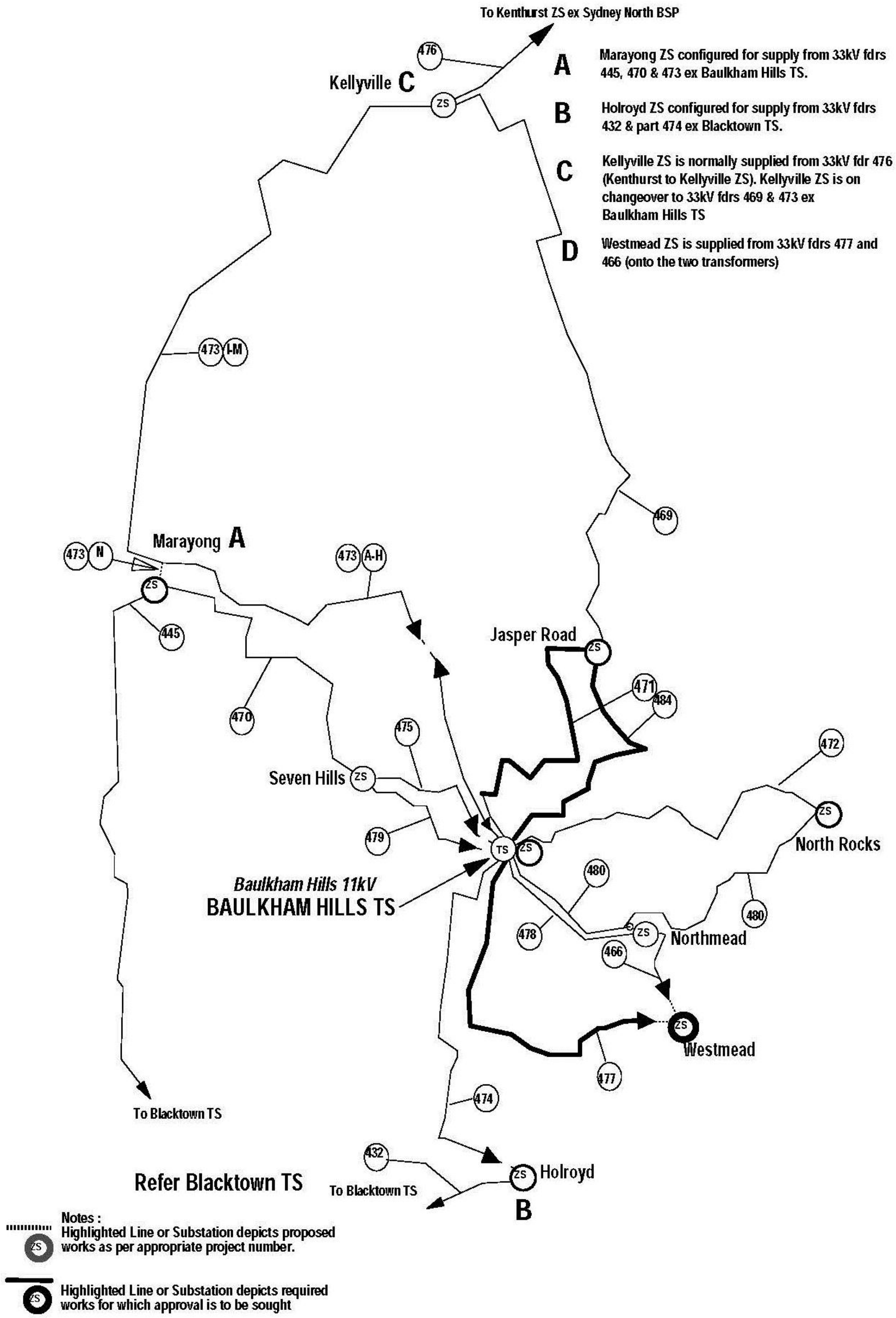
TABLE 28: BAULKHAM HILLS TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
466 - Northmead ZS to Westmead ZS	44.6	27.5	29.3	33.4	37.4	41.4
469 - Jasper Rd ZS to Kellyville ZS	21.0	7.3	7.3	7.2	7.0	6.9
470 - Marayong ZS to Seven Hills ZS	34.0	21.1	21.0	21.1	20.9	20.9
471 - Baulkham Hills TS to Jasper Rd ZS	42.0	34.1	35.5	37.6	38.2	39.2
472 - Baulkham Hills TS to North Rocks ZS	42.0	18.8	18.4	18.5	18.3	18.3
473 - Baulkham Hills TS to TEE	32.0	20.1	20.1	20.3	20.0	20.1
473 - Kellyville ZS to TEE	21.0	10.6	10.8	10.9	10.9	10.9
473 - Marayong ZS to TEE	31.2	20.3	20.3	20.5	20.2	20.3
474 - Baulkham Hills TS to Holroyd ZS	47.9	38.7	39.0	38.4	38.6	38.7
475 - Baulkham Hills TS to Seven Hills ZS	44.8	32.0	31.9	32.1	31.8	32.0
477 - Baulkham Hills TS to Westmead ZS	45.5	27.9	29.7	34.0	38.2	42.4
478 - Baulkham Hills TS to Northmead ZS	42.0	34.0	34.5	36.5	38.1	39.9
479 - Baulkham Hills TS to Seven Hills ZS	45.6	32.0	31.9	32.1	31.8	31.9
480 - Baulkham Hills TS to Northmead ZS	42.0	36.0	36.2	37.8	39.0	40.5
480 - North Rocks ZS to Northmead ZS	42.0	18.8	18.4	18.5	18.3	18.4
484 - Baulkham Hills TS to Jasper Rd ZS	42.0	33.9	35.3	37.4	38.0	39.0

TABLE 29: BAULKHAM HILLS TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Capacity of feeders 477 (Baulkham Hills TS to Westmead ZS) is reached during outage of feeder 466 (Northmead ZS to Westmead ZS)	S2026/27	Continue to monitor development in area. Conduct non-network investigation when necessary	Continue to monitor
Westmead ZS exceeds its firm capacity (transformer capacity and 11kV busbar rating) Transformer in 2021/22 and 11kV busbar in 2022/23	S2021/22	Monitor the loading yearly prior to this time and if Westmead UWS and the Westmead Hospital complex proceeds as forecast, then investigate options including non-network options.	Investigate Options
Summer contingency operation of splitting the bar at Kellyville ZS to allow supply from Sydney North and Baulkham Hills, identifed an overload of Feeder 471 by 0.25 MVA under loss of Feeder 484 and a overload of Feeder 484 by 0.7 MVA under loss of Feeder 471 occurred in 2022/23	S2022/23	Investigate options including non-network options.	Investigate Options

A.1.3 BAULKHAM HILLS TS NETWORK MAP



A.2 BELLAMBI TRANSMISSION SUBSTATION

A.2.1 BELLAMBI TS CONNECTION POINTS

Bellambi Transmission Substation has three 60MVA 132/33kV transformers providing a firm capacity of 120 MVA. Bellambi Transmission Substation is supplied from TransGrid's Dapto BSP via two 132kV feeders 980 and 981, which each have a rating of 163/176MVA summer/winter.

TABLE 30: BELLAMBI TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bulli ZS	33/11kV	2 x 15	30	15	4.75	1.72
Corrimal ZS	33/11kV	2 x 19	38	19	2.00	1.86
Darkes Forest ZS	33/11kV	2 x 5	10	5	-	0.01
Helensburgh ZS	33/11kV	2 x 12.5	25	12.5	6.50	0.72
Mt Ousley ZS	33/11kV	2 x 35	70	35	5.25	1.29
Russell Vale ZS	33/11kV	2 x 25	50	25	4.00	1.7
Wombarra ZS	33/11kV	2 x 5	10	5	6.00	0.83
Bellambi TS	132/33kV	3 x 60	180	120	1.50	-

TABLE 31: BELLAMBI TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bulli ZS	0.979	10.2	11.5	9.1	9.2	9.2	9.3	9.2
Corrimal ZS	0.998	16.1	18.7	15.1	15.0	14.9	14.8	14.8
Darkes Forest ZS	0.960	0.7	0.9	0.9	0.9	0.9	0.9	0.9
Helensburgh ZS	0.985	8.5	8.8	8.9	8.8	8.8	8.8	8.8
Mount Ousley ZS	0.970	18.8	20.8	17.6	17.5	17.5	17.5	17.4
Russell Vale ZS	0.976	13.2	13.8	14.4	15.0	14.9	14.8	14.8
Wombarra ZS	0.981	3.9	4.2	4.2	4.8	4.7	4.7	4.7
Bellambi TS	0.980	78.2	80.7	75.4	76.3	76.1	76.0	75.7

TABLE 32: BELLAMBI TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bulli ZS	0.991	11.9	12.2	11.0	11.0	11.1	11.1	11.1
Corrimal ZS	0.998	17.7	18.4	18.3	18.7	18.6	18.6	18.6
Darkes Forest ZS	0.959	0.7	0.4	0.4	0.4	0.4	0.4	0.4
Helensburgh ZS	0.993	10.0	10.3	10.4	10.4	10.3	10.3	10.3
Mount Ousley ZS	0.900	18.5	18.1	19.9	20.4	21.7	21.7	21.7
Russell Vale ZS	0.990	15.1	16.3	16.3	16.2	16.2	16.2	16.1
Wombarra ZS	0.989	5.8	5.8	5.8	6.3	6.3	6.3	6.3
Bellambi TS	0.999	86.7	87.9	83.4	84.6	85.6	85.5	85.4

A.2.2 BELLAMBI TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Bellambi TS operates at 33kV.

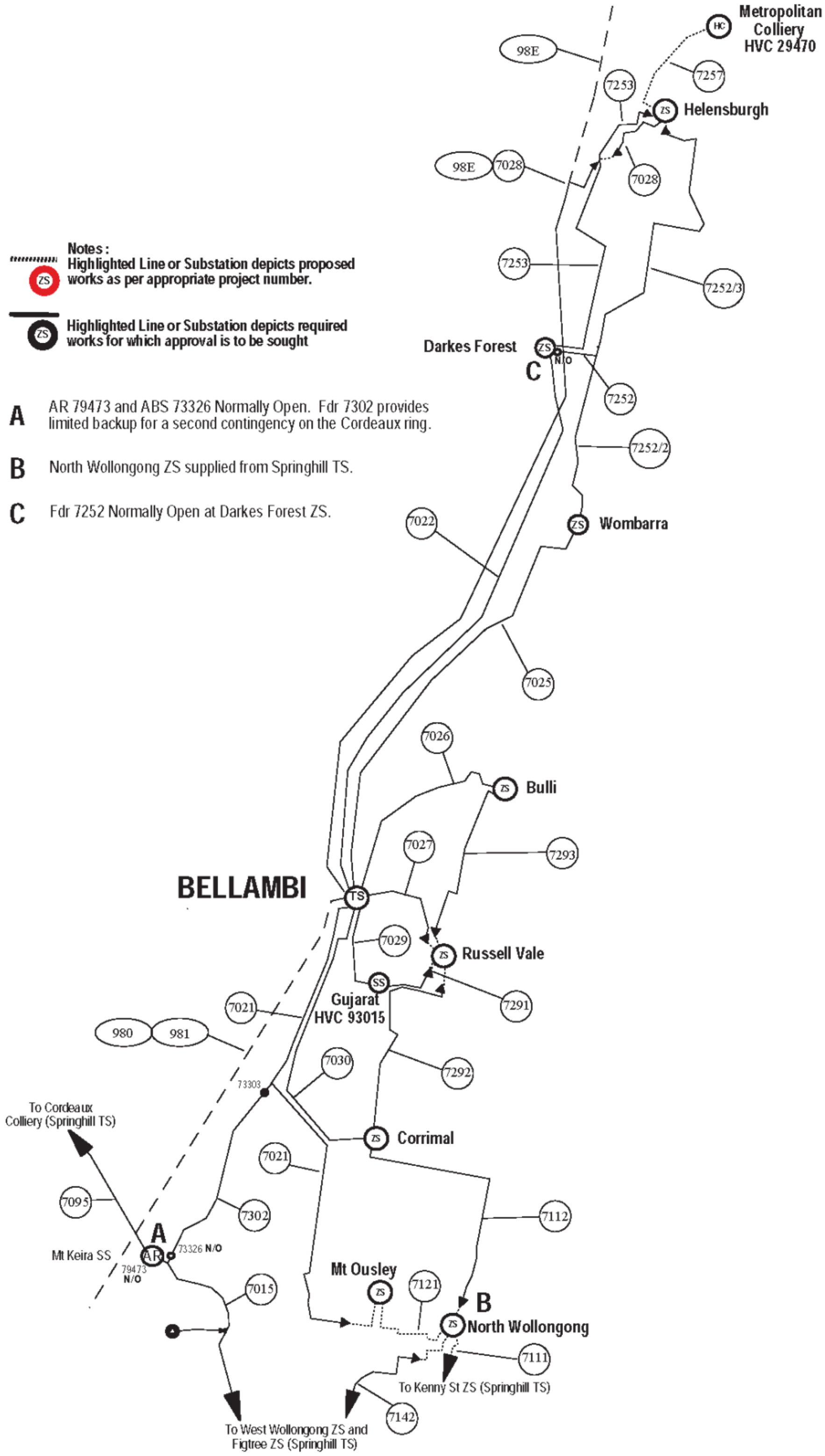
TABLE 33: BELLAMBI TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7021 - Bellambi TS to TEE	35.4	22.1	23.7	23.7	23.7	23.7
7021 - ABS 73303 to TEE	35.7	9.4	10.1	10.2	11.4	11.7
7021 - Mount Ousley ZS to TEE	35.4	22.2	23.8	23.7	23.7	23.7
7022 - Bellambi TS to Darkes Forest ZS	44.2	14.2	14.2	14.2	14.2	14.2
7025 - Bellambi TS to Wombarra ZS	44.2	14.1	14.1	14.1	14.1	14.1
7026 - Bellambi TS to Bulli ZS	19.7	15.7	15.9	15.8	15.8	15.8
7027 - Bellambi TS to Russell Vale ZS	32.0	23.4	23.8	23.7	23.7	23.7
7028 - Bellambi TS to Helensburgh ZS	44.4	13.0	13.1	13.0	13.0	13.0
7029 - Bellambi TS to South Bulli SS	32.1	22.4	22.7	22.6	22.6	22.6
7030 - Bellambi TS to Corrimal ZS	53.7	23.3	24.0	23.9	23.9	23.9
7112 - Corrimal ZS to North Wollongong ZS	50.0	22.1	23.7	23.7	23.7	23.7
7121 - Mount Ousley ZS to North Wollongong ZS	35.4	22.1	23.7	23.7	23.7	23.7
7252 - Darkes Forest ZS to ABS 25639	21.7	0.0	0.0	0.0	0.0	0.0
7252 - ABS 25639 to ABS 70660	21.7	0.0	0.0	0.0	0.0	0.0
7252 - Wombarra ZS to ABS 70660	21.7	7.7	7.7	7.7	7.7	7.7
7252 - Helensburgh ZS to ABS 70660	21.2	7.7	7.7	7.7	7.7	7.7
7253 - Darkes Forest ZS to Helensburgh ZS	21.2	13.8	13.8	13.8	13.8	13.8
7291 - South Bulli SS to Russell Vale ZS	32.0	19.9	20.2	20.1	20.1	20.1
7292 - Corrimal ZS to Russell Vale ZS	32.0	22.9	23.6	23.6	23.5	23.5
7293 - Bulli ZS to Russell Vale ZS	13.4	11.3	11.3	11.3	11.3	11.3

TABLE 34: BELLAMBI TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.2.3 BELLAMBI TS NETWORK MAP



A.3 BLACKTOWN TRANSMISSION SUBSTATION

A.3.1 BLACKTOWN TS CONNECTION POINTS

Blacktown TS has four 120 MVA 132/33kV transformers providing a firm capacity of 360MVA and is supplied from Sydney West BSP via two dual circuit steel towers lines forming 132kV feeders 93Z/93A and 9J1/9J2.

TABLE 35: BLACKTOWN TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bossley Park ZS	33/11kV	2 x 35	70	35	6.00	2.05
Greystanes ZS	33/11kV	2 x 25	50	25	4.75	1.66
Holroyd ZS	33/11kV	1 x 17.25 + 2 x 25	67.25	42.25	6.75	2.28
Leabons Lane ZS	33/11kV	2 x 25	50	25	-	1.8
Marayong ZS	33/11kV	3 x 25	75	50	9.00	1.83
Newton ZS	33/11kV	3 x 25	75	50	8.00	1.02
Prospect ZS	33/11kV	3 x 15	45	30	2.25	2.02
Quarries ZS	33/11kV	2 x 35	70	35	9.75	0.96
Blacktown TS	132/33kV	4 x 120	480	360	10.50	-

TABLE 36: BLACKTOWN TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bossley Park ZS	0.994	29.3	31.6	29.6	29.5	29.4	29.3	29.3
Greystanes ZS	0.997	23.4	24.0	17.6	17.5	17.4	17.3	17.2
Holroyd ZS	0.969	31.8	37.0	37.0	37.2	37.1	37.0	36.8
Leabons Lane ZS	0.951	21.9	22.6	18.6	22.0	21.9	21.9	21.8
Marayong ZS	0.985	39.9	40.1	40.0	39.9	39.8	39.7	39.7
Newton ZS	0.950	32.4	34.1	32.8	33.6	33.6	33.6	33.6
Prospect ZS	0.982	29.7	31.7	27.7	29.1	29.1	29.1	29.0
Quarries ZS	0.961	28.8	30.1	21.2	28.6	30.9	30.9	30.8
Blacktown TS	0.984	244.0	279.6	258.0	273.2	278.2	281.0	283.8

TABLE 37: BLACKTOWN TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bossley Park ZS	0.999	18.6	19.5	18.7	18.7	18.7	18.6	18.6
Greystanes ZS	0.996	17.5	18.2	15.9	15.9	15.8	15.8	15.7
Holroyd ZS	0.986	23.9	26.5	25.3	25.3	25.3	25.2	25.2
Leabons Lane ZS	0.970	16.6	17.7	12.8	16.5	16.5	16.4	16.4
Marayong ZS	0.998	36.0	36.3	36.2	37.5	37.4	37.4	37.3
Newton ZS	0.950	22.5	21.5	23.7	26.0	26.4	26.4	26.5
Prospect ZS	0.997	23.8	22.0	23.7	24.0	24.0	24.0	24.0
Quarries ZS	0.973	19.5	20.4	12.2	12.2	12.2	12.2	12.2
Blacktown TS	0.995	181.6	190.2	188.1	194.6	197.7	200.5	203.4

A.3.2 BLACKTOWN TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Blacktown TS operates at 33kV.

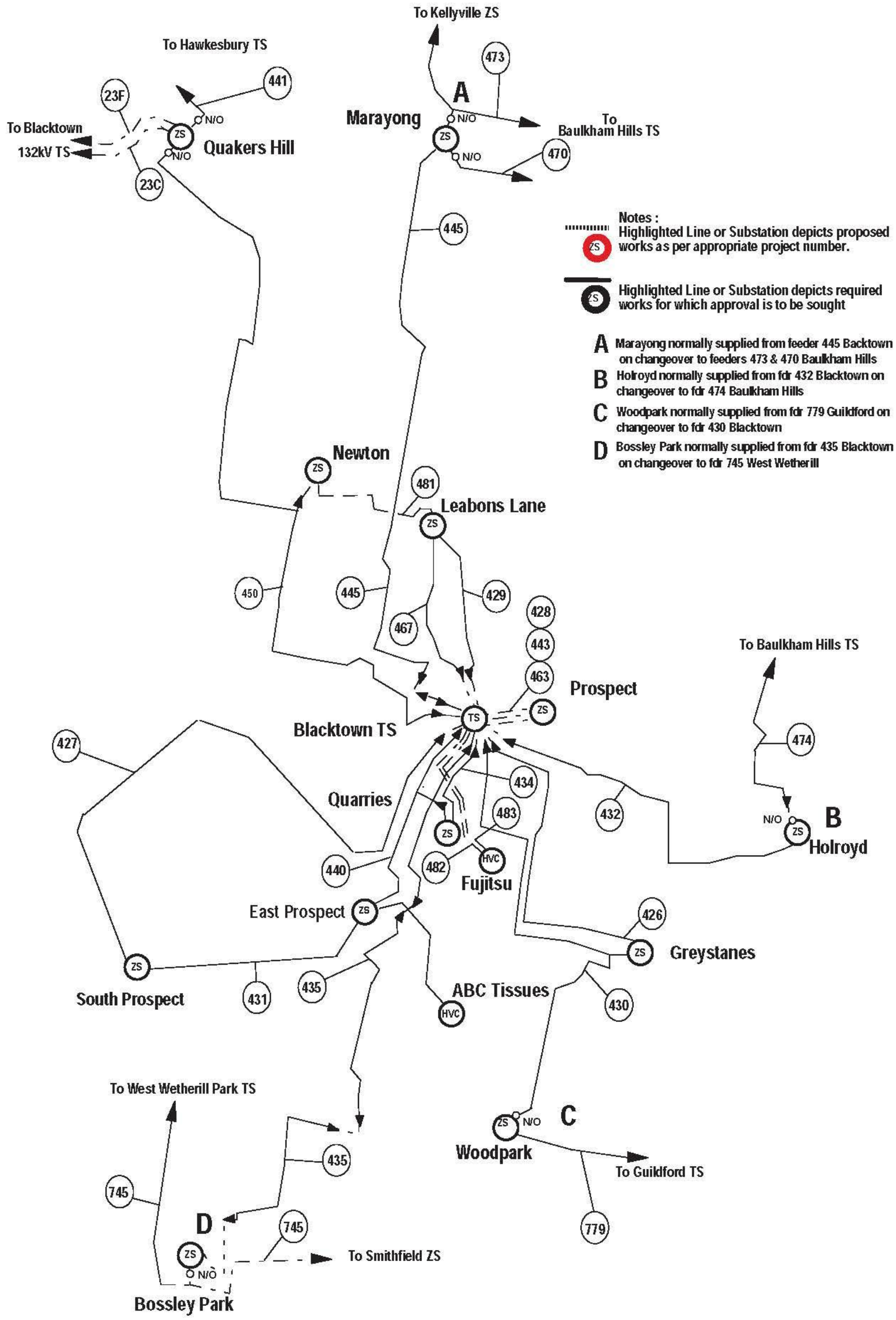
TABLE 38: BLACKTOWN TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
426 - Blacktown TS to Greystanes ZS	42.0	17.7	17.1	17.1	17.1	17.1
427 - Blacktown TS to South Prospect ZS	50.0	19.2	19.2	18.8	18.7	18.7
428 - Blacktown TS to Prospect ZS	17.0	13.0	13.3	13.4	13.5	13.5
429 - Blacktown TS to Leabons Lane ZS	42.0	35.2	37.1	37.3	37.4	37.6
430 - Blacktown TS to TEE	42.0	23.4	24.0	24.1	24.1	24.2
430 - Greystanes ZS to TEE	42.0	17.7	17.1	17.1	17.0	17.0
430 - TEE to Woodpark ZS	42.0	22.4	23.6	23.8	23.9	23.9
431 - East Prospect ZS to South Prospect ZS	30.0	14.9	14.5	14.6	14.6	14.7
432 - Blacktown TS to Holroyd ZS	42.0	39.4	38.3	38.5	38.5	38.5
433 - Blacktown TS to Prospect ZS	17.0	15.9	16.1	16.2	16.2	16.3
434 - Blacktown TS to Quarries ZS	42.0	24.6	29.1	31.3	31.4	31.4
435 - Blacktown TS to Bossley Park ZS	42.0	30.5	29.4	29.6	29.6	29.7
440 - Blacktown TS to TEE	42.0	32.9	38.8	41.3	41.3	41.4
440 - Quarries ZS to TEE	42.0	21.9	29.0	31.7	31.8	31.8
440 - East Prospect ZS to TEE	42.0	18.8	18.8	18.4	18.3	18.3
445 - Blacktown TS to Marayong ZS	45.5	43.0	41.5	41.8	41.8	41.9
450 - Blacktown TS to TEE	42.0	35.1	34.9	35.1	35.2	35.4
450 - Newton ZS to TEE	45.5	35.2	34.9	35.1	35.3	35.5
450 - TEE to TEE	42.0	0.0	0.0	0.0	0.0	0.0
450 - TEE to OPEN BOND	24.0	0.0	0.0	0.0	0.0	0.0
450 - Quakers Hill ZS to TEE	42.0	0.0	0.0	0.0	0.0	0.0
463 - Blacktown TS to Prospect ZS	17.0	16.9	16.4	16.5	16.5	16.6
467 - Blacktown TS to Leabons Lane ZS	42.0	36.2	38.1	38.3	38.4	38.6
481 - Leabons Lane ZS to Newton ZS	50.0	34.4	34.2	34.4	34.5	34.8

TABLE 39: BLACKTOWN TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.3.3 BLACKTOWN TS NETWORK MAP



A.4 CAMELLIA TRANSMISSION SUBSTATION

A.4.1 CAMELLIA TS CONNECTION POINTS

Camellia Transmission Substation is supplied at 132kV from the Holroyd Bulk Supply Point via Endeavour Energy's Guildford Transmission Substation. Camellia TS currently supplies Lennox ZS and Rosehill ZS. There is a proposal to connect Ausgrid zone substations, Auburn and Lidcombe to Camellia TS. The approximate timing is 2020 and no constraint is expected on Camellia TS within the forecast period as a result.

TABLE 40: CAMELLIA TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Lennox ZS	33/11kV	3 x 25	75	50	-	0.45
Rosehill ZS	33/11kV	3 x 25	75	30	6.75	2.71
Camellia TS	132/33 kV	3 x 120	360	240	4.25	17.3

TABLE 41: CAMELLIA TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Lennox ZS	0.961	0.972	20.3	20.8	23.0	23.1	23.1	23.3
Rosehill ZS	0.945	0.952	22.3	21.0	23.8	23.8	23.9	24.4
Camellia TS	0.961	0.952	47.5	61.9	49.1	49.2	93.2	94.4

TABLE 42: CAMELLIA TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Lennox ZS	0.996	0.996	16.8	17.3	19.4	21.2	21.2	21.3
Rosehill ZS	0.973	0.987	19.6	19.9	21.9	22.0	22.0	22.0
Camellia TS	0.996	0.978	48.8	42.3	44.6	46.5	46.5	84.1

A.4.2 CAMELLIA TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Camellia TS operates at 33kV.

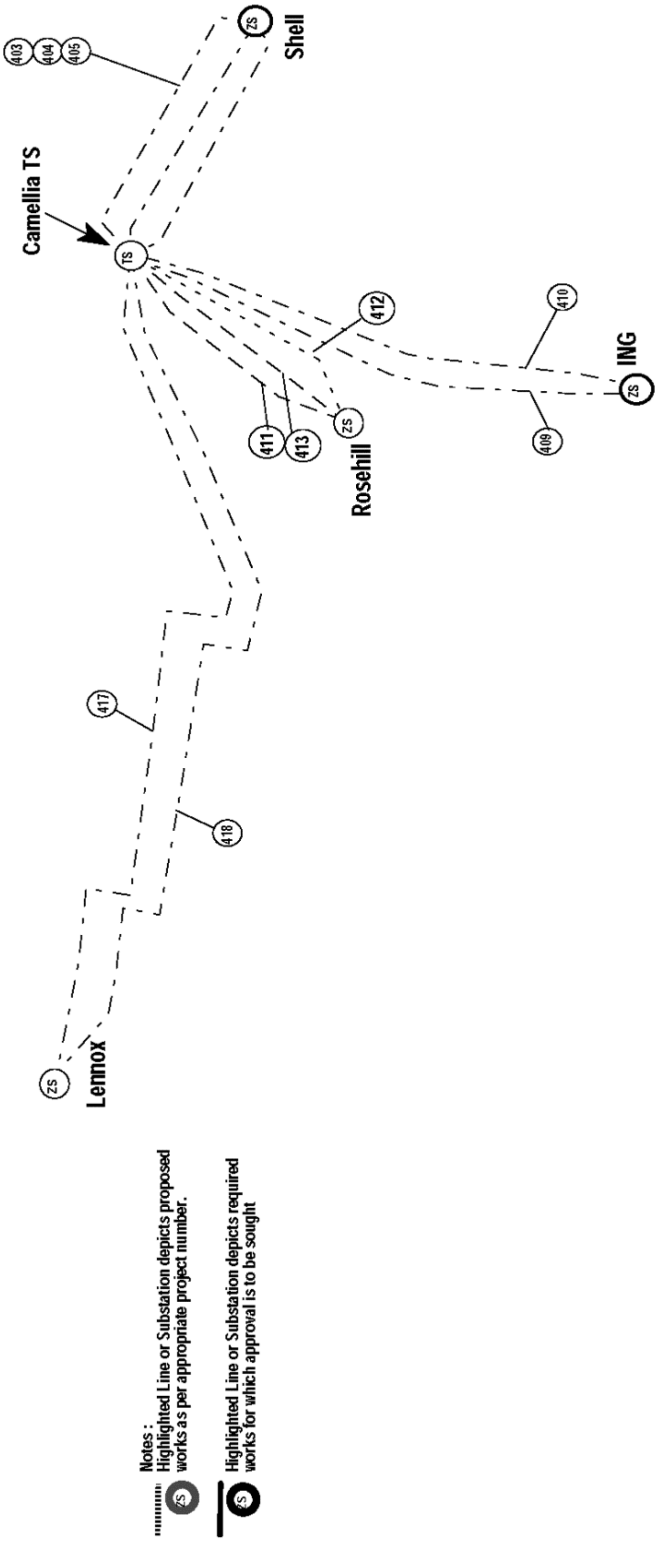
TABLE 43: CAMELLIA TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
411 - Camellia TS to Rosehill ZS	47.0	13.8	13.8	14.1	14.3	14.8
412 - Camellia TS to Rosehill ZS	46.9	10.2	10.2	10.4	10.6	10.9
413 - Camellia TS to Rosehill ZS	46.9	13.8	13.8	14.1	14.3	14.8
417 - Camellia TS to Lennox ZS	50.0	22.8	22.9	23.3	23.4	23.7
418 - Camellia TS to Lennox ZS	42.9	22.8	23.0	23.3	23.4	23.8

TABLE 44: CAMELLIA TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.4.3 CAMELLIA TS NETWORK MAP



A.5 CARLINGFORD TRANSMISSION SUBSTATION

A.5.1 CARLINGFORD TS CONNECTION POINTS

Carlingford Transmission Substation has three 120 MVA 132/66kV double-wound transformers and one 120 MVA 132/66kV auto transformer. The auto transformer was the former system spare and was installed at Carlingford following the failure of one of the original units. This unit has relatively lower impedance than the other units. This results in unequal load sharing and reduces effective capacity whenever the unit is in service.

TABLE 45: CARLINGFORD TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Castle Hill ZS	66/11kV	3 x 25	75	50	4.75	0.71
Dundas ZS	66/11kV	3 x 35	105	52.5	3.25	3.18
Rydalmere ZS	66/11kV	1 x 25 + 1 x 33 + 1 x 35	105	70	14.00	1.21
West Pennant Hills ZS	66/11kV	2 x 35	70	35	5.25	1.92
Carlingford TS	132/66kV	4 x 120	480	360	23.25	-

TABLE 46: CARLINGFORD TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Castle Hill ZS	0.959	24.8	25.6	23.6	24.0	24.6	25.3	26.0
Dundas ZS	0.973	42.2	49.0	37.7	38.8	38.6	38.4	38.2
Rydalmere ZS	0.979	38.7	40.2	35.8	35.7	35.6	35.5	35.4
West Pennant Hills ZS	0.984	24.4	27.2	20.9	20.9	20.1	20.6	21.1
Carlingford TS	0.997	226.4	231.8	194.6	200.7	201.5	203.9	206.3

TABLE 47: CARLINGFORD TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Castle Hill ZS	0.983	17.8	16.0	16.3	16.7	17.2	18.0	19.1
Dundas ZS	0.976	37.6	37.9	36.3	38.4	39.4	39.4	39.3
Rydalmere ZS	0.977	30.9	31.1	32.5	32.4	32.4	32.3	32.3
West Pennant Hills ZS	0.982	22.6	19.8	18.0	18.0	18.0	17.2	17.7
Carlingford TS	0.982	187.4	188.5	175.4	181.6	183.5	185.3	188.6

A.5.2 CARLINGFORD TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Carlingford TS operates at 66kV.

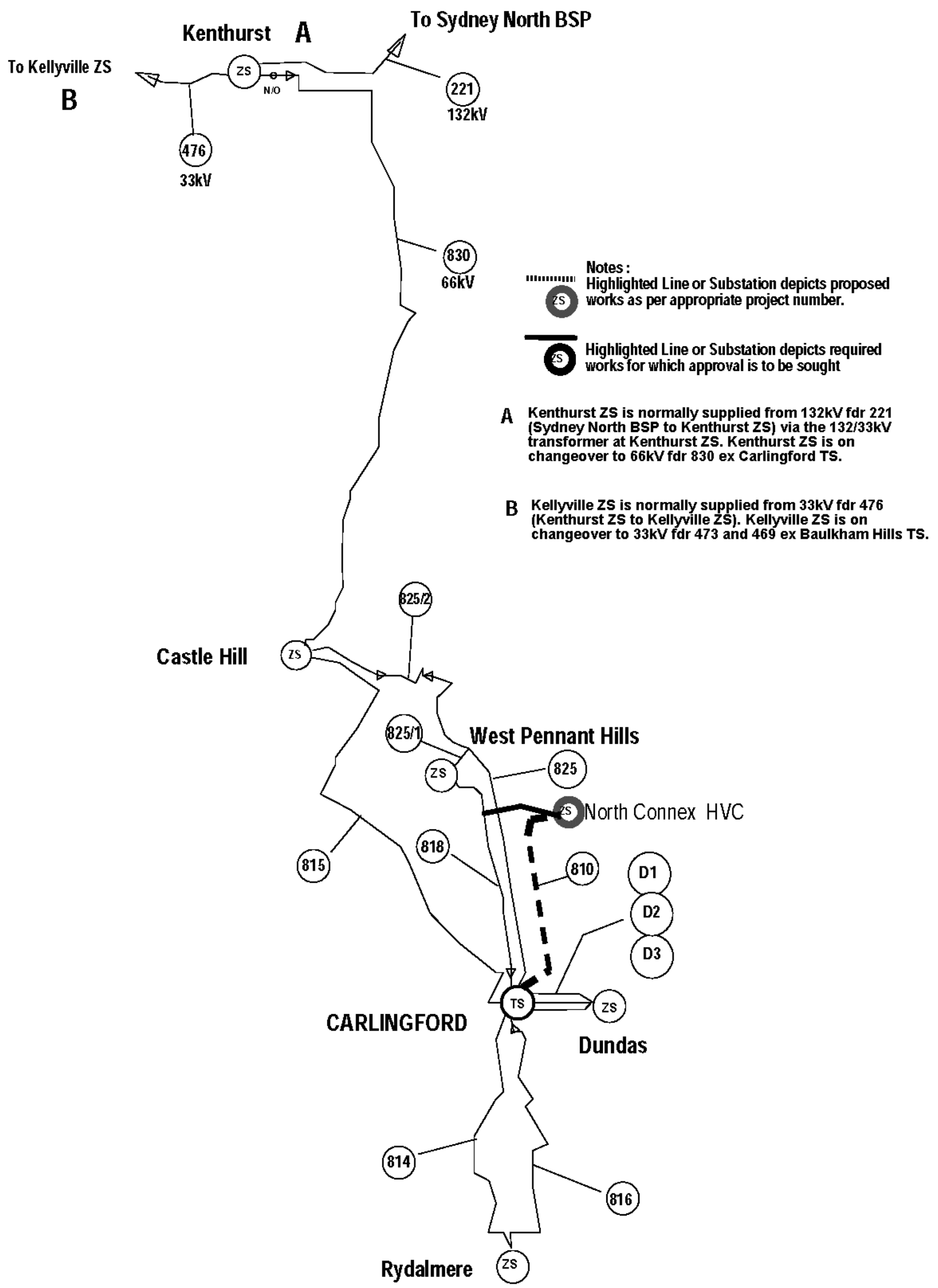
TABLE 48: CARLINGFORD TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
814 - Carlingford TS to Rydalmere ZS	67.0	36.4	35.6	35.7	35.7	35.8
815 - Carlingford TS to Castle Hill ZS	38.1	24.1	24.2	24.9	25.7	26.6
816 - Carlingford TS to Rydalmere ZS	58.0	36.3	35.6	35.7	35.7	35.8
818 - Carlingford TS to West Pennant Hills ZS	40.0	28.1	28.3	28.0	28.6	29.1
818 - Northconnex SS to TEE	40.5	29.5	29.2	29.1	30.0	31.0
825 - Carlingford TS to TEE	40.5	26.4	26.7	27.1	27.6	27.9
825 - Castle Hill ZS to TEE	86.0	21.0	20.6	19.9	20.4	21.1
825 - West Pennant Hills ZS to TEE	32.0	19.0	18.9	18.8	18.7	18.6
830 - Castle Hill ZS to Kenthurst ZS	96.0	23.6	24.2	23.8	23.7	23.6
DUNDAS1 - Carlingford TS to Dundas ZS	96.0	29.2	29.9	29.4	29.3	29.2
DUNDAS2 - Carlingford TS to Dundas ZS	96.0	15.1	15.5	15.2	15.2	15.1

TABLE 49: CARLINGFORD TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.5.3 CARLINGFORD TS NETWORK MAP



Endeavour Energy

A.6 DAPTO BULK SUPPLY POINT

A.6.1 DAPTO BSP CONNECTION POINTS

Dapto Bulk Supply Point is owned by TransGrid and has three 375 MVA 330/132kV transformers. Endeavour Energy is supplied at 132kV from Dapto BSP. Dapto BSP supplies 132kV north to Bellambi, Springhill and Outer Harbour TS's; south to Mt Terry TS, Shoalhaven TS and West Tomerong TS as well as Ulladulla ZS; and west to Burrawang Pumping Station then further west providing backup to Fairfax Lane TS. Dapto BSP also supplies 132kV to the Essential Energy network at Bateman's Bay ZS and Moruya North TS. The Essential Energy substations are supplied through the Evans Lane Switching Station which is also the connection point for Ulladulla ZS. Tallawarra SS, which is connected to Springhill TS and to Dapto BSP, connects Energy Australia's 435MW generator to the 132kV network.

TABLE 50: DAPTO BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Ulladulla ZS	132/11kV	2 x 30	60	30	3.25	3.32
West Dapto ZS (Proposed)	132/11kV	2 x 45	90	45	-	-
Yatte Yattah ZS	132/11kV	1 x 6.5	6.5	NA	1.25	0.55
Bellambi TS	132/33kV	3 x 60	180	120	1.50	-
Mount Terry TS	132/33kV	2 x 120	240	120	1.25	-
Outer Harbour TS	132/33kV	2 x 60	120	60	-	-
Shoalhaven TS	132/33kV	3 x 60	180	120	4.75	-
Springhill TS	132/33kV	3 x 120	360	240	17.50	-
West Tomerong TS	132/33kV	2 x 60	120	60	2.25	-

TABLE 51: DAPTO BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Ulladulla ZS	0.938	21.1	28.6	24.2	26.0	26.0	26.0	25.9
West Dapto ZS (Proposed)	-	-	-	-	-	-	2.7	3.2
Yatte Yattah ZS	-	3.2	-	-	-	-	-	-
Bellambi TS	0.950	0.980	78.2	80.7	75.4	76.3	76.1	76.0
Mount Terry TS	0.948	0.948	103.4	110.4	104.5	110.2	112.2	112.6
Outer Harbour TS	0.972	0.982	24.5	23.7	31.0	31.0	31.0	31.0
Shoalhaven TS	0.982	0.986	89.3	92.9	91.7	97.9	97.8	97.9
Springhill TS	0.969	0.964	172.8	179.8	164.7	170.0	170.6	179.8
West Tomerong TS	0.978	0.977	40.2	50.4	39.7	39.7	39.9	39.8
Dapto BSP	0.997	0.981	651.7	679.5	620.3	636.8	638.8	648.8

TABLE 52: DAPTO BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Ulladulla ZS	0.938	25.9	26.3	23.5	23.6	23.7	23.8	23.8
West Dapto ZS (Proposed)	-	-	-	-	-	-	-	2.3
Yatte Yattah ZS	-	3.9	4.1	-	-	-	-	-
Bellambi TS	0.985	0.999	86.7	87.9	83.4	84.6	85.6	85.5
Mount Terry TS	0.948	0.948	94.1	97.0	98.7	100.2	101.8	103.5
Outer Harbour TS	0.980	0.970	28.8	33.2	28.1	28.1	28.1	28.1
Shoalhaven TS	0.985	0.995	82.8	77.3	76.4	79.9	85.1	85.0
Springhill TS	0.972	0.972	155.7	157.3	160.1	164.6	165.3	164.2
West Tomerong TS	0.992	0.991	43.0	46.7	50.0	51.0	51.5	51.5
Dapto BSP	0.998	0.994	651.8	688.9	709.7	721.5	730.4	730.8

A.6.2 DAPTO BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Dapto BSP operates at 132kV.

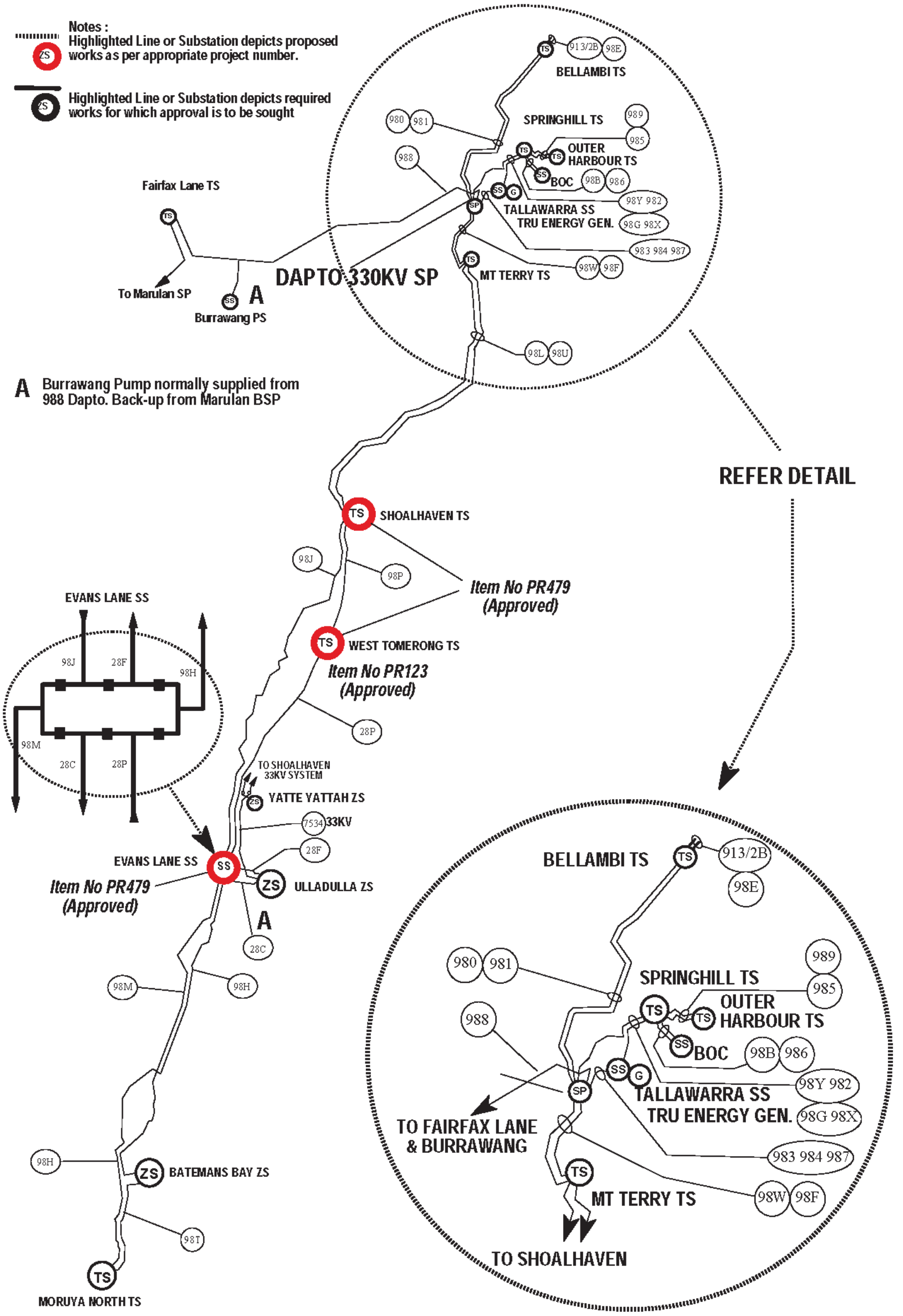
TABLE 53: DAPTO BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
28C - Evans Lane SS to Ulladulla ZS	96.0	30.1	32.3	32.3	32.3	32.2
28F - Evans Lane SS to Ulladulla ZS	96.0	30.3	32.5	32.5	32.5	32.4
28P - West Tomerong TS to Evans Lane SS	214.0	80.3	82.3	82.3	82.4	82.3
980 - Bellambi TS to Dapto BSP	163.0	82.6	82.6	82.5	82.4	82.3
981 - Bellambi TS to Dapto BSP	163.0	82.6	82.6	82.5	82.4	82.3
982 - Dapto BSP to Springhill TS	343.9	119.3	121.4	121.6	123.8	123.4
983 - Dapto BSP to Tallawarra SS	342.9	119.6	118.0	118.0	118.0	118.0
984 - Dapto BSP to Tallawarra SS	343.9	113.1	111.6	111.6	111.6	111.6
985 - Outer Harbour TS to Springhill TS	164.6	30.7	30.8	30.8	30.8	30.8
987 - Dapto BSP to Tallawarra SS	342.9	0.0	0.0	0.0	0.0	0.0
989 - Outer Harbour TS to Springhill TS	164.6	30.2	30.3	30.3	30.4	30.4
98F - Dapto BSP to Mount Terry TS	354.0	301.7	317.3	319.6	320.5	321.0
98G - Springhill TS to Tallawarra SS	342.9	201.2	203.6	203.8	207.9	208.6
98H - Evans Lane SS to Moruya North ZS	182.0	50.3	50.8	50.9	50.9	51.0
98J - Shoalhaven TS to Evans Lane SS	214.0	124.3	123.6	124.0	124.0	123.8
98L - Mount Terry TS to Shoalhaven TS	260.6	214.1	225.1	225.5	221.2	221.4
98M - Evans Lane SS to Batemans Bay ZS	86.9	53.0	53.6	53.7	53.8	53.8
98P - Shoalhaven TS to West Tomerong TS	214.0	121.9	121.4	121.4	121.3	121.2
98U - Mount Terry TS to Shoalhaven TS	260.6	214.1	225.2	225.6	221.3	221.5
98W - Dapto BSP to Mount Terry TS	354.0	301.9	317.4	319.7	320.6	321.2
98X - Springhill TS to Tallawarra SS	342.9	180.1	183.3	183.5	186.4	186.5
98Y - Dapto BSP to Springhill TS	343.9	145.3	147.3	147.7	152.3	153.0

TABLE 54: DAPTO BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.6.3 DAPTO BSP NETWORK MAP



A.7 FAIRFAX LANE TRANSMISSION SUBSTATION

A.7.1 FAIRFAX LANE TS CONNECTION POINTS

Fairfax Lane Transmission Substation has three 60MVA 132/33kV transformers providing a firm capacity of 120MVA. The substation is supplied via 132kV feeder 98C from Marulan BSP with an alternative supply from Dapto BSP via feeder 988. Feeder 98C is rated at 168/190 MVA summer/winter with 988 rated at 133/146 MVA summer/winter. The capacity of each of these 132kV feeders is adequate to meet the needs of the area within the forecast period.

TABLE 55: FAIRFAX LANE TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Berrima Junction ZS	33/11kV	1 x 20	20	NA	-	-
Bowral ZS	33/11kV	2 x 10 + 1 x 12.5	32.5	20	11.25	1.74
Mittagong ZS	33/11kV	2 x 12.5 + 1 x 15	40	25	12.75	2.07
Moss Vale ZS	33/11kV	2 x 25	50	25	14.00	1.57
Ringwood ZS	33/11kV	2 x 12.5	25	12.5	1.25	1.06
Robertson ZS	33/11kV	2 x 3.75	7.5	3.75	-	0.60
Fairfax Lane TS	132/33kV	3 x 60	180	120	15.75	-

TABLE 56: FAIRFAX LANE TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Berrima Junction ZS	0.950	1.7	1.3	1.3	1.3	1.3	1.3	1.3
Bowral ZS	0.964	15.7	18.2	14.2	14.1	14.0	14.0	13.9
Mittagong ZS	0.980	14.6	19.1	15.0	14.9	14.8	14.8	14.7
Moss Vale ZS	0.942	16.1	17.7	14.7	14.6	14.5	14.5	14.4
Ringwood ZS	0.975	5.5	5.7	4.5	4.5	4.5	4.4	4.4
Robertson ZS	0.950	3.5	3.9	3.9	3.9	3.8	3.8	3.8
Fairfax Lane TS	0.977	76.2	71.9	73.5	73.3	73.0	72.8	72.6

TABLE 57: FAIRFAX LANE TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Berrima Junction ZS	0.950	1.1	1.6	1.6	2.3	2.3	2.3	2.3
Bowral ZS	0.985	17.5	17.1	17.1	17.0	17.0	17.0	17.0
Mittagong ZS	0.992	16.3	19.5	19.8	19.8	19.8	19.7	19.7
Moss Vale ZS	0.961	19.0	18.2	18.5	18.5	18.4	18.4	18.4
Ringwood ZS	0.986	6.4	6.6	6.3	6.3	6.3	6.3	6.3
Robertson ZS	0.950	4.9	4.9	4.9	4.9	4.9	4.9	4.9
Fairfax Lane TS	0.973	89.3	85.6	86.7	87.2	87.1	87.0	86.9

A.7.2 FAIRFAX LANE TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Fairfax Lane TS is at 33kV.

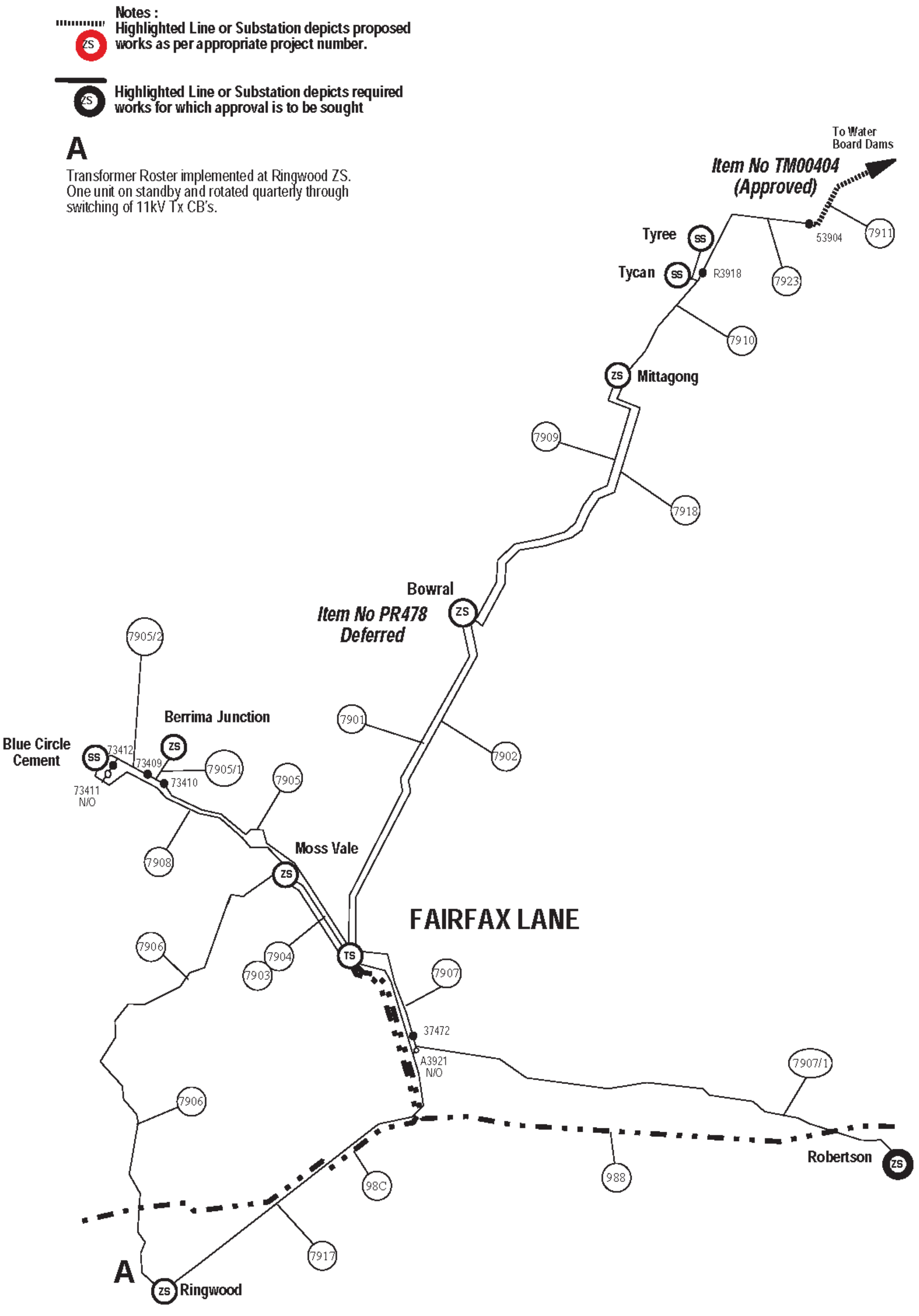
TABLE 58: FAIRFAX LANE TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7901 - Fairfax Lane TS to Bowral ZS	42.4	41.4	41.3	41.2	41.1	41.1
7902 - Fairfax Lane TS to Bowral ZS	42.4	41.4	41.3	41.2	41.1	41.1
7903 - Fairfax Lane TS to Moss Vale ZS	35.2	28.2	28.2	28.2	28.1	28.1
7904 - Fairfax Lane TS to Moss Vale ZS	32.5	28.3	28.2	28.2	28.1	28.1
7906 - Moss Vale ZS to Ringwood ZS	13.4	6.2	6.2	6.2	6.2	6.2
7907 - Fairfax Lane TS to ABS 37472	32.0	4.9	4.9	4.9	4.9	4.8
7907 - Robertson ZS to ABS A3921	27.0	4.9	4.9	4.9	4.9	4.9
7909 - Bowral ZS to Mittagong ZS	29.2	23.0	23.0	22.9	22.9	22.9
7917 - Fairfax Lane TS to ABS A3921	32.0	6.2	6.2	6.2	6.1	6.1
7917 - Ringwood ZS to ABS A3921	17.7	6.2	6.2	6.2	6.1	6.1
7918 - Bowral ZS to Mittagong ZS	43.0	23.0	23.0	22.9	22.9	22.9

TABLE 59: FAIRFAX LANE TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Robertson ZS firm rating exceeded. The load is 31% above the firm rating for a single transformer (3.75 MVA)	W2017	The non-firm rating for Robertson ZS is 7.5 MVA. The situation will continue to be monitored and options to be investigated in the future	Continue to Monitor
The load on Bowral ZS is approaching its firm rating. Each 10 MVA transformer is approaching full load for outage of the other 10 MVA transformer due to impedance mismatch with the 12.5 MVA transformer. As a result, effective firm capacity is approximately 19 MVA and not 20 MVA.	W2026	A project for the augmentation of the transformers was deferred due to the installation of capacitors in previous years.	Continue to Monitor

A.7.3 FAIRFAX LANE TS NETWORK MAP



Endeavour Energy

A.8 GUILDFORD TRANSMISSION SUBSTATION

A.8.1 GUILDFORD TS CONNECTION POINTS

Guildford Transmission Substation is supplied at 132kV from Holroyd Bulk Supply Point by feeders 93F and 93L and also from Sydney West BSP by feeders 93M (via West Wetherill Park) and 93J (via Granville and Camellia) with two normally open bus-sections between the two supply sources. Guildford TS bus supplies 132kV to the Parramatta CBD network.

TABLE 60: GUILDFORD TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Cabramatta ZS	33/11kV	2 x 25	50	25	4.00	1.27
Carramar ZS	33/11kV	2 x 25	50	25	12.25	1.00
Fairfield ZS	33/11kV	3 x 25	75	50	13.75	1.26
Sherwood ZS	33/11kV	2 x 25	50	25	10.25	1.32
Smithfield ZS	33/11kV	3 x 25	75	50	7.50	3.52
South Granville ZS	33/11kV	2 x 25	50	25	6.25	1.05
Woodpark ZS	33/11kV	2 x 25	50	25	31.25	0.24
Yennora ZS	33/11kV	2 x 25	50	25	8.25	1.56
Guildford TS	132/33kV	3 x 120	360	240	2.00	213.70

TABLE 61: GUILDFORD TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Cabramatta ZS	0.977	18.2	19.9	17.5	17.4	17.4	17.3	17.3
Carramar ZS	0.984	16.9	16.4	15.9	15.9	15.8	15.8	15.7
Fairfield ZS	0.997	25.7	26.8	33.0	36.2	36.1	36.1	36.1
Guildford (Ausgrid)	0.998	27.2	30.4	26.5	26.3	26.6	26.5	26.4
Sherwood ZS	0.997	36.6	39.3	32.8	32.7	32.5	32.3	32.2
Smithfield ZS	0.956	19.6	19.6	17.1	17.0	17.0	16.9	16.9
South Granville ZS	0.971	21.4	22.6	21.9	23.4	23.3	23.3	23.3
Woodpark ZS	0.991	20.6	20.6	19.7	19.8	19.8	19.7	19.7
Yennora ZS	0.964	218.9	211.0	202.9	206.8	206.7	206.4	206.0
Guildford TS	0.977	18.2	19.9	17.5	17.4	17.4	17.3	17.3

TABLE 62: GUILDFORD TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Cabramatta ZS	0.991	14.4	15.8	13.8	13.8	13.7	13.7	13.7
Carramar ZS	0.995	13.0	14.1	13.5	13.5	13.5	13.5	13.5
Fairfield ZS	0.995	25.4	20.7	26.0	27.3	27.3	27.3	27.3
Guildford (Ausgrid)	0.978	21.2	21.5	20.2	20.1	20.1	20.0	20.0
Sherwood ZS	0.997	27.2	28.9	25.6	25.5	25.4	25.4	25.3
Smithfield ZS	0.977	13.7	13.0	12.3	12.3	12.3	12.2	12.2
South Granville ZS	0.978	20.7	19.3	20.8	20.8	20.8	20.8	20.8
Woodpark ZS	0.987	16.2	16.2	16.3	16.8	16.8	16.7	16.7
Yennora ZS	0.983	180.0	177.0	170.1	171.6	171.5	171.6	171.8
Guildford TS	0.991	14.4	15.8	13.8	13.8	13.7	13.7	13.7

A.8.2 GUILDFORD TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Guildford TS operates at 33kV.

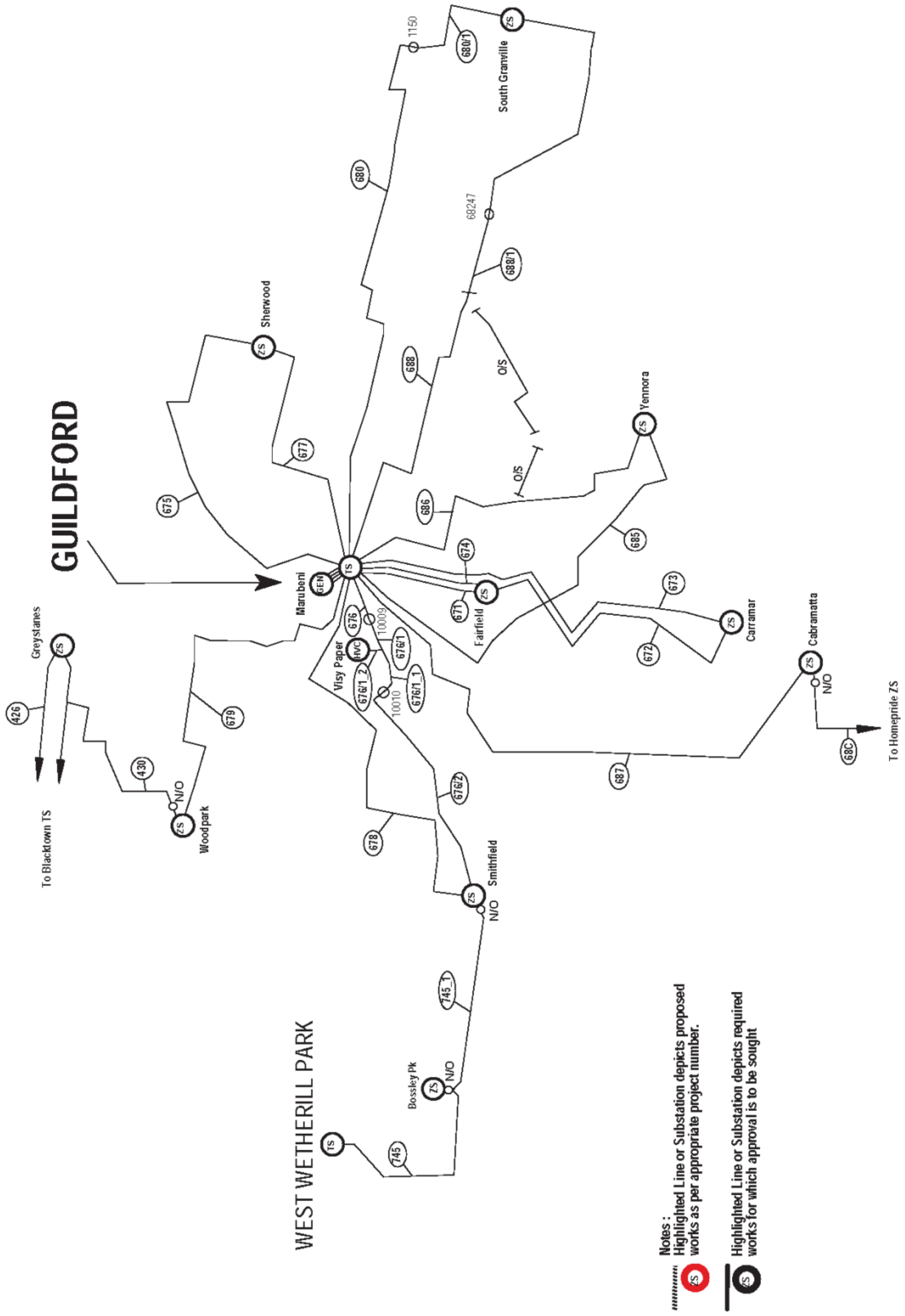
TABLE 63: GUILDFORD TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
671 - Guildford TS to Fairfield ZS	58.0	39.8	42.9	42.5	41.8	41.8
672 - Carramar ZS to Fairfield ZS	28.0	16.6	16.4	16.5	16.1	16.1
673 - Guildford TS to Carramar ZS	28.0	17.1	17.8	17.9	17.6	17.6
674 - Guildford TS to Fairfield ZS	55.0	33.6	35.6	35.8	35.2	35.2
675 - Guildford TS to Sherwood ZS	42.0	27.5	27.0	27.6	27.0	26.9
677 - Guildford TS to Sherwood ZS	32.0	27.4	26.9	27.5	26.9	26.8
678 - Guildford TS to Smithfield ZS	34.0	18.9	18.9	18.6	18.2	18.2
679 - Guildford TS to Woodpark ZS	42.0	22.9	24.6	24.4	24.0	24.0
680 - Guildford TS to ABS 1150	24.0	18.1	17.8	17.9	17.5	17.5
680 - South Granville ZS to ABS 1150	24.0	18.1	17.8	17.9	17.5	17.5
685 - Guildford TS to Yennora ZS	24.0	20.6	20.5	20.6	20.3	20.2
686 - Guildford TS to Yennora ZS	42.0	20.4	20.6	20.4	20.0	20.0
687 - Guildford TS to Cabramatta ZS	42.0	32.3	32.2	32.7	33.1	33.5
688 - Guildford TS to ABS 1153	42.0	17.9	17.6	17.7	17.4	17.4
688 - South Granville ZS to ABS 1153	24.0	17.9	17.7	17.7	17.4	17.4
688 - Guildford TS to ABS 1153	24.0	17.9	17.6	17.7	17.4	17.4
745 - West Wetherill Park TS to ABS 52347	55.0	29.7	29.2	29.1	29.1	29.1
745 - ABS 52347 to TEE	55.0	29.7	29.2	29.1	29.1	29.1
745 - Bossley Park ZS to TEE	45.5	29.7	29.2	29.1	29.1	29.1
745 - Smithfield ZS to TEE	45.5	22.3	21.8	21.8	21.7	21.6

TABLE 64: GUILDFORD TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.8.3 GUILDFORD TS NETWORK MAP



A.9 HAWKESBURY TRANSMISSION SUBSTATION

A.9.1 HAWKESBURY TS CONNECTION POINTS

Hawkesbury Transmission Substation is supplied at 132kV from Vineyard Bulk Supply Point by feeders 227 and 234. Hawkesbury TS has three 120 MVA 132/33kV transformers and presently supplies Cattai, Glossodia, Glenorie, Kurrajong, North Richmond, East Richmond, Riverstone, South Windsor, Windsor and Wisemans zone substations. It also supplies the Sydney Trains substation at Clarendon.

TABLE 65: HAWKESBURY TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Cattai ZS	33/11kV	1 x 15 + 1 x 25	40	15	3.75	0.73
East Richmond ZS	33/11kV	2 x 35	70	35	6.75	1.02
Glossodia ZS	33/11kV	2 x 25	50	25	1.75	1.13
Glenorie ZS	33/11kV	1 x 15	15	NA	9.00	0.34
Kurrajong ZS	33/11kV	2 x 15	30	15	7.25	1.2
North Richmond ZS	33/11kV	2 x 25	50	25	2.00	0.84
Riverstone ZS	33/11kV	2 x 25	50	25	11.75	0.69
South Windsor ZS	33/11kV	3 x 25	75	50	5.00	1.87
Windsor ZS	33/11kV	2 x 35	70	35	15.75	0.97
Wisemans ZS	33/11kV	1 x 12.5	12.5	NA	8.00	0.26
Hawkesbury TS	132/33kV	3 x 120	360	240	10.50	-

TABLE 66: HAWKESBURY TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Cattai ZS	0.926	11.9	14.2	12.9	12.8	12.7	12.7	12.6
East Richmond ZS	0.983	28.1	29.5	25.8	25.8	25.7	25.6	25.5
Glossodia ZS	0.941	17.7	21.3	16.8	17.0	16.8	16.7	16.6
Glenorie ZS	0.959	6.0	7.1	7.1	7.0	7.0	6.9	6.9
Kurrajong ZS	0.944	13.2	15.2	10.8	10.8	10.7	10.6	10.5
North Richmond ZS	0.952	13.7	16.6	15.5	16.8	17.0	17.0	16.9
Riverstone ZS	0.995	15.8	21.2	13.0	18.4	20.2	24.8	25.4
South Windsor ZS	0.966	36.5	36.1	34.9	36.2	37.7	37.6	37.5
Windsor ZS	0.949	21.9	23.4	25.8	26.3	26.3	26.2	26.2
Wisemans Ferry ZS	0.946	5.8	6.4	6.4	6.4	6.4	6.3	6.3
Hawkesbury TS	0.977	170.3	181.0	157.4	165.5	168.2	171.9	171.9

TABLE 67: HAWKESBURY TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Cattai ZS	0.972	9.0	8.7	9.1	9.3	9.3	9.3	9.3
East Richmond ZS	0.991	20.2	19.1	18.9	18.9	18.9	18.8	18.8
Glossodia ZS	0.979	12.7	11.7	11.6	11.8	11.8	11.8	11.8
Glenorie ZS	0.987	5.0	5.0	4.8	4.7	4.7	4.7	4.7
Kurrajong ZS	0.977	10.5	10.6	10.3	10.2	10.2	10.2	10.1
North Richmond ZS	0.984	11.1	11.0	11.1	11.5	11.5	11.5	11.4
Riverstone ZS	0.996	15.5	13.6	11.3	14.2	15.2	16.4	17.8
South Windsor ZS	0.993	26.9	27.2	28.3	28.8	29.5	31.8	31.7
Windsor ZS	0.977	13.3	13.1	13.7	14.6	14.6	14.6	14.5
Wisemans Ferry ZS	0.969	5.1	5.1	5.5	5.5	5.5	5.4	5.4
Hawkesbury TS	0.983	144.5	122.9	123.7	128.5	130.1	133.2	134.4

A.9.2 HAWKESBURY TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Hawkesbury TS operates at 33kV.

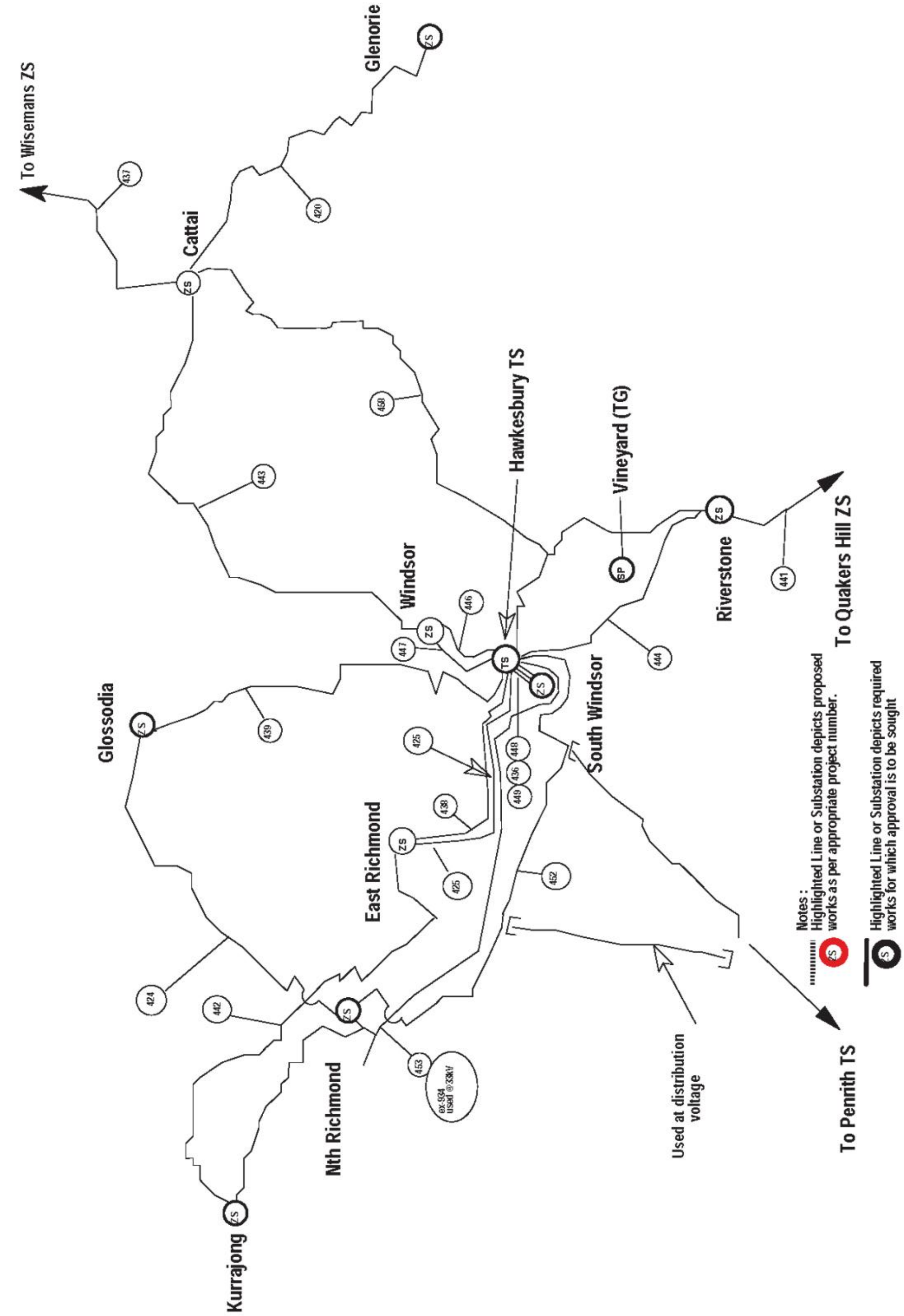
TABLE 68: HAWKESBURY TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
424 - Glossodia ZS to North Richmond ZS	26.0	19.8	20.2	19.7	19.4	19.4
425 - Hawkesbury TS to East Richmond ZS	27.4	31.9	32.2	31.8	31.5	31.8
436 - Hawkesbury TS to South Windsor ZS	30.9	19.1	19.9	21.2	21.1	20.6
437 - Cattai ZS to Wisemans ZS	19.0	7.4	7.4	7.2	7.2	7.2
438 - Hawkesbury TS to East Richmond ZS	27.4	30.9	31.3	30.8	30.5	30.9
439 - Hawkesbury TS to Glossodia ZS	26.0	19.6	20.4	20.2	19.9	20.1
441 - Quakers Hill ZS to Riverstone ZS	16.0	7.4	9.6	10.6	13.2	13.6
442 - East Richmond ZS to Kurrajong ZS	21.0	13.1	13.7	13.5	13.3	13.3
443 - Windsor ZS to Cattai ZS	28.9	29.7	29.6	29.1	28.7	28.9
444 - Hawkesbury TS to Riverstone ZS	42.0	13.9	18.3	19.9	24.5	25.4
446 - Hawkesbury TS to Windsor ZS	42.0	38.1	38.8	38.3	38.1	38.6
447 - Hawkesbury TS to Windsor ZS	42.0	38.0	38.6	38.1	37.9	38.5
448 - Hawkesbury TS to South Windsor ZS	30.9	16.5	17.2	17.4	17.2	18.0
449 - Hawkesbury TS to South Windsor ZS	30.9	20.4	21.2	22.6	22.5	22.1
452 - Hawkesbury TS to North Richmond ZS	21.3	16.1	16.8	16.6	16.4	16.4
453 - Hawkesbury TS to TEE	21.0	18.1	18.9	18.6	18.4	18.4
453 - North Richmond ZS to TEE	42.0	20.0	21.2	21.0	20.7	20.8
453 - Kurrajong ZS to TEE	21.0	11.4	11.5	11.2	11.1	11.2
458 - Hawkesbury TS to TEE	46.4	28.5	30.2	30.3	31.4	32.1
458 - Cattai ZS to ABS 39588	36.0	29.4	29.4	28.8	28.5	28.9
458 - Riverstone ZS to TEE	19.0	7.0	9.2	10.0	12.6	12.9
458 - ABS 39588 to TEE	36.0	29.4	29.3	28.8	28.4	28.8

TABLE 69: HAWKESBURY TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
The firm rating of Riverstone ZS will be exceeded by S2022.	S2022	Investiagte options including non-network options. New release areas creating an increase in demand.	Long term plan is establishing a new zone substation in the area which will take some load of Riverstone ZS and its feeders.
On outage of Feeder 444 (Hawkesbury TS to Riverstone ZS) will cause Feeder 441 (Riverstone ZS to Quakers Hill ZS) to exceeds its raing.	S2024	Investiagte options including non-network options. New release areas creating an increase in demand.	Long term plan is establishing a new zone substation in the area which will take some load of Riverstone ZS and its feeders.
On outage of feeder 444 (Hawkesbury TS to Riverstone ZS), load on feeder 458 (Hawkesbury TS tee to CattaiZS)will exceed its rating.	S2027	Investiagte options including non-network options. New release areas creating an increase in demand.	Long term plan is establishing a new zone substation in the area which will take some load of Riverstone ZS and its feeders.

A.9.3 HAWKESBURY TS NETWORK MAP



A.10 HOLROYD BULK SUPPLY POINT

A.10.1 HOLROYD BSP CONNECTION POINTS

Holroyd Bulk Supply Point is owned by Transgrid and has two tail ended 375 MVA 330/132kV transformers providing a firm capacity of 375MVA to Endeavour Energy. Endeavour Energy is supplied at 132kV to Guildford TS by Endeavour Energy feeders 93F and 93L. Holroyd Bulk Supply Point supplies Guildford TS, Camellia TS, Granville ZS, North Parramatta ZS, West Parramatta ZS and East Parramatta SS. Guildford TS operates on a split dual busbar arrangement normally supplied on feeders 93F/93L on one busbar from Holroyd BSP. Sydney West BSP backs up supply to Guildford TS via feeders 93J/93T.

TABLE 70: HOLROYD BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Granville ZS	132/11kV	2 x 45	90	45	8.50	1.25
North Parramatta ZS	132/11kV	2 x 55	110	55	8.00	0.84
West Parramatta ZS	132/11kV	3 x 45	135	90	30.50	0.25
Camellia TS	132/33kV	3 x 120	360	240	4.25	-
Guildford TS	132/33kV	3 x 120	360	240	2.00	-

TABLE 71: HOLROYD BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Granville ZS	0.981	29.3	28.4	26.6	29.0	32.4	33.0	33.4
North Parramatta ZS	0.999	31.1	32.6	30.5	32.4	35.3	35.6	36.0
West Parramatta ZS	0.970	51.2	53.1	53.6	56.0	72.3	72.7	73.8
Camellia TS	0.952	47.5	61.9	49.1	49.2	93.2	94.4	96.1
Guildford TS	0.964	218.9	211.0	202.9	206.8	206.7	206.4	206.0
Holroyd BSP	1.000	407.7	362.7	360.0	370.7	436.2	438.3	441.5

TABLE 72: HOLROYD BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Granville ZS	0.977	22.7	20.7	21.6	23.2	25.1	27.2	27.7
North Parramatta ZS	0.998	27.0	26.3	27.1	28.6	28.6	28.7	29.0
West Parramatta ZS	0.960	33.2	37.0	45.3	47.5	49.9	50.7	51.8
Camellia TS	0.978	48.8	42.3	44.6	46.5	46.5	84.1	85.0
Guildford TS	0.983	180.0	177.0	170.1	171.6	171.5	171.6	171.8
Holroyd BSP	0.965	308.3	365.7	295.7	304.1	307.9	346.8	349.6

A.10.2 HOLROYD BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Holroyd BSP operates at 132kV.

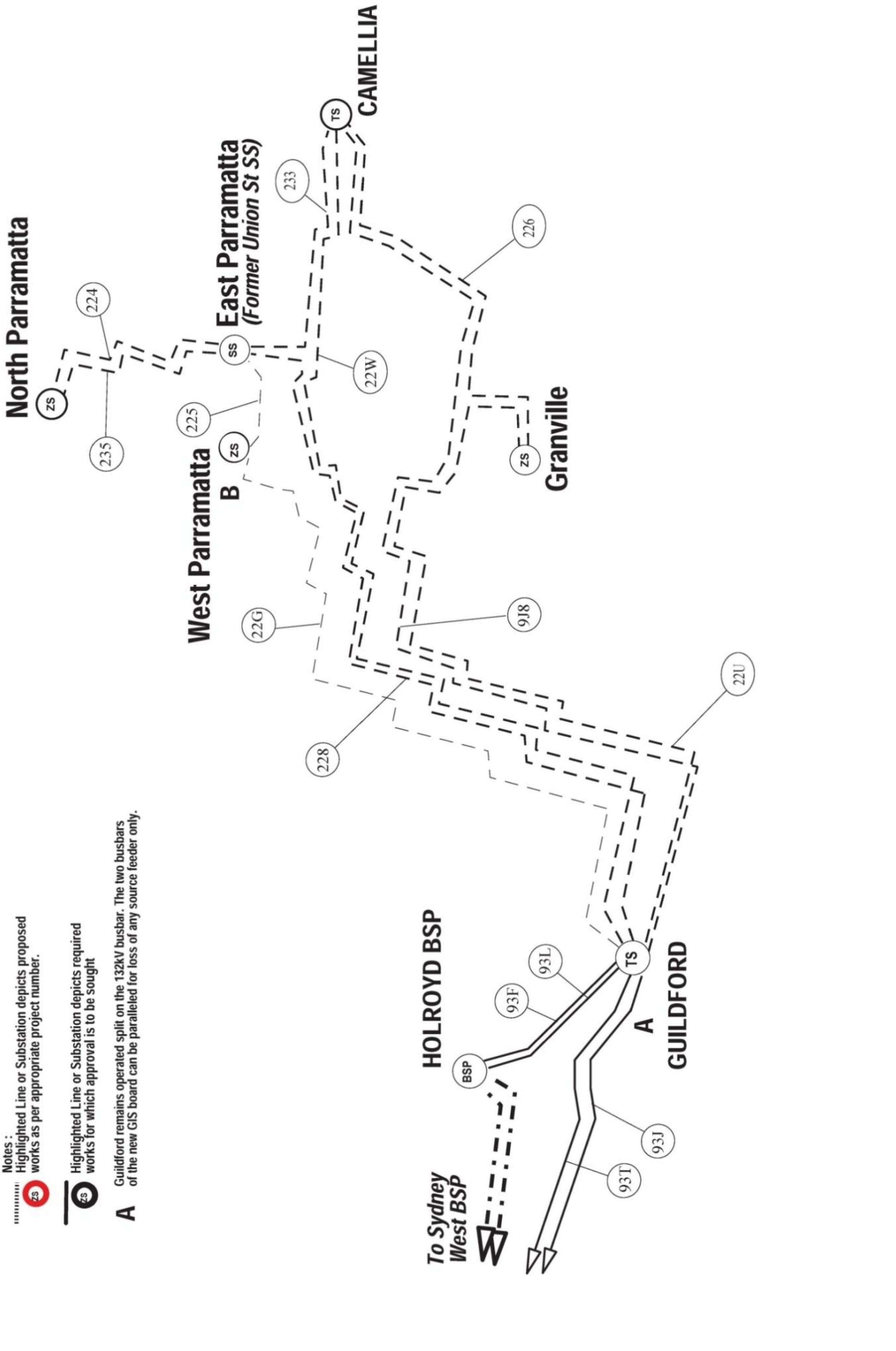
TABLE 73: HOLROYD BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
224 - East Parramatta SS to North Parramatta ZS	80.0	31.8	33.6	37.0	37.3	37.8
225 - East Parramatta SS to West Parramatta ZS	172.0	59.1	61.4	81.9	82.5	84.1
226 - Camellia TS to Granville ZS	117.1	27.4	29.7	33.5	34.2	34.6
228 - Guildford TS to East Parramatta SS	110.9	51.6	53.6	73.2	73.9	75.2
22G - Guildford TS to West Parramatta ZS	251.0	58.9	61.2	81.6	82.2	83.8
22U - Guildford TS to Granville ZS	117.1	41.1	42.7	61.3	62.2	63.2
22W - Camellia TS to Guildford TS	110.9	39.4	40.4	57.6	58.3	59.3
233 - Camellia TS to East Parramatta SS	110.9	35.8	37.8	41.5	41.6	42.3
235 - East Parramatta SS to North Parramatta ZS	80.0	31.9	33.8	37.1	37.4	37.9
93F - Holroyd BSP to Guildford TS	505.0	355.6	368.6	437.7	440.8	444.8
93L - Holroyd BSP to Guildford TS	505.0	356.7	365.9	440.7	443.7	448.6
9J8 - Camellia TS to Guildford TS	117.1	41.5	42.5	59.7	60.4	61.5

TABLE 74: HOLROYD BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Outage of either 132kV Feeder 93L/93F will result in the corresponding Holroyd BSP 375 MVA transformer being overloaded.	S2023	Investigate load transfers to Sydney West	Engage Joint Planning with Transgrid

A.10.3 HOLROYD BSP NETWORK MAP



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A.11 ILFORD TRANSMISSION SUBSTATION

A.11.1 ILFORD TS CONNECTION POINTS

Ilford Transmission Substation (TS) is supplied at 132kV from Mt Piper TS by a single feeder 94M and a single 60MVA 132/66kV transformer. The backup supply is provided through the 66kV network from Mt Piper TS.

TABLE 75: ILFORD TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bylong ZS	66/11kV	2 x 1.5	3	1.5	8.00	0.01
Ilford Hall ZS	66/11kV	1 x 2.5	2.5	NA	0.75	0.06
Kandos ZS	66/11kV	2 x 5	10	5	4.50	0.51
Ilford TS	132/66kV	1 x 60	60	NA	4.75	-

TABLE 76: ILFORD TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bylong ZS	0.973	0.3	0.4	0.4	0.4	0.4	0.4	0.4
Ilford Hall ZS	0.880	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Kandos ZS	0.900	3.4	4.3	4.4	4.4	4.4	4.4	4.3
Ilford TS	0.970	4.5	5.3	4.9	15.6	15.6	15.6	22.3

TABLE 77: ILFORD TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bylong ZS	0.991	0.4	0.3	0.3	1.0	1.0	1.0	1.0
Ilford Hall ZS	0.918	0.5	0.5	0.5	0.5	0.5	0.5	0.4
Kandos ZS	0.914	4.6	4.2	4.6	4.7	4.6	4.6	4.6
Ilford TS	0.970	5.6	6.2	5.0	5.9	16.6	16.6	23.3

A.11.2 ILFORD TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Ilford TS operates at 66kV.

TABLE 78: ILFORD TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
839 - Bylong ZS to Kandos ZS	114.0	12.6	20.4	20.4	20.4	20.4
841 - Ilford TS to Kandos ZS	60.0	17.1	24.9	24.9	24.9	24.9

TABLE 79: ILFORD TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

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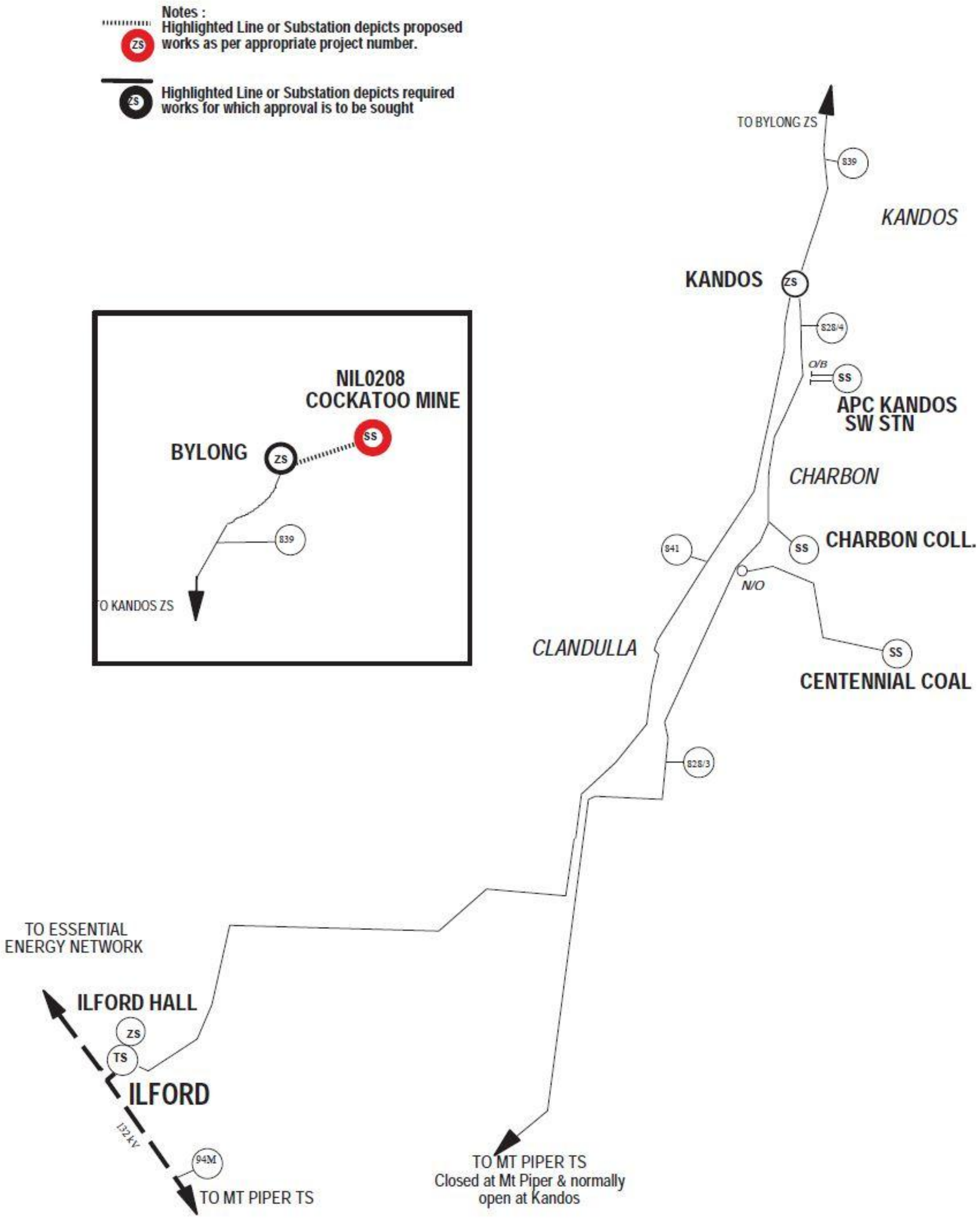
A.11.3 ILFORD TS NETWORK MAP



A.12 INGLEBURN BULK SUPPLY POINT

A.12.1 INGLEBURN BSP CONNECTION POINTS

Ingleburn BSP is owned by TransGrid and has two 250 MVA 330/66kV transformers. There is sufficient capacity at this substation to supply its existing catchment for the medium to long term.

TABLE 80: INGLEBURN BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bow Bowing ZS	66/11kV	3 x 35	105	70	3.75	1.68
Macquarie Fields ZS	66/11kV	2 x 33	66	33	3.75	2.92
Minto ZS	66/11kV	2 x 33 +1 x 35	101	66	5.00	5.97

TABLE 81: INGLEBURN BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bow Bowing ZS	0.990	44.8	46.7	51.5	51.4	51.3	51.2	51.1
Macquarie Fields ZS	0.989	26.6	28.3	23.8	23.8	23.9	23.9	23.9
Minto ZS	0.982	64.0	68.4	59.1	59.1	59.2	59.4	59.6
Ingleburn BSP	0.974	136.3	170.5	134.9	134.9	134.9	135.0	135.0

TABLE 82: INGLEBURN BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bow Bowing ZS	0.996	38.3	41.6	46.4	46.4	46.3	46.3	46.2
Macquarie Fields ZS	0.997	22.3	22.9	21.0	21.2	21.3	21.4	21.4
Minto ZS	0.993	53.9	52.0	49.7	49.7	49.8	49.9	50.2
Ingleburn BSP	0.994	114.6	129.5	117.3	117.4	117.6	117.7	118.0

A.12.2 INGLEBURN BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Ingleburn BSP operates at 66kV.

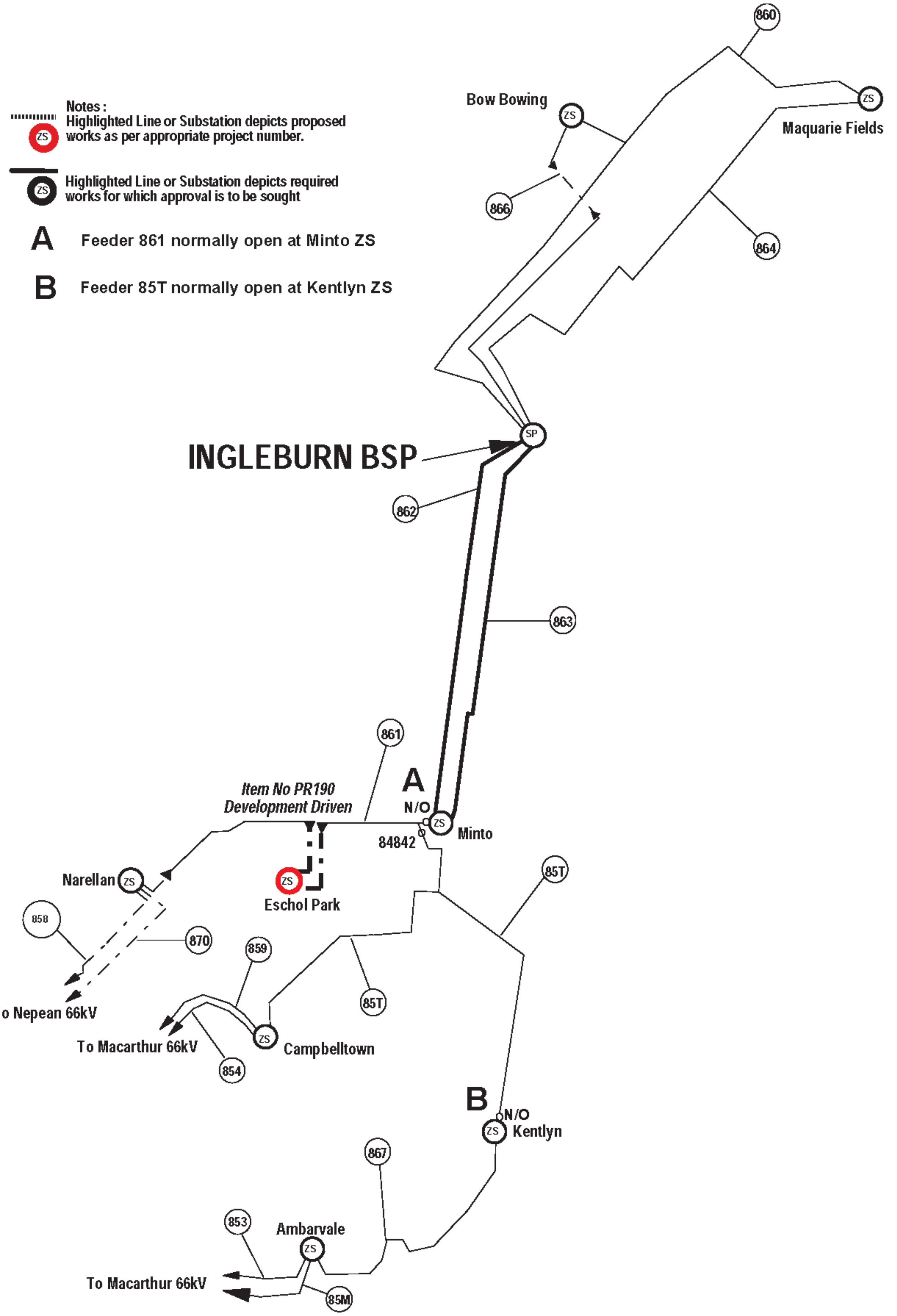
TABLE 83: INGLEBURN BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
860 - Ingleburn BSP to TEE	64.0	64.0	63.9	63.8	63.7	63.6
860 - Macquarie Fields ZS to TEE	64.0	25.2	25.3	25.3	25.4	25.4
860 - Bow Bowing ZS to TEE	64.0	53.3	53.2	53.1	52.9	52.8
862 - Ingleburn BSP to Minto ZS	64.0	64.2	64.2	64.3	64.5	64.8
863 - Ingleburn BSP to Minto ZS	64.0	64.2	64.2	64.3	64.5	64.8
864 - Ingleburn BSP to Macquarie Fields ZS	64.0	25.2	25.3	25.3	25.3	25.3
866 - Ingleburn BSP to Bow Bowing ZS	64.0	53.3	53.1	53.0	52.9	52.8

TABLE 84: INGLEBURN BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Outage of feeder 866 (Ingleburn BSP-to Bow Bowing ZS) will cause feeder 860 to exceed its firm rating.	Existing	Feeder 860 is to be opened at Macquarie Fields when the feeder is supplying Bow Bowing without support from feeder 866.	Utilise transfer capacity and continue to monitor
Potential greenfield development at Eschol Park cannot be supported from the existing Minto ZS network. This load growth is not included in the demand forecasts as timing is uncertain.	Existing	A non-network option will be investigated when the residential development becomes firm. The network options is the establishment of Eschol Park ZS (project PR190.	Continue to monitor and investigate non-network options when necessary.
Outage of either 862 or 863 BSP-Minto, will cause the respective feeders to exceed their line ratings.	S2018	Probabilistic planning analysis will need to be conducted. The load on the feeders requires monitoring and is affected by the residential development at Eschol Park.	Continue to monitor and investigate non-network options when necessary.

A.12.3 INGLEBURN BSP NETWORK MAP



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A.13 KATOOMBA NORTH TRANSMISSION SUBSTATION

A.13.1 KATOOMBA NORTH TS CONNECTION POINTS

Katoomba North Transmission Substation is supplied at 132kV from Wallerawang Bulk Supply Point by feeders 940 and 941. Both feeders are teed off and tail ended to the two 60MVA 132/66kV transformers at Katoomba North TS.

TABLE 85: KATOOMBA NORTH TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Blackheath ZS	66/11kV	2 x 7	14	7	9.00	1.04
Katoomba ZS	66/11kV	2 x 25	50	25	7.75	1.86
Wentworth Falls ZS	66/11kV	1 x 10	10	NA	1.00	1.12
Katoomba North TS	132/66kV	2 x 60	120	60	2.00	-

TABLE 86: KATOOMBA NORTH TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Blackheath ZS	0.984	5.1	4.4	4.3	4.3	4.3	4.3	4.3
Katoomba ZS	0.975	14.3	13.9	13.7	13.7	13.6	13.6	13.6
Wentworth Falls ZS	0.992	4.9	4.8	4.7	4.7	4.7	4.6	4.6
Katoomba North TS	0.975	21.2	23.3	20.5	20.4	20.3	20.3	20.2

TABLE 87: KATOOMBA NORTH TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Blackheath ZS	0.990	7.0	7.2	7.2	7.2	7.1	7.1	7.1
Katoomba ZS	0.985	18.6	20.7	20.8	20.8	20.7	20.7	20.7
Wentworth Falls ZS	0.994	6.7	6.8	6.8	6.8	6.7	6.7	6.7
Katoomba North TS	0.972	32.1	32.9	31.2	31.1	31.1	31.0	31.0

A.13.2 KATOOMBA NORTH TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Katoomba North TS operates at 66kV.

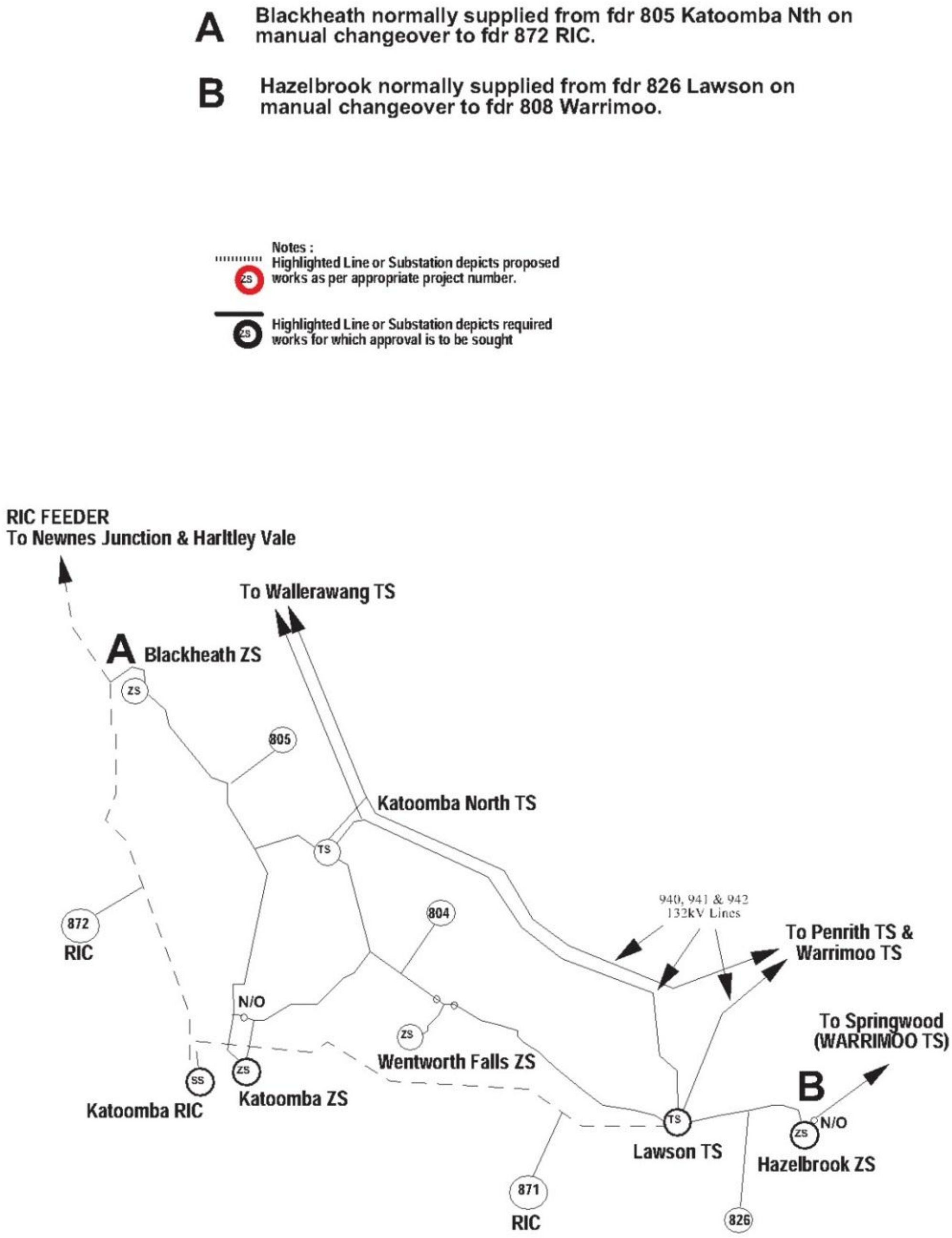
TABLE 88: KATOOMBA NORTH TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
805 - Katoomba North TS to TEE	109.3	28.5	28.5	28.4	28.4	28.4
805 - Blackheath ZS to TEE	22.0	7.2	7.2	7.1	7.1	7.1
805 - ABS 14024 to TEE	22.0	21.4	21.4	21.4	21.4	21.4
805 - Katoomba ZS to ABS 14024	22.0	21.4	21.4	21.4	21.4	21.4

TABLE 89: KATOOMBA NORTH TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.13.3 KATOOMBA NORTH TS NETWORK MAP



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A.14 LAWSON TRANSMISSION SUBSTATION

A.14.1 LAWSON TS CONNECTION POINTS

Lawson Transmission Substation is supplied at 132kV by Feeder 941 from Wallerawang BSP with the alternate supply being Feeder 942 from Penrith TS. Lawson TS provides limited backup supply to Katoomba North TS at 66kV.

TABLE 90: LAWSON TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Hazelbrook ZS	66/11kV	2 x 25	50	25	3.25	1.92
Lawson TS	132/66kV	2 x 52	104	52	2.75	-

TABLE 91: LAWSON TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Hazelbrook ZS	0.993	8.6	8.7	8.7	8.7	8.6	8.6	8.5
Lawson TS	0.985	19.1	27.3	23.1	23.0	23.0	22.9	22.9

TABLE 92: LAWSON TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Hazelbrook ZS	0.987	9.8	9.6	9.6	9.6	9.6	9.5	9.5
Lawson TS	0.985	21.1	23.8	25.0	25.0	25.0	25.0	25.0

A.14.2 LAWSON TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Lawson TS operates at 66kV.

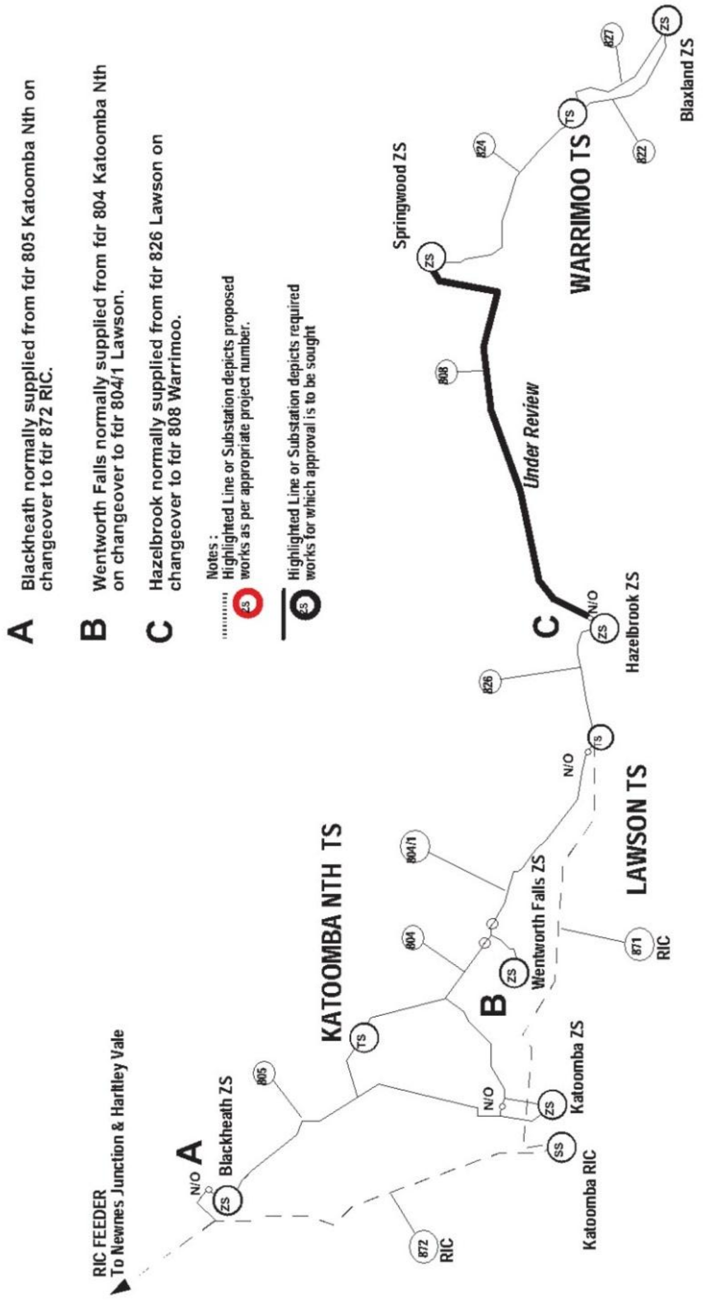
TABLE 93: LAWSON TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
804 - Katoomba North TS to TEE	109.1	27.8	27.8	27.8	27.7	27.7
804 - Lawson TS to ABS T034	22.0	0.0	0.0	0.0	0.0	0.0
804 - ABS T034 to TEE	22.0	0.2	0.2	0.2	0.2	0.2
804 - Wentworth Falls ZS to TEE	52.0	6.7	6.7	6.7	6.7	6.7
804 - ABS T035 to TEE	22.0	6.7	6.7	6.7	6.7	6.6
804 - ABS 14023 to TEE	22.0	21.3	21.3	21.3	21.2	21.2
804 - Katoomba ZS to ABS 14023	22.0	21.3	21.3	21.3	21.2	21.2
808 - Hazelbrook ZS to Springwood ZS	21.7	23.8	23.6	23.4	23.2	23.0
824 - Warrimoo TS to Springwood ZS	44.8	32.2	32.1	32.0	31.9	31.8
826 - Lawson TS to Hazelbrook ZS	49.7	32.2	32.1	32.0	31.9	31.8

TABLE 94: LAWSON TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Thermal capacity of standby feeder 808 is exceeded during outage of Feeder 824.	S 2017/18	A project to augment Feeder 808 is deferred. This is due to the summer demand reduction at Springwood ZS. The level of network risk is minimal within the forecast period, considering the availability of 11kV emergency transfer capability.	Continue to Monitor

A.14.3 LAWSON TS NETWORK MAP



A.15 LIVERPOOL TRANSMISSION SUBSTATION

A.15.1 LIVERPOOL TS CONNECTION POINTS

Liverpool TS has three 120MVA 132/33kV transformers providing a firm capacity of 240MVA. Liverpool TS is supplied by two 132kV feeders, 23L and 93G from the West Liverpool TS busbar. Mutual backup is provided between West Liverpool TS and Liverpool TS via two 33kV feeders 504 and 508. These feeders provide an alternative supply in the event of an outage of 132kV feeder 93G (the more robust of the two 132kV feeders to Liverpool TS) when the station load exceeds 170MVA or during the outage of one transformer at West Liverpool TS.

TABLE 95: LIVERPOOL TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Anzac Village ZS	33/11kV	3 x 25	75	50	7.00	2.34
Canley Vale ZS	33/11kV	3 x 25	75	50	7.25	3.11
Casula ZS	33/11kV	2 x 35	70	35	5.75	2.77
Chipping Norton ZS	33/11kV	2 x 35	70	35	7.00	1.51
Liverpool ZS	33/11kV	3 x 35	105	70	6.75	4.90
Moorebank ZS	33/11kV	3 x 35	105	70	13.50	0.97
Liverpool TS	132/33 kV	3 x 120	360	240	4.25	-

TABLE 96: LIVERPOOL TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Anzac Village ZS	0.961	25.1	27.3	21.7	21.9	22.6	24.0	25.6
Canley Vale ZS	0.998	28.0	32.9	25.4	25.3	25.1	25.0	24.9
Casula ZS	0.970	30.2	33.1	33.2	33.3	33.4	33.7	34.0
Chipping Norton ZS	0.966	19.9	21.2	23.7	25.7	25.8	25.7	25.7
Liverpool ZS	0.977	37.5	38.0	37.1	38.1	39.2	40.5	41.9
Moorebank ZS	0.964	27.5	30.5	32.1	32.1	32.1	32.1	32.0
Liverpool TS	0.989	169.5	177.6	159.8	162.9	165.1	168.3	171.9

TABLE 97: LIVERPOOL TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Anzac Village ZS	0.988	20.5	17.0	15.8	16.0	16.3	17.0	18.2
Canley Vale ZS	1.000	25.2	26.5	23.6	23.5	23.5	23.4	23.4
Casula ZS	0.997	20.5	21.0	18.9	19.1	19.1	19.3	19.6
Chipping Norton ZS	0.954	14.2	14.3	15.1	15.2	15.2	15.2	15.2
Liverpool ZS	0.997	28.8	30.2	27.1	28.6	28.9	29.4	29.9
Moorebank ZS	0.984	23.4	24.9	25.2	25.3	25.3	25.3	25.3
Liverpool TS	0.983	131.7	136.2	124.6	126.7	127.8	129.7	132.3

A.15.2 LIVERPOOL TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Liverpool TS operates at 33kV.

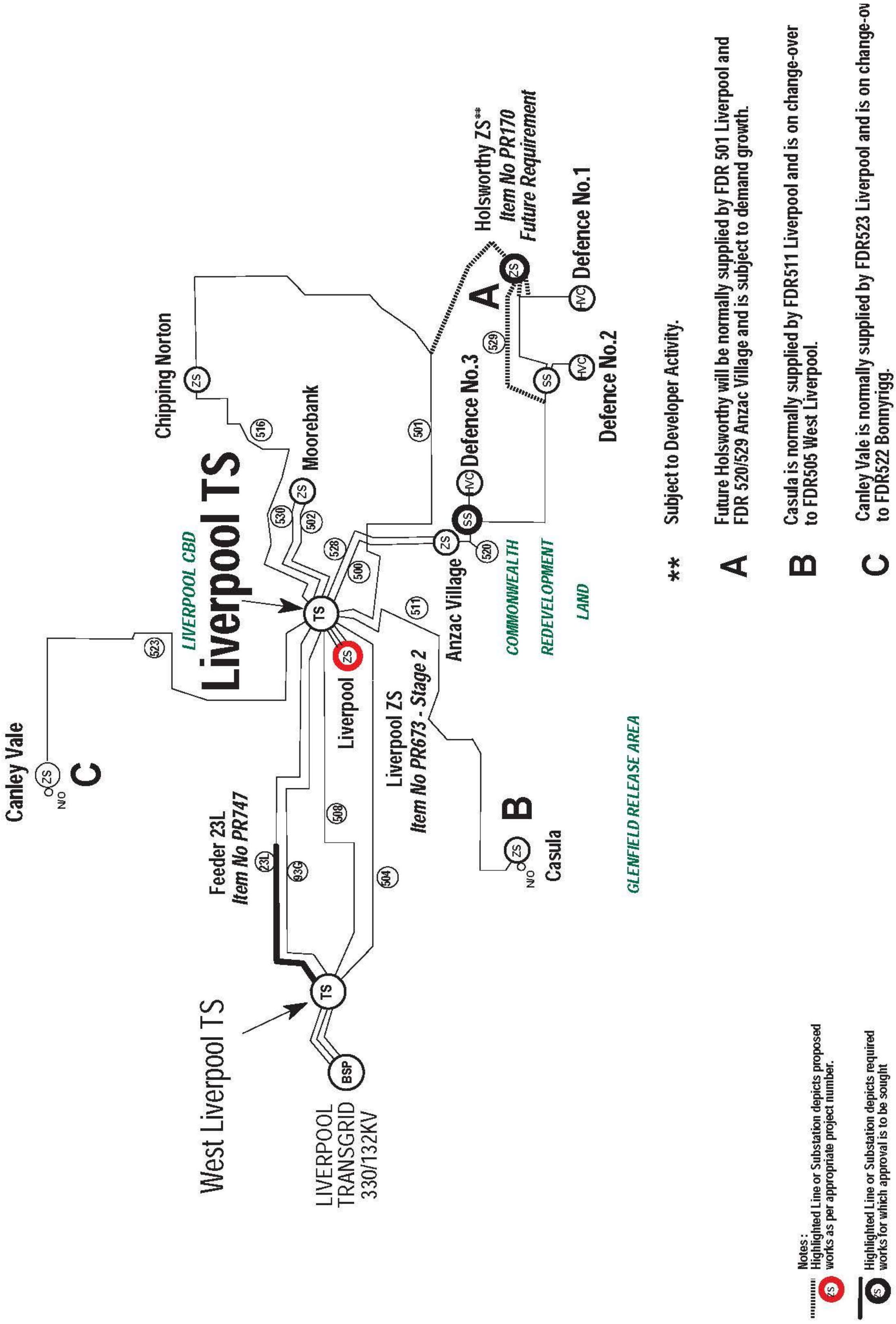
TABLE 98: LIVERPOOL TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
23L - Liverpool TS to West Liverpool TS	229.8	160.4	163.9	166.4	168.0	172.0
500 - Liverpool TS to Anzac Village ZS	52.0	30.8	31.7	33.3	35.4	37.8
501 - Liverpool TS to Chipping Norton ZS	36.2	24.7	27.0	27.2	26.9	26.6
502 - Liverpool TS to Moorebank ZS	46.4	32.5	32.7	32.8	32.5	32.2
505 - West Liverpool TS to TEE	42.0	35.8	35.6	35.8	35.7	36.1
505 - Prestons ZS to TEE	68.0	31.3	32.0	32.1	31.1	31.1
505 - Casula ZS to TEE	42.0	34.4	34.1	34.4	34.4	35.0
511 - Liverpool TS to Casula ZS	36.0	34.3	34.6	34.8	34.8	34.9
516 - Liverpool TS to Chipping Norton ZS	38.1	24.2	26.4	26.6	26.3	26.0
522 - Bonnyrigg ZS to Canley Vale ZS	34.0	26.2	26.2	25.7	25.4	25.4
523 - Liverpool TS to Canley Vale ZS	42.0	25.4	25.4	25.3	24.9	24.6
528 - Liverpool TS to Anzac Village ZS	52.0	30.8	31.7	33.3	35.4	37.8
530 - Liverpool TS to Moorebank ZS	46.4	32.5	32.7	32.8	32.5	32.2
93G - Liverpool TS to West Liverpool TS	250.0	160.5	163.8	166.3	168.0	172.0
T4 - Liverpool TS to Liverpool 11kV	50.0	25.2	26.0	26.9	27.5	28.3
T5 - Liverpool TS to Liverpool 11kV	50.0	25.1	26.0	26.9	27.6	28.3
T6 - Liverpool TS to Liverpool 11kV	50.0	12.3	12.7	13.2	13.5	13.8

TABLE 99: LIVERPOOL TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.15.3 LIVERPOOL TS NETWORK MAP



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A.16 LIVERPOOL BULK SUPPLY POINT

A.16.1 LIVERPOOL BSP CONNECTION POINTS

Liverpool Bulk Supply Point is owned by TransGrid and has three tail-ended 375 MVA 330/132kV transformers providing a firm capacity of 750 MVA. Endeavour Energy is supplied at 132kV from Liverpool BSP by feeders 93B, 93N and 93R. Liverpool TS (located near Liverpool CBD) is then supplied from the West Liverpool 132kV busbar by feeders 23L and 93G.

TABLE 100: LIVERPOOL BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Abbotsbury ZS	132/11kV	2 x 45	90	45	5.25	3.69
Denham Court TS	132/33kV	1 x 60	60	NA	7.75	-
Liverpool TS	132/33kV	3 x 120	360	240	4.25	-
West Liverpool TS	132/33kV	3 x 120	360	240	6.50	-

TABLE 101: LIVERPOOL BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Abbotsbury ZS	0.900	38.9	42.7	45.2	45.0	44.7	44.5	44.3
Denham Court TS	0.610	10.1	12.4	15.2	8.5	8.5	8.5	8.5
Liverpool TS	0.989	169.5	177.6	159.8	162.9	165.1	168.3	171.9
West Liverpool TS	0.985	192.4	194.0	199.8	209.9	217.4	226.0	234.9
Liverpool BSP	0.987	409.3	491.7	401.0	409.6	418.9	430.2	442.2

TABLE 102: LIVERPOOL BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Abbotsbury ZS	0.900	22.2	24.3	23.6	23.6	23.5	23.4	23.4
Denham Court TS	0.804	7.0	14.9	15.4	16.6	11.9	11.9	11.9
Liverpool TS	0.983	131.7	136.2	124.6	126.7	127.8	129.7	132.3
West Liverpool TS	0.989	147.7	143.2	139.7	145.5	151.6	156.0	158.4
Liverpool BSP	0.991	295.9	316.4	278.4	286.6	289.8	295.6	300.2

A.16.2 LIVERPOOL BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Liverpool BSP operates at 132kV.

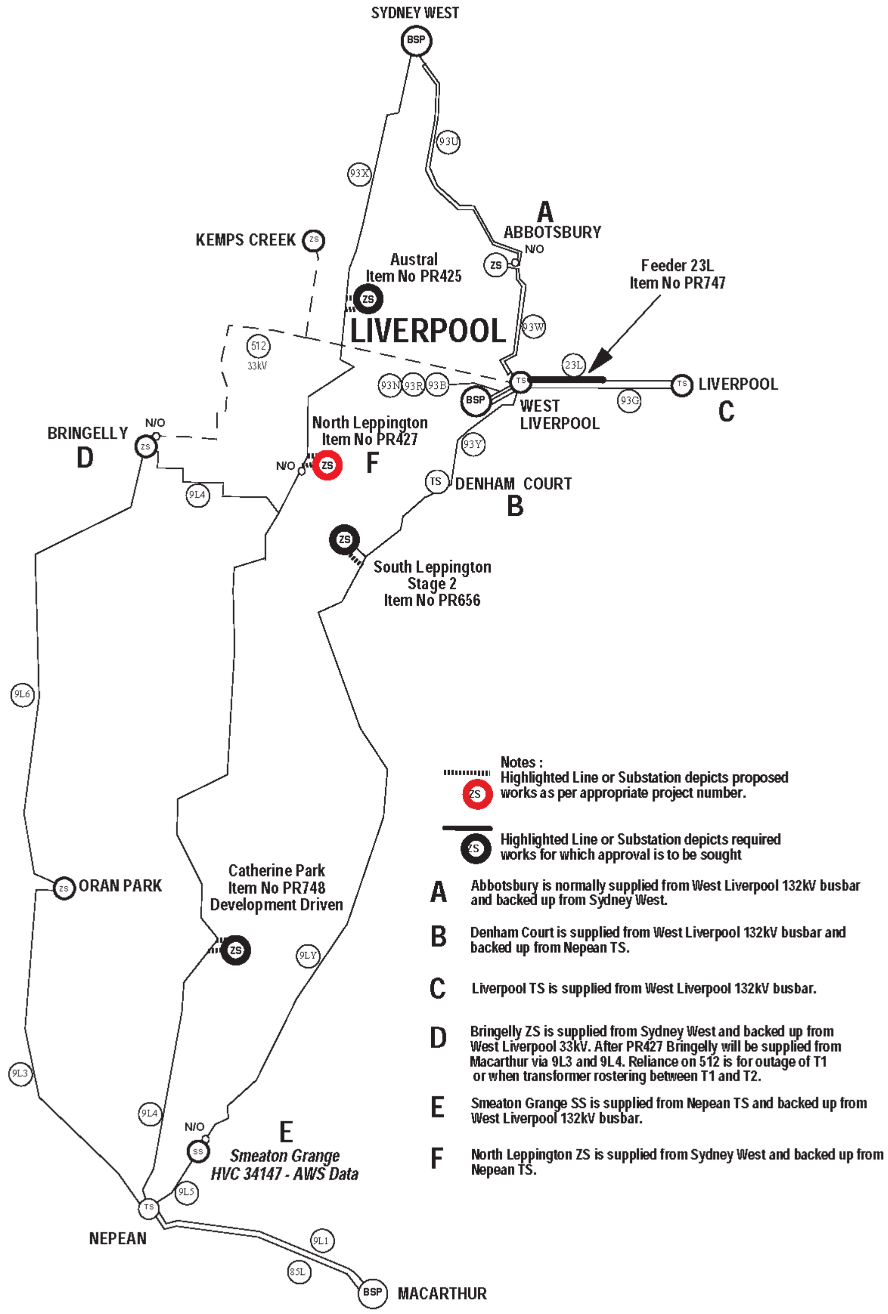
TABLE 103: LIVERPOOL BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
93B - Liverpool BSP to West Liverpool TS	375.0	195.1	201.3	205.8	213.7	221.6
93N - Liverpool BSP to West Liverpool TS	375.0	195.1	201.4	205.9	213.7	221.7
93R - Liverpool BSP to West Liverpool TS	375.0	192.9	199.1	203.4	211.2	219.0
93W - West Liverpool TS to Abbotsbury ZS	78.2	49.0	48.8	48.5	48.0	47.8
93Y - Denham Court TS to West Liverpool TS	148.6	33.6	31.3	37.5	40.1	42.0

TABLE 104: LIVERPOOL BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Feeder 23L exceeds its contingency rating of 230MVA for outage of 93G (West Liverpool TS to Liverpool TS).	2025/26	Transfer Casula ZS and Canley Vale ZS to West Liverpool TS with back-up feeders 504 and 508 closed reduces load to 184MVA. Also investigate possible augment feeder 23L and non-network options.	Replace 2750m overhead section of 23L with underground cable to match feeder 93G. This will also result in equal load share of both 23L and 93G during system normal operation. Avoids need to transfer multiple zone substations to West Liverpool TS.

A.16.3 LIVERPOOL BSP NETWORK MAP



A.17 MACARTHUR BULK SUPPLY POINT

A.17.1 MACARTHUR BSP CONNECTION POINTS

Macarthur BSP is owned by TransGrid and serves as the bulk supply point for the South West Growth Sector at 132kV and the greater Campbelltown area at 66kV. Macarthur BSP supplies electricity at 132kV through one 375MVA 330/132kV transformer and 66kV through one 250MVA 330/66kV transformer. Macarthur BSP will be ultimately configured with two 375MVA 330/132kV and two 250MVA 330/66kV transformers.

TABLE 105: MACARTHUR BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Ambarvale ZS	66/11kV	2 x 35	70	35	6.25	3.01
Appin ZS	66/11kV	1 x 15	15	NA	3.75	0.6
Campbelltown ZS	66/11kV	3 x 35	105	70	13.25	2.14
Kentlyn ZS	66/11kV	2 x 33	66	33	6.00	3.65
North Leppington ZS	132/11kV	2 x 45	90	45	-	-
Oran Park ZS	132/11kV	2 x 45	90	45	1.75	0.39
South Leppington ZS	132/11kV	1 x 45	45	NA	-	0.29
Nepean TS 33kV	132/33kV	3 x 60	180	120	-	-
Nepean TS 66kV	132/66kV	2 x 120	240	120	-	-

TABLE 106: MACARTHUR BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Ambarvale ZS	0.995	25.1	26.4	22.1	22.3	23.6	24.9	24.8
Appin ZS	0.934	6.3	6.7	4.7	4.7	4.6	4.6	4.6
Campbelltown ZS	0.984	53.5	54.4	52.3	52.4	52.9	53.8	55.0
Kentlyn ZS	0.985	33.1	38.8	28.3	28.2	28.1	28.1	28.1
North Leppington ZS	-	-	-	-	11.4	11.5	11.9	12.9
Oran Park ZS	0.950	-	11.9	15.9	20.7	24.3	28.4	32.7
South Leppington ZS	0.974	4.2	6.0	11.8	14.7	18.7	22.7	26.3
Nepean TS	0.967	183.3	164.1	153.0	157.8	159.0	160.1	161.3
Macarthur BSP 66kV	0.995	142.0	173.2	140.4	140.4	142.9	145.9	148.3
Macarthur BSP 132kV	0.950	191.7	233.5	187.5	215.3	228.1	242.2	257.5

TABLE 107: MACARTHUR BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Ambarvale ZS	0.993	19.1	21.3	18.1	18.1	18.6	19.9	21.4
Appin ZS	0.978	4.5	5.5	5.6	5.6	5.5	5.5	5.5
Campbelltown ZS	0.992	35.8	38.0	39.6	39.5	39.6	40.1	40.8
Kentlyn ZS	0.997	30.1	30.7	29.5	29.5	29.5	29.5	29.6
North Leppington ZS	-	-	-	-	-	8.1	8.6	9.6
Oran Park ZS	0.950	-	-	13.2	16.6	19.4	21.1	22.9
South Leppington ZS	0.997	2.6	3.4	7.4	13.6	13.6	19.5	21.8
Nepean TS	0.966	149.4	153.0	145.6	145.8	150.9	152.6	154.3
Macarthur BSP 66kV	0.992	120.4	122.3	115.8	115.7	116.5	118.3	120.8
Macarthur BSP 132kV	0.973	158.4	191.7	165.0	181.4	200.7	214.7	226.2

A.17.2 MACARTHUR BSP SUB-TRANSMISSION SYSTEM

The two sub-transmission networks supplied by Macarthur BSP operate at 132kV and 66kV respectively.

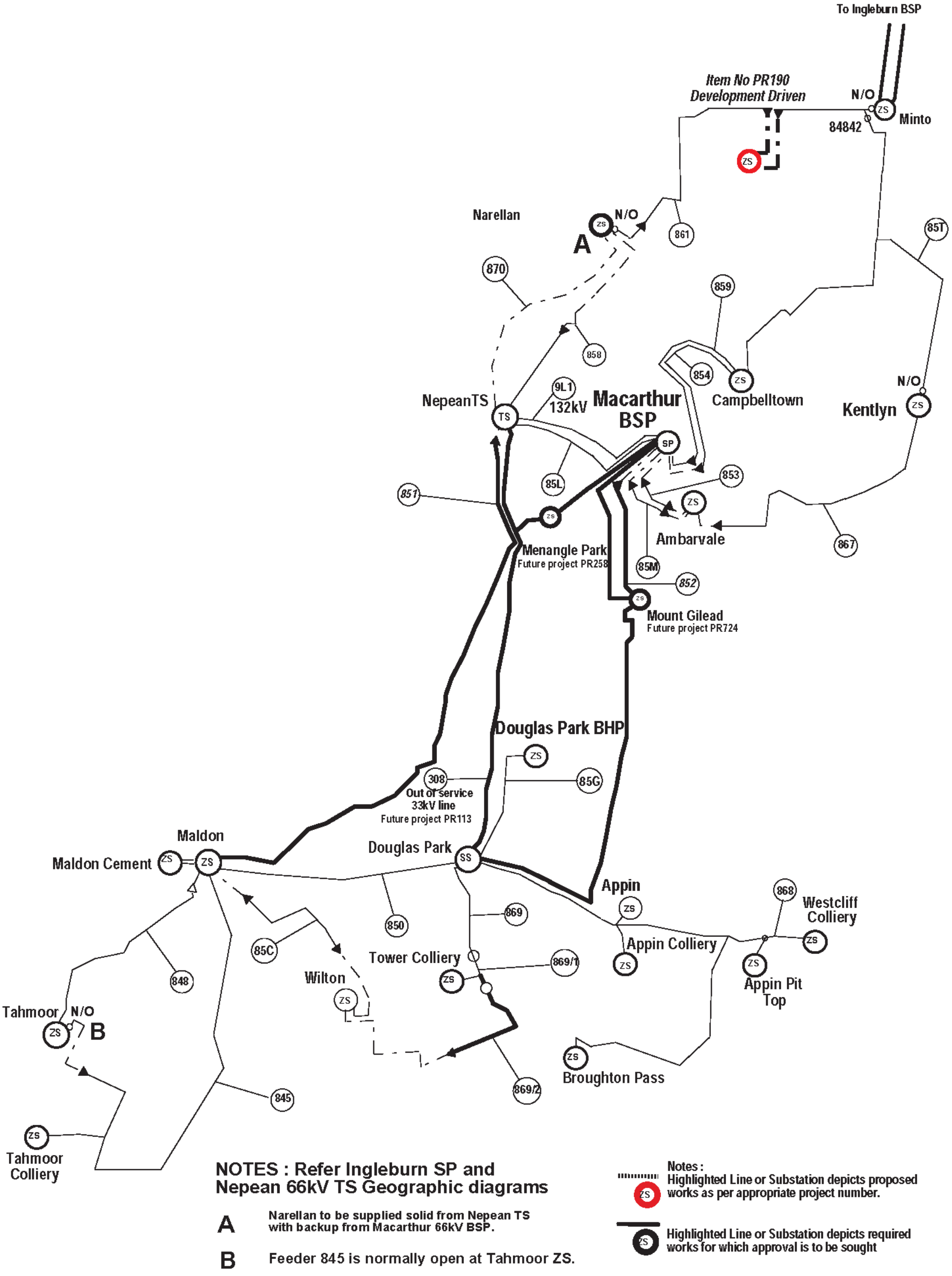
TABLE 108: MACARTHUR BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
9L1 - Macarthur BSP to Nepean TS	358.0	161.0	172.1	180.8	189.9	201.0
852 - Douglas Park SS to Mount Gilead ZS	60.0	93.4	98.3	98.7	99.8	100.0
852 - Macarthur BSP to Douglas Park SS	60.0	93.5	98.4	98.8	99.9	100.1
853 - Macarthur BSP to Ambarvale ZS	66.6	51.5	51.8	53.2	54.7	54.7
854 - Macarthur BSP to Campbelltown ZS	64.0	84.1	84.4	85.0	86.2	87.8
859 - Macarthur BSP to Campbelltown ZS	66.6	53.8	54.1	54.8	55.9	57.4
85L - Macarthur BSP to Nepean TS	179.0	67.4	74.1	76.5	78.8	81.7
85M - Macarthur BSP to Ambarvale ZS	86.0	51.5	51.8	53.2	54.7	54.7
85T - Kentlyn ZS to TEE	72.0	31.0	30.9	30.8	31.2	31.3
85T - TEE to Campbelltown ZS	72.2	31.0	30.8	30.7	31.1	31.2
85T - ABS 84842 to TEE	72.2	23.2	24.2	24.7	25.1	25.4
861 - Minto ZS to TEE	64.0	0.0	0.0	0.0	0.0	0.0
861 - ABS 84842 to TEE	64.0	23.2	24.2	24.7	25.1	25.4
861 - Narellan ZS to TEE	49.7	23.2	24.2	24.7	25.1	25.4
867 - Kentlyn ZS to Ambarvale ZS	74.0	30.3	30.1	30.0	30.4	30.5

TABLE 109: MACARTHUR BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Outage of either feeder 851 (Nepean TS to Maldon ZS) or 852 (Macarthur BSP to Douglas Park SS) results in the firm capacity of the remaining feeder being exceeded.	S2018	There is load at risk with existing generation levels of 38MW.	Investigate options
Outage of Feeder 851 results in Feeder 869 Tower Power Stn tee Wilton ZS to be overloaded	S2027	Augment Feeder 869	Investigate options
When 66kV feeder 85L is out the firm rating of Nepean 66kV is exceed.	S2018	Further investigation is required including load diversity, probabilistic planning analysis and cyclic ratings on the 132/66 kV transformers at Nepean TS.	Continue to monitor
When 66kV feeder 85L is out 132kV feeder 93Y West Liverpool TS to Denham Court TS is overloaded.	S2023	The second 330/132kV transformer will be required at Macarthur BSP. Feeder 85L will be connected to 132kV and become 9L2. A third 132/66kV transformer and busbar will be required at Nepean TS. Probabilistic planning analysis is required.	Continue to monitor
The two Nepean TS 132/66kV transformers are overloaded for an outage on the single 330/66 kV transformer at Macarthur BSP.	S2018	Joint planning with Transgrid has resulted in a project for a second 330/66kV transformer at Macarthur BSP.	A second 330/66kV transformer at Macarthur BSP

A.17.3 MACARTHUR BSP NETWORK MAP



A.18 MARULAN BULK SUPPLY POINT

A.18.1 MARULAN BSP CONNECTION POINTS

Marulan BSP only has a single 330/132kV, 160MVA transformer supplying both Fairfax Lane and Essential Energy's Goulburn TS. Fairfax Lane Transmission substation is supplied via 132kV feeder 98C from Marulan BSP with an alternative supply from feeder 988 Dapto BSP. Feeder 98C is rated at 168/190 MVA summer/winter with 988 rated at 133/146 MVA summer/winter.

TABLE 110: MARULAN BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Fairfax Lane TS	132kV	3 x 60	180	120	15.75	-

TABLE 111: MARULAN BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Fairfax Lane TS	0.977	76.2	71.9	73.5	73.3	73.0	72.8	72.6
Marulan BSP	0.947	78.0	79.0	73.5	73.2	73.0	72.8	72.6

TABLE 112: MARULAN BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Fairfax Lane TS	0.973	89.3	85.6	86.7	87.2	87.1	87.0	86.9
Marulan BSP	0.945	95.2	92.5	89.2	89.8	89.6	89.5	89.4

A.18.2 MARULAN BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Marulan BSP operates at 132kV.

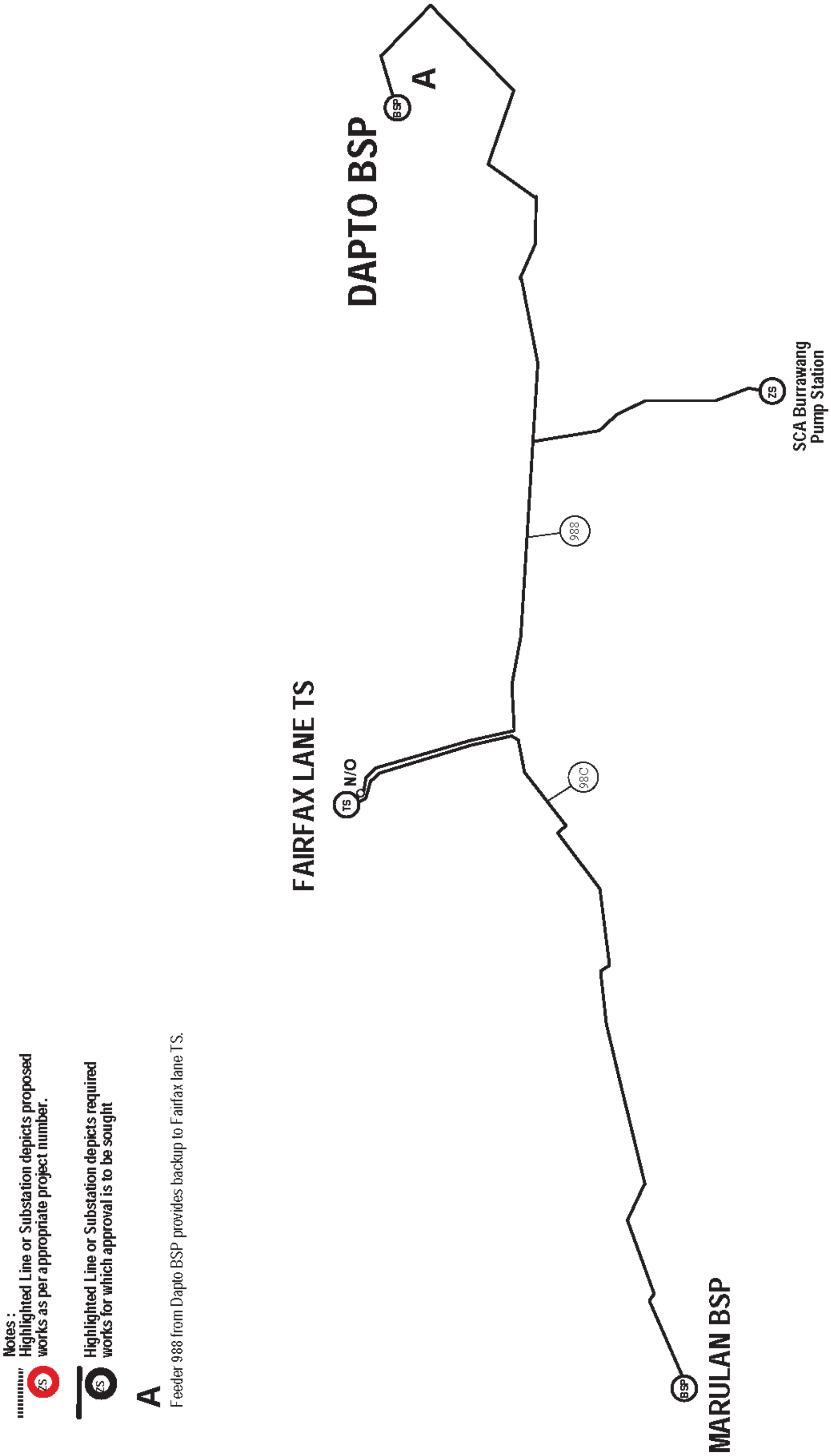
TABLE 113: MARULAN BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
98C - Marulan BSP to Fairfax Lane TS	168.0	88.9	88.8	88.6	88.5	88.4

TABLE 114: MARULAN BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.18.3 MARULAN BSP NETWORK MAP



A.19 MT DRUITT TRANSMISSION SUBSTATION

A.19.1 MT DRUITT TS CONNECTION POINTS

Mt Druitt TS is currently supplied from Sydney West BSP via Feeder 932 and Feeder 939/219 via Mamre ZS. Backup supply is available via Feeders 936 and 933 from Regentville BSP via Penrith TS for a loss of Feeder 932 and a combined Mamre and Mt Druitt load above the rating of Feeder 939. Mt Druitt TS is equipped with three 120 MVA 132/33kV transformers with provision for a fourth unit.

TABLE 115: MT DRUITT TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Claremont Meadows ZS	33/11kV	3 x 25	75	50	3.00	1.58
Horsley Park ZS	33/11kV	2 x 25	50	25	0.75	0.35
Plumpton ZS	33/11kV	3 x 25	75	50	-	3.72
St Marys ZS	33/11kV	2 x 25 + 1 x 19	69	44	5.25	2.4
Werrington ZS	33/11kV	3 x 35	105	70	8.00	2.03
Whalan ZS	33/11kV	3 x 25	75	50	4.00	2.34
Mt Druitt TS	132/33kV	3 x 120	360	240	8.25	10.80

TABLE 116: MT DRUITT TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Claremont Meadows ZS	0.994	28.8	30.3	32.2	33.5	34.1	33.9	33.8
Horsley Park ZS	0.977	9.1	10.3	9.4	9.4	9.3	9.3	9.3
Plumpton ZS	0.967	32.7	36.1	30.5	30.3	30.2	30.0	29.8
St Marys ZS	0.977	35.5	35.7	31.2	31.1	31.0	30.8	30.7
Werrington ZS	0.977	36.8	37.1	37.5	38.9	38.8	38.7	38.6
Whalan ZS	0.980	32.9	32.8	30.2	30.2	30.1	30.1	30.1
Mount Druitt TS	0.991	143.9	150.7	145.0	146.8	146.8	146.4	145.9

TABLE 117: MT DRUITT TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Claremont Meadows ZS	0.996	22.0	22.5	22.0	22.6	23.7	23.8	23.7
Horsley Park ZS	0.973	8.4	8.3	8.4	8.4	8.3	8.3	8.3
Plumpton ZS	1.000	24.8	25.4	23.4	23.3	23.3	23.2	23.1
St Marys ZS	0.995	25.7	23.0	23.7	23.6	23.6	23.6	23.5
Werrington ZS	0.987	32.9	33.2	34.6	36.6	36.5	36.5	36.5
Whalan ZS	1.000	21.6	21.5	20.4	20.6	20.6	20.5	20.5
Mount Druitt TS	0.995	116.3	111.5	104.7	106.7	107.4	107.3	107.2

A.19.2 MT DRUITT TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Mt Druitt TS operates at 33kV.

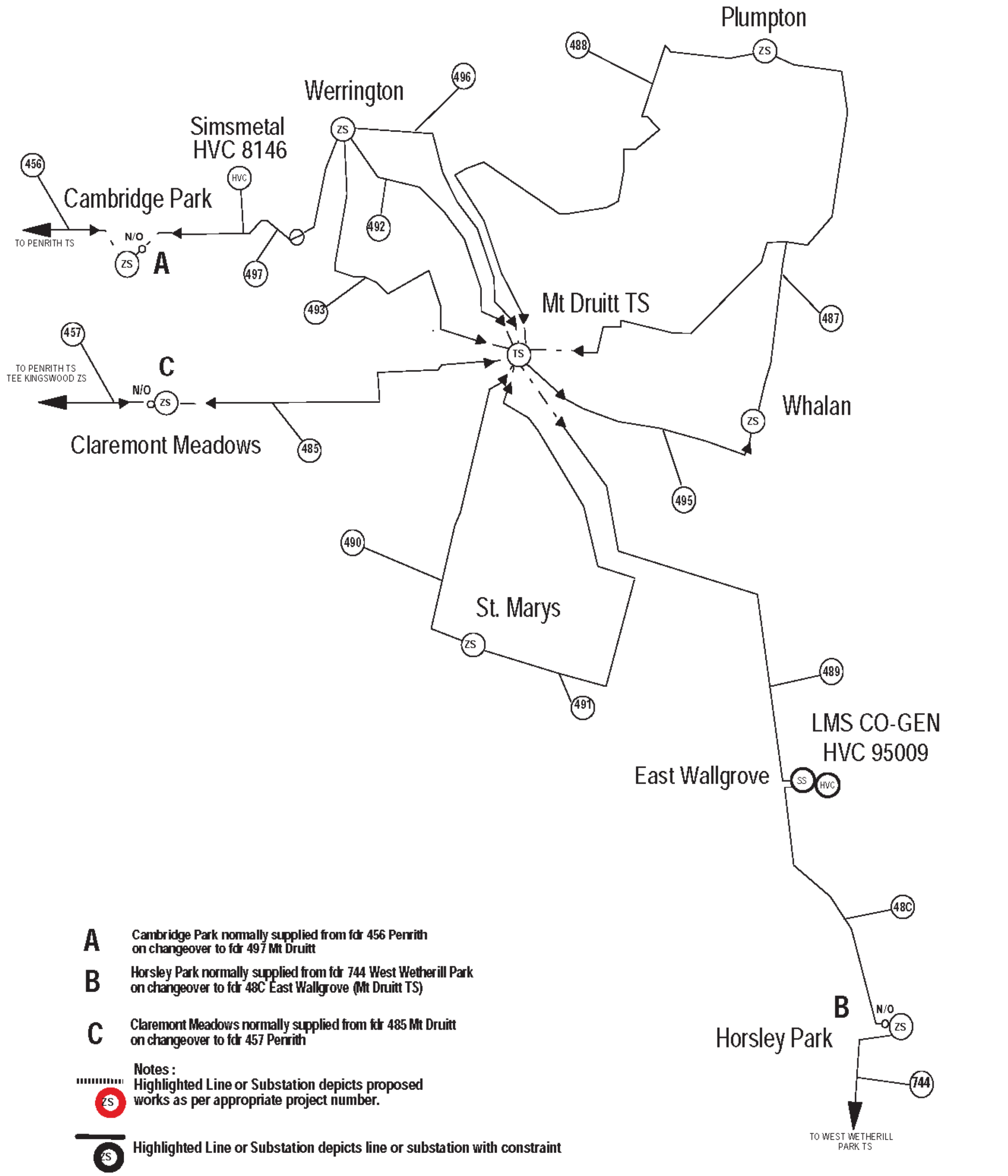
TABLE 118: MT DRUITT TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
485 - Mount Druitt TS to Claremont Meadows ZS	50.0	33.5	34.2	35.0	35.0	34.9
487 - Mount Druitt TS to TEE	42.0	32.3	31.5	31.5	31.3	31.3
487 - Plumpton ZS to TEE	42.0	32.3	31.5	31.5	31.3	31.3
487 - Whalan ZS to TEE	42.0	31.6	30.9	31.0	31.0	31.1
488 - Mount Druitt TS to Plumpton ZS	42.0	32.4	31.6	31.5	31.4	31.3
489 - Mount Druitt TS to East Wallgrove SS	34.0	8.8	8.8	8.7	8.7	8.7
48C - East Wallgrove SS to Horsley Park ZS	42.0	9.6	9.4	9.3	9.3	9.3
490 - Mount Druitt TS to St Marys ZS	34.0	32.8	32.0	32.0	31.9	31.9
491 - Mount Druitt TS to St Marys ZS	34.0	32.9	32.2	32.2	32.0	32.0
492 - Mount Druitt TS to Werrington ZS	32.0	24.9	25.2	25.3	25.3	25.3
493 - Mount Druitt TS to Werrington ZS	34.0	21.9	22.2	22.2	22.2	22.3
495 - Mount Druitt TS to Whalan ZS	42.0	31.3	30.7	30.8	30.8	30.8
496 - Mount Druitt TS to Werrington ZS	45.5	25.9	26.3	26.4	26.4	26.4

TABLE 119: MT DRUITT TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.19.3 MT DRUITT TS NETWORK MAP



A.20 MOUNT PIPER BULK SUPPLY POINT

A.20.1 MOUNT PIPER BSP CONNECTION POINTS

Mt Piper BSP is owned by TransGrid and supplies both Endeavour Energy and Essential Energy. Endeavour Energy's demand is limited to 45MVA on each feeder, being the rating of the metering equipment. Mt Piper TS is equipped with two 120MVA 132/66/11kV transformers each with a cyclic rating of 150MVA.

TABLE 120: MOUNT PIPER BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Blackmans Flat ZS	66/11kV	2 x 10	20	10	1.50	0.40
Hartley Vale ZS	66/11kV	2 x 2.5	5	2.5	1.00	0.07

TABLE 121: MOUNT PIPER BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Blackmans Flat ZS	0.963	5.5	4.8	4.8	4.8	4.7	4.7	4.7
Hartley Vale ZS	0.986	1.3	0.6	0.6	0.6	0.6	0.6	0.6
Mount Piper TS	0.913	28.5	28.4	27.2	27.2	27.2	27.2	27.1

TABLE 122: MOUNT PIPER BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Blackmans Flat ZS	0.979	6.1	6.3	6.3	6.3	6.2	6.2	6.2
Hartley Vale ZS	0.989	1.6	1.4	1.4	1.4	1.4	1.4	1.4
Mount Piper TS	0.940	32.8	27.2	32.9	32.9	32.9	32.9	32.9

A.20.2 MOUNT PIPER BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Mount Piper BSP operates at 66kV and 132kV.

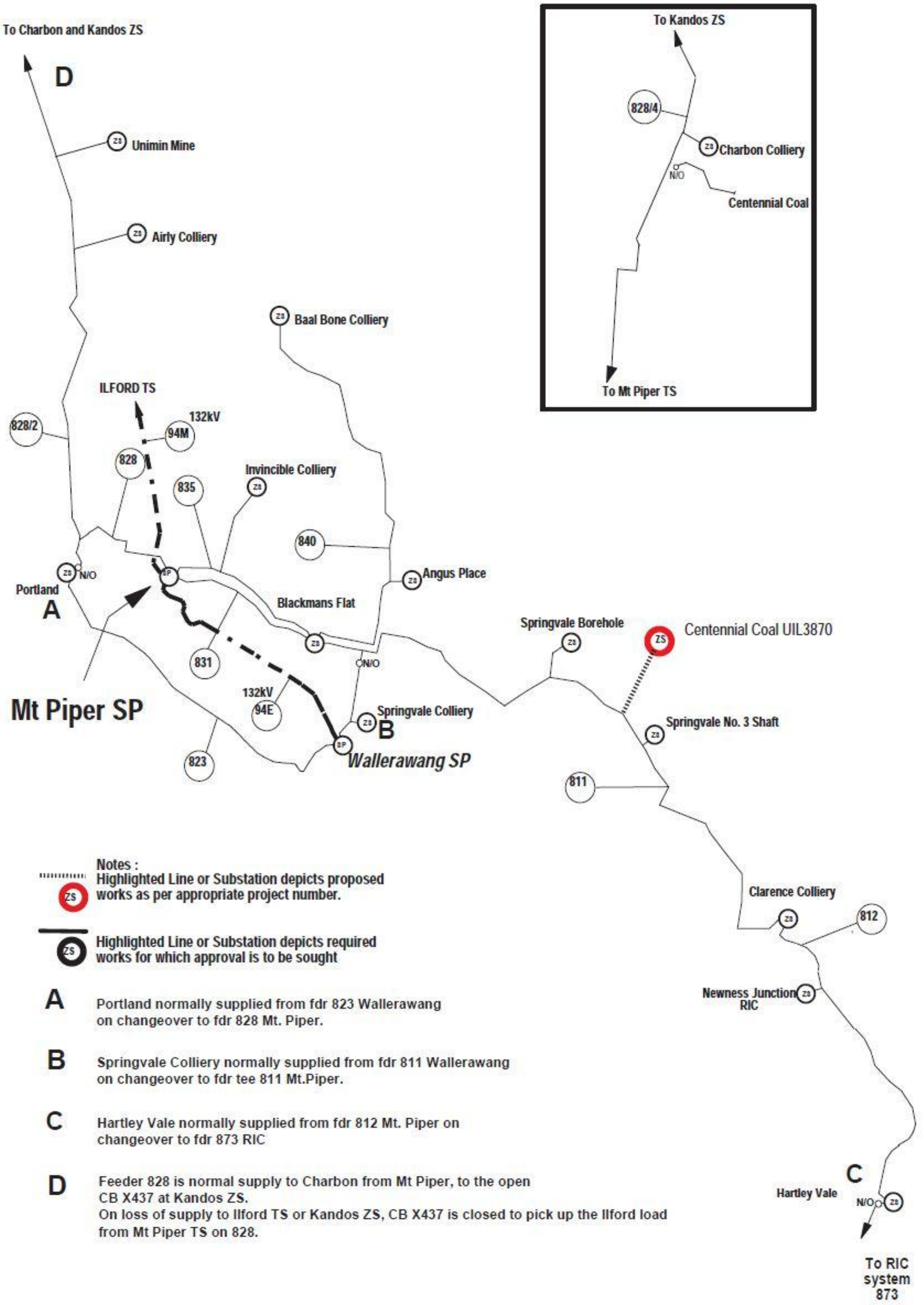
TABLE 123: MOUNT PIPER BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
831 - Mount Piper TS to Blackmans Flat ZS	49.7	33.1	33.2	33.2	33.1	33.1
94M - Mount Piper TS to TEE	74.0	7.0	21.6	21.5	24.1	31.1
94M - Ilford TS to TEE	74.0	6.8	21.7	21.7	24.2	31.2
94Y - Mount Piper BSP to Mount Piper TS	121.6	167.4	178.0	152.3	184.4	184.2

TABLE 124: MOUNT PIPER BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.20.3 MOUNT PIPER BSP NETWORK MAP



A.21 MOUNT TERRY TRANSMISSION SUBSTATION

A.21.1 MOUNT TERRY TS CONNECTION POINTS

Mt Terry Transmission Substation is equipped with two 120MVA 132/33kV transformers providing a firm capacity of 120 MVA. The substation is fed from Dapto BSP via 132kV feeders 98F and 98W. Feeders 98L and 98U from Mt Terry provide supply to Shoalhaven TS and onto the south coast substations of West Tomerong, Ulladulla, Moruya North and Batemans Bay.

TABLE 125: MOUNT TERRY TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Albion Park ZS	33/11kV	3 x 12.5	37.5	23.2	3.00	3.03
Calderwood ZS (Proposed)	33/11kV	3 x 25	75	50	-	-
Gerringong ZS	33/11kV	2 x 5	10	5	4.50	0.94
Jamberoo ZS	33/11kV	1 x 3.75	3.75	NA	0.75	0.32
Kiama ZS	33/11kV	2 x 12.5 + 1 x 15	40	25	4.00	1.94
Shellharbour ZS	33/11kV	2 x 20 + 1 x 25	65	40	4.75	3.03
Warilla ZS	33/11kV	2 x 10 + 1 x 12.5	32.5	20	7.00	2.57
Mount Terry TS	132/33kV	2 x 120	240	120	1.25	-

TABLE 126: MOUNT TERRY TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Albion Park ZS	0.984	21.7	24.0	21.1	23.6	24.3	20.5	20.4
Calderwood ZS (Proposed)	-	-	-	-	-	-	4.4	5.1
Gerringong ZS	0.973	4.7	5.7	5.7	6.3	6.2	6.2	6.2
Jamberoo ZS	0.953	2.8	3.2	2.7	2.7	2.6	2.6	2.6
Kiama ZS	0.978	10.5	11.4	10.9	11.8	13.1	13.0	13.0
Shellharbour ZS	0.997	27.5	29.6	36.3	38.0	38.0	38.2	38.2
Warilla ZS	0.963	17.7	19.2	21.1	21.0	21.0	20.9	20.8
Mount Terry TS	0.948	103.4	110.4	104.5	110.2	112.2	112.6	113.1

TABLE 127: MOUNT TERRY TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Albion Park ZS	0.998	18.8	19.8	19.9	20.4	21.7	22.1	20.6
Calderwood ZS (Proposed)	-	-	-	-	-	-	-	1.8
Gerringong ZS	0.973	6.6	6.5	6.5	6.5	6.5	6.5	6.5
Jamberoo ZS	0.990	2.3	2.4	2.4	2.4	2.4	2.4	2.4
Kiama ZS	0.986	14.2	14.7	15.4	15.8	16.2	16.2	16.1
Shellharbour ZS	0.996	25.9	27.3	32.4	33.2	33.2	33.2	33.1
Warilla ZS	0.986	20.1	20.5	21.3	21.2	21.2	21.2	21.1
Mount Terry TS	0.948	94.1	97.0	98.7	100.2	101.8	103.5	103.6

A.21.2 MOUNT TERRY TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Mount Terry TS operates at 33kV.

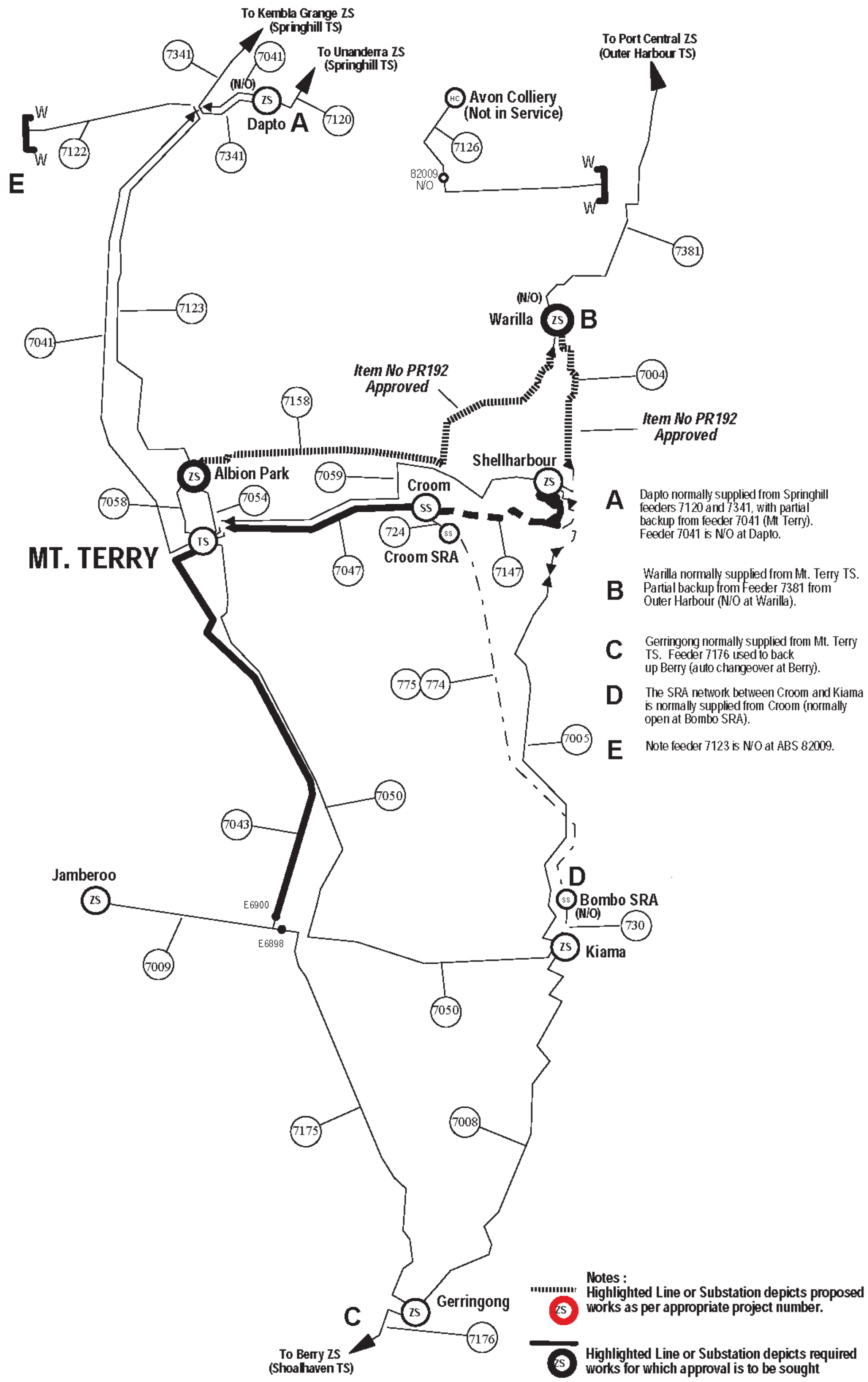
TABLE 128: MOUNT TERRY TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7004 - Shellharbour ZS to Warilla ZS	32.1	22.5	22.3	22.2	22.2	22.2
7005 - Kiama ZS to Shellharbour ZS	13.4	14.4	14.8	14.8	14.8	14.7
7008 - Gerringong ZS to Kiama ZS	20.6	9.4	9.5	9.5	9.5	9.4
7009 - AR E6900 to TEE	13.2	13.0	13.2	13.1	13.1	13.1
7009 - Jamberoo ZS to TEE	10.0	2.9	2.9	2.8	2.8	2.8
7009 - AR E6898 to TEE	13.2	10.6	10.7	10.7	10.7	10.7
7041 - Mount Terry TS to Dapto ZS	27.4	15.8	16.3	16.7	18.0	19.0
7043 - Mount Terry TS to AR E6900	11.9	13.0	13.2	13.1	13.1	13.1
7050 - Mount Terry TS to Kiama ZS	22.5	20.9	21.3	21.3	21.2	21.2
7054 - Mount Terry TS to Albion Park ZS	45.7	38.2	40.1	41.0	37.5	37.4
7058 - Mount Terry TS to Albion Park ZS	45.7	37.9	39.8	40.7	37.1	37.1
7059 - Mount Terry TS to Shellharbour ZS	33.2	31.2	31.8	32.2	32.2	32.2
7158 - Albion Park ZS to Warilla ZS	32.1	24.5	24.6	24.8	24.9	24.9
7175 - AR E6898 to Gerringong ZS	13.4	10.6	10.7	10.7	10.7	10.7
7176 - Berry ZS to Gerringong ZS	16.4	9.2	9.2	9.2	9.1	9.1

TABLE 129: MOUNT TERRY TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Albion Park ZS firm rating is exceeded. The load is 3.5% above the firm rating in S2017 and then below the firm rating at end of the forecast period.	S2017	The proposed Calderwood ZS will ultimately off load Albion Park ZS. Non-network options wil be investigated.	PR657
Warilla ZS firm rating is exceeded. The load is 6% above the firm rating in W2026.	Existing	The situation will continue to be monitored in accordance with acceptable network capacity planning standards. Investigate additional load transfers and alternate non-network options in the future.	Continue to monitor
Gerringong ZS firm rating is exceeded both summer and winter in 2017.	Existing	Options include the installation of the refurbished Ex-Russell Vale 10 MVA TX No. 3 and demand management.	Conduct investigations.
Feeder 7047 is overloaded for an outage of feeder 7059	S2018	The situation will continue to be monitored and options to re-rate feeder will be studied if required.	Investigate Options
Feeder 7147 is overloaded for an outage of feeder 7059	S2019	The situation will continue to be monitored and options to re-rate feeder will be studied if required.	Investigate re-rating of feeder
Feeder 7043 is overloaded for an outage of feeder 7050	S2019	The situation will continue to be monitored and options to re-rate feeder will be studied if required.	Investigate re-rating of feeder

A.21.3 MOUNT TERRY TS NETWORK MAP



A.22 NEPEAN TRANSMISSION SUBSTATION

A.22.1 NEPEAN TS CONNECTION POINTS

Nepean TS is supplied from Macarthur BSP by 132kV Feeder 9L1 and 66kV Feeder 85L. Nepean TS has back up supply from Sydney West BSP on Feeder 93X and Liverpool BSP via West Liverpool TS on Feeder 9L5. Nepean TS is equipped with two 120MVA 132/66 transformers and three 60 MVA 132/33kV transformers giving a firm capacity of 120MVA on both the 66kV and 33kV busbars.

TABLE 130: NEPEAN TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Cawdor ZS	33/11kV	2 x 25	50	25	9.50	1.36
Maldon ZS	66/11kV	2 x 35	70	35	4.25	2.01
Narellan ZS	66/11kV	3 x 35	105	70	6.50	4.47
Nepean ZS	66/11kV	2 x 35	70	35	0.25	2.65
Oakdale ZS	33/11kV	2 x 10	20	10	2.25	0.25
Tahmoor ZS	66/11kV	2 x 25	50	25	7.25	1.84
The Oaks ZS	33/11kV	1 x 15	15	NA	-	0.64
Wilton ZS	66/11kV	2 x 20	40	20	3.50	0.52
Nepean TS	132/33kV	3 x 60	180	120	-	-
Nepean TS	132/66kV	2 x 120	240	120	-	107.00

TABLE 131: NEPEAN TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Cawdor ZS	0.955	25.0	27.7	27.6	27.5	27.4	27.3	27.2
Maldon ZS	0.985	19.1	22.9	17.6	20.7	20.6	20.5	20.4
Narellan ZS	0.969	63.8	75.8	66.0	68.6	69.6	70.5	71.1
Nepean ZS	0.969	35.8	42.8	34.1	35.1	35.8	36.3	36.6
Oakdale ZS	0.949	4.7	1.9	2.0	2.0	2.0	2.0	2.0
Tahmoor ZS	0.992	18.3	18.2	14.4	14.3	14.2	14.1	14.0
The Oaks ZS	0.986	6.5	6.1	6.1	6.0	6.0	6.0	6.0
Wilton ZS	0.991	3.6	2.5	2.7	2.9	3.2	3.9	4.9
Nepean TS 33kV	0.933	30.7	52.9	36.7	36.5	36.3	36.2	36.0
Nepean TS 66kV	0.979	152.6	129.8	116.4	121.3	122.7	124.0	125.3

TABLE 132: NEPEAN TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Cawdor ZS	0.983	17.3	17.9	17.9	17.8	17.8	17.8	17.7
Maldon ZS	0.989	17.2	17.7	16.3	16.2	19.4	19.4	19.3
Narellan ZS	0.981	41.4	40.8	43.8	42.8	44.0	45.0	45.8
Nepean ZS	0.992	21.5	23.6	23.2	24.3	25.2	25.9	26.4
Oakdale ZS	0.949	4.7	1.9	2.0	2.0	2.0	2.0	2.0
Tahmoor ZS	0.993	14.4	14.7	14.0	14.0	13.9	13.9	13.9
The Oaks ZS	0.986	6.5	6.1	6.1	6.0	6.0	6.0	6.0
Wilton ZS	0.982	3.2	2.8	3.1	3.3	3.4	3.7	4.2
Nepean TS 33kV	0.934	18.1	24.8	25.1	25.0	25.0	24.9	24.8
Nepean TS 66kV	0.972	131.3	128.1	120.5	120.8	125.9	127.7	129.4

A.22.2 NEPEAN TS SUB-TRANSMISSION SYSTEM

The sub-transmission networks supplied by Nepean TS operate at 132kV, 66kV and 33kV respectively.

TABLE 133: NEPEAN TS – SUMMER

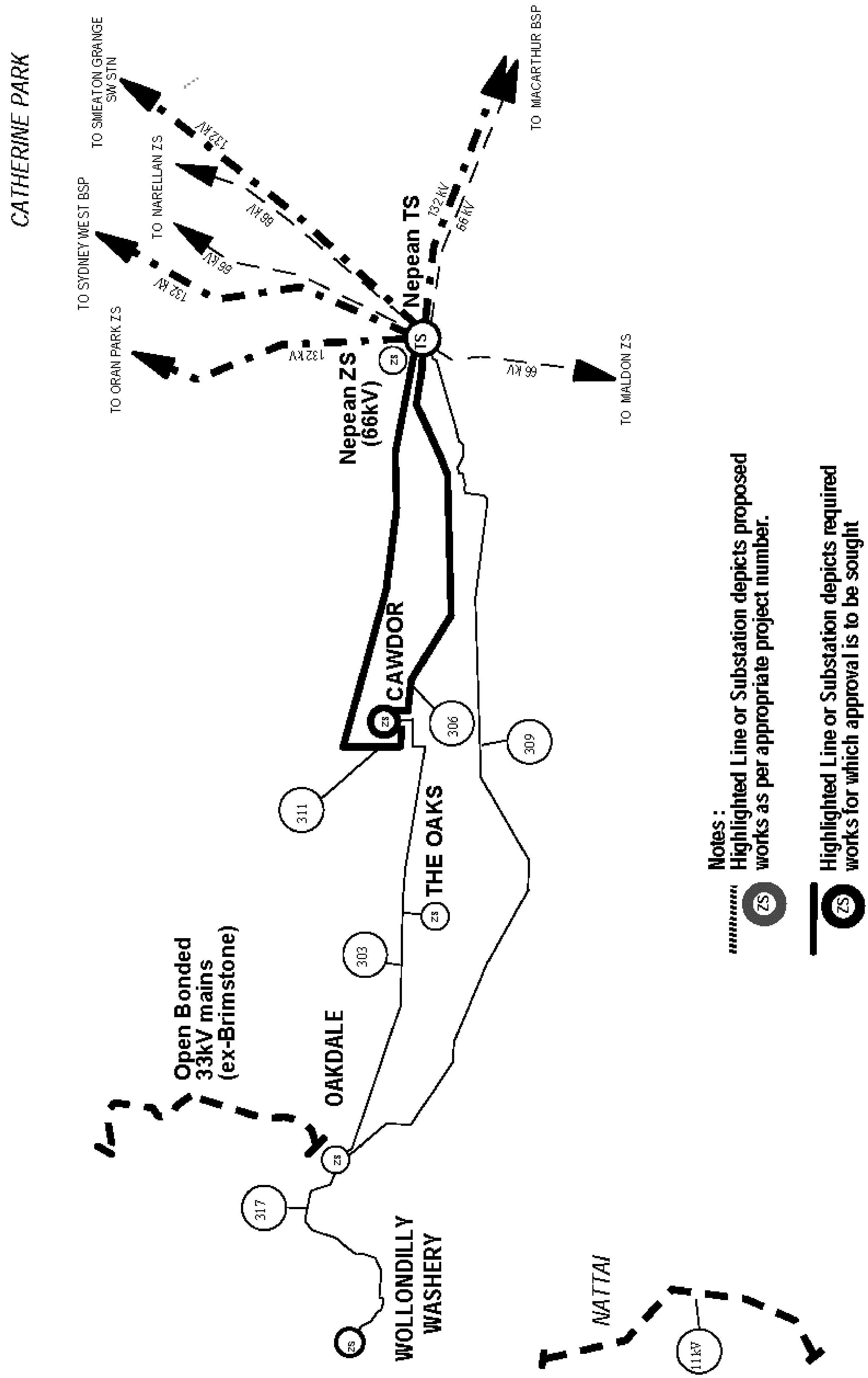
Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
9L3 - Nepean TS to Oran Park ZS	159.7	16.8	21.2	25.2	29.6	34.6
9L5 - Nepean TS to Smeaton Grange SS	171.9	7.1	9.9	13.6	17.4	21.2
9L6 - Bringelly ZS to Oran Park ZS	145.0	16.6	20.9	24.3	28.7	33.6
303 - Cawdor ZS to ABS 87183	25.5	12.6	12.6	12.6	12.5	12.5
303 - ABS 87183 to TEE	25.5	12.6	12.6	12.6	12.5	12.5
303 - TEE to The Oaks ZS	33.5	8.9	8.9	8.8	8.8	8.8
303 - TEE to ABS 87184	25.5	3.9	3.9	3.9	3.9	3.9
303 - ABS 87184 to Oakdale ZS	25.5	3.9	3.9	3.9	3.9	3.9
306 - Nepean TS to Cawdor ZS	22.8	34.4	34.3	34.2	34.1	34.1
309 - Nepean TS to Oakdale ZS	29.2	7.0	6.9	6.9	6.9	6.9
311 - Nepean TS to Cawdor ZS	29.0	34.7	34.6	34.5	34.4	34.4
848 - Maldon ZS to Tahmoor ZS	60.0	16.7	16.9	16.8	16.8	16.6
850 - Douglas Park SS to Maldon ZS	51.0	44.0	47.0	47.2	47.6	47.7
851 - Nepean TS to Maldon ZS	60.0	91.3	95.9	96.4	97.5	98.9
858 - Nepean TS to Narellan ZS	49.7	46.4	48.5	49.7	50.4	51.1
85C - Maldon ZS to Wilton ZS	83.6	25.2	26.7	26.6	26.3	25.5
869 - Douglas Park SS to ABS 90426	40.0	21.4	23.1	23.3	23.7	24.1
869 - ABS 90426 to TEE	40.0	21.4	23.1	23.3	23.8	24.1
869 - Tower Power Station 66kV to TEE	60.0	9.6	9.7	9.7	9.8	9.8
869 - ABS 90427 to TEE	40.0	27.7	29.5	29.7	30.2	30.6
869 - Wilton ZS to ABS 90427	40.0	27.7	29.5	29.7	30.2	30.6
870 - Nepean TS to Narellan ZS	72.5	72.0	75.7	76.9	78.4	79.6
NEPEAN6 - Nepean TS to Nepean 11kV	86.0	38.1	39.7	40.9	41.7	42.4
NEPEAN7 - Nepean TS to Nepean 11kV	86.0	38.1	39.7	40.9	41.8	42.4

TABLE 134: NEPEAN TS – IDENTIFIED LIMITATIONS

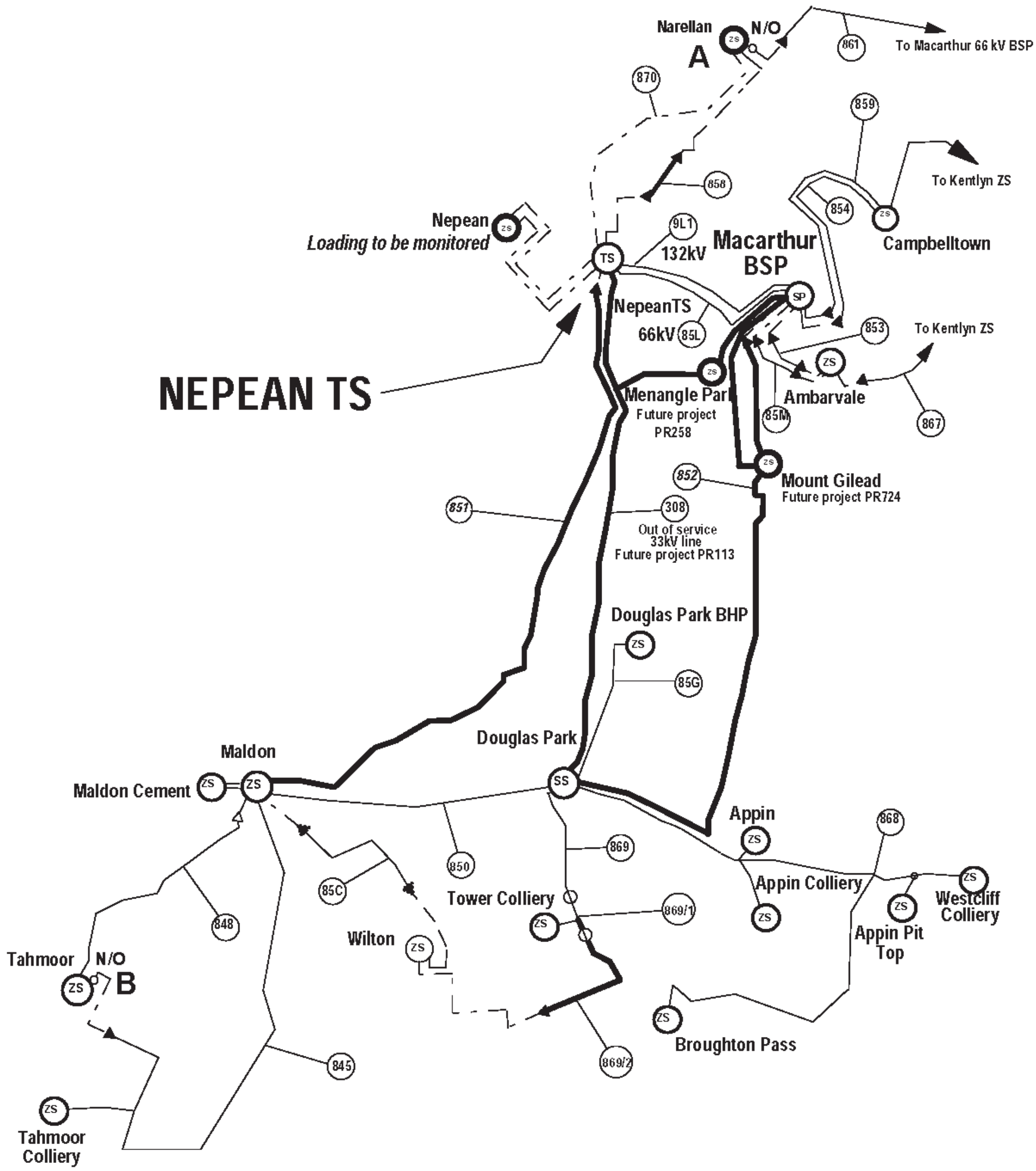
Network Constraint	Year	Investigation	Solution
Cawdor ZS has exceeded its firm rating.	S2017	Apply probabilistic planning analysis. May need augmenting with third transformer.	Investigate non-network options. Continue to monitor.
Outage of feeder 306 or 311 Nepean TS – Cawdor ZS will cause the in-service feeder to exceed its rating.	S2018	Investigate constraint to determine if line augmentation is required. Monitor actual loads for next year. Apply probabilistic planning analysis.	Investigate non-network options. Continue to monitor.
Outage of feeder 870 (Nepean TS to Narellan ZS) will cause feeder 858 to exceed its rating.	S2018	The network will be operated so that load on Narrellan ZS is split between feeders 858 & 861 from Macarthur 66kV for an outage of feeder 870. Continue to monitor and consider demand management prior to augmentation of feeder 858.	Utilise transfer capacity & monitor
Outage of feeder 858 Nepean TS – Narellan ZS will cause 870 to exceed its rating.	S2019	Outage of 858 results in the load on feeder 870 exceeding its rating. No 1 transformer at Narellan ZS will be supplied by feeder 861 from Macarthur 66kV. Narellan ZS needs to be off loaded onto Nepean ZS and onto proposed Catherine Park ZS to keep Narellan ZS within its firm rating.	Continue to monitor
Narellan ZS transformer connected to bus sections 2&3 is overloaded when connected as a single transformer.	S2018	Configure the three transformers on a split 11kV busbar arrangement. Proposed Catherine Field ZS can be used to off load bus sections 2&3 at Narellan ZS. Off load Narellan ZS onto Nepean ZS.	Investigate Options
Nepean ZS will exceed its firm rating in 2018.	S2019	Investigate constraint to determine, cyclic ratings and if demand management solution is possible. Monitor actual loads for next year. Apply probabilistic planning analysis. Install third 66/11kV transformer as the Spring Farm & Elderslie residential release areas are progressing.	Monitor, assess ratings

Network Constraint	Year	Investigation	Solution
Outage of either feeder 851 or 852 results in an overload on the other feeder.	S2018	There is load at risk with embedded generation drops below 38 MW. Options include augmenting out-of-service 33kV feeder 308 to 66kV and connect it to Nepean 66kV TS & Douglas Park SS and non-network options.	Investigate Options
Outage of feeder 851 results in feeder 869 Tower Power Station Tee to Wilton ZS to be overloaded.	S2027	Options include augmenting feeder 869 from the Tower Power Station Tee to Wilton ZS and demand management.	Investigate Options
Outage of feeder 869 results in an overload feeders 851 & 852.	S2023	Investigate augmentation of O/S feeder 308	Investigate Options
Cawdor ZS has exceeded its firm rating.	S2017	Apply probabilistic planning analysis. May need augmenting with third transformer.	Investigate non-network options. Continue to monitor.

A.22.3 NEPEAN TS NETWORK MAP



Endeavour Energy



NOTES : Refer Ingleburn BSP and Macarthur BSP 66kV Geographic

A Narellan to be supplied solid from Nepean TS with backup from Macarthur 66kV BSP.

B Feeder 845 is normally open at Tahmoor ZS.

Notes :

Highlighted Line or Substation depicts proposed works as per appropriate project number.

Highlighted Line or Substation depicts required works for which approval is to be sought

Endeavour Energy

A.23 OUTER HARBOUR TRANSMISSION SUBSTATION

A.23.1 OUTER HARBOUR TS CONNECTION POINTS

Outer Harbour Transmission Substation is supplied from Dapto Bulk Supply Point via Springhill TS by 132kV feeders 985 & 989. Outer Harbour TS is equipped with two 60 MVA 132/33kV transformers providing a firm capacity of 60MVA.

TABLE 135: OUTER HARBOUR TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Port Central ZS	33/11kV	2 x 19	38	19	13.00	0.53
Outer Harbour TS	132/33kV	2 x 60	120	60	-	-

TABLE 136: OUTER HARBOUR TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Port Central ZS	0.966	12.4	10.4	10.8	10.8	10.8	10.8	10.8
Outer Harbour TS	0.982	24.5	23.7	31.0	31.0	31.0	31.0	31.0

TABLE 137: OUTER HARBOUR TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Port Central ZS	0.986	12.8	9.7	9.4	9.4	9.4	9.4	9.4
Outer Harbour TS	0.970	28.8	33.2	28.1	28.1	28.1	28.1	28.1

A.23.2 OUTER HARBOUR TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Outer Harbour TS operates at 33kV.

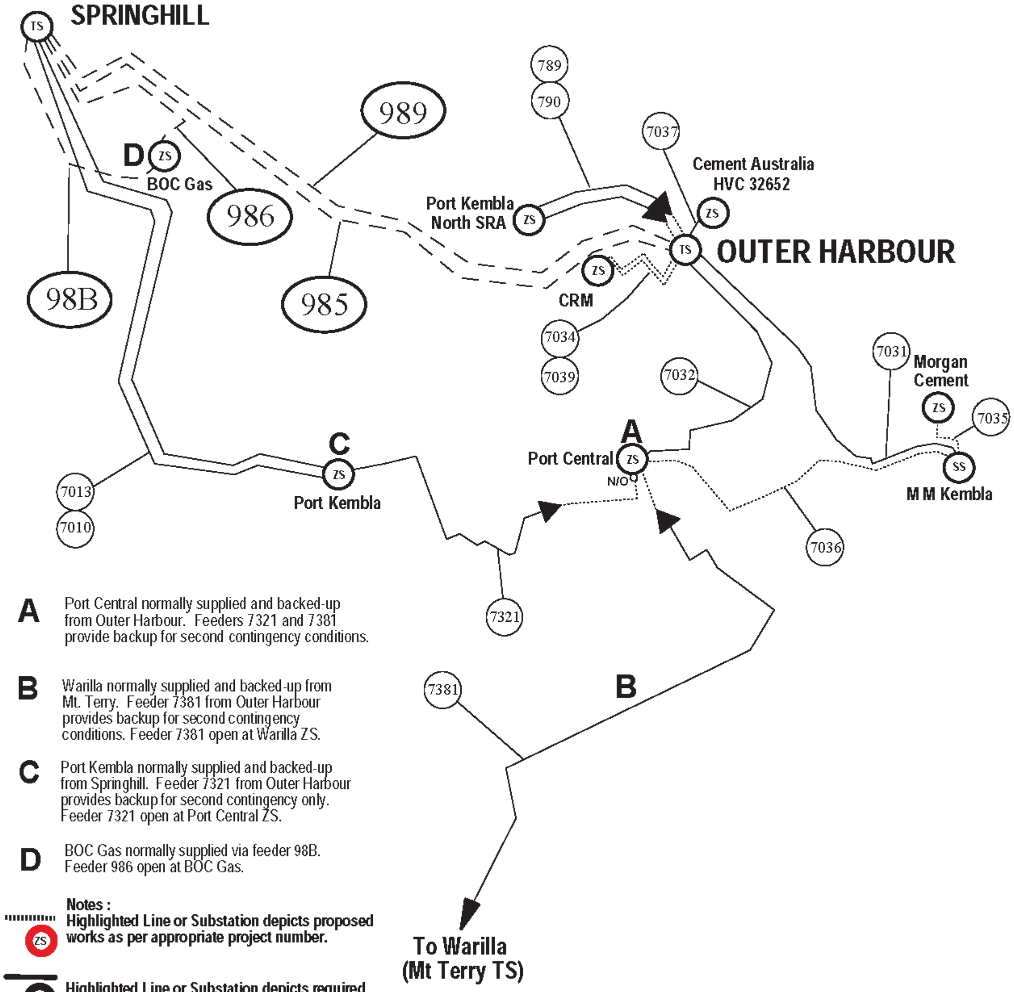
TABLE 138: OUTER HARBOUR TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7031 - Outer Harbour TS to MM KEMBLA SS	50.0	22.5	22.3	22.3	22.4	22.4
7032 - Outer Harbour TS to Port Central ZS	44.3	22.5	22.3	22.3	22.4	22.4
7036 - MM KEMBLA SS to Port Central ZS	50.3	12.2	12.2	12.2	12.2	12.2
7321 - Port Central ZS to Port Kembla ZS	27.4	0.0	0.0	0.0	0.0	0.0
7381 - Port Central ZS to Warilla ZS	32.9	0.0	0.0	0.0	0.0	0.0

TABLE 139: OUTER HARBOUR TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.23.3 OUTER HARBOUR TS NETWORK MAP



A Port Central normally supplied and backed-up from Outer Harbour. Feeders 7321 and 7381 provide backup for second contingency conditions.

B Warilla normally supplied and backed-up from Mt. Terry. Feeder 7381 from Outer Harbour provides backup for second contingency conditions. Feeder 7381 open at Warilla ZS.

C Port Kembla normally supplied and backed-up from Springhill. Feeder 7321 from Outer Harbour provides backup for second contingency only. Feeder 7321 open at Port Central ZS.

D BOC Gas normally supplied via feeder 98B. Feeder 986 open at BOC Gas.

Notes :

ZS Highlighted Line or Substation depicts proposed works as per appropriate project number.

ZS Highlighted Line or Substation depicts required works for which approval is to be sought

A.24 PENRITH TRANSMISSION SUBSTATION

A.24.1 PENRITH TS CONNECTION POINTS

Penrith TS is supplied from Regentville BSP by 132kV feeders 222 and 238. Penrith TS is equipped with three 120MVA 132/33kV transformers providing a firm capacity of 240MVA.

TABLE 140: PENRITH TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Cambridge Park ZS	33/11kV	2 x 25	50	25	3.75	2.12
Cranebrook ZS	33/11kV	3 x 25	75	50	3.75	1.50
Emu Plains ZS	33/11kV	3 x 25	75	50	3.75	2.49
Jordan Springs ZS	33/11kV	2 x 25	50	25	4.25	1.45
Kingswood ZS	33/11kV	3 x 25	75	50	11.25	2.53
Penrith TS	132/33kV	3 x 120	360	240	8.25	-

TABLE 141: PENRITH TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Cambridge Park ZS	0.988	17.5	21.8	17.9	17.8	17.7	17.6	17.5
Cranebrook ZS	0.991	29.7	26.5	27.5	29.5	29.4	29.3	29.2
Emu Plains ZS	0.999	32.1	35.5	29.6	30.3	30.2	30.1	29.9
Jordan Springs ZS	0.900	18.4	23.4	27.6	28.4	28.4	28.4	28.3
Kingswood ZS	0.951	45.8	47.0	45.1	45.4	48.1	48.0	47.9
Penrith TS	0.952	132.3	148.9	130.3	133.7	135.8	135.3	134.8

TABLE 142: PENRITH TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Cambridge Park ZS	0.996	14.8	13.2	12.4	12.5	12.5	12.4	12.4
Cranebrook ZS	0.993	24.3	24.3	26.7	26.9	26.8	26.8	26.8
Emu Plains ZS	0.997	29.3	26.8	25.9	26.4	26.3	26.3	26.2
Jordan Springs ZS	0.900	11.0	13.6	17.2	17.8	17.9	17.8	17.8
Kingswood ZS	0.990	33.8	33.0	31.4	31.9	31.8	31.7	31.7
Penrith TS	0.991	105.7	116.0	110.7	112.5	112.4	112.2	112.0

A.24.2 PENRITH TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Penrith TS operates at 33kV.

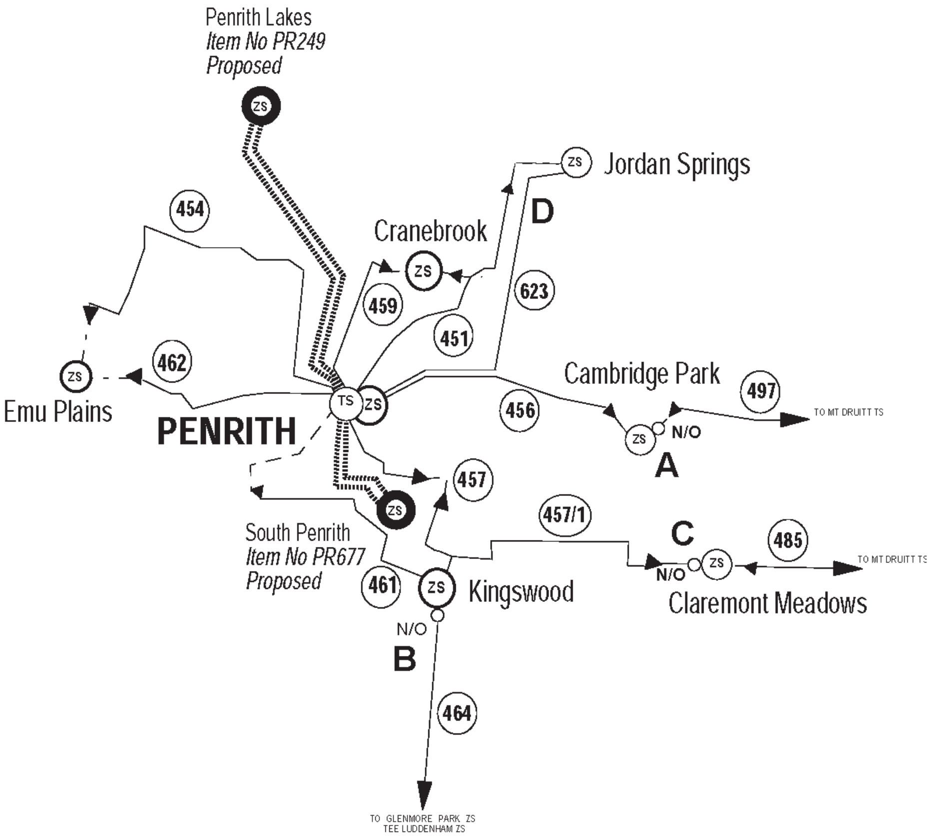
TABLE 143: PENRITH TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
451 - Jordan Springs ZS to ABS 97008	42.0	29.1	29.7	29.8	29.7	29.7
451 - Penrith TS to TEE	42.0	36.5	38.2	38.2	38.2	38.1
451 - Cranebrook ZS to TEE	42.0	27.6	29.3	29.3	29.2	29.2
451 - ABS 97008 to TEE	42.0	29.1	29.7	29.8	29.7	29.7
454 - Penrith TS to Emu Plains ZS	42.0	30.1	30.5	30.4	30.3	30.3
456 - Penrith TS to Cambridge Park ZS	34.0	17.9	17.7	17.6	17.5	17.4
457 - Penrith TS to TEE	42.0	34.0	34.7	36.3	36.2	36.2
457 - Claremont Meadows ZS to ABS 5915	50.0	33.2	34.7	35.6	35.5	34.8
457 - Kingswood ZS to TEE	42.0	34.0	33.8	36.3	36.3	36.2
457 - ABS 5915 to TEE	38.1	33.2	34.7	35.6	35.5	34.8
459 - Penrith TS to Cranebrook ZS	42.0	27.4	29.2	29.2	29.1	29.1
461 - Penrith TS to Kingswood ZS	42.0	34.1	34.7	37.1	37.0	36.4
462 - Penrith TS to Emu Plains ZS	42.0	29.7	30.1	30.0	29.9	29.9
623 - Penrith TS to Jordan Springs ZS	33.2	29.1	29.7	29.8	29.8	29.7

TABLE 144: PENRITH TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

A.24.3 PENRITH TS NETWORK MAP



Notes :

Highlighted Line or Substation depicts proposed works as per appropriate project number.

Highlighted Line or Substation depicts line or substation with constraints

A Cambridge Park is normally supplied from fdr 456 Penrith, on changeover to fdr 497 Mt Druitt .

B Kingswood is normally supplied from fdr's 461 and 457 Penrith on changeover to fdr 464 Regentville.

C Claremont Meadows is normally supplied from fdr 485 Mt Druitt on changeover to fdr 457/1 Penrith.

D Jordan Springs is normally supplied from fdr 623 and fdr 451 Penrith.

A.25 REGENTVILLE BULK SUPPLY POINT

A.25.1 REGENTVILLE BSP CONNECTION POINTS

Regentville Bulk Supply Point is owned by TransGrid and is equipped with two 375 MVA 330/132kV transformers providing a firm capacity of 375MVA.

TABLE 145: REGENTVILLE BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Glenmore Park ZS	33/11kV	2 x 45	90	45	4.50	3.24
Luddenham ZS	33/11kV	2 x 15	30	15	4.25	0.52
North Warragamba ZS	33/11kV	1 x 25 + 1 x 15	40	15	-	0.73
Penrith ZS	33/11kV	2 x 65	130	65	4.00	0.87
Penrith TS	132/33kV	3 x 120	360	240	8.25	-
Warrimoo TS	132/33kV	2 x 60	120	60	4.75	-

TABLE 146: REGENTVILLE BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Glenmore Park ZS	0.977	38.3	44.8	38.0	38.2	39.5	39.3	39.1
Luddenham ZS	0.926	12.1	10.9	8.6	13.1	14.8	14.8	14.7
North Warragamba ZS	0.918	10.5	12.0	10.3	10.2	10.1	10.1	10.0
Penrith ZS	0.971	46.2	46.7	47.7	54.8	56.1	61.5	70.1
Penrith TS	0.952	132.3	148.9	130.3	133.7	135.8	135.3	134.8
Warrimoo TS	0.937	53.3	61.1	44.7	44.4	44.0	43.7	43.4
Regentville BSP	0.967	413.4	353.0	275.9	290.4	296.5	300.8	308.4

TABLE 147: REGENTVILLE BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Glenmore Park ZS	0.995	22.9	23.2	22.1	22.3	23.5	23.5	23.4
Luddenham ZS	0.923	7.1	7.2	6.9	7.5	7.5	7.4	7.4
North Warragamba ZS	0.918	8.2	8.3	8.1	8.1	8.0	8.0	8.0
Penrith ZS	0.998	31.1	32.4	36.5	39.1	39.7	39.7	39.8
Penrith TS	0.991	105.7	116.0	110.7	112.5	112.4	112.2	112.0
Warrimoo TS	0.968	43.1	47.8	42.3	42.2	42.1	42.0	41.9
Regentville BSP	0.967	227.6	278.4	219.3	224.2	225.8	225.4	225.0

A.25.2 REGENTVILLE BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Regentville BSP operates at 132kV and is further transformed to 33kV at Penrith Transmission Substation and Glenmore Park Zone Substation.

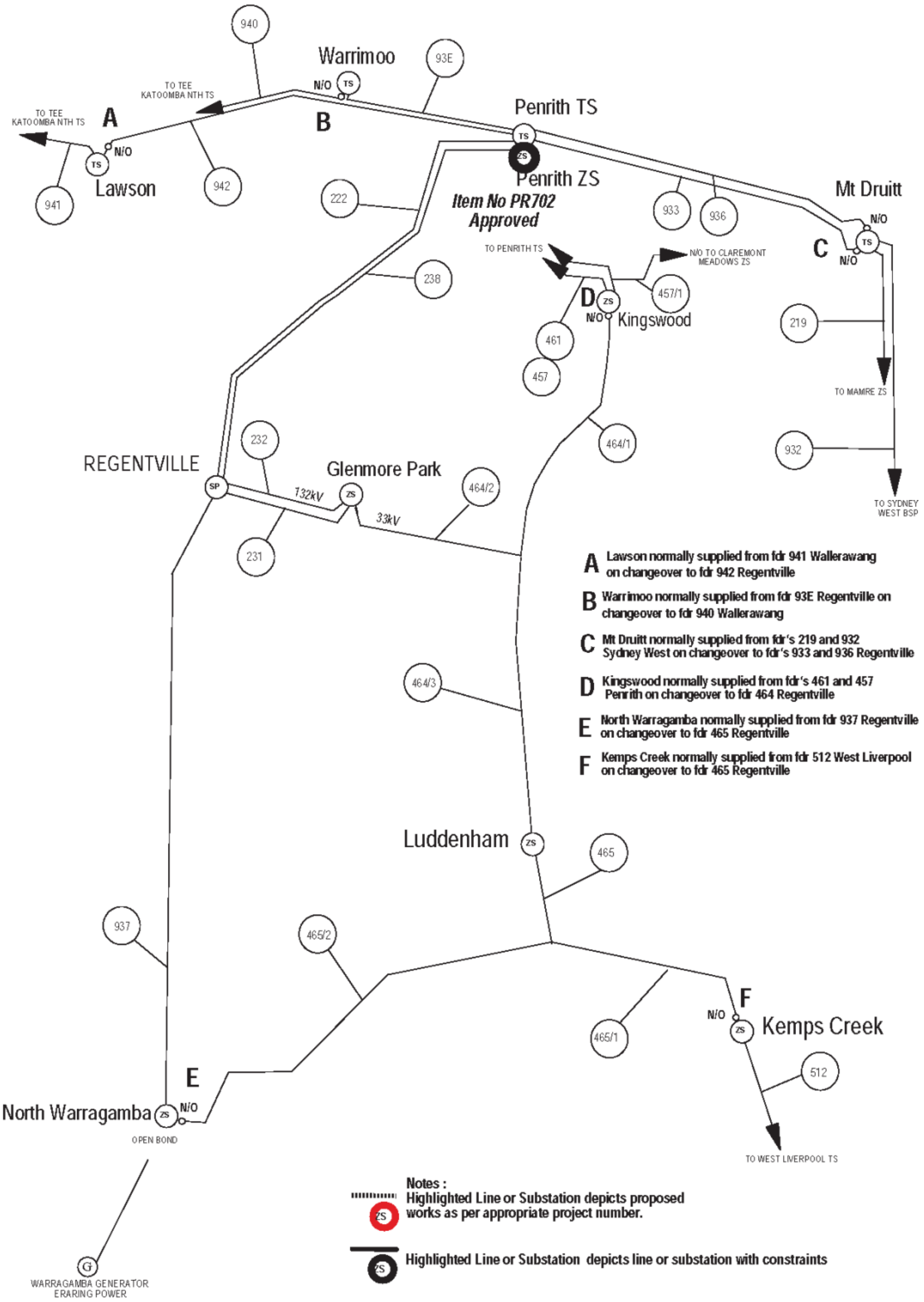
TABLE 148: REGENTVILLE BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
222 - Regentville BSP to Penrith TS	447.9	214.8	226.4	229.3	234.7	244.2
231 - Regentville BSP to Glenmore Park ZS	171.5	47.0	52.0	55.6	55.4	55.2
232 - Regentville BSP to Glenmore Park ZS	171.5	47.0	52.1	55.6	55.4	55.2
238 - Regentville BSP to Penrith TS	447.9	214.8	226.4	229.3	234.7	244.2
464 - Kingswood ZS to TEE	17.0	14.9	15.0	16.0	16.0	15.9
464 - Glenmore Park ZS to TEE	57.4	24.0	29.0	32.1	34.9	42.6
464 - Luddenham ZS to TEE	57.4	22.6	26.0	29.5	34.9	42.6
465 - Luddenham ZS to ABS 67504	21.0	13.6	15.2	17.9	18.6	26.3
465 - Kemps Creek ZS to ABS 67503	21.0	13.7	15.1	17.9	18.6	26.3
465 - North Warragamba ZS to ABS 67504	25.0	11.8	11.8	11.7	11.6	11.6
933 - Mount Druitt TS to Penrith TS	120.0	0.7	0.7	0.7	0.7	0.7
936 - Mount Druitt TS to Penrith TS	120.0	0.7	0.7	0.7	0.7	0.7
937 - Regentville BSP to North Warragamba ZS	61.7	10.2	10.2	10.1	10.1	10.0
93E - Penrith TS to Warrimoo TS	90.0	40.4	40.8	40.7	40.1	40.0
942 - Lawson TS to Penrith TS	90.3	24.7	25.0	22.6	24.6	24.6

TABLE 149: REGENTVILLE BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Firm rating of Penrith 11kV ZS (52MVA) will be exceeded in 2019.	S2019	Temporary solution for exceeded firm rating of Penrith 11kV is load transfer of approx. 3MVA to Cranebrook ZS and Emu Plains ZS. Permanent solution includes developing a new zone substation in Penrith area. A non-network option will be investigatedfor the Penrith area.	Investigate Options
Feeders 464 and 465 are exceeded with an outage of feeder 512.	S2022	Emergency rating of feeder 464 is 57 MVA. Investigate augmentation of feeder 465. Demand Management will also be investigated.	Investigate options
On outage of feeder 464, minimum tap position on Luddenham ZS is reached.	S2027	Emergency rating of feeder 464 is 57 MVA. Investigate augmentation of feeder 465. Demand Management will also be investigated.	Investigate options

A.25.3 REGENTVILLE BSP NETWORK MAP



Endeavour Energy

A.26 SHOALHAVEN TRANSMISSION SUBSTATION

A.26.1 SHOALHAVEN TS CONNECTION POINTS

Shoalhaven TS is supplied by 132kV feeders 98L and 98U from Dapto BSP via Mt Terry TS. The Shoalhaven 132kV busbar supplies the West Tomerong TS, Evans Lane SS and Ulladulla ZS system by feeders 98J and 98P as well as Essential Energy's Batemans Bay and Moruya North substations. Shoalhaven TS is equipped with three 60MVA 132/33kV transformers providing a firm capacity of 120MVA.

TABLE 150: SHOALHAVEN TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Berry ZS	33/11kV	2 x 15	30	15	5.00	1.18
Bolong ZS	33/11kV	1 x 12.5	12.5	NA	1.00	0.28
Bomaderry ZS	33/11kV	3 x 15	45	30	2.50	2.35
Kangaroo Valley ZS	33/11kV	1 x 5 + 1 x 2.5	7.5	2.5	0.75	0.31
Nowra ZS	33/11kV	2 x 35	70	35	3.25	3.22
Shoalhaven TS	132/33kV	3 x 60	180	120	4.75	-

TABLE 151: SHOALHAVEN TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Berry ZS	0.966	8.2	9.0	8.2	8.2	8.2	8.1	8.1
Bolong ZS	0.948	2.3	3.0	3.0	3.0	3.0	3.0	2.9
Bomaderry ZS	0.961	21.1	21.0	19.8	21.7	21.7	21.9	22.3
Kangaroo Valley ZS	0.942	2.5	3.1	2.4	2.4	2.4	2.4	2.3
Nowra ZS	0.990	23.5	26.2	23.7	23.7	23.6	23.6	23.5
Shoalhaven TS	0.986	89.3	92.9	91.7	97.9	97.8	97.9	98.1

TABLE 152: SHOALHAVEN TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Berry ZS	0.982	7.8	7.9	7.7	7.8	7.8	7.8	7.7
Bolong ZS	0.959	2.8	2.6	2.6	2.6	2.6	2.5	2.5
Bomaderry ZS	0.982	18.5	18.8	18.2	21.4	21.4	21.4	21.3
Kangaroo Valley ZS	0.942	3.2	3.0	3.1	3.1	3.0	3.0	3.0
Nowra ZS	0.993	20.5	18.0	18.7	19.3	19.3	19.3	19.3
Shoalhaven TS	0.995	82.8	77.3	76.4	79.9	85.1	85.0	85.0

A.26.2 SHOALHAVEN TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Shoalhaven TS operates at 33kV.

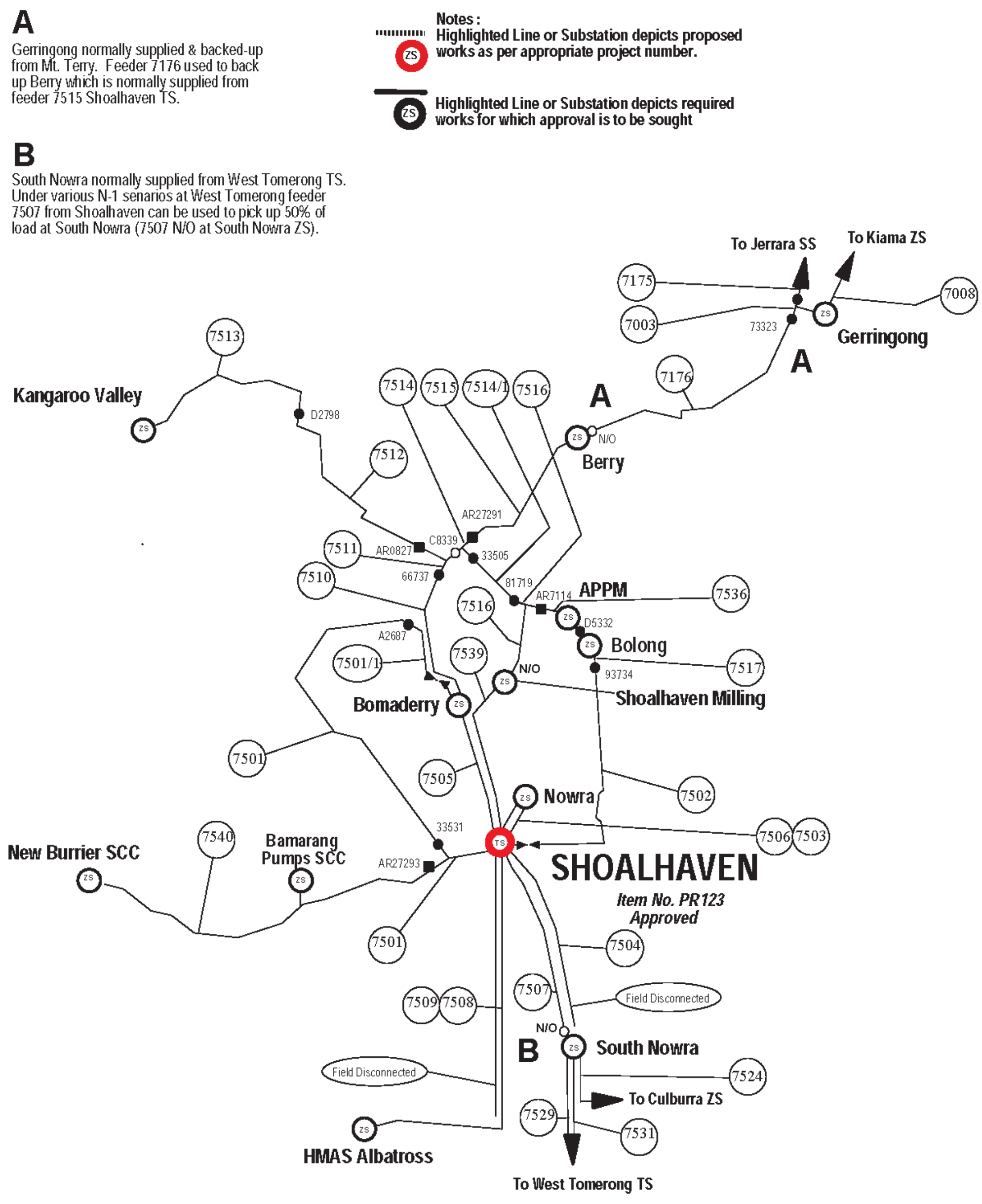
TABLE 153: SHOALHAVEN TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7501 - Shoalhaven TS to TEE	35.2	28.3	28.2	28.2	28.1	28.3
7501 - Bomaderry ZS to ABS A2687	33.5	25.8	25.7	25.6	25.5	25.9
7501 - ABS A2687 to TEE	35.2	25.8	25.7	25.6	25.5	25.9
7501 - AR 27293 to TEE	35.2	2.6	2.6	2.6	2.6	2.6
7502 - Shoalhaven TS to ABS 93734	46.6	56.1	63.0	63.1	63.5	63.5
7503 - Shoalhaven TS to Nowra ZS	74.6	0.0	0.0	0.0	0.0	0.0
7505 - Shoalhaven TS to Bomaderry ZS	43.4	24.8	24.7	24.6	24.8	25.2
7506 - Shoalhaven TS to Nowra ZS	74.6	24.2	24.2	24.1	23.8	23.8
7507 - Shoalhaven TS to South Nowra ZS	35.1	0.0	0.0	0.0	0.0	0.0
7510 - Bomaderry ZS to ABS 66737	13.6	11.4	11.4	11.3	11.3	11.3
7512 - Kangaroo Valley ZS to AR A0827	13.3	3.2	3.1	3.1	3.1	3.1
7514 - ABS C8339 to TEE	13.3	8.9	8.9	8.8	8.8	8.8
7514 - ABS 33505 to ABS 81719	13.3	11.6	11.5	11.5	11.5	11.4
7514 - ABS 33505 to TEE	13.3	11.6	11.5	11.5	11.5	11.4
7514 - AR 27291 to TEE	13.3	10.3	10.5	10.5	10.5	10.4

TABLE 154: SHOALHAVEN TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Shoalhaven TS bus section No 1 exceed capacity upon an outage of bus section No 2	Existing	Bus section No 1 supplies Manildra, Bomaderry, Nowra and Kangaroo Valley at greater than 60MVA. Investigate transferring load onto another bus section to avoid limitation under contingency.	Swap Feeders and continue to monitor

A.26.3 SHOALHAVEN TS NETWORK MAP



A.27 SPRINGHILL TRANSMISSION SUBSTATION

A.27.1 SPRINGHILL TS CONNECTION POINTS

Springhill Transmission Substation is supplied by 132kV feeders 982 and 98Y from TransGrid's Dapto BSP. It is also supplied by feeders 983/984, which have been cut in and out of Tallawarra SS as part of the Tallawarra generation project. Springhill TS is equipped with three 120MVA 132/33kV transformers that supply Endeavour Energy's network with a firm capacity of 240MVA. A further five 60MVA 132/33kV transformers supply BlueScope Steel at 33kV.

TABLE 155: SPRINGHILL TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Dapto ZS	33/11kV	3 x 25	75	50	2.75	4.32
Figtree ZS	33/11kV	2 x 25	50	25	1.25	2.33
Inner Harbour ZS	33/11kV	2 x 12.5	25	12.5	-	0.01
Kembla Grange ZS	33/11kV	2 x 10	20	10	6.25	0.34
Kenny Street ZS	33/11kV	2 x 25	50	25	8.50	0.14
North Wollongong ZS	33/11kV	2 x 19	38	19	12.25	0.31
Port Kembla ZS	33/11kV	2 x 25	50	25	7.25	1.19
South Wollongong ZS	33/11kV	2 x 19	38	19	12.00	0.45
Unanderra ZS	33/11kV	3 x 12	36	24	8.25	0.55
West Wollongong ZS	33/11kV	1 x 10 + 2 x 12.5	35	22.5	1.75	1.11
Springhill TS	132/33kV	3 x 120	360	240	17.50	7.25

TABLE 156: SPRINGHILL TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Dapto ZS	0.992	32.9	34.7	30.5	31.6	32.3	34.6	36.3
Figtree ZS	0.969	21.8	24.8	26.0	26.0	25.9	25.9	25.8
Inner Harbour ZS	0.874	9.6	8.9	8.9	8.9	8.9	8.9	8.9
Kembla Grange ZS	0.968	4.1	4.4	4.7	5.0	5.1	10.7	10.7
Kenny Street ZS	0.939	19.2	19.4	18.5	20.5	20.5	20.6	20.6
North Wollongong ZS	0.988	13.4	13.5	14.6	14.8	14.7	14.7	14.7
Port Kembla ZS	0.975	11.9	13.1	13.1	13.9	13.9	13.9	13.8
South Wollongong ZS	0.990	14.8	15.0	17.1	18.3	18.3	18.3	18.3
Unanderra ZS	0.980	13.0	17.1	13.0	14.2	14.3	18.3	18.2
West Wollongong ZS	0.963	12.7	13.9	12.5	12.4	12.4	12.3	12.3
Springhill TS	0.964	172.8	179.8	164.7	170.0	170.6	179.8	181.0

TABLE 157: SPRINGHILL TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Dapto ZS	0.999	25.6	26.5	27.0	27.3	27.6	26.2	27.0
Figtree ZS	0.988	20.0	19.7	19.8	20.9	20.9	20.9	20.8
Inner Harbour ZS	0.899	9.8	10.3	10.3	10.3	10.3	10.3	10.3
Kembla Grange ZS	0.981	3.5	3.7	4.0	4.5	4.6	4.7	3.1
Kenny Street ZS	0.941	14.0	13.7	14.0	14.0	14.2	14.2	14.3
North Wollongong ZS	0.993	13.3	13.5	13.9	14.3	14.3	14.3	14.3
Port Kembla ZS	0.993	13.6	14.0	14.0	14.7	14.7	14.6	14.6
South Wollongong ZS	0.993	13.9	12.7	12.8	14.4	14.4	14.4	14.4
Unanderra ZS	0.980	12.4	12.6	12.8	13.0	13.2	13.3	13.3
West Wollongong ZS	0.985	11.6	13.1	13.2	13.7	13.7	13.6	13.6
Springhill TS	0.972	155.7	157.3	160.1	164.6	165.3	164.2	163.6

A.27.2 SPRINGHILL TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Springhill TS operates at 33kV.

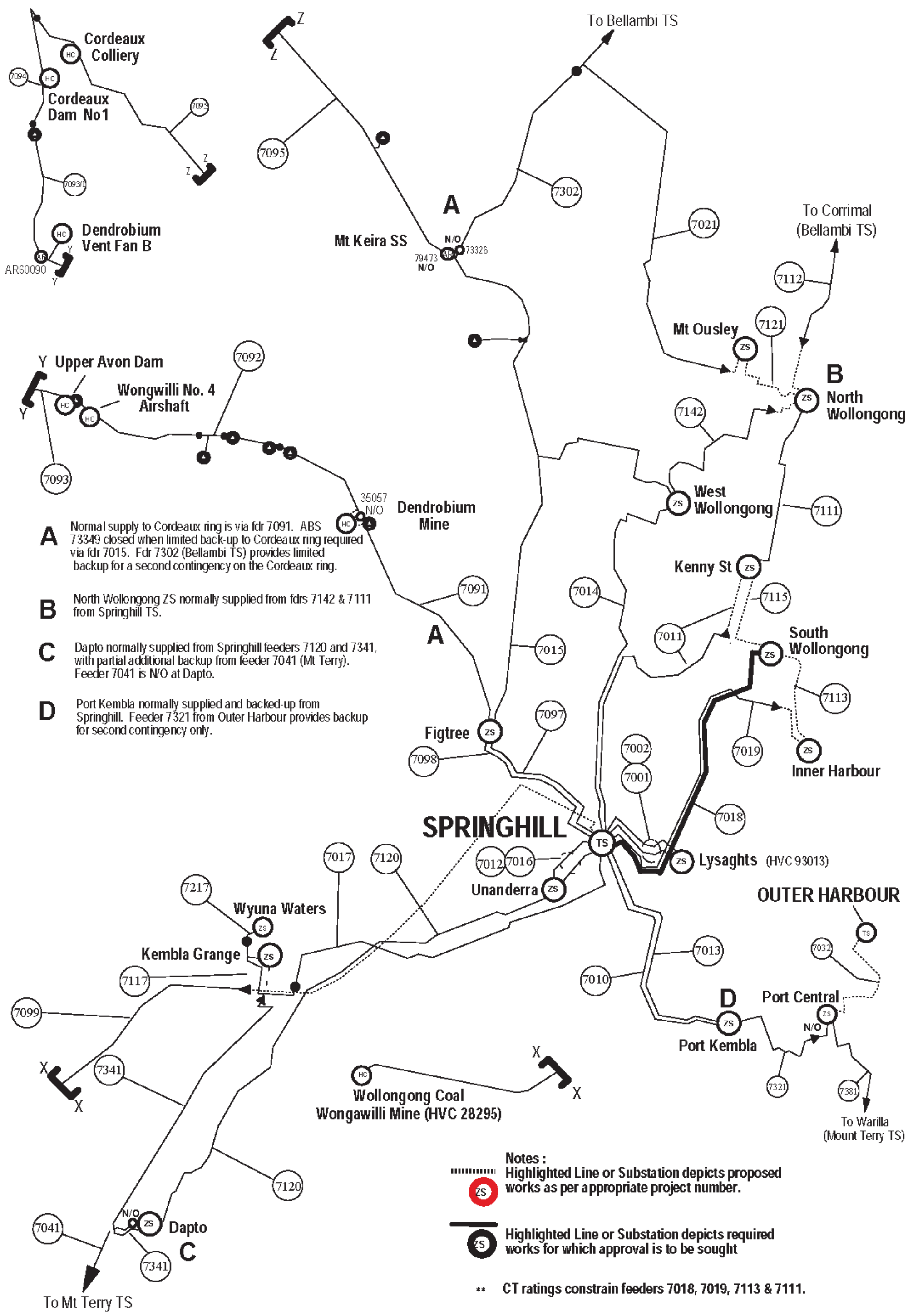
TABLE 158: SPRINGHILL TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7010 - Springhill TS to Port Kembla ZS	19.7	14.8	15.1	15.0	15.0	15.0
7011 - Springhill TS to Kenny Street ZS	30.9	25.3	26.3	26.3	26.5	26.6
7012 - Springhill TS to Unanderra ZS	44.4	25.0	26.2	26.7	33.7	34.8
7013 - Springhill TS to Port Kembla ZS	19.7	14.8	15.1	15.0	15.0	15.0
7014 - Springhill TS to West Wollongong ZS	42.8	21.2	21.7	21.7	21.9	21.9
7015 - Figtree ZS to TEE	46.3	10.9	11.3	11.3	11.4	11.4
7015 - TEE to TEE	13.4	9.4	10.0	10.1	11.3	11.6
7015 - ABS 73326 to TEE	13.4	9.4	10.0	10.2	11.4	11.6
7015 - AR 79473 to TEE	29.2	6.4	6.4	6.4	6.5	6.5
7015 - West Wollongong ZS to TEE	46.3	10.9	11.3	11.3	11.4	11.4
7016 - Springhill TS to Unanderra ZS	33.2	26.5	27.7	28.3	35.7	36.9
7017 - Springhill TS to ABS 73318	33.2	23.3	24.0	24.6	32.4	33.4
7018 - Springhill TS to South Wollongong ZS	41.4	33.9	35.2	35.2	35.5	35.6
7019 - Springhill TS to Inner Harbour ZS	46.3	24.1	25.0	25.0	25.2	25.3
7097 - Springhill TS to Figtree ZS	42.8	44.6	44.5	44.5	44.8	44.9
7098 - Springhill TS to Figtree ZS	49.7	44.6	44.5	44.4	44.8	44.8
7111 - Kenny Street ZS to North Wollongong ZS	50.0	18.0	18.2	18.2	18.2	18.2
7113 - Inner Harbour ZS to South Wollongong ZS	34.9	14.7	15.0	15.0	15.0	15.0
7115 - Kenny Street ZS to South Wollongong ZS	30.9	21.3	22.4	22.4	22.6	22.7
7120 - Dapto ZS to Unanderra ZS	33.2	38.0	39.2	40.3	50.4	52.7
7142 - North Wollongong ZS to West Wollongong ZS	28.6	16.6	17.8	17.8	18.0	18.1
7341 - Dapto ZS to Kembla Grange ZS	32.1	16.4	16.9	17.3	18.9	20.0

TABLE 159: SPRINGHILL TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Feeder 7018 (Springhill TS to South Wollongong ZS) exceeds its limitation for an outage of feeders 7011, 7019, 7014 or 7142.	Existing	Limitation caused by the 500A CT (C3) at South Wollongong ZS on feeder 7018. Investigate changing the 500A CT to a 1000A CT.	Continue to monitor
Feeder 7097 is overloaded for outage of Feeder 7098	Existing	Manage Load at risk	Monitor

A.27.3 SPRINGHILL TS NETWORK MAP



A.28 SYDNEY NORTH BULK SUPPLY POINT

A.28.1 SYDNEY NORTH BSP CONNECTION POINTS

Sydney North Bulk Supply Point is owned by TransGrid and has five 375 MVA 330/132kV transformers. Both Endeavour Energy and Ausgrid take supply at 132kV from this BSP. Kellyville and Kenthurst zone substations are normally supplied from Sydney North while Carlingford TS is capable of being supplied from Sydney North under contingency conditions, subject to rearrangement of the Ausgrid system.

TABLE 160: SYDNEY NORTH BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Kellyville ZS	33/11kV	2 x 25	50	25	2.50	1.64
Kenthurst ZS	66/11kV & 33/11kV	1 x 25(33kV) + 1 x 25(66kV)	50	25	6.75	1.06

TABLE 161: SYDNEY NORTH BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Kellyville ZS	0.986	19.9	20.0	17.6	17.8	17.7	17.6	17.5
Kenthurst ZS	0.967	20.3	23.3	18.1	18.0	17.9	17.8	17.7
Sydney North BSP	0.995	37.8	38.2	31.6	31.7	31.5	31.3	31.1

TABLE 162: SYDNEY NORTH BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Kellyville ZS	0.993	13.4	13.4	12.6	12.8	12.8	12.7	12.7
Kenthurst ZS	0.989	15.7	16.0	15.0	15.0	15.0	15.0	14.9
Sydney North BSP	0.995	29.5	29.3	27.5	27.7	27.6	27.5	27.5

A.28.2 SYDNEY NORTH BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Sydney North BSP operates at 132kV.

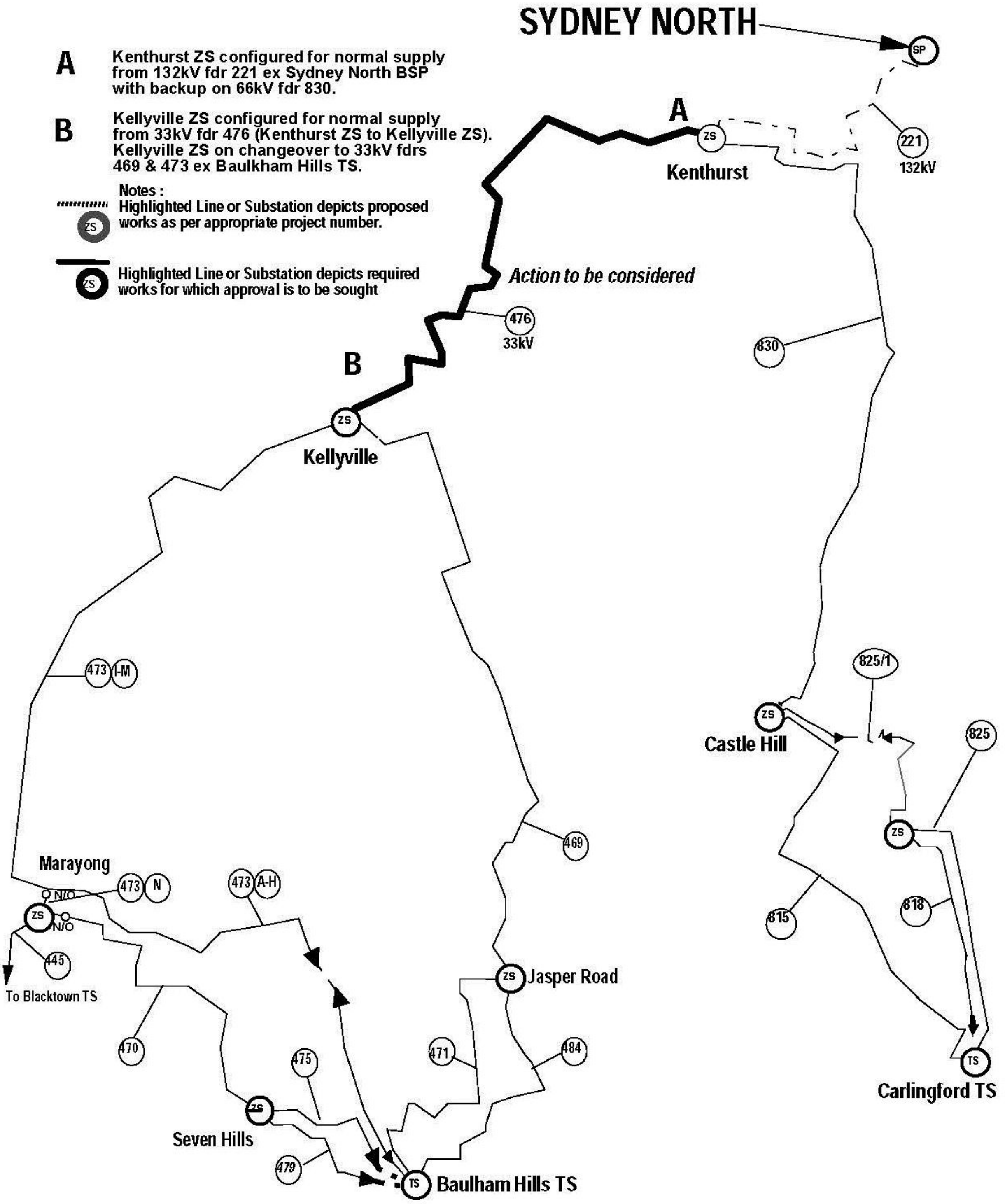
TABLE 163: SYDNEY NORTH BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
221 - Sydney North BSP to Kenthurst ZS	128.0	37.9	38.0	37.7	37.5	37.2
476 - Kellyville ZS to Kenthurst ZS	19.0	18.7	18.9	18.8	18.6	18.5

TABLE 164: SYDNEY NORTH BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
The capacity of feeder 476 (Kenthurst ZS to Kellyville ZS) is exceeded under normal operating conditions.	2017/18	Supply part of Kellyville ZS load from Baulkham Hills to reduce load below the rating of feeder 476 on peak demand days. Additional load to be transferred to Mungerie Park ZS.	Utilise transfer capacity and continue to monitor

A.28.3 SYDNEY NORTH BSP NETWORK MAP



A.29 SYDNEY WEST BULK SUPPLY POINT

A.29.1 SYDNEY WEST BSP CONNECTION POINTS

Sydney West Bulk Supply Point is owned by TransGrid and is equipped with five 375 MVA 330/132kV transformers providing a firm capacity of 1,500MVA. Endeavour Energy's network is supplied at 132kV from Sydney West BSP.

TABLE 165: SYDNEY WEST BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Arndell Park ZS	132/11kV	2 x 45	90	45	6.50	1.61
Baulkham Hills ZS	132/11kV	2 x 45	90	45	16.75	2.69
Bringelly ZS	132/11kV	1 x 19 + 1 x 25	44	19	2.75	0.62
Doonside ZS	132/11kV	3 x 45	135	90	4.25	7.23
Eastern Creek ZS	132/11kV	2 x 45	90	45	9.25	0.1
Huntingwood ZS	132/11kV	2 x 45	90	45	7.50	0.55
Mamre ZS	132/11kV	3 x 45	135	90	4.25	3.38
North Eastern Creek ZS	132/11kV	2 x 45	90	45	3.75	0.09
Oran Park ZS	132/11kV	2 x 45	90	45	1.75	0.39
Quakers Hill ZS	132/11kV	2 x 25(33kV) + 1 x 45(132kV)	95	50	4.75	3.91
Rooty Hill ZS	132/11kV	2 x 45	90	45	0.25	3.67
Science Park ZS (Proposed)	132/11kV	2 x 45	90	45	-	-
Southpipe Oakdale ZS (Proposed)	132/11kV	2 x 45	90	45	-	-
West Wetherill Park ZS	132/11kV	2 x 45	90	45	4.50	0.24
Wetherill Park ZS	132/11kV	2 x 45	90	45	0.25	0.52
Baulkham Hills TS	132/33kV	4 x 60	240	180	11.75	-
Blacktown TS	132/33kV	4 x 120	480	360	10.50	-
Carlingford TS	132/33kV	4 x 120	480	360	23.25	-
Mount Druitt TS	132/33kV	3 x 120	360	240	8.25	-
West Wetherill Park TS	132/33kV	1 x 120	120	NA	-	-

TABLE 166: SYDNEY WEST BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Arndell Park ZS	0.994	28.0	32.1	32.1	35.3	35.2	35.1	35.1
Baulkham Hills ZS	0.924	34.0	35.7	32.8	32.7	32.6	32.5	32.4
Bringelly ZS	0.992	13.3	14.6	12.6	11.6	11.6	11.5	11.4
Doonside ZS	0.971	41.8	49.4	40.0	39.7	39.5	39.3	39.0
Eastern Creek ZS	0.978	18.7	19.7	32.7	36.9	41.8	45.0	46.1
Huntingwood ZS	0.977	22.9	27.0	33.9	40.4	47.0	38.5	41.1
Mamre ZS	0.991	48.2	57.2	49.1	53.8	59.2	64.5	67.7
North Eastern Creek ZS	0.959	10.6	10.6	15.5	19.4	20.3	20.2	20.2
Oran Park ZS	-	8.6	11.9	-	-	-	-	-
Quakers Hill ZS	0.978	37.5	44.2	39.5	40.0	39.8	39.6	39.5
Rooty Hill ZS	0.962	37.6	42.6	36.4	37.7	37.7	37.6	37.5
Science Park ZS (Proposed)	-	-	-	-	0.5	3.1	5.8	8.4
Southpipe Oakdale ZS (Proposed)	0.900	-	-	1.6	4.5	8.4	13.5	18.7
West Wetherill Park ZS	0.916	29.3	32.7	37.4	37.4	37.3	37.3	37.2
Wetherill Park ZS	0.979	38.4	29.1	30.9	30.8	30.8	30.8	30.7
Baulkham Hills TS	0.954	134.1	141.4	129.8	134.1	138.7	143.1	146.4
Blacktown TS	0.984	244.0	279.6	258.0	273.2	278.2	281.0	283.8
Carlingford TS	0.997	226.4	231.8	194.6	200.7	201.5	203.9	206.3
Mount Druitt TS	0.991	143.9	150.7	145.0	146.8	146.8	146.4	145.9
Sydney West BSP	0.995	1105.3	1236.5	1163.3	1215.4	1247.6	1277.1	1301.8

TABLE 167: SYDNEY WEST BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Arndell Park ZS	0.996	22.6	22.1	24.8	25.5	25.4	25.4	25.4
Baulkham Hills ZS	0.924	28.9	25.2	25.2	25.3	25.3	25.2	25.2
Bringelly ZS	0.985	10.8	10.4	9.2	9.2	8.5	8.5	8.7
Doonside ZS	0.988	32.0	32.7	30.5	30.5	30.4	30.3	30.3
Eastern Creek ZS	0.987	16.2	16.5	20.8	26.0	29.8	34.7	37.9
Huntingwood ZS	0.990	20.5	23.0	26.7	32.5	38.0	43.6	30.2
Mamre ZS	0.998	33.9	39.2	35.3	36.3	37.4	37.3	37.3
North Eastern Creek ZS	0.994	8.4	8.4	12.4	12.4	12.4	12.4	12.4
Oran Park ZS	-	4.7	10.7	-	-	-	-	-
Quakers Hill ZS	0.993	24.4	26.4	25.8	27.4	27.4	27.3	27.3
Rooty Hill ZS	0.982	24.9	26.4	23.8	24.8	24.8	24.8	24.7
Science Park ZS (Proposed)	0.916	27.0	26.4	31.7	32.0	32.0	31.9	31.9
Southpipe Oakdale ZS (Proposed)	0.979	28.2	27.9	29.1	30.1	30.0	30.0	30.0
West Wetherill Park ZS	0.996	22.6	22.1	24.8	25.5	25.4	25.4	25.4
Wetherill Park ZS	0.924	28.9	25.2	25.2	25.3	25.3	25.2	25.2
Baulkham Hills TS	0.989	108.0	123.1	100.5	103.7	106.6	111.2	115.3
Blacktown TS	0.995	181.6	190.2	188.1	194.6	197.7	200.5	203.4
Carlingford TS	0.982	187.4	188.5	175.4	181.6	183.5	185.3	188.6
Mount Druitt TS	0.995	116.3	111.5	104.7	106.7	107.4	107.3	107.2
Sydney West BSP	0.988	1000.2	918.9	867.6	899.6	916.5	934.5	947.7

A.29.2 SYDNEY WEST BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Sydney West BSP operates at 132kV.

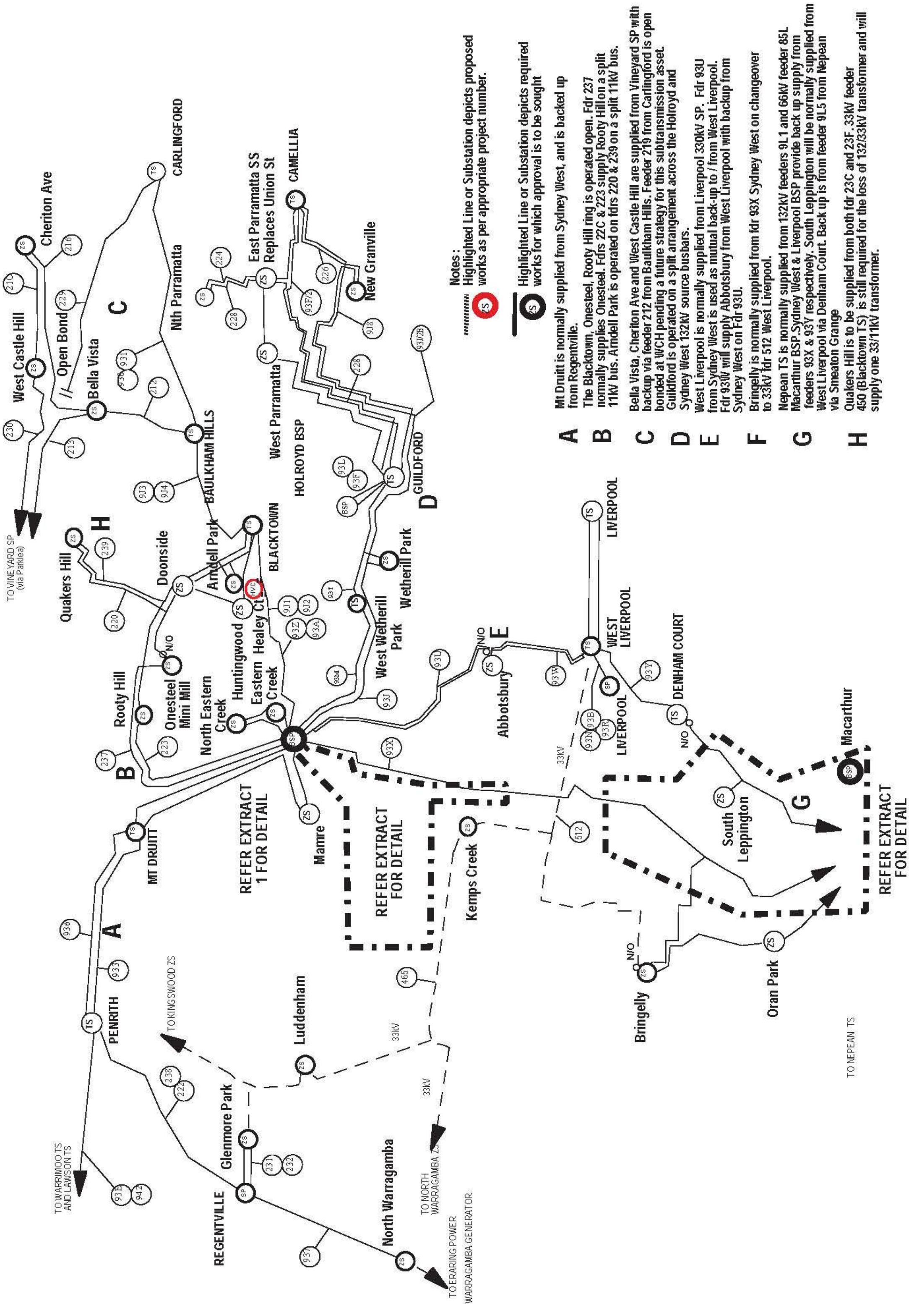
TABLE 168: SYDNEY WEST BSP – SUMMER

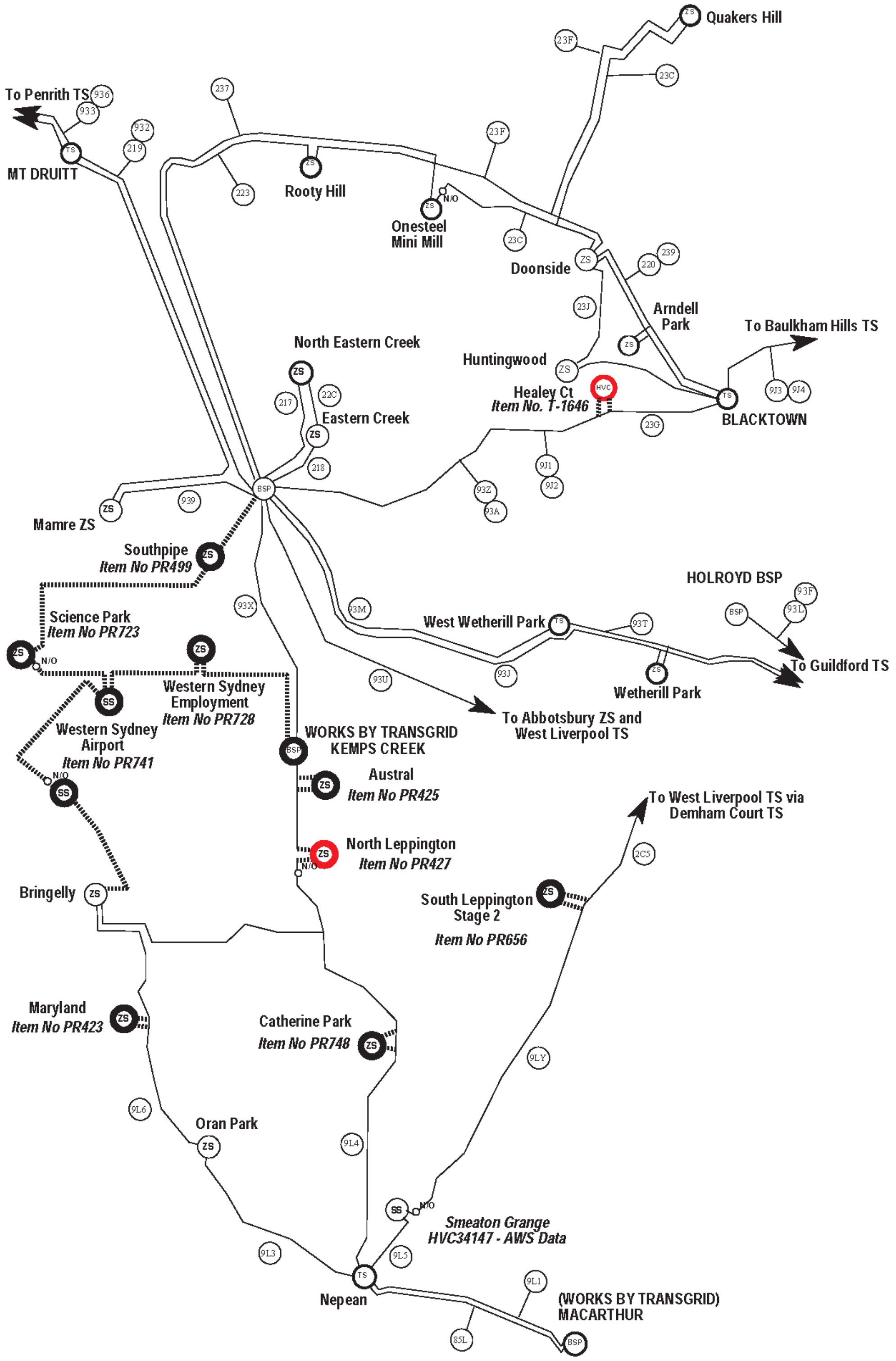
Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
212 - Baulkham Hills TS to Bella Vista ZS	231.8	56.7	82.5	85.9	88.4	91.5
217 - Sydney West BSP to North Eastern Creek ZS	172.0	48.0	56.4	61.4	65.0	66.3
218 - Sydney West BSP to Eastern Creek ZS	171.9	48.2	56.6	61.6	65.2	66.5
219 - Mount Druitt TS to Mamre ZS	229.8	50.4	55.3	60.1	66.2	70.0
220 - Blacktown TS to TEE	130.0	83.1	88.5	90.2	85.4	86.7
220 - Arndell Park ZS to TEE	80.0	33.1	36.6	35.8	35.8	35.8
220 - Doonside ZS to TEE	120.0	67.3	71.1	73.3	68.5	69.7
223 - Sydney West BSP to Rooty Hill ZS	130.1	38.6	40.1	39.3	39.2	39.2
229 - Carlingford TS to OPEN BOND	99.7	0.9	0.9	0.9	0.9	0.9
22C - Eastern Creek ZS to North Eastern Creek ZS	171.9	32.8	37.1	41.6	45.1	46.4
239 - Blacktown TS to TEE	130.0	83.2	88.5	90.3	85.5	86.8
239 - Arndell Park ZS to TEE	80.0	33.1	36.5	35.8	35.8	35.8
239 - Doonside ZS to TEE	120.0	67.4	71.2	73.4	68.6	69.8
23C - Doonside ZS to TEE	130.0	59.4	60.4	59.1	59.0	58.9
23C - Quakers Hill ZS to TEE	130.3	40.8	41.1	40.2	40.1	40.0
23C - Rooty Hill ZS to TEE	76.0	39.3	40.8	39.9	39.9	39.9
23G - Blacktown TS to Huntingwood ZS	175.8	90.0	96.6	99.8	92.9	94.8
23J - Doonside ZS to Huntingwood ZS	162.3	55.5	55.0	51.8	54.1	53.2
744 - West Wetherill Park TS to Horsley Park ZS	21.0	9.3	9.1	9.1	9.1	9.0
930 - Baulkham Hills TS to Carlingford TS	511.9	194.6	200.3	197.3	200.1	203.0
931 - Baulkham Hills TS to Carlingford TS	511.9	194.6	200.3	197.3	200.1	203.0
932 - Sydney West BSP to Mount Druitt TS	511.9	184.2	190.3	192.6	198.3	201.8
939 - Sydney West BSP to Mamre ZS	229.8	81.0	85.1	88.0	92.5	95.1
93A - Blacktown TS to TEE	505.0	6.4	14.2	17.7	21.7	25.6
93J - Sydney West BSP to TEE	511.9	72.1	71.6	70.3	70.3	70.4
93J - Wetherill Park ZS to TEE	120.0	31.8	31.7	31.1	31.1	31.1
93J - Guildford TS to TEE	505.0	57.4	57.0	55.9	56.0	56.0
93M - Sydney West BSP to West Wetherill Park TS	505.0	70.5	70.1	68.8	68.8	68.9
93T - West Wetherill Park TS to TEE	511.9	43.0	42.6	41.8	41.8	41.9
93T - Wetherill Park ZS to TEE	120.0	31.9	31.7	31.1	31.2	31.2
93T - Guildford TS to TEE	505.0	57.5	57.1	56.0	56.0	56.1
93U - Sydney West BSP to Abbotsbury ZS	78.2	47.3	47.0	46.8	46.6	46.5
93X - Sydney West BSP to Kemps Creek BSP	199.8	38.1	42.3	46.1	51.8	58.4
93X - Bringelly ZS to TEE	229.8	27.5	31.3	34.4	38.7	43.5
93X - Catherine Park ZS to TEE	172.2	1.8	1.8	1.9	1.9	1.9
93Z - Sydney West BSP to Blacktown TS	505.0	251.4	265.8	267.3	268.2	272.8
9J1 - Sydney West BSP to Blacktown TS	505.0	253.2	267.7	269.1	270.0	274.7
9J2 - Blacktown TS to TEE	505.0	6.6	14.2	17.7	21.7	25.6
9J3 - Baulkham Hills TS to Blacktown TS	511.9	331.6	340.0	338.0	344.5	350.6
9J4 - Baulkham Hills TS to Blacktown TS	511.9	331.6	340.0	338.0	344.5	350.6

TABLE 169: SYDNEY WEST BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Mt Drutt needs to be switched to radial supply with one transformer being supplied from Penrith TS when the Mt Druitt network is abnormally switched to supply Cambridge Park ZS and Kingswood ZS	S2018	When Mt Druitt is supplying Cambridge Park ZS and Kingswood ZS, Mt Druitt needs to be switched to radial supply to make provision for possible loss of Feeder 932	Investigate double tee off arrangement for Mamre ZS to restore feeder 939 to full rating.

A.29.3 SYDNEY WEST BSP NETWORK MAP





Endeavour Energy

A.30 VINEYARD BULK SUPPLY POINT

A.30.1 VINEYARD BSP CONNECTION POINTS

Vineyard Bulk Supply Point is owned by TransGrid and has three 375 MVA 330/132kV transformers installed, providing a firm capacity of 750MVA. Endeavour Energy is supplied at 132kV from Vineyard BSP.

TABLE 170: VINEYARD BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bella Vista ZS	132/11kV	3 x 45	135	90	5.50	3.12
Box Hill ZS (Proposed)	132/22kV	2 x 45	90	45	-	-
Cheriton Avenue ZS	132/11kV	2 x 45	90	45	3.50	1.67
Marsden Park ZS	132/11kV	1 x 45	45	NA	-	-
Mungerie Park ZS	132/11kV	3 x 45	135	90	0.50	3.69
Parklea ZS	132/11kV	3 x 45	135	90	5.50	9.93
Schofields ZS	132/11kV	2 x 45	90	45	4.75	1.3
South Marsden Park ZS	132/11kV	1 x 15	15	NA	-	0.04
West Castle Hill ZS	132/11kV	2 x 65	130	65	5.00	9.54
Hawkesbury TS	132/33kV	3 x 120	360	240	10.50	-

TABLE 171: VINEYARD BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bella Vista ZS	0.967	40.5	52.7	49.0	50.2	50.1	51.5	53.1
Box Hill ZS (Proposed)	-	-	-	-	-	-	-	15.4
Cheriton Avenue ZS	0.968	29.2	33.8	29.9	30.4	34.5	35.2	36.0
Marsden Park ZS	0.900	-	-	8.1	14.4	17.8	21.6	26.2
Mungerie Park ZS	0.950	53.2	58.5	64.3	69.4	75.5	82.3	75.9
Parklea ZS	0.958	94.6	106.8	87.4	90.0	92.2	95.5	99.8
Schofields ZS	0.900	22.4	19.6	28.9	33.3	40.8	47.8	54.5
South Marsden Park ZS	0.967	-	4.7	13.1	14.8	16.9	18.1	20.0
West Castle Hill ZS	0.935	44.1	47.5	43.2	44.3	45.6	47.1	48.8
Hawkesbury TS	0.977	170.3	181.0	157.4	165.5	168.2	171.9	171.9
Vineyard BSP	0.970	470.2	500.8	468.5	521.5	549.3	577.4	606.3

TABLE 172: VINEYARD BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bella Vista ZS	0.994	28.2	28.3	28.0	30.0	30.8	30.9	33.1
Box Hill ZS (Proposed)	-	-	-	-	-	-	-	13.4
Cheriton Avenue ZS	0.998	25.2	24.0	27.1	27.5	28.1	26.5	27.7
Marsden Park ZS	0.900	-	-	6.5	20.4	12.5	14.9	18.3
Mungerie Park ZS	1.000	31.2	32.0	33.7	44.8	51.8	59.3	58.4
Parklea ZS	0.993	54.8	57.4	51.1	54.2	56.3	59.2	62.8
Schofields ZS	0.900	14.9	16.9	18.5	25.4	31.2	34.4	36.8
South Marsden Park ZS	0.900	-	-	13.9	16.0	17.7	19.3	20.8
West Castle Hill ZS	0.971	29.4	27.8	27.1	27.9	28.9	30.0	31.3
Hawkesbury TS	0.983	144.5	122.9	123.7	128.5	130.1	133.2	134.4
Vineyard BSP	0.982	309.7	314.5	328.1	390.3	414.7	434.6	462.8

A.30.2 VINEYARD BSP SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Vineyard BSP operates at 132kV.

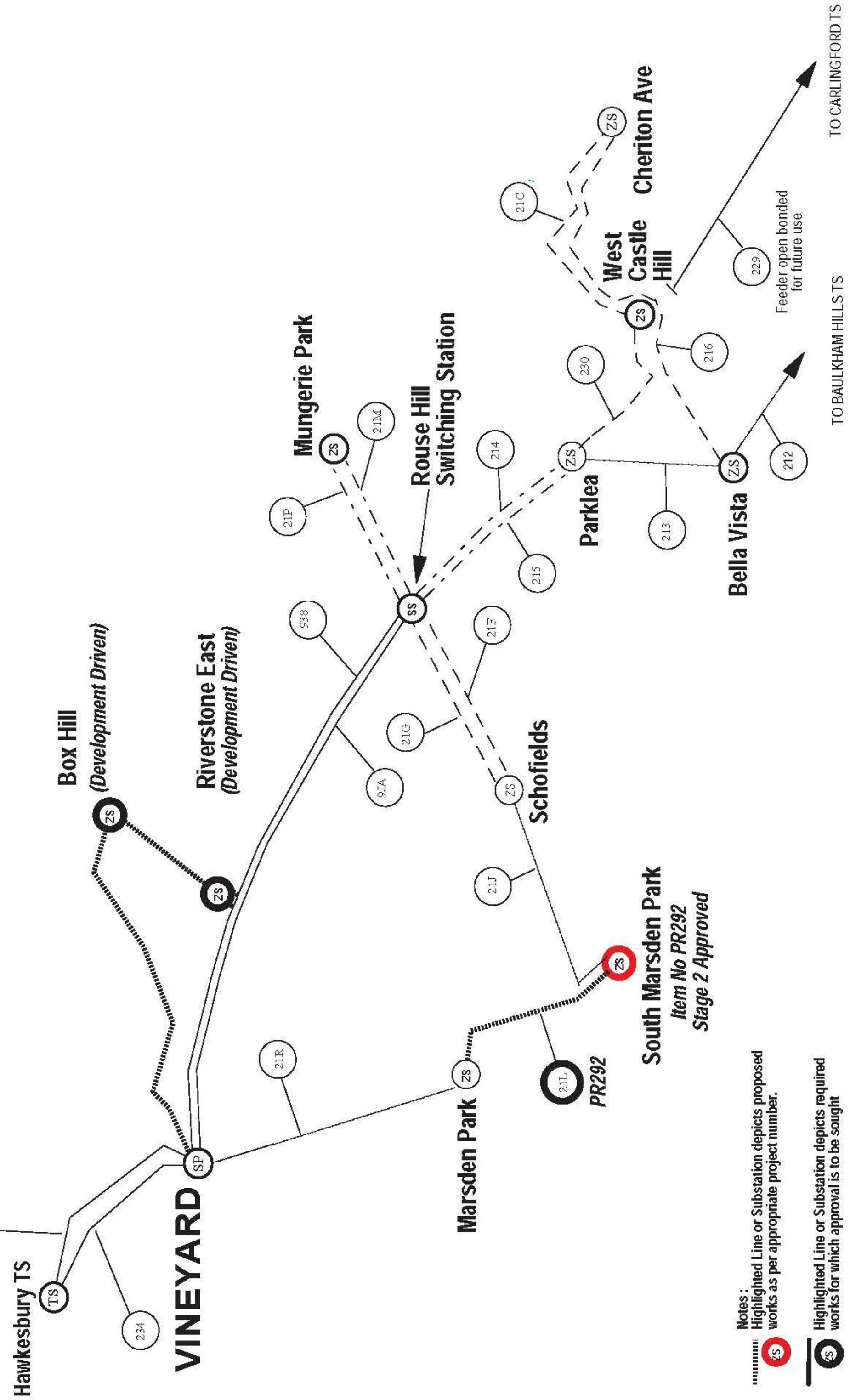
TABLE 173: VINEYARD BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
213 - Bella Vista ZS to Parklea ZS	171.9	125.7	126.9	134.5	136.7	141.3
214 - Rouse Hill SS to Parklea ZS	189.1	209.5	214.9	222.5	229.4	237.6
215 - Rouse Hill SS to Parklea ZS	189.1	209.5	214.9	222.5	229.4	237.6
216 - Bella Vista ZS to Cheriton Avenue ZS	172.0	76.5	77.2	84.1	85.6	88.4
21C - Cheriton Avenue ZS to West Castle Hill ZS	172.0	81.4	82.0	87.6	88.7	91.5
21M - Rouse Hill SS to Mungerie Park ZS	172.0	69.2	74.2	82.3	89.4	81.4
21P - Rouse Hill SS to Mungerie Park ZS	172.0	69.2	74.2	82.3	89.4	81.4
21R - Vineyard BSP to Marsden Park ZS	230.0	37.3	30.9	34.9	40.4	46.4
227 - Vineyard BSP to Hawkesbury TS	229.8	159.5	165.2	169.7	171.2	170.9
230 - Parklea ZS to West Castle Hill ZS	172.0	124.4	125.6	133.2	135.4	140.0
234 - Vineyard BSP to Hawkesbury TS	229.8	159.5	165.2	169.7	171.2	170.9
938 - Vineyard BSP to Rouse Hill SS	495.0	335.0	371.4	400.8	420.3	430.7
9JA - Vineyard BSP to Rouse Hill SS	495.0	335.0	371.4	400.8	420.3	430.7

TABLE 174: VINEYARD BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Exceed firm rating of Parklea ZS	S2019	Conduct non-network option investigation. Investigate options to utilise available capacity at Bella Vista ZS.	Investigate options
Exceed firm rating of Schofields ZS	S2021	Continue to monitor lot releases uptake and load growth. Conduct non-network option investigation when required. Third power transformer may be required.	Investigate options
Exceed firm rating of West Castle Hill ZS	S2024	Continue to monitor, conduct load transfer to Bells Vista ZS when required	Continue to monitor
Exceed firm rating of Cheriton Avenue ZS	S2026	Continue to monitor, conduct load transfer to Castle Hill ZS when required	Continue to monitor
Exceed firm rating of Mungerie Park ZS	S2026	Continue to monitor, new zone substation in Riverstone East may allow for load transfer. Investigate non-network options.	Investigate options
Outage of either feeder 214 or 215 (Rouse Hill SS to Parklea ZS) will exceed the capacity of the in-service feeders until the backup feeder 212 is utilised	Existing	Investigate schemes to switch in feeder 212 within a defined time period or implement an automation scheme to offload feeders 214 and 215. Investigate non-network options and reinstatement of feeder 229 to increase contingency capacity from Sydney West via Baulkham Hills.	Investigate options
Outage of either feeder 9JA or 938 (Vineyard BSP to Rouse Hill SS) will result in overload of the in-service feeder.	S2025	Solution to previous constraint will mitigate this	Investigate options
Outage of either feeder 213 (Parklea ZS to Bella Vista ZS) or 230 (Parklea ZS to West Castle Hill ZS) will result in overload of the other	S2027	Solution to previous constraint will mitigate this	Investigate options

A.30.3 VINEYARD BSP NETWORK MAP



A.31 WALLERAWANG BULK SUPPLY POINT

A.31.1 WALLERAWANG BSP CONNECTION POINTS

Wallerawang Bulk Supply Point is owned by TransGrid and provides supply to both Endeavour Energy and Essential Energy at both 132kV and 66kV. The 132kV busbar is supplied via two 330/132kV 375MVA transformers, which in turn supplies the 66kV busbar through two 132/66kV 60MVA transformers.

TABLE 175: WALLERAWANG BSP – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Lithgow ZS	66/11kV	1 x 30 + 1 x 35	65	30	1.50	1.85
Meadow Flat ZS	66/11kV	1 x 2.5	2.5	NA	3.50	0.12
Portland ZS	66/11kV	2 x 10	20	10	0.75	0.47
Katoomba North TS	132/66kV	2 x 60	120	60	2.00	-
Lawson TS	132/66kV	2 x 52	104	52	2.75	-

TABLE 176: WALLERAWANG BSP – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Lithgow ZS	0.989	13.3	14.1	14.3	14.3	14.3	14.2	14.2
Meadow Flat ZS	1.000	0.8	0.9	0.9	0.9	0.9	0.9	0.9
Portland ZS	0.999	2.4	2.8	2.8	2.7	2.7	2.7	2.7
Katoomba North TS	0.975	21.2	23.3	20.5	20.4	20.3	20.3	20.2
Lawson TS	0.985	19.1	27.3	23.1	23.0	23.0	22.9	22.9
Wallerawang BSP 66kV	0.935	19.0	36.3	24.2	24.3	24.2	24.1	24.0
Wallerawang BSP 132kV	0.979	68.3	51.0	43.6	43.5	43.4	43.2	43.1

TABLE 177: WALLERAWANG BSP – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Lithgow ZS	0.989	16.9	17.4	16.6	17.0	17.0	16.9	16.9
Meadow Flat ZS	0.996	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Portland ZS	0.999	3.1	3.0	3.0	3.0	3.0	3.0	3.0
Katoomba North TS	0.972	32.1	32.9	31.2	31.1	31.1	31.0	31.0
Lawson TS	0.985	21.1	23.8	25.0	25.0	25.0	25.0	25.0
Wallerawang BSP 66kV	0.935	23.8	41.7	30.3	30.6	30.6	30.6	30.5
Wallerawang BSP 132kV	0.979	93.6	80.9	56.1	56.1	56.0	55.9	55.8

A.31.2 WALLERAWANG BSP SUB-TRANSMISSION SYSTEM

The sub-transmission networks supplied by Wallerawang BSP operate at 132kV and 66kV respectively.

TABLE 178: WALLERAWANG BSP – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
940 - Wallerawang BSP to TEE	102.0	76.2	76.0	60.2	75.7	75.6
940 - Katoomba North TS to TEE	160.0	32.4	32.3	32.3	32.2	32.2
940 - Warrimoo TS to TEE	90.0	43.9	43.8	39.5	43.6	43.4
941 - Wallerawang BSP to TEE	108.6	57.8	57.7	44.0	57.6	57.5
941 - Katoomba North TS to TEE	108.6	32.1	32.0	20.7	31.9	31.9
941 - Lawson TS to TEE	108.6	25.4	25.4	25.4	25.4	25.3
817 - Wallerawang BSP to Meadow Flat ZS	21.1	1.3	1.3	1.3	1.2	1.2
823 - Wallerawang BSP to Portland ZS	20.0	5.6	5.6	5.6	5.6	5.6
857 - Wallerawang BSP to Lithgow ZS	32.0	17.4	17.4	17.3	17.3	17.2
85X - Wallerawang BSP to Lithgow ZS	28.9	17.5	17.5	17.5	17.4	17.4

TABLE 179: WALLERAWANG BSP – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Nil			

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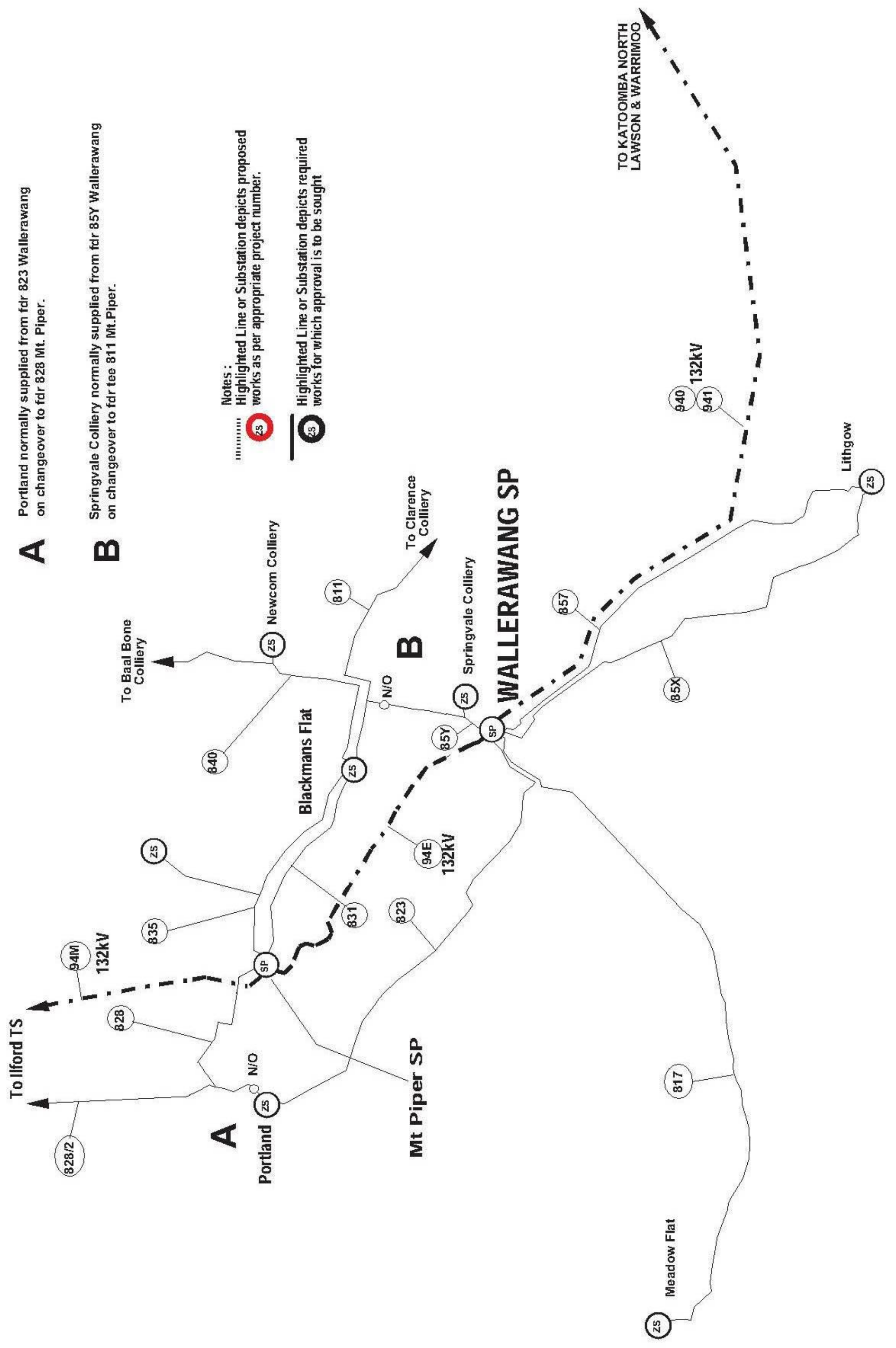
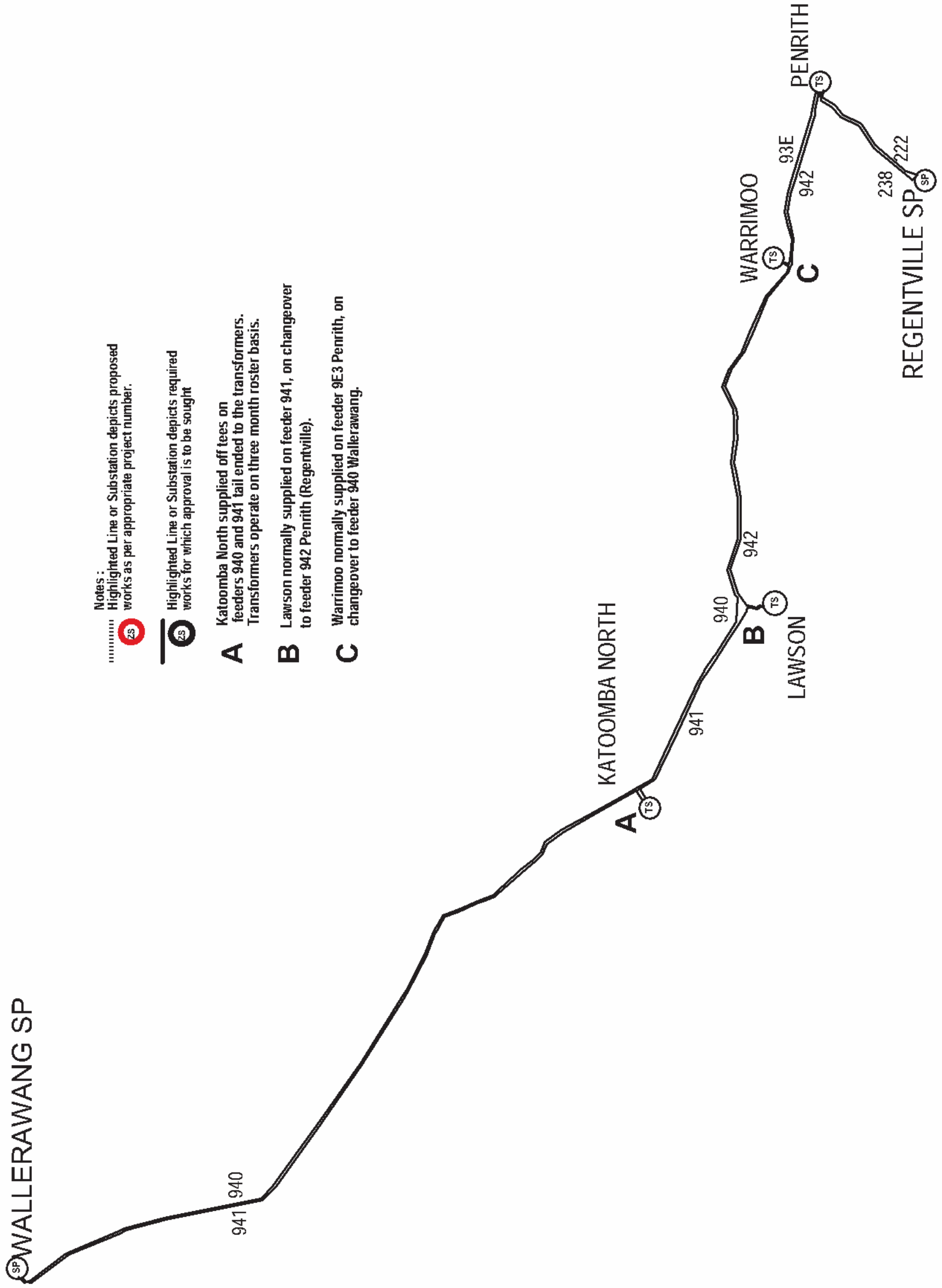
A.31.3 WALLERAWANG BSP NETWORK MAP





Notes :
Highlighted Line or Substation depicts proposed works as per appropriate project number.
Highlighted Line or Substation depicts required works for which approval is to be sought
A Katoomba North supplied off tees on feeders 940 and 941 tail ended to the transformers. Transformers operate on three month roster basis.
B Lawson normally supplied on feeder 941, on changeover to feeder 942 Penrith (Regentville).
C Warrimoo normally supplied on feeder 9E3 Penrith, on changeover to feeder 940 Wallerawang.
WALLERAWANG SP
940
941
KATOOMBA NORTH
A
941
940
942
B
LAWSON
WARRIMOO
C
93E
942
PENRITH
238
222
REGENTVILLE SP

A.32 WARRIMOO TRANSMISSION SUBSTATION

A.32.1 WARRIMOO TS CONNECTION POINTS

Warrimoo TS is supplied by 132kV Feeder 93E from Regentville BSP via Penrith TS. An alternative supply is available from Wallerawang BSP via 132kV Feeder 940. Warrimoo TS is equipped with two 60MVA 132/66/11kV transformers providing a firm capacity of 60MVA at 66kV.

TABLE 180: WARRIMOO TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Blaxland ZS	33/11kV	2 x 35	70	35	3.75	2.79
Springwood ZS	33/11kV	2 x 35	70	35	1.50	3.35
Warrimoo TS	132/33kV	2 x 60	120	120	4.75	-

TABLE 181: WARRIMOO TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Blaxland ZS	0.961	25.3	29.7	20.9	20.7	20.6	20.4	20.3
Springwood ZS	0.972	26.3	33.3	22.6	22.4	22.2	22.1	21.9
Warrimoo TS	0.937	53.3	61.1	44.7	44.4	44.0	43.7	43.4

TABLE 182: WARRIMOO TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Blaxland ZS	0.981	19.3	19.7	19.7	19.6	19.6	19.5	19.5
Springwood ZS	0.992	23.5	23.1	21.9	21.9	21.8	21.8	21.7
Warrimoo TS	0.968	43.1	47.8	42.3	42.2	42.1	42.0	41.9

A.32.2 WARRIMOO TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by Warrimoo TS operates at 66kV.

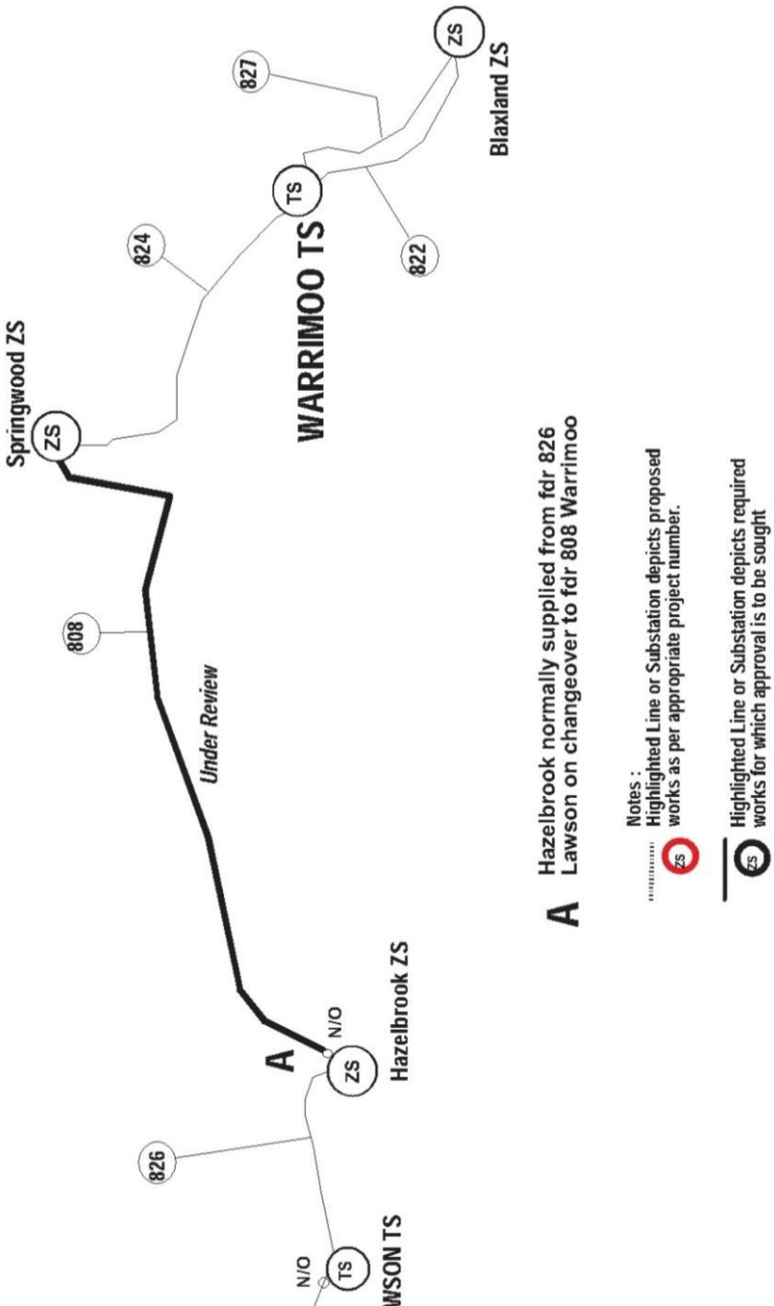
TABLE 183: WARRIMOO TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
822 - Warrimoo TS to Blaxland ZS	30.0	21.5	20.8	20.7	20.5	20.4
827 - Warrimoo TS to Blaxland ZS	42.0	21.7	20.9	20.8	20.7	20.5

TABLE 184: WARRIMOO TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Thermal capacity of standby feeder 808 is exceeded when it supplies Springwood ZS during outage of Feeder 824.	S 2017/18	Demand had declined on Springwood ZS but has recently shown an increase. The level of network risk is minimal within the forecast period, considering the availability of 11kV emergency transfer capability.	Continue to monitor

A.32.3 WARRIMOO TS NETWORK MAP



A.33 WEST LIVERPOOL TRANSMISSION SUBSTATION

A.33.1 WEST LIVERPOOL TS CONNECTION POINTS

West Liverpool TS is supplied from TransGrid's Liverpool Bulk Supply Point at 132kV by three 375MVA tail-ended transformers and feeders 93B, 93N and 93R. Mutual backup between Sydney West BSP and West Liverpool TS is supplied via 132kV feeders 93U and 93W via Abbotsbury ZS. West Liverpool TS is equipped with three 120MVA 132/33kV transformers providing a firm capacity of 240MVA.

TABLE 185: WEST LIVERPOOL TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Bonnyrigg ZS	33/11kV	3 x 35	105	70	5.75	3.67
Edmondson Park ZS	33/11kV	2 x 35	105	70	-	0.1
Hinchinbrook ZS	33/11kV	3 x 25	75	50	5.75	3.74
Homepride ZS	33/11kV	3 x 25	75	50	14.00	0.81
Kemps Creek ZS	33/11kV	2 x 25	50	25	1.50	3.33
Prestons ZS	33/11kV	3 x 25	75	50	7.00	3.32
West Liverpool ZS	33/11kV	3 x 35	105	70	8.25	2.28
West Liverpool TS	132/33kV	4 x 120	480	360	6.50	-

TABLE 186: WEST LIVERPOOL TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Bonnyrigg ZS	0.970	30.3	38.2	33.5	35.2	35.0	34.8	34.6
Edmondson Park ZS	-	-	-	-	9.2	13.9	17.7	19.8
Hinchinbrook ZS	0.963	42.5	50.2	48.6	48.3	48.8	49.3	49.7
Homepride ZS	0.989	34.5	36.6	38.0	38.8	39.7	40.7	41.9
Kemps Creek ZS	0.977	12.8	14.2	12.5	10.8	12.1	15.9	21.4
Prestons ZS	0.944	28.0	30.8	30.6	31.0	31.0	30.8	30.6
West Liverpool ZS	0.970	37.4	37.9	40.9	41.8	42.5	42.9	43.2
West Liverpool TS	0.985	192.4	194.0	199.8	209.9	217.4	226.0	234.9

TABLE 187: WEST LIVERPOOL TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Bonnyrigg ZS	0.992	23.2	23.6	21.9	22.0	21.9	21.9	21.8
Edmondson Park ZS	-	-	-	-	-	9.3	12.6	13.9
Hinchinbrook ZS	0.963	24.4	27.0	27.6	28.6	28.7	29.3	29.7
Homepride ZS	0.995	26.7	27.3	28.0	28.3	28.6	29.0	29.4
Kemps Creek ZS	0.984	11.2	10.4	10.5	10.8	9.3	9.4	9.6
Prestons ZS	0.987	15.7	17.0	20.8	21.9	19.9	19.9	19.8
West Liverpool ZS	0.989	30.9	30.5	33.2	36.4	37.2	37.7	38.1
West Liverpool TS	0.989	147.7	143.2	139.7	145.5	151.6	156.0	158.4

A.33.2 WEST LIVERPOOL TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by West Liverpool TS operates at 33kV.

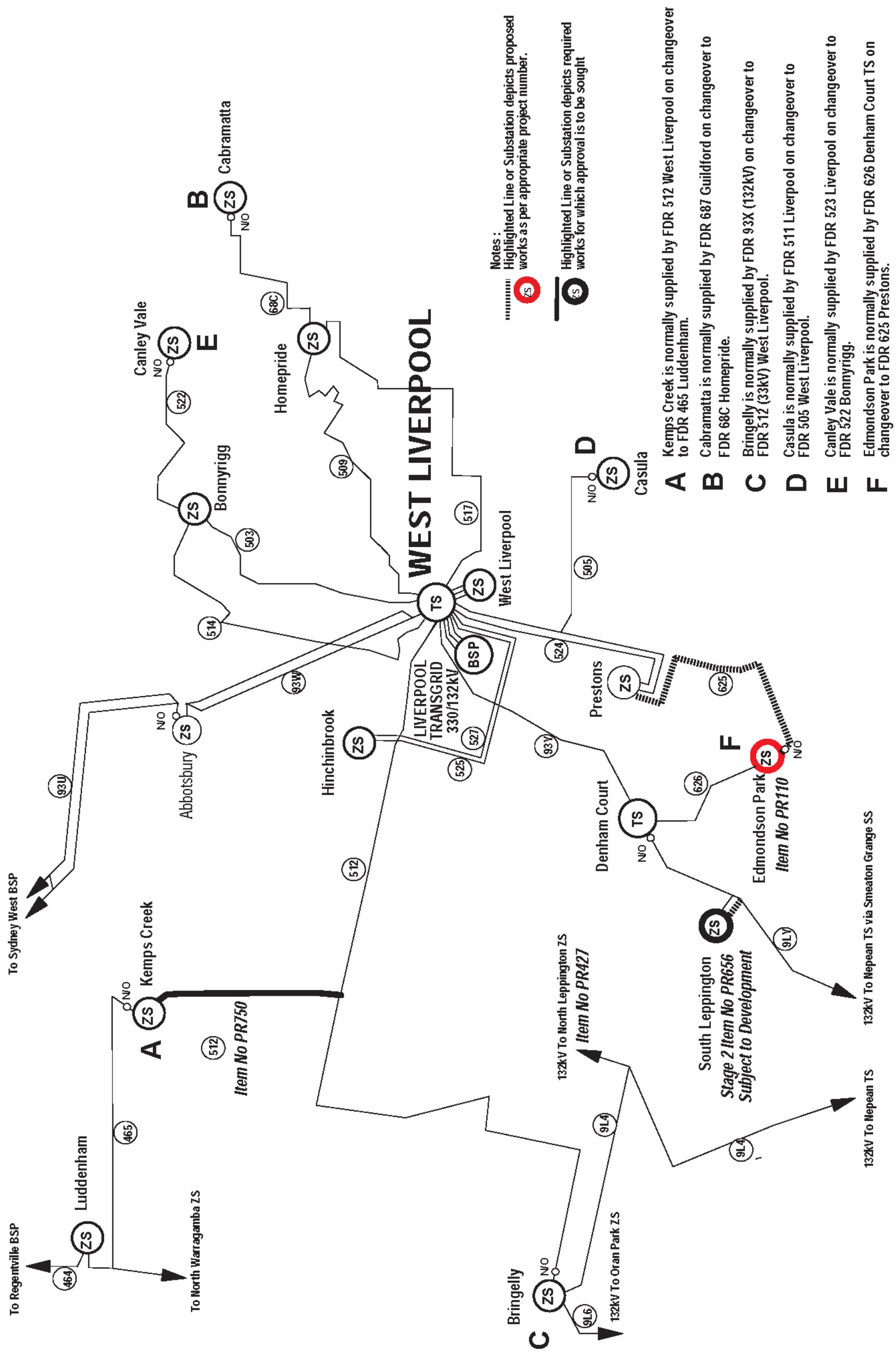
TABLE 188: WEST LIVERPOOL TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
503 - West Liverpool TS to Bonnyrigg ZS	42.0	34.9	37.0	36.9	35.7	35.8
504 - Liverpool TS to West Liverpool TS	42.0	0.0	0.0	0.0	0.0	0.0
508 - Liverpool TS to West Liverpool TS	44.8	0.0	0.0	0.0	0.0	0.0
509 - West Liverpool TS to Homepride ZS	42.0	34.2	34.3	35.0	35.4	36.3
512 - West Liverpool TS to Austral ZS	33.2	22.6	26.4	30.8	35.3	43.4
512 - TEE to Kemps Creek ZS	21.0	22.7	26.5	31.0	35.5	43.6
512 - TEE to Bringelly ZS	21.0	0.1	0.1	0.1	0.1	0.1
514 - West Liverpool TS to Bonnyrigg ZS	42.0	35.0	37.2	37.0	35.9	36.0
517 - West Liverpool TS to Homepride ZS	36.1	25.7	26.5	27.2	28.1	28.3
524 - West Liverpool TS to Prestons ZS	68.0	31.2	31.8	32.0	31.0	31.0
525 - West Liverpool TS to Hinchinbrook ZS	68.0	50.8	50.8	51.5	50.9	51.5
527 - West Liverpool TS to Hinchinbrook ZS	68.0	50.8	50.8	51.5	50.9	51.5
626 - Denham Court TS to Edmondson Park ZS	50.0	5.9	9.5	14.3	18.5	21.2
68C - Cabramatta ZS to Homepride ZS	43.3	18.2	17.9	18.0	17.8	17.9
WLIVT5 - West Liverpool TS to West Liverpool 11kV	50.0	20.9	21.5	21.9	21.6	21.8
WLIVT6 - West Liverpool TS to West Liverpool 11kV	50.0	20.9	21.5	21.9	21.6	21.8
WLIVT7 - West Liverpool TS to West Liverpool 11kV	50.0	20.9	21.5	21.9	21.6	21.9

TABLE 189: WEST LIVERPOOL TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Outage of 464 (Regentville BSP to Luddenham ZS) overloads 512 (West Liverpool TS - tee to Kemps Creek ZS).	2019/20	Options inlcude augmentation of Feeder 512 tee to Kemps Creek ZS and demand management.	Investigate options
Feeder 512 Tee to Kemps Creek is overloaded under system normal conditions.	2022/23	Options inlcude augmentation of Feeder 512 tee to Kemps Creek ZS and demand management.	Investigate options

A.33.3 WEST LIVERPOOL TS NETWORK MAP



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A.34 WEST TOMERONG TRANSMISSION SUBSTATION

A.34.1 WEST TOMERONG TS CONNECTION POINTS

West Tomerong Transmission Substation is supplied from Dapto BSP by 132kV Feeder 98P via Mount Terry TS 132kV feeders 98L and 98U and subsequently supplied via Shoalhaven TS feeder 98P. West Tomerong TS is equipped with two 60MVA 132/33kV transformers providing a firm capacity of 60MVA.

TABLE 190: WEST TOMERONG TS – TRANSFORMER RATING AND SUBSTATION DETAILS

Substation	Voltage Levels	Transformer Description (MVA)	Installed Capacity Total 'N' (MVA)	Firm Rating Secure 'N-1' (MVA)	95% Peak Load Exceeded (hours)	Embedded Generation (MW)
Culburra ZS	33/11kV	2 x 10	20	10	1.00	1.71
Huskisson ZS	33/11kV	2 x 20	40	20	2.00	1.70
South Nowra ZS	33/11kV	2 x 25	50	25	1.75	0.49
Sussex Inlet ZS	33/11kV	2 x 15	30	15	2.25	1.04
Tomerong ZS	33/11kV	2 x 15	30	15	1.50	1.70
Yatte Yattah ZS	33/11kV	1 x 6.5	6.5	NA	1.25	0.55
West Tomerong TS	132/33kV	2 x 60	120	60	2.25	-

TABLE 191: WEST TOMERONG TS – SUMMER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2016	2017	2018	2019	2020	2021	2022
Culburra ZS	0.961	8.7	11.5	11.5	11.4	11.4	11.3	11.3
Huskisson ZS	0.965	15.0	15.5	15.8	15.8	15.8	15.8	15.7
South Nowra ZS	0.911	11.1	10.5	11.4	11.5	12.0	12.0	12.0
Sussex Inlet ZS	0.957	5.2	7.5	8.0	8.0	8.0	8.0	8.0
Tomerong ZS	0.967	8.5	11.0	11.0	11.0	11.0	10.9	10.9
Yatte Yattah ZS	0.952	-	5.1	5.0	5.0	5.0	5.0	4.9
West Tomerong TS	0.977	40.2	50.4	39.7	39.7	39.9	39.8	39.7

TABLE 192: WEST TOMERONG TS – WINTER DEMAND FORECAST

Substation Name	Forecast PF	Actual (MVA)		Forecast (MVA)				
		2015	2016	2017	2018	2019	2020	2021
Culburra ZS	0.976	10.7	11.2	11.3	11.3	11.3	11.2	11.2
Huskisson ZS	0.969	14.3	15.0	14.3	14.3	14.2	14.2	14.2
South Nowra ZS	0.956	7.5	9.7	9.9	10.7	11.2	11.2	11.2
Sussex Inlet ZS	0.983	6.1	5.9	6.0	6.3	6.3	6.3	6.3
Tomerong ZS	0.987	9.0	9.2	7.3	7.3	7.4	7.4	7.4
Yatte Yattah ZS	0.972	-	-	3.2	3.2	3.1	3.1	3.1
West Tomerong TS	0.991	43.0	46.7	50.0	51.0	51.5	51.5	51.4

A.34.2 WEST TOMERONG TS SUB-TRANSMISSION SYSTEM

The sub-transmission network supplied by West Tomerong TS operates at 33kV.

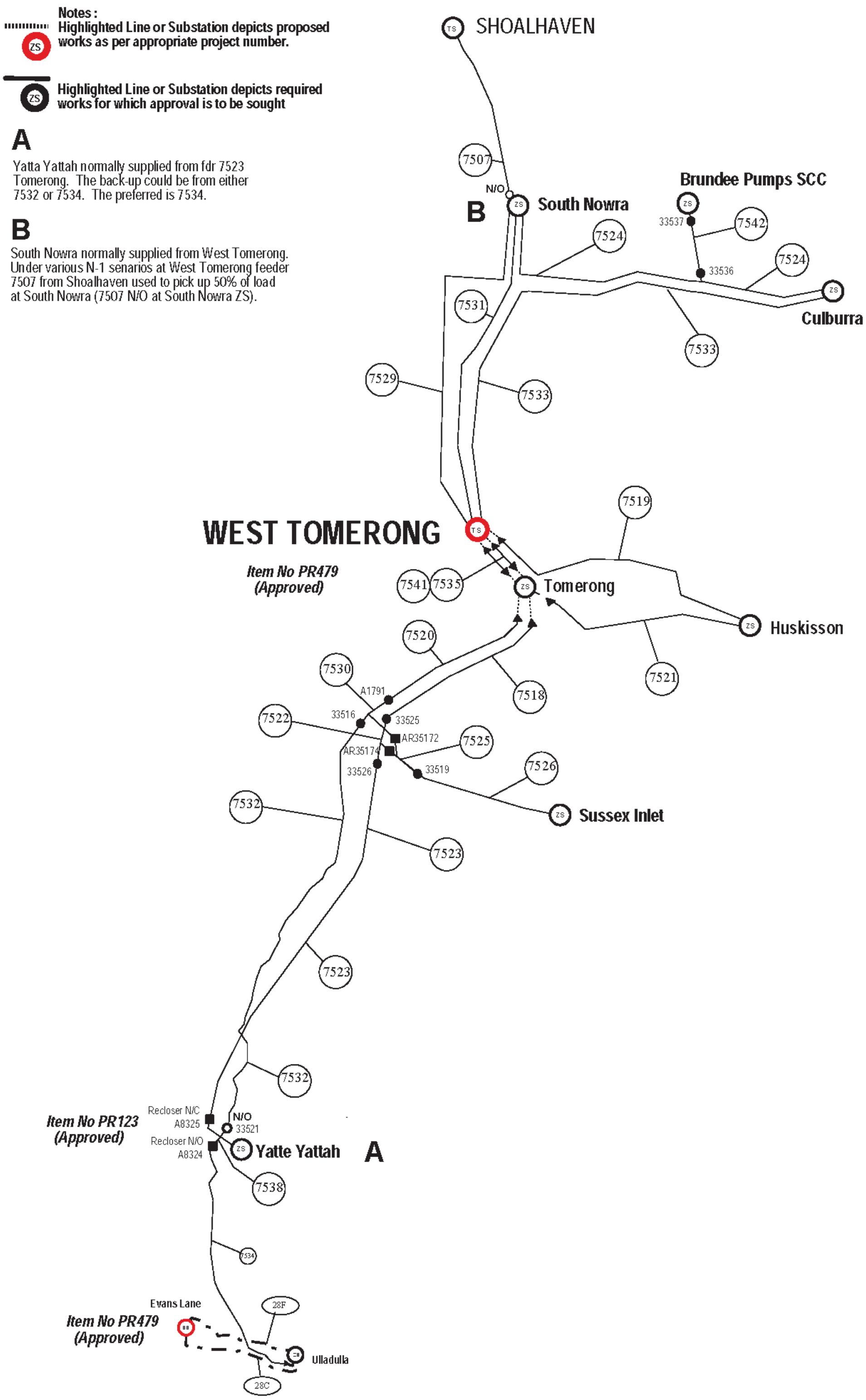
TABLE 193: WEST TOMERONG TS – SUMMER

Feeder Name	Capacity (MVA)	Forecast (MVA)				
		2018	2019	2020	2021	2022
7518 - Tomerong ZS to ABS 33525	20.7	8.1	8.0	8.1	8.0	7.9
7519 - West Tomerong TS to Huskisson ZS	20.7	16.0	15.9	15.9	15.7	15.7
7520 - Tomerong ZS to ABS 65840	14.1	8.0	7.9	8.0	7.8	7.8
7521 - Huskisson ZS to Tomerong ZS	20.7	15.9	15.7	15.8	15.6	15.5
7522 - ABS 33525 to TEE	20.7	8.1	8.1	8.1	8.0	8.0
7522 - AR 35174 to TEE	14.1	8.1	8.1	8.1	8.0	8.0
7522 - ABS 33526 to TEE	14.1	0.0	0.0	0.0	0.0	0.0
7523 - ABS 33526 to ABS 33527	13.3	0.5	0.5	0.5	0.5	0.5
7524 - South Nowra ZS to ABS 33536	14.5	12.3	12.1	12.1	11.9	11.8
7524 - Culburra ZS to ABS 33536	43.1	12.0	11.8	11.8	11.6	11.5
7525 - AR 35172 to TEE	14.1	8.2	8.1	8.2	8.0	8.0
7525 - AR 35174 to TEE	14.1	8.1	8.1	8.1	8.0	8.0
7525 - ABS 33519 to TEE	14.1	8.0	7.9	8.0	7.8	7.8
7529 - West Tomerong TS to South Nowra ZS	20.7	13.9	13.8	14.3	14.1	14.0
7531 - West Tomerong TS to South Nowra ZS	20.7	14.3	14.2	14.6	14.4	14.4
7533 - West Tomerong TS to Culburra ZS	14.5	11.8	11.6	11.6	11.4	11.3
7534 - Ulladulla ZS to AR A8324	8.9	5.3	5.2	5.2	5.2	5.2
7535 - West Tomerong TS to Tomerong ZS	53.7	24.4	24.2	24.2	23.9	23.8
7541 - West Tomerong TS to Tomerong ZS	44.6	24.4	24.2	24.2	23.9	23.8

TABLE 194: WEST TOMERONG TS – IDENTIFIED LIMITATIONS

Network Constraint	Year	Investigation	Solution
Culburra ZS firm rating is exceeded in summer 2017. The LAR is 15% over firm.	Existing	The situation will continue to be monitored in accordance with acceptable network capacity planning standards. Investigate additional load transfers and non-network options in the future.	Continue to monitor

A.34.3 WEST TOMERONG TS NETWORK MAP



APPENDIX B: DETAILS OF RIT-D AUGMENTATION PROJECTS

B.1 MENANGLE PARK ZONE SUBSTATION

The proposed Menangle Park ZS will cater for the new residential release areas in the Greater Macarthur Priority Growth Area and will produce a total of 3,700 to 4,000 lots. The development area will also contain a shopping centre, school and community facilities. This area currently has limited supply from Ambarvale ZS feeder T874, refer Figure 13. The 11kV network supplying this area does not have sufficient capacity to supply this level of growth. Developing additional 11kV feeders is environmentally very challenging as there is difficult terrain and a freeway to cross and would be cost prohibitive. To supply the development and cater for an ultimate load of 24 - 28 MVA the Menangle Park ZS is proposed to be established.

B.1.1 NON-NETWORK OPTION INVESTIGATION

This project will require a screening test to be conducted during 2017/18 to determine the feasibility of a non-network option. If it is determined that there is sufficient demand reduction available a Non-Network Options Report will be issued requesting submission for non-network proposals.

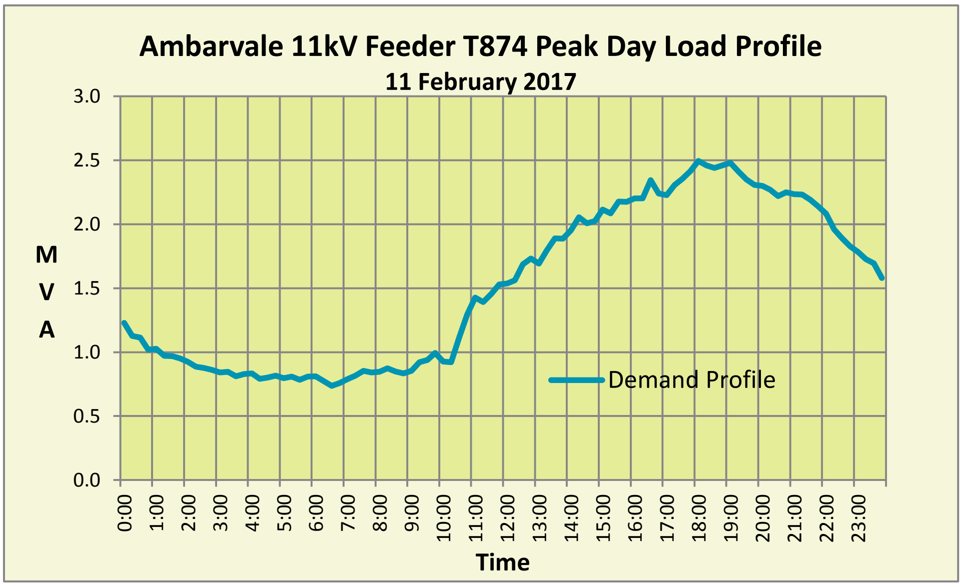
B.1.2 NON-NETWORK OPPORTUNITIES

The principal contributors to the peak demand in this area are the existing rural area along with growth in demand from the new residential development. For demand management to be successful peak demand is to be reduced by 1.5 MVA by the summer 2022 quickly increasing to 20 MVA in 5 years. This indicates the high rate of growth for this area and the challenges faced in supplying the development.

B.1.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Menangle Park Zone Substation to supply the growth in demand.

FIGURE 13: AMBARVALE 11KV FEEDER T874 LOAD PROFILE 11 FEBRUARY 2017



B.2 FEEDER 308 REBUILD

Feeder 308 is out-of-service and constructed at 33kV. It is proposed to rebuild this feeder to 66kV and use it as the second supply to Menangle Park ZS. This feeder will also provide back-up to southern Nepean which is currently supplied by two 66kV feeders 851 and 852. These feeders supply eight major customer zone substations and five Endeavour Energy substations. Feeders 851 and 852 are rated at 60 MVA summer. The rebuild of the out of service 33kV feeder 308 to 66kV will address these issues being, the alternate supply to Menangle Park and the limitation on feeders 851 and 852.

B.2.1 NON-NETWORK OPTION INVESTIGATION

This project will require a screening test to be conducted during 2017/18 to determine the feasibility of a non-network option. If it is determined that there is sufficient demand reduction available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.2.2 NON-NETWORK OPPORTUNITIES

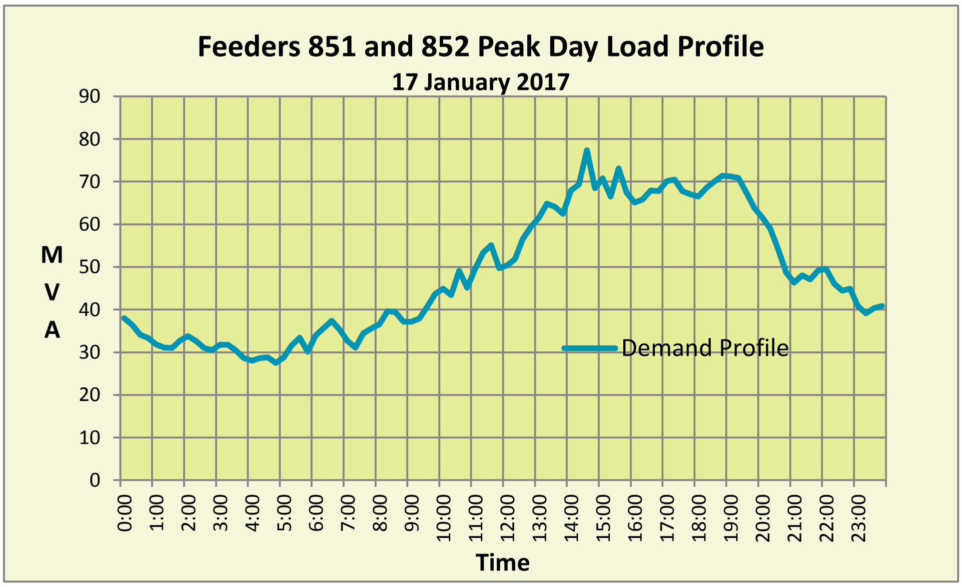
The principal contributors to the peak demand are the major customers in the Southern Nepean area together with the residential areas and commercial centres. Opportunities for demand reduction will need to be investigated in all areas.

Demand Management opportunities include network support from major customers with embedded generation plants to ensure a minimum level of generation is maintained during peak times. Power factor correction at the major customer zone substations is also an opportunity. The residential and commercial sector may also provide opportunities. The area in summer limited due to the reduced summer rating of the 66kV feeders. Demand reduction will need to occur during times of network peak shown in Figure 14 below.

B.2.3 NETWORK OPTIONS

The Network option for this project is to rebuild the out-of-service 33kV feeder 308 to 66kV construction with in the same easement and along the roadway corridors to Menangle Park ZS.

FIGURE 14: FEEDERS 851 AND 852 LOAD PROFILE 17 JANUARY 2017



B.3 CALDERWOOD ZONE SUBSTATION

The proposed Calderwood ZS will cater for primarily residential development as part of the West Lake Illawarra expansion area. The development is expected to contain an ultimate load of 128 MVA. This region is currently being supplied by the 11kV network from Dapto ZS and cannot sustain this magnitude of growth. New residential release areas in the Calderwood Valley precinct are expected to yield 7,000 residential lots and some commercial development with an ultimate peak demand of about 28 MVA.

B.3.1 NON-NETWORK OPTION INVESTIGATION

This project will require a screening test to be conducted during 2017/18 to determine the feasibility of a non-network option. If it is determined that there is sufficient demand reduction available a Non-Network Options Report will be issued requesting submission for non-network proposals.

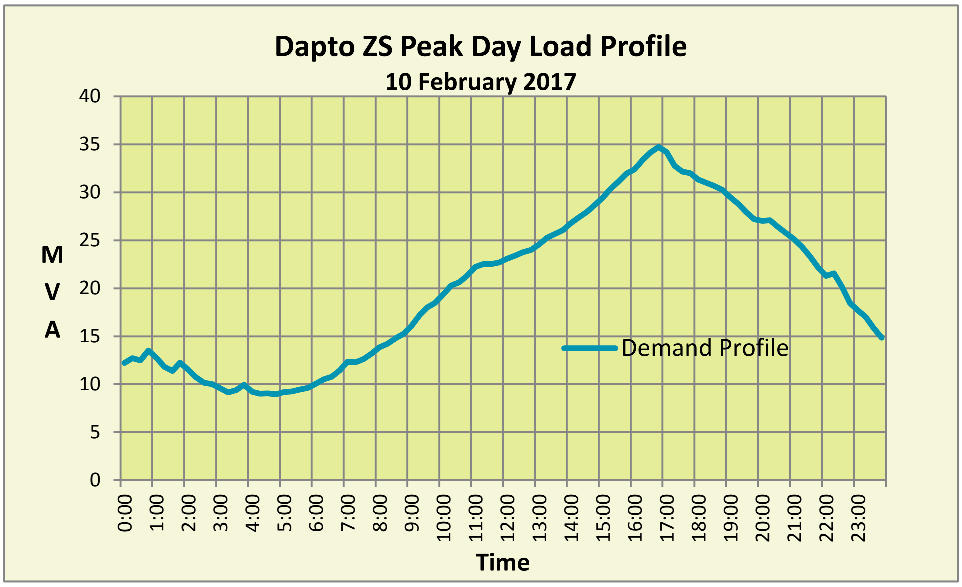
B.3.2 NON-NETWORK OPPORTUNITIES

The Dapto region consists of commercial and residential load. Potential for demand reduction may be available in these sectors. For demand management to be successful, peak demand is to be reduced by 2.6 MVA by the summer of 2021 on the 11kV network supplying this area from Dapto ZS to defer the network expenditure by one year. A demand growth of 1.0 MVA per annum is forecast. Demand reduction will need to occur during times of network peak shown in Figure 15 below.

B.3.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Calderwood ZS to supply the new growth area.

FIGURE 15: DAPTO ZS LOAD PROFILE 10 FEBRUARY 2017



B.4 SOUTH PENRITH ZONE SUBSTATION

The proposed South Penrith ZS will cater for the new residential, industrial and commercial release areas in and around the Penrith CBD. The residential development will ultimately produce 2,000 high density dwellings. The area is currently being supplied by the Penrith 11kV ZS. The substation and the 11kV network supplying this area cannot sustain this magnitude of growth. The zone substation capacity is 52 MVA against a forecast demand of 54.8 MVA by summer 2019. There is also an additional 20 MVA of industrial load enquiries for Penrith 11kV ZS.

B.4.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.4.2 NON-NETWORK OPPORTUNITIES

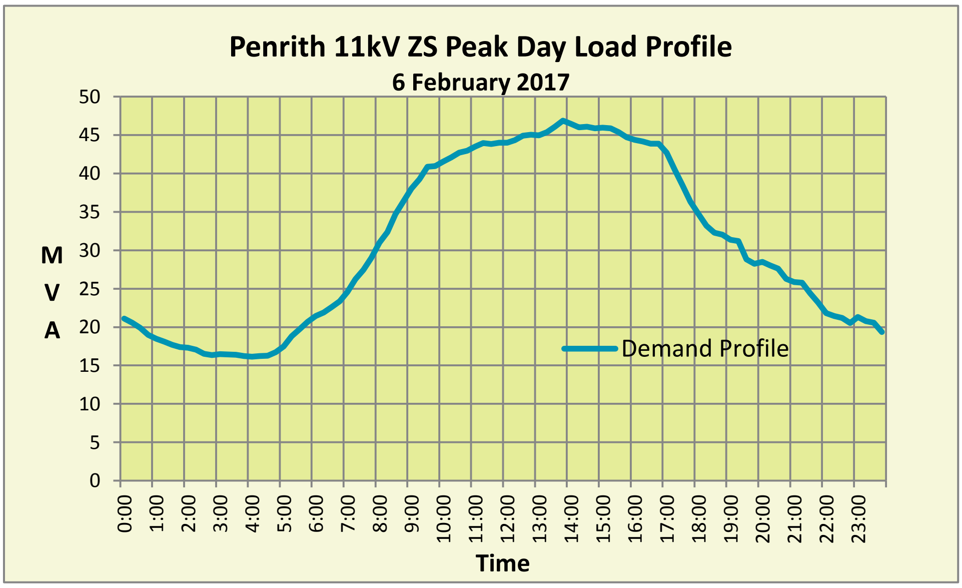
The principal contributors to the peak demand are the existing residential, industrial and commercial sectors along with a growth in demand from the new residential industrial and commercial developments. Opportunities for demand reduction include air-conditioner cycling, power factor correction, demand response initiatives and voluntary load reduction schemes. There is also potential for new embedded generation initiatives to reduce the peak in demand.

In order to adequately address the constraint and allow for the deferral of investment in the network, a non-network solution would need to reduce the summer peak demand by 3.2 MVA by summer 2020/21to defer the network expenditure for one year. Demand reduction will also need to take into account the additional yearly load increases due to proposed development. Demand reduction will need to occur during times of network peak shown in Figure 16 below.

B.4.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed South Penrith ZS to cater for the growth in load.

FIGURE 16: PENRITH 11KV ZS LOAD PROFILE 6 FEBRUARY 2017



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B.5 BOX HILL ZONE SUBSTATION

Box Hill ZS will cater for the new residential release areas in the Box Hill, Box Hill North and Box Hill Industrial precinct and will ultimately produce over 17,000 lots and 122 hectares of employment lands. The area is currently supplied by Mungerie Park ZS and Riverstone ZS. The 11kV and 22kV network supplying this area cannot sustain this magnitude of growth.

B.5.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

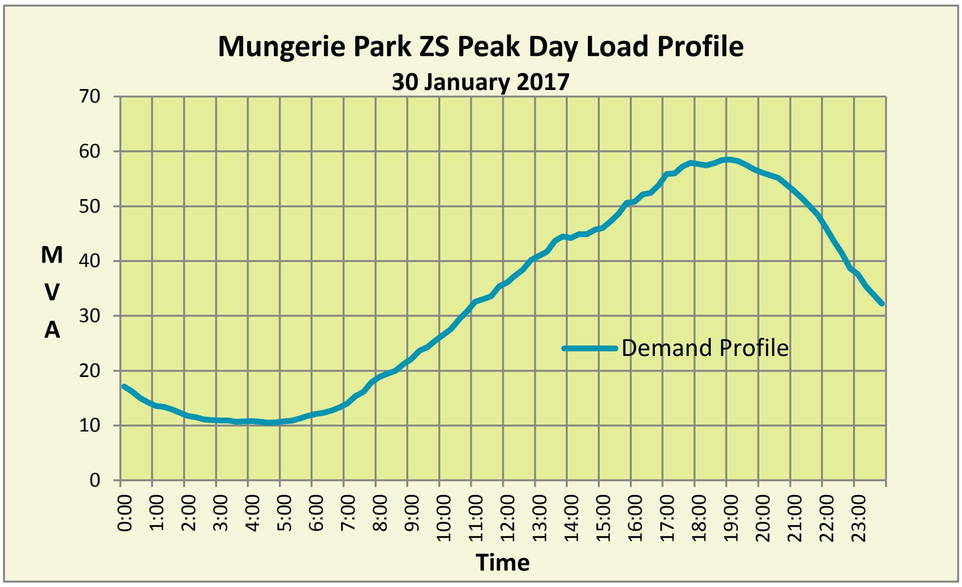
B.5.2 NON-NETWORK OPPORTUNITIES

The proposed Box Hill supply area consists of new residential release areas. For demand management to be successful, peak demand is to be reduced by 5 MVA by the summer of 2020/21 to defer the network expenditure by one year. Demand reduction will need to maintain 4 to 5 MVA reduction per year to keep pace with the forecast increase in demand in the new release areas in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 17 below.

B.5.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Box Hill ZS to supply the new growth area.

FIGURE 17: MUNGERIE PARK ZS LOAD PROFILE 30 JANUARY 2017



B.6 SOUTHPIPE ZONE SUBSTATION

The Southpipe development contains industrial and commercial sectors located in the south western region adjacent the Eastern Creek industrial area. The total proposed development area is approximately 656ha. The current area is supplied by the 11kV network from Eastern Creek ZS and Horsley Park ZS. The 11kV network supplying this area from these substations does not have sufficient capacity to supply this level of growth.

B.6.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

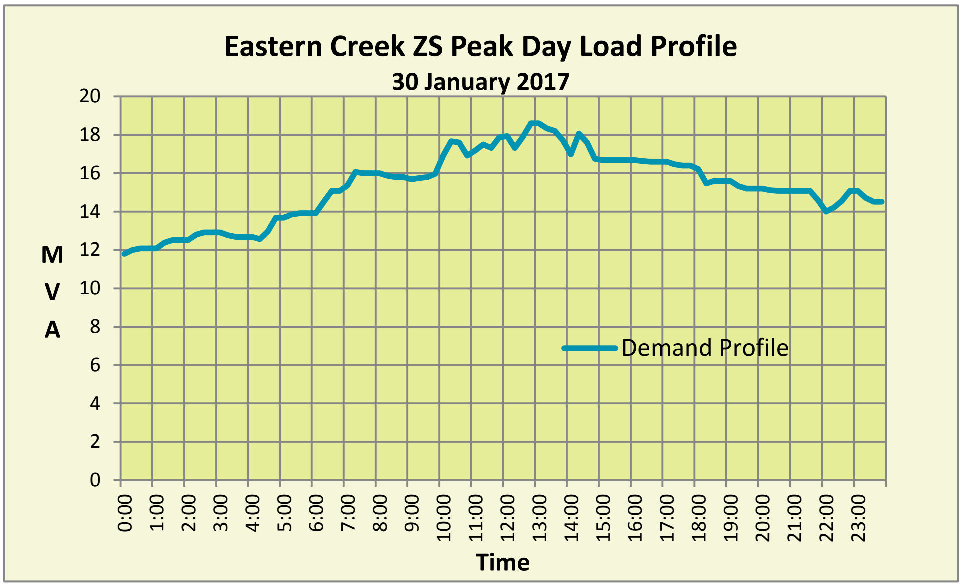
B.6.2 NON-NETWORK OPPORTUNITIES

The new development area consists of industrial and commercial load. For demand management to be successful peak demand is to be reduced by 4.5 MVA by summer 2019 on the 11kV network supplying this area from Eastern Creek and Horsley Park ZS's to defer the network expenditure by one year. This demand will increase by around 5 MVA per annum to 2025. Demand reduction will need to occur during times of network peak shown in Figure 18 below.

B.6.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Southpipe ZS to supply the new growth area.

FIGURE 18: EASTERN CREEK ZS LOAD PROFILE 30 JANUARY 2017



B.7 MARSDEN PARK ZONE SUBSTATION

This proposed substation will cater for the new residential release areas in the Marsden Park precinct and will ultimately produce 10,300 lots. The area is currently supplied by Riverstone ZS. The 11kV network supplying this area cannot sustain this magnitude of growth. Marsden Park ZS (Stage 1) was constructed with a single transformer (commissioned in March 2017). However, this substation will not have sufficient 11kV back-up under first level contingency to supply the growth in demand by 2019. This capacity limitation will need to be addressed. To supply the residential release areas the stage 1 construction of Marsden Park ZS will need to be augmented to 45 MVA (firm).

B.7.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test will be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.7.2 NON-NETWORK OPPORTUNITIES

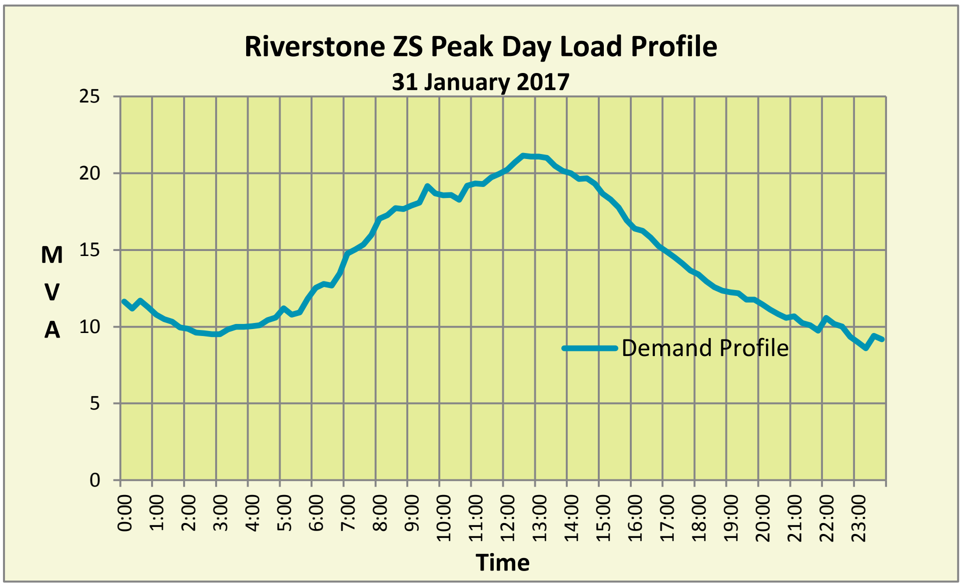
The principal contributors to the peak demand are the existing residential and commercial sectors along with a growth in demand from the new residential development. Opportunities for demand reduction include air-conditioner cycling and voluntary load reduction schemes. There is also potential for embedded generation initiatives to reduce the peak in demand.

In order to adequately address the constraint and allow for the deferral of investment in the network, a non-network solution would need to reduce the summer peak demand by 5.7 MVA by summer 2019. Demand reduction will need to increase by 4 to 5 MVA per year to keep pace with the forecast increase in demand in the new release areas in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 19 below.

B.7.3 NETWORK OPTIONS

Network options that will be investigated include the augmentation of the Marsden Park ZS to provide full redundancy and to cater for the growth in demand.

FIGURE 19: RIVERSTONE ZS LOAD PROFILE 31 JANUARY 2017



B.8 SCIENCE PARK ZONE SUBSTATION

The Science Park development contains industrial and commercial sectors located adjacent to the proposed Western Sydney Airport. The total proposed development area is approximately 300ha. The area is currently supplied by the 11kV network from Kemps Creek, Luddenham and Mamre ZSs. The 11kV network supplying this area from these substations does not have sufficient capacity to supply the forecast level of growth. To supply the new industrial and commercial release sectors and cater for an ultimate load of 99 MVA the proposed Science Park ZS is to be established.

B.8.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test will be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

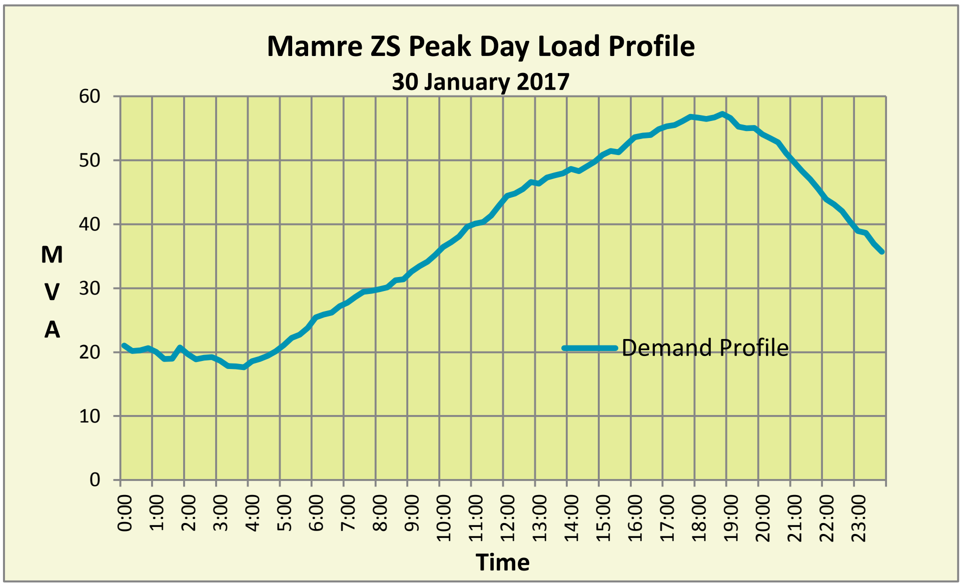
B.8.2 NON-NETWORK OPPORTUNITIES

The new development area consists of industrial and commercial load. For demand management to be successful, peak demand is to be reduced by 8 MVA by the summer of 2022 on the 11kV network supplying this area from Kemps Creek, Luddenham and Mamre ZSs to defer the network expenditure by a year. This demand will increase by around 2 to 3 MVA per annum. Demand reduction will need to occur during times of network peak shown in Figure 20 below.

B.8.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the Science Park ZS to supply the new growth area.

FIGURE 20: MAMRE ZS LOAD PROFILE 30 JANUARY 2017



B.9 FEEDERS 214/215 PARKLEA ZS

The 132 kV feeders 214 and 215 supply Parklea, West Castel Hill, Cheriton Ave. and Bella Vista ZS's from Rouse Hill 132 kV switching station. Both feeders are rated at 172 MVA and experience a network constraint with an outage of either feeder. Both feeders exceed their capacity by 132 MVA. An automated switching system is implemented to transfer load to adjacent supply points. However, there is still load at risk remaining that needs to be addressed.

B.9.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test will be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

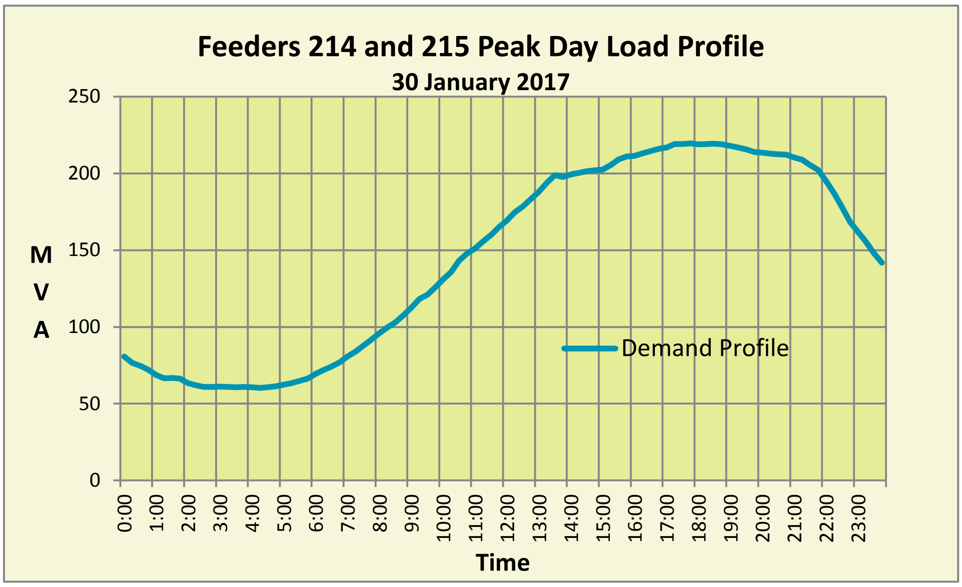
B.9.2 NON-NETWORK OPPORTUNITIES

These feeders supply Parklea, Bella Vista, West Castle Hill and Cheriton Ave ZSs. The supply areas for these substations include major commercial and industrial sectors and a range of residential areas in terms of density. For demand management to be successful, peak demand is to be reduced by 24 MVA by the summer of 2018 Growing by 6 to 7 MVA per annum. Demand reduction will need to occur during times of network peak shown in Figure 21 below.

B.9.3 NETWORK OPTIONS

Network options that will be investigated include the rebuilding of an out-of-service 66kV feeder to transfer a zone substation from feeders 214 / 215 during outage conditions.

FIGURE 21: FEEDERS 215 AND 215 LOAD PROFILE 30 JANUARY 2017



B.10 PARKLEA ZONE SUBSTATION

The development of new residential release areas in Bella Vista Central and Kellyville precincts will ultimately produce 12,000 medium and high density dwellings and is currently being supplied by Parklea ZS. The ZS and 22kV network supplying this area cannot sustain this magnitude of growth. There is also re-development occurring along the North-West Rail Link (NWRL) currently under construction which could add an additional 35 MVA to Parklea ZS over a ten year period. Parklea ZS has a firm capacity of 90 MVA with the potential of having a cyclic rating allocated. The official forecast shows the firm rating being exceeded in 2020 however the additional NWRL load may bring this constraint forward to 2019, depending on the application of cyclic rating. Network options are currently being investigated to supply the growth in demand.

B.10.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2018/19. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.10.2 NON-NETWORK OPPORTUNITIES

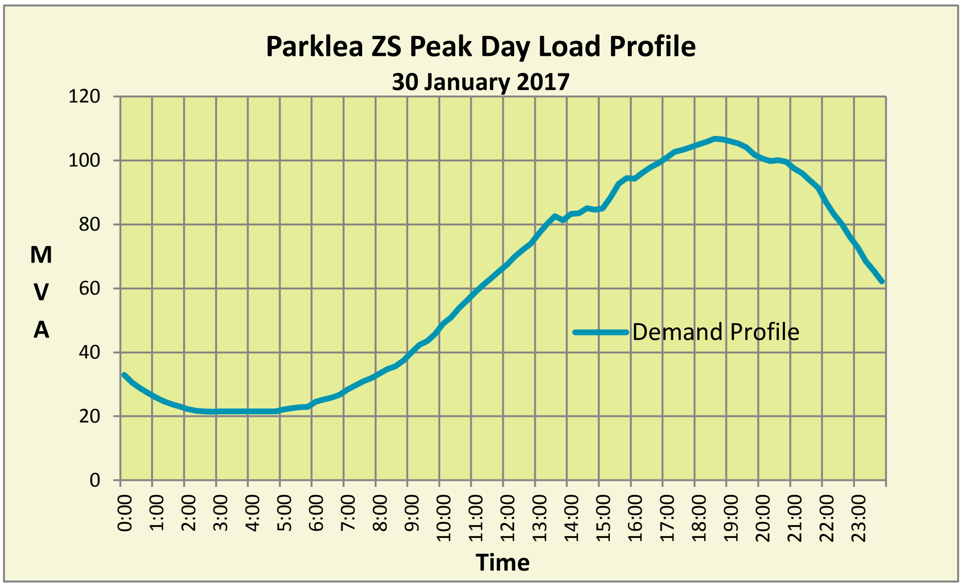
The principal contributors to the peak demand are the existing residential and commercial sectors along with a growth in demand from the new high density residential and commercial development adjacent the NWRL. Opportunities for demand reduction include air-conditioner cycling, power factor correction and voluntary load reduction schemes. There is also potential for new embedded generation initiatives to reduce the peak in demand.

In order to adequately address the constraint and allow for the deferral of investment in the network, a non-network solution would need to reduce the summer peak demand by about 2.2 MVA by summer 2020 (which includes the NWRL load). Demand reduction will need to increase by 3 to 4 MVA per year to keep pace with the forecast increase in demand in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 22 below.

B.10.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Riverstone East ZS to allow for load transfer to occur and the installation of auto transformers to allow the transfer of load to the Bella Vista 11kV system.

FIGURE 22: PARKLEA ZS LOAD PROFILE 30 JANUARY 2017



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B.11 MARYLAND ZONE SUBSTATION

The proposed residential and commercial release areas in Maryland and Lowes Creek precincts will produce a total of 11,000 lots and an ultimate load of 44 MVA. This area will initially be supplied by the Oran Park and Bringelly ZSs. The 11kV network supplying this area from these substations does not have sufficient capacity to supply this level of growth. The 11kV network capacity supplying the precincts is 5.2 MVA with a forecast load of 7.2 MVA by 2019 and growing by 1 MVA per annum.

B.11.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2018/19. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.11.2 NON-NETWORK OPPORTUNITIES

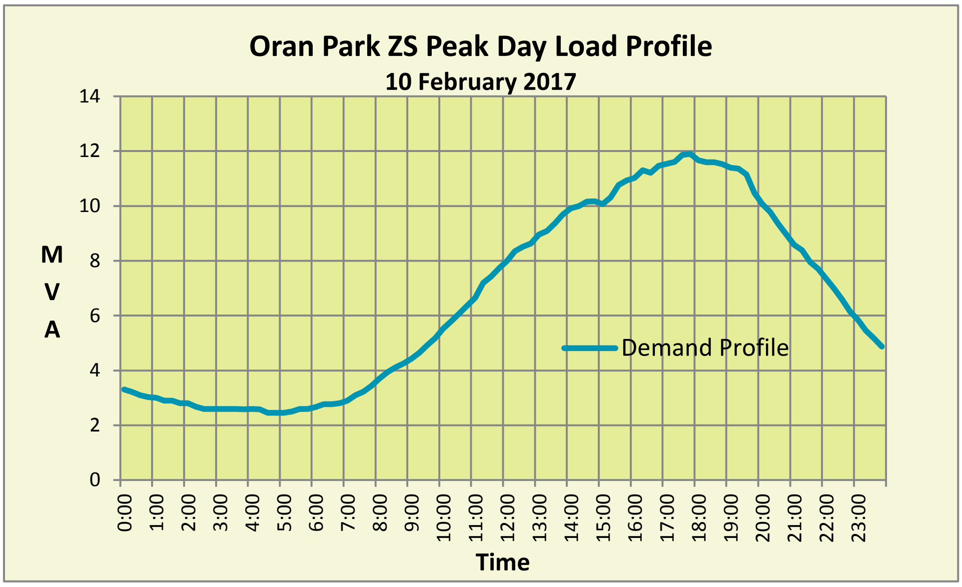
The principal contributors to the peak demand in this area are the existing industrial, commercial and residential sectors along with growth in demand from the new residential and commercial developments. Opportunities for demand reduction include air-conditioner cycling and voluntary load reduction schemes. There is also a potential for new embedded generation initiatives to reduce the peak in demand.

In order to adequately address the constraint and allow for the deferral of investment in the network, a non-network solution would need to reduce the summer peak demand by 2.0 MVA by summer 2019. Demand reduction will need to increase by 1 MVA per year to keep pace with the forecast increase in demand on the 11kV network in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 23 below.

B.11.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Maryland ZS to provide for the growth in demand.

FIGURE 23: ORAN PARK ZS LOAD PROFILE 10 FEBRUARY 2017



B.12 WEST DAPTO ZS

This proposed substation will cater for primarily residential development growth as part of the West Lake Illawarra expansion area. The development is expected to contain an ultimate load of 128 MVA. This increase in demand cannot be sustained by the 11kV network from Dapto ZS.

B.12.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2018/19. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

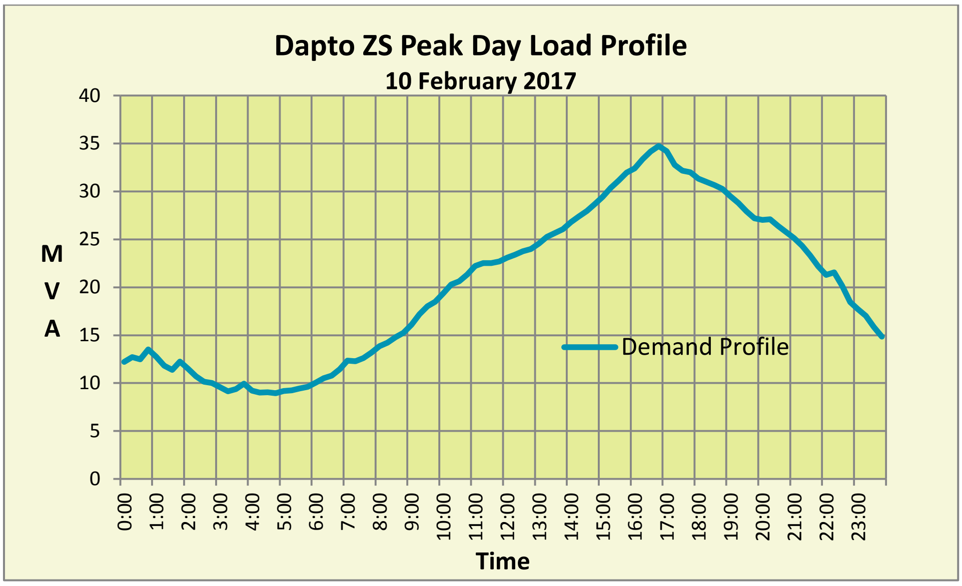
B.12.2 NON-NETWORK OPPORTUNITIES

The main opportunity for demand reduction exists in the commercial and residential sectors in the Dapto region. For demand management to be successful, peak demand is to be reduced by 2 MVA by summer 2021 on the 11kV network supplying the area from Dapto ZS to defer the network expenditure by one year. Demand reduction will need to increase by 1 to 2 MVA per year to keep pace with the forecast increase in demand on the 11kV network in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 24 below.

B.12.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed West Dapto ZS to provide for the growth in demand.

FIGURE 24: DAPTO ZS LOAD PROFILE 10 FEBRUARY 2017



B.13 WESTERN SYDNEY AIRPORT 132KV SUPPLY

The Western Sydney Priority Growth area is planned as Sydney's third city anchored by the proposed Western Sydney Airport with the potential for more than 100,000 dwellings and 100,000 jobs. This project establishes a switching station and 132kV feeders to the Western Sydney Airport and surrounding development area including the Western Sydney Employment Land and Science Park. Supply to the Western Sydney Airport will be required by 2026 with the employment lands requiring supply earlier.

B.13.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2019/20. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

B.13.2 NON-NETWORK OPPORTUNITIES

The area is entirely greenfield development driven by a major customer and surrounding employment lands. The main opportunity for demand reduction exists within these development areas. In order to defer the construction of the 132kV feeders and surrounding substations the demand growth is to be targeted.

B.13.3 NETWORK OPTIONS

Network options that will be investigated include the construction of 132kV feeders to supply the growth in demand.

No demand profile for this development is available.

B.14 RIVERSTONE EAST ZS

The proposed Riverstone East ZS is to cater for the new residential release areas in the Riverstone area within the North West Sector. The new release area will ultimately produce 5,800 lots and the area is currently being supplied by the Riverstone ZS. An ultimate load of 23 MVA is expected from the release areas. This increase in demand cannot be sustained by the 11kV network supplying this area from Riverstone ZS.

B.14.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2018/19. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

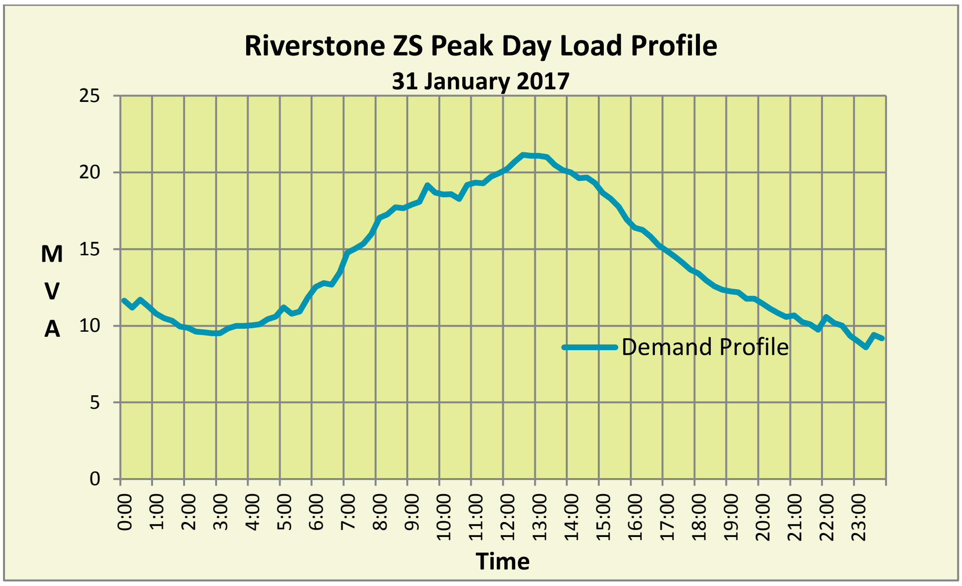
B.14.2 NON-NETWORK OPPORTUNITIES

The Riverstone release area consists of new residential and commercial areas. Potential for demand reduction may be available in these sectors and the existing load on the 11kV back-up feeders from Riverstone ZS. For demand management to be successful, peak demand is to be reduced by 4.7 MVA by the summer of 2022 on the 11kV network supplying the area from Riverstone ZS to defer the network expenditure by one year. Demand reduction will need to occur during times of network peak shown in Figure 25 below.

B.14.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Riverstone East ZS to provide for the growth in demand.

FIGURE 25: RIVERSTONE ZS LOAD PROFILE 31 JANUARY 2017



B.15 MT GILEAD ZS

The proposed Mt Gilead ZS is to cater for the new residential release areas in the Mount Gilead area. The new release will ultimately produce 17,550 lots and the area is currently being supplied by the Ambarvale ZS. An ultimate load of 74.2 MVA is expected from the release areas. This increase in demand cannot be sustained by the 11kV network supplying this area from Ambarvale ZS which is limited to a 9 MVA back-up capacity. One feeder is planned to be established to supply the initial stages of the development.

B.15.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2019/20. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

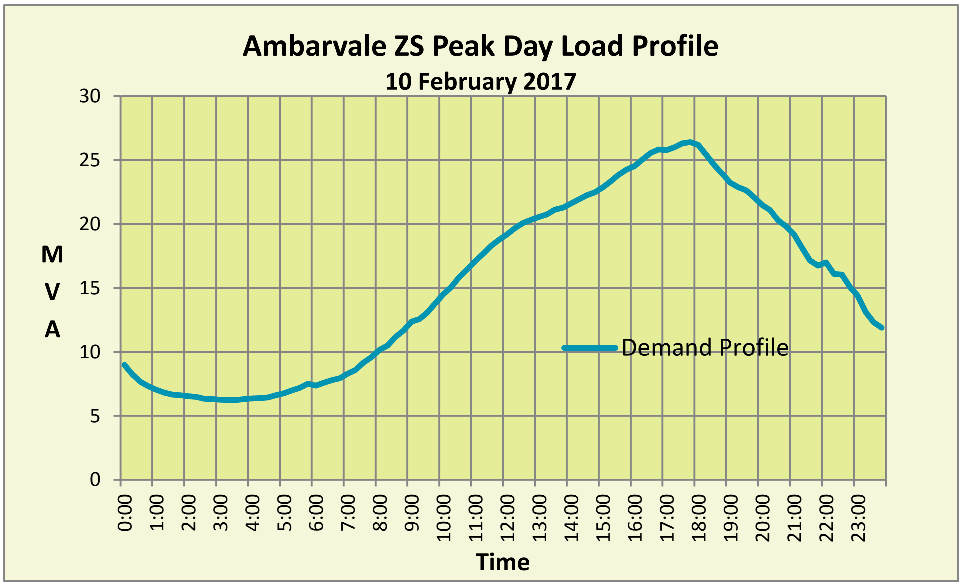
B.15.2 NON-NETWORK OPPORTUNITIES

The development area consists of new release residential and commercial load. Potential for demand reduction may be available from these sectors. For demand management to be successful, peak demand is to be reduced by 2 MVA by the summer of 2024 on the 11kV network supplying the area from Ambarvale ZS to defer the network expenditure by one year. Demand reduction will need to occur during times of network peak shown in Figure 26 below.

B.15.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Mt Gilead ZS to provide for the growth in demand.

FIGURE 26: AMBARVALE ZS LOAD PROFILE 10 FEBRUARY 2017



B.16 WESTERN SYDNEY EMPLOYMENT LANDS ZS

The Western Sydney Employment Land development contains industrial and commercial sectors located adjacent to the proposed Western Sydney Airport. The current area is currently supplied by the 11kV network from Kemps Creek, Luddenham and Mamre ZS. The 11kV network supplying this area from these substations does not have sufficient capacity to supply this level of growth. The new Western Sydney Employment industrial and commercial release sectors will have an ultimate load of 208 MVA.

B.16.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2019/20. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

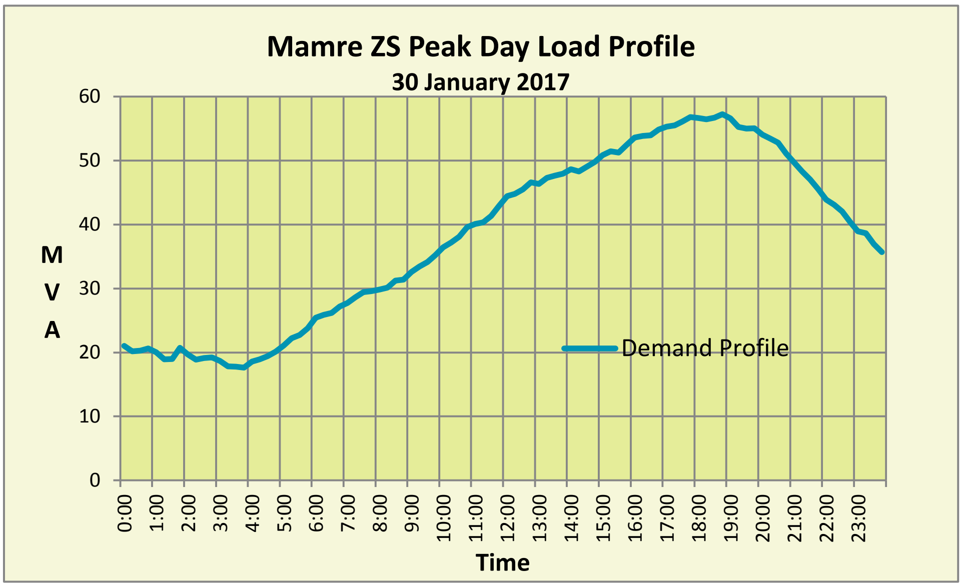
B.16.2 NON-NETWORK OPPORTUNITIES

The new development area consists of industrial and commercial load. For demand management to be successful, peak demand is to be reduced by 12 MVA by the summer of 2024 on the 11kV network supplying this area from Kemps Creek, Luddenham and Mamre ZSs to defer the network expenditure by a year. This demand will increase by around 3 MVA per annum. Demand reduction will need to occur during times of network peak shown in Figure 27 below.

B.16.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed Western Sydney Employment Land ZS to provide for the growth in demand.

FIGURE 27: MAMRE ZS LOAD PROFILE 30 JANUARY 2017



B.17 NORTH BOMADERRY ZS

The proposed North Bomaderry ZS will cater for primarily residential development growth as part of the North Nowra/Bomaderry expansion area. The development is expected to contain an ultimate load of 22 MVA. This region is currently being supplied by the 11kV network from Bomaderry ZS and cannot sustain this magnitude of growth. It is planned to develop an 11kV feeder from Bomaderry ZS to supply the initial stage of this development.

B.17.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2019/20. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

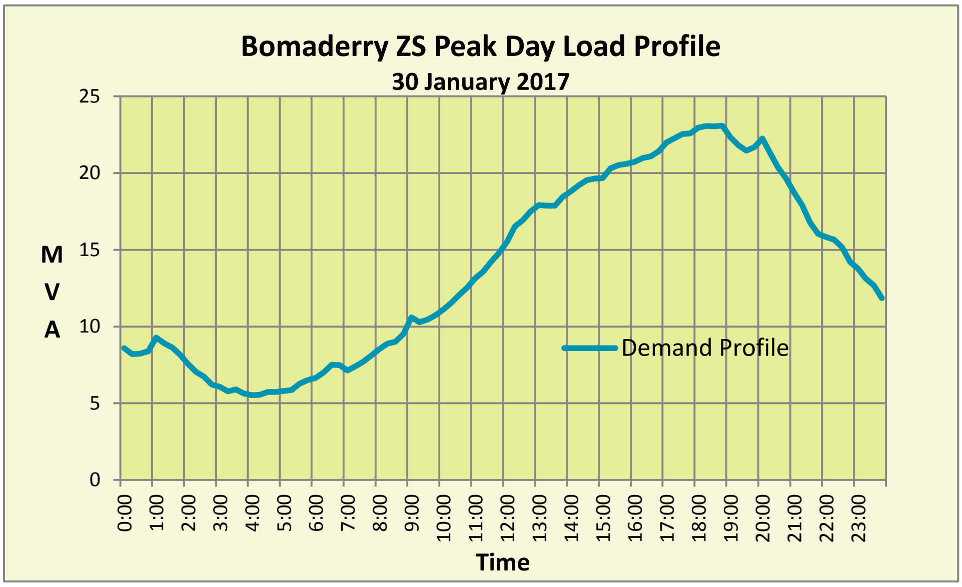
B.17.2 NON-NETWORK OPPORTUNITIES

The North Nowra/Bomaderry region consists of commercial and residential load. Potential for demand reduction may be available in these sectors. For Demand management to be successful peak demand is to be reduced by 0.4 MVA by summer 2020 on the 11kV network supplying this area from Bomaderry ZS to defer the network option by one year. This demand will increase by around 0.4 MVA per annum based on forecast lot release rates. Demand reduction will need to occur during times of network peak shown in Figure 28 below.

B.17.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the proposed North Bomaderry ZS to provide for the growth in demand.

FIGURE 28: BOMADERRY ZS LOAD PROFILE 30 JANUARY 2017



B.18 CATHERINE PARK ZS

The proposed Catherine Park ZS will cater for the new residential release areas in Catherine Fields. The nearby release areas including Catherine Fields, The Hermitage and Gregory Hills will ultimately produce 7,300 lots and is currently being supplied by Oran Park ZS. The nearby Narellan ZS also has capacity issues created by miss-matched transformers which cannot be paralleled, which results in a lower firm capacity than the documented 70 MVA. The proposed Catherine Park ZS with a firm rating of 45 MVA will offload Narellan ZS and supply the residential development areas. The initial stages of the development will be supplied by three new 11kV feeders from Oran Park ZS.

B.18.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2021/22. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

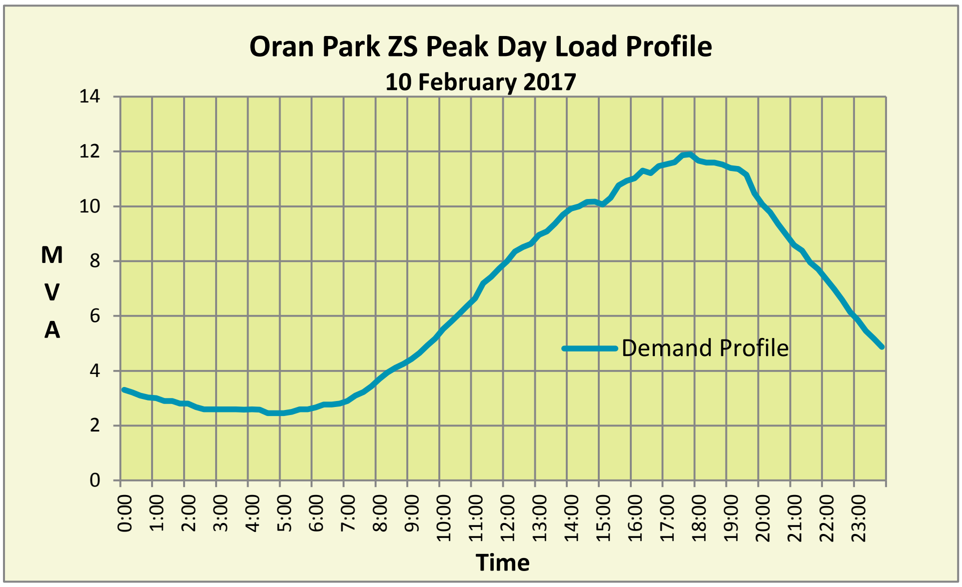
B.18.2 NON-NETWORK OPPORTUNITIES

A study is to be conducted to determine the extent of the overload and the required demand management to defer the proposed network option. This analysis will be conducted during 2018. Demand reduction will need to occur during times of network peak which is shown in Figure 29 below.

B.18.3 NETWORK OPTIONS

Network options that will be investigated include the construction of Catherine Park ZS to provide for the growth in demand.

FIGURE 29: ORAN PARK ZS LOAD PROFILE 10 FEBRUARY 2017



B.19 TERMEIL ZS

The proposed Termeil ZS is required primarily to cater for future commercial spot loads and organic residential load growth including expansion of existing holiday parks. A large spot load has requested a firm load of 1.7 MVA. This application, along with other commercial sites is expected to increase demand by 4.5 MVA within the next decade. This area is currently being supplied by the 11kV network from Ulladulla ZS and cannot sustain this magnitude of growth.

The existing Termeil 11kV feeder spur is supplied from Ulladulla ZS via a complex distribution network. It is the only closed loop 11kV feeder system within Endeavour Energy where two feeders ULE2 and ULL2 are run as a solid ring (at Termeil) some 20km's from Ulladulla ZS which then feeds into the 18km long Termeil spur. The Termeil spur line demand can triple from 1.0 MVA to 3.0 MVA during seasonal peak holiday periods. The existing ULE2 and ULL2 configuration includes multiple voltage regulators, auto-reclosers and a 1.0 MW diesel generator to maintain capacity, voltage regulation and reliability on this remote distribution network. The arrangement is currently operating just within acceptable capacity, voltage regulation and protection limits with no headroom for additional large loads.

B.19.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2020/21. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued requesting submission for non-network proposals.

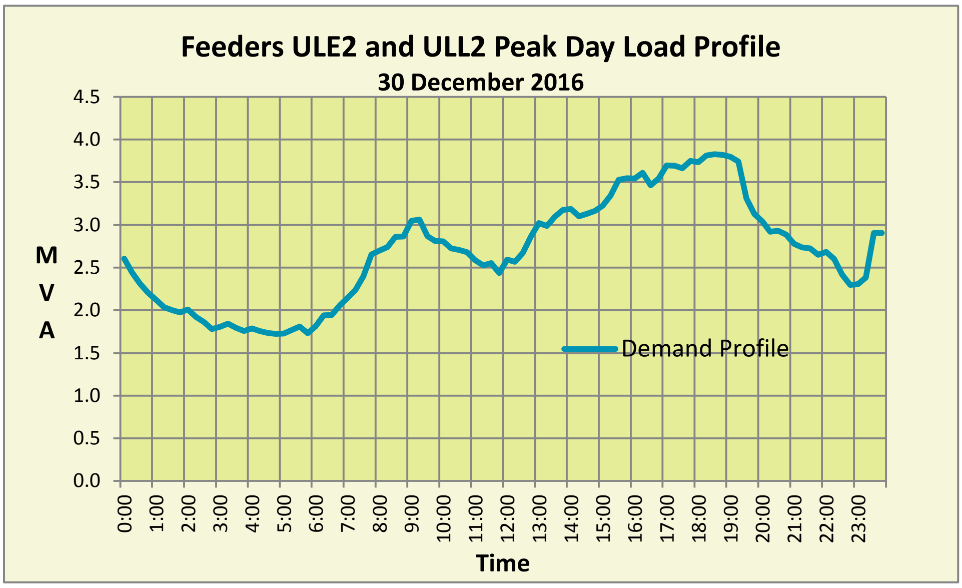
B.19.2 NON-NETWORK OPPORTUNITIES

The Termeil region consists of commercial, residential and holiday accommodation load. Potential for demand reduction may be available in these sectors. For demand management to be successful it needs to reduce peak demand by 0.5 MVA by the summer of 2018 to defer the network expenditure by one year growing to about 4 MVA, as development occurs. Demand reduction is to be on the 11kV network supplying this area from Ulladulla ZS. Demand reduction will need to occur during times of network peak shown in Figure 30 below.

B.19.3 NETWORK OPTIONS

Network options that will be investigated include the construction of Termeil ZS to provide for the growth in demand.

FIGURE 30: ULLADULLA 11KV FEEDERS ULE2 AND ULL2 LOAD PROFILE 30 DECEMBER 2016



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APPENDIX C: DETAILS OF RIT-D RETIREMENT AND DE-RATING PROJECTS

C.1 MARAYONG ZONE SUBSTATION

The Marayong ZS major equipment has reached its end-of-life and further repair or maintenance is not warranted. A project has been developed to build a new substation on the adjacent site to replace the existing substation. Replacement of power transformers will be like-for-like, being 3 x 25 MVA. An opportunity exists to install one less transformer if sufficient demand can be removed on a permanent basis.

C.1.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test was conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test identified that a demand management program was feasible consequently a Non-Network Options Report was issued. The Non-Network Options Report tender closes on 12 January 2018.

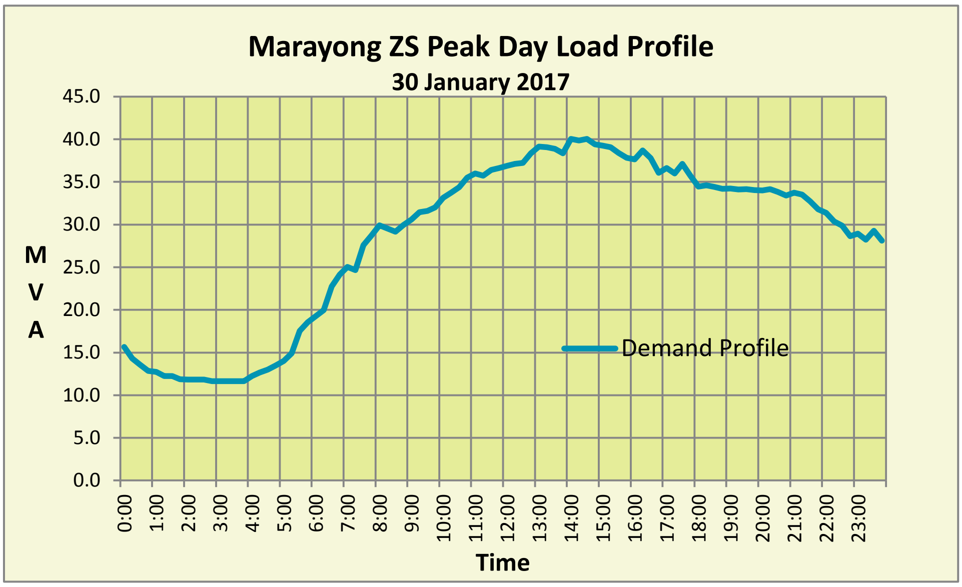
C.1.2 NON-NETWORK OPPORTUNITIES

The peak demand on Marayong ZS is currently 40 MVA. 85% of the demand is industrial load reaching 35 MVA during the peak. The residential demand accounts for the remaining 5 MVA of the total peak demand. Consequently, the industrial load is to be targeted for demand reduction. To enable a 25 MVA firm substation to be built, 13.5 MVA of demand at peak time must be removed on a permanent basis. Demand reduction will need to address the load profile shown in Figure 31 below.

C.1.3 NETWORK OPTIONS

Network options that will be investigated include the rebuild of Marayong ZS to replace all assets that have reached the end of their usable life.

FIGURE 31: MARAYONG ZS LOAD PROFILE 30 JANUARY 2017



C.2 CARLINGFORD TRANSMISSION SUBSTATION

The Carlingford TS control building has reached the end of its life and further repair or maintenance is not warranted. As a result the existing control building and associated protection and control equipment will be retired. An opportunity exists to provide non-network solution(s) to avoid the replacement of the control building and associated protection and control equipment.

C.2.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

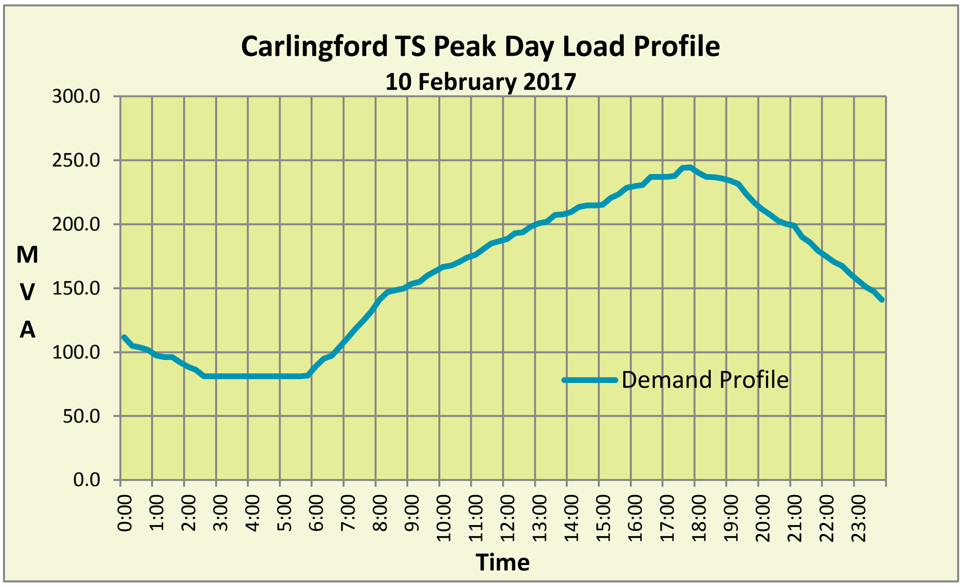
C.2.2 NON-NETWORK OPPORTUNITIES

The load type on the Carlingford TS is varied containing all customer types. The total demand at Carlingford TS is around 230 MVA. The control building and its associated protection and control equipment is necessary for the operation of the entire substation and therefore the level of demand reduction required to remove the need to replace the control building is 100% of the demand on Carlingford TS. If feasible, a Non-Network Options Report requesting submission for non-network proposals will be issued. Demand reduction will need to address the load profile shown in Figure 34 below.

C.2.3 NETWORK OPTIONS

The network option being investigated to address the need caused by the pending asset retirement is to construct a new control building with associated new protection and control equipment adjacent the existing control building.

FIGURE 32: CARLINGFORD TS LOAD PROFILE 10 FEBRUARY 2017



C.3 SUSSEX INLET ZONE SUBSTATION

The 11kV outdoor switchyard equipment at Sussex Inlet ZS has reached the end of its life and further repair or maintenance is not warranted. Consequently the 11kV switchyard will be retired. An opportunity exists to provide non-network solution(s) to avoid the network project to replace the switchyard with a new 11kV switchboard in a new control building with new protection and control equipment.

The existing power transformers will be retained in service.

C.3.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to remove the constraint. The screening test will be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

C.3.2 NON-NETWORK OPPORTUNITIES

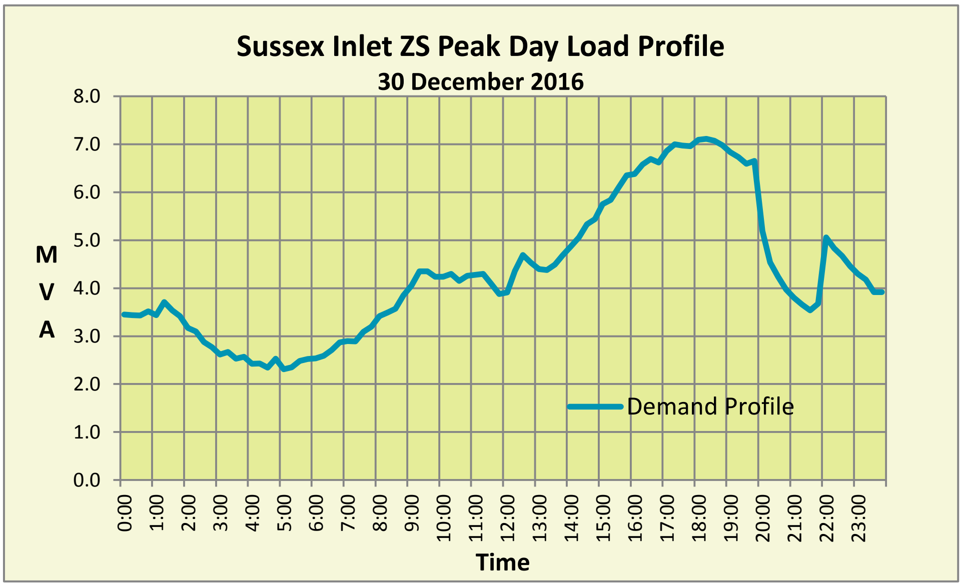
There is limited opportunities for DM with this type of project as lowering the demand on the substation is unlikely to alter the quantity of 11kV circuit breakers required or the performance level required of the switchgear and hence their cost.

Notwithstanding this, an analysis will be conducted to determine if there are any such opportunities and if so, a Non-Network Options Report will be issued requesting submission for non-network proposals. Demand reduction will need to address the load profile shown in Figure 33 below.

C.3.3 NETWORK OPTIONS

Network options that will be investigated include the construction of a new control building with an indoor 11kV busbar and new protection and control equipment to replace the assets that have reached the end of their life.

FIGURE 33: SUSSEX INLET ZS LOAD PROFILE 30 DECEMBER 2016



C.4 FEEDER 7028 – BELLAMBI TS TO HELENSBURGH ZS

33kV Feeder 7028 from Bellambi TS to Helensburgh ZS currently utilises one side of a double circuit steel tower line whose towers are corroded and have reached the end of their life. Further repair or maintenance is not cost effective and therefore it is proposed that this line be retired. A network project is proposed to be developed to build a new line to replace the existing line. An opportunity exists for a non-network solution to enable to the feeder to be replaced with a lower capacity feeder.

C.4.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2017/18. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

C.4.2 NON-NETWORK OPPORTUNITIES

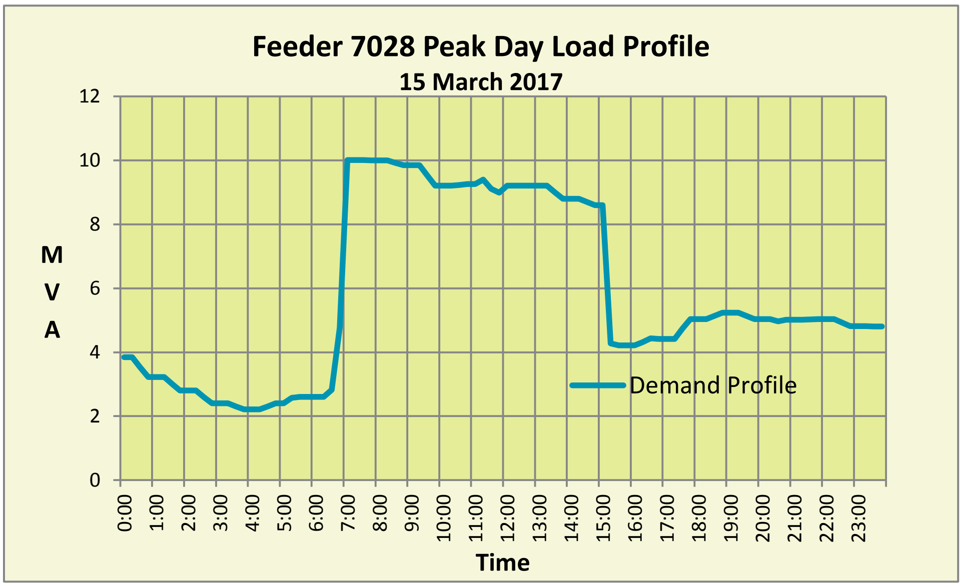
Feeder 7028 supplies Helensburgh ZS as part of an interconnected network but is also required to supply the entire Helensburgh ZS load from time to time during maintenance or emergency situations. Figure 36 shows the load profile of Helensburgh ZS on a recent peak demand day.

Helensburgh ZS supplies the township of Helensburgh, the surrounding residential areas and several major customers. An analysis will be conducted to determine if there exists opportunities to reduce sufficient demand to justify installing a reduced conductor size on the new line. The analysis will include the voltage levels required at the extremities of the feeder. If shown to be feasible, the detail will be included in a Non-Network Options Report requesting submission for non-network proposals.

C.4.3 NETWORK OPTIONS

Network options that will be investigated include the reconstruction of Feeder 7028 to replace all assets that have reached the end of their life.

FIGURE 34: FEEDER 7028 LOAD PROFILE 15 MARCH 2017



C.5 WEST WOLLONGONG ZS

The 11kV switchboard at West Wollongong ZS has reached the end of its life and is proposed to be replaced in a new control building. Two of the existing power transformers are in satisfactory condition and are likely to be retained in service. The third transformer is approaching the end of its life and is likely to be replaced. An opportunity exists to avoid replacing the third transformer if sufficient demand can be removed from the substation on a permanent basis

C.5.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2019/20. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

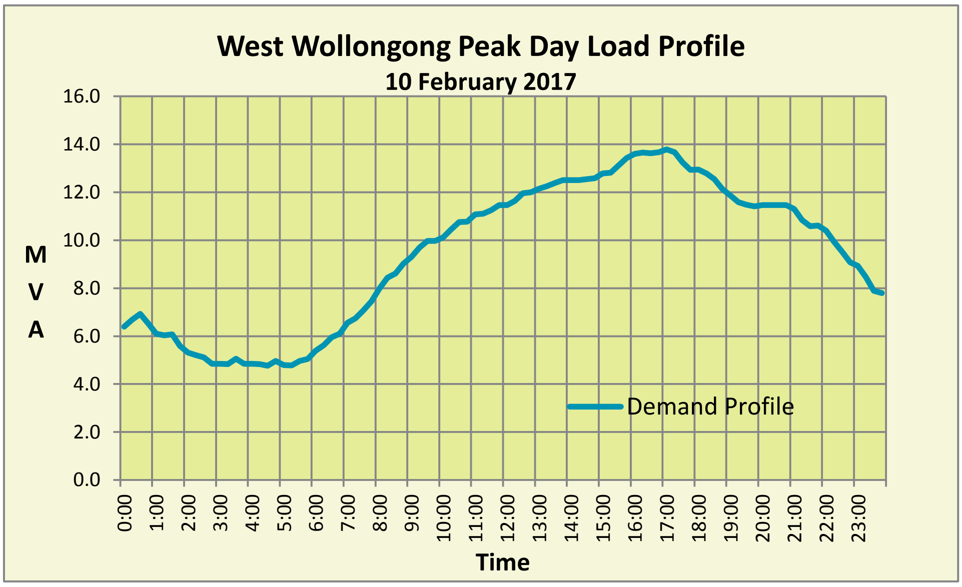
C.5.2 NON-NETWORK OPPORTUNITIES

West Wollongong ZS supplies two major hospitals, several major customers, a shopping centre and the surrounding residential areas. The existing firm capacity is 22 MVA with a peak demand around 13 MVA. An analysis will be conducted to determine if there exists opportunities to reduce sufficient demand to justify installing one less transformer when the 11kV switchboard is replaced. If so, the detail will be included in a Non-Network Options Report requesting submission for non-network proposals. Demand reduction will need to occur during times of network peak demand as shown in Figure 35 below.

C.5.3 NETWORK OPTIONS

Network options that will be investigated include the replacement of the control building and 11kV busbar and the third power transformer at West Wollongong ZS to replace those assets that have reached the end of their life.

FIGURE 35: WEST WOLLONGONG ZS LOAD 10 FEBRUARY 2017



C.6 UNANDERRA ZONE SUBSTATION

The 11kV switchboard and the control building at Unanderra ZS have reached the end of their life and are proposed to be retired and replaced with a new control building and 11kV switchboard. Unanderra ZS currently includes 3 x 12 MVA transformers giving it a firm transformer capacity of 24MVA. The peak demand currently reaches 17 MVA with a proposed major spot load likely to increase demand substantially over the 10 year forecast period.

An opportunity exists to change the design of the substation from three transformers to two transformers when the 11kV switchboard is replaced if sufficient demand can be removed from the substation on a permanent basis.

C.6.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2020/21. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

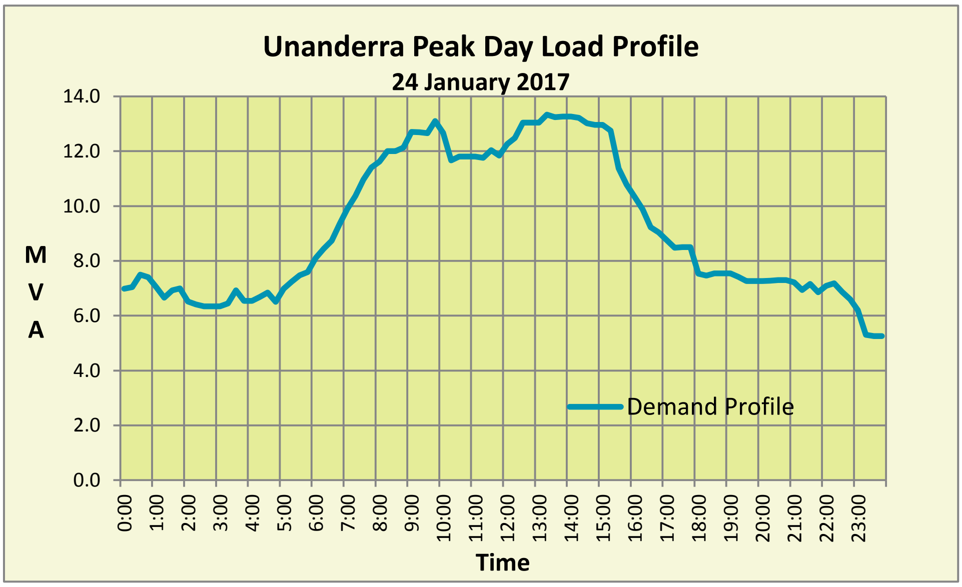
C.6.2 NON-NETWORK OPPORTUNITIES

Unanderra ZS supplies an industrial area containing several major customers. It also supplies the surrounding residential area. An analysis will be conducted to determine if there exists opportunities to reduce sufficient demand to justify changing the substation from three transformer to a two transformer design. If so, the detail will be included in a Non-Network Options Report requesting submission for non-network proposals. Demand reduction will need to occur during times of network peak shown in Figure 36 below.

C.6.3 NETWORK OPTIONS

Network options that will be investigated include the replacement of the control building and the 11kV switchboard at Unanderra ZS to replace all assets that have reached the end of their life.

FIGURE 36: UNANDERRA ZS LOAD 24 JANUARY 2017



C.7 GREYSTANES ZONE SUBSTATION

The 33kV and 11kV equipment at Greystanes ZS has reached the end of its life and further repair or maintenance is not cost effective. Therefore a project is proposed to be developed to replace the majority of the substation's assets. The transformers are currently in satisfactory condition. However, there may be an opportunity to replace these units if it provides strategic benefits. If so, an opportunity may exist to reduce the capacity of the substation if sufficient demand can be removed on a permanent basis. Greystanes ZS currently includes 2 x 25 MVA transformers. The peak demand reached 24 MVA but this will reduce after the planned load transfer of 2.2 MVA to Holroyd ZS takes place

C.7.1 SCREENING TEST

This capacity constraint is a RIT-D project and consequently a screening test will be conducted to ascertain the feasibility of demand management initiatives to address the constraint. The screening test is planned to be conducted during 2021/22. If it is determined that there is sufficient demand reduction potential available a Non-Network Options Report will be issued.

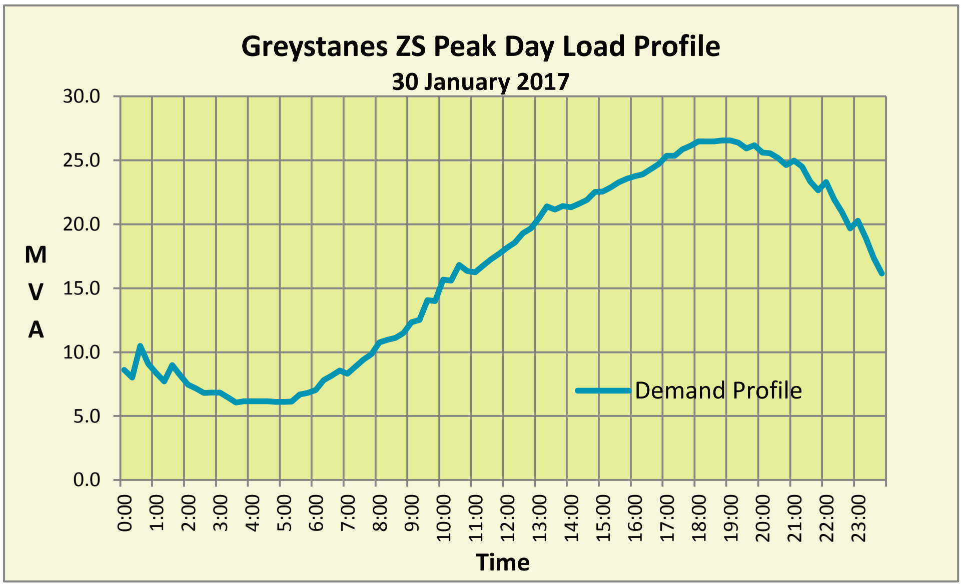
C.7.2 NON-NETWORK OPPORTUNITIES

The Greystanes ZS predominantly supplies a residential area. The existing firm capacity is 25 MVA. An analysis will be conducted to determine if there exists opportunities to reduce sufficient demand to justify installing one less transformer. If so, the detail will be included in a Non-Network Options Report requesting submission for non-network proposals. Demand reduction will need to occur during times of network peak as shown in Figure 37 below.

C.7.3 NETWORK OPTIONS

Network options that will be investigated include the redevelopment of the substation to replace all assets that have reached the end of their life.

FIGURE 37: GREYSTANES ZS LOAD 30 JANUARY 2017



APPENDIX D: DETAILS OF NON RIT-D PROJECTS

D.1 AUSTRAL ZONE SUBSTATION

The proposed mobile Austral ZS will cater for the new residential release areas in the Austral precinct. The nearby release areas will ultimately yield 14,000 lots representing about 55 MVA of demand. The 11kV network supplied from Hinchinbrook ZS and Kemps Creek ZS has 4.9 MVA of spare capacity for up to 1,225 new dwellings. At a growth rate of 250 dwellings per year, capacity will be exhausted 2022. Demand is expected to continue to grow by 1.0 MVA per annum.

D.1.1 SCREENING TEST

This capacity constraint does not meet the RIT-D threshold as the network option is less than $5 million. A screening test will still be conducted to ascertain the feasibility of demand management initiatives to address the network constraint. It is planned to conduct the screening test during 2017/18. If it is determined that there is sufficient demand reduction potential available Endeavour will consider the most cost-effective means of implementing a non-network option. This may include approaching the market or direct negotiations with customers.

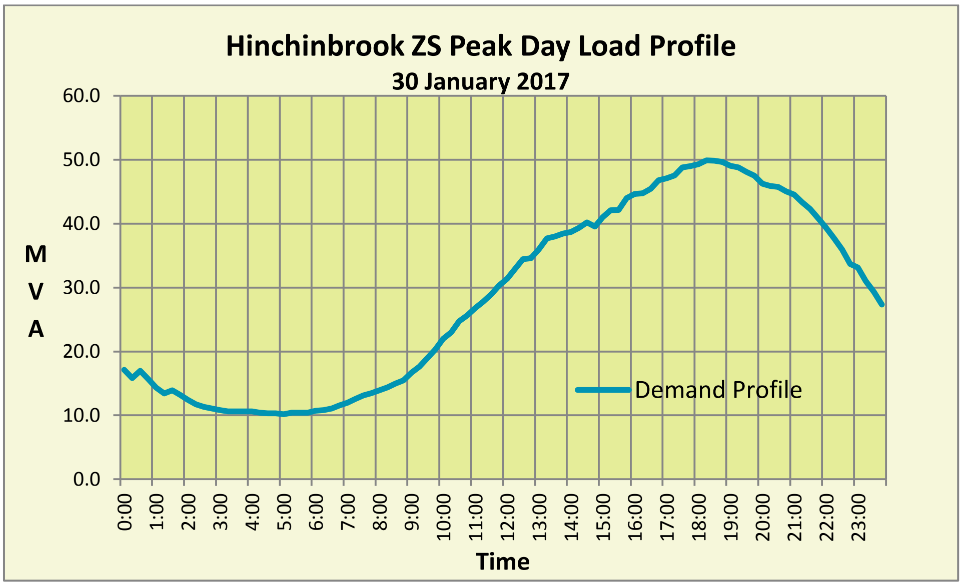
D.1.2 NON-NETWORK OPPORTUNITIES

The Austral release area precinct consists of new residential release areas. For demand management to be successful, peak demand is to be reduced by 1.0 MVA by 2022 to defer the network expenditure by one year. Demand reduction will need to increase by 1.0 MVA per year to keep pace with the forecast increase in demand in the new release areas in order to continue to defer network investment. Demand reduction will need to occur during times of network peak shown in Figure 38 below.

D.1.3 NETWORK OPTIONS

Network options that will be investigated include the construction of the mobile Austral ZS to provide for the growth in demand.

FIGURE 38: HINCHINBROOK ZS LOAD PROFILE 30 JANUARY 2017



APPENDIX E: OVERLOADED PRIMARY DISTRIBUTION FEEDERS

Note that in the table "Cap + Fdr" indicates that the feeder is double cabled with a capacitor bank and the actual feeder load is be subject to further investigation.

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
Abbotsbury ZS	AB1246	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Abbotsbury ZS	AB1289	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Albion Park ZS	APA2	Summer	0.0%	0.0%	3.4%	0.16	Monitor
		Winter	0.0%	0.0%	0.0%		
Albion Park ZS	APG2	Summer	1.4%	4.2%	9.3%	0.43	Monitor
		Winter	0.0%	0.0%	0.0%		
Albion Park ZS	APH2	Summer	0.0%	0.0%	4.8%	0.22	Monitor
		Winter	0.0%	0.0%	0.0%		
Anzac Village ZS	AZ1227	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Anzac Village ZS	AZ1253	Summer	6.3%	9.2%	14.5%	0.66	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Anzac Village ZS	AZ1272	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Arndell Park ZS	17058	Summer	32.2%	35.9%	42.5%	1.94	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Arndell Park ZS	46752	Summer	5.7%	8.6%	13.9%	0.64	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Arndell Park ZS	46774	Summer	0.0%	0.0%	4.5%	0.20	Monitor
		Winter	0.0%	0.0%	0.0%		
Baulkham Hills 11kV	35304	Summer	8.8%	11.8%	17.2%	0.79	Monitor
		Winter	0.0%	0.0%	0.0%		
Baulkham Hills 11kV	35305	Summer	50.8%	55.0%	62.6%	2.86	New Project
		Winter	0.0%	0.0%	0.0%		
Baulkham Hills 11kV	35327	Summer	0.1%	2.9%	7.9%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Baulkham Hills 11kV	35335	Summer	0.0%	2.4%	7.3%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
Bella Vista ZS	49319	Summer	6.6%	9.6%	14.9%	0.68	Monitor
		Winter	0.0%	0.0%	0.0%		
Bella Vista ZS	49348	Summer	6.5%	9.5%	14.8%	0.68	Monitor
		Winter	0.0%	0.0%	0.0%		
Bella Vista ZS	49357	Summer	13.5%	16.7%	22.3%	1.02	Monitor
		Winter	0.0%	0.0%	0.0%		
Bella Vista ZS	49362	Summer	16.7%	19.9%	25.7%	1.18	Monitor
		Winter	0.0%	0.0%	0.0%		
Bella Vista ZS	49395	Summer	0.0%	0.0%	4.9%	0.22	Monitor
		Winter	0.0%	0.0%	0.0%		
Blaxland ZS	R250	Summer	8.3%	11.3%	16.8%	0.77	Existing Project
		Winter	0.0%	0.0%	0.0%		
Blaxland ZS	R256	Summer	6.7%	9.6%	15.0%	0.68	Existing Project
		Winter	1.3%	4.1%	9.1%		
Blaxland ZS	R257	Summer	0.0%	0.0%	0.0%	0.58	Existing Project
		Winter	4.6%	7.5%	12.7%		
Blaxland ZS	R259	Summer	0.0%	0.0%	0.0%	4.43	Cap Bank
		Winter	82.7%	87.8%	97.0%		
Bomaderry ZS	BDA2	Summer	6.9%	9.9%	15.3%	0.70	New Feeder
		Winter	0.0%	0.0%	0.0%		
Bomaderry ZS	BDF2	Summer	28.5%	32.1%	38.5%	1.76	New Feeder
		Winter	2.5%	5.4%	10.5%		
Bomaderry ZS	BDG2	Summer	7.9%	10.9%	16.3%	0.75	Monitor
		Winter	0.0%	0.0%	0.0%		
Bonnyrigg ZS	8776	Summer	8.3%	11.3%	16.8%	0.77	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Bonnyrigg ZS	8779	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Bow Bowing ZS	W182	Summer	0.4%	3.2%	8.2%	0.38	Monitor
		Winter	0.4%	3.2%	8.2%		
Bow Bowing ZS	W184	Summer	0.0%	0.0%	3.9%	0.18	Monitor

Endeavour Energy

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	0.0%		
Bow Bowing ZS	W185	Summer	23.8%	27.2%	33.4%	1.53	Cap Bank
		Winter	0.0%	0.0%	0.0%		
Bow Bowing ZS	W187	Summer	0.3%	3.1%	8.1%	0.47	HVC
		Winter	2.2%	5.1%	10.2%		
Bow Bowing ZS	W193	Summer	0.0%	2.1%	7.0%	0.32	HVC
		Winter	0.0%	0.0%	3.0%		
Bow Bowing ZS	W194	Summer	29.4%	33.0%	39.5%	1.81	HVC
		Winter	29.6%	33.2%	39.7%		
Bringelly ZS	X877/B	Summer	0.0%	0.0%	2.4%	0.11	Monitor
		Winter	0.0%	0.0%	0.0%		
Campbelltown ZS	CT1296	Summer	18.8%	22.1%	28.0%	1.28	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Canley Vale ZS	CV1221	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Castle Hill ZS	C824	Summer	0.0%	1.3%	6.2%	0.28	Monitor
		Winter	0.0%	0.0%	0.0%		
Castle Hill ZS	C832	Summer	23.8%	27.3%	33.5%	1.53	New Project
		Winter	22.0%	25.4%	31.5%		
Cawdor ZS	CD1241	Summer	5.8%	8.8%	14.1%	0.64	Existing Project
		Winter	0.0%	0.0%	0.0%		
Cawdor ZS	CD1267	Summer	21.3%	24.6%	30.7%	1.40	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Cawdor ZS	CD1271	Summer	2.9%	5.8%	10.9%	0.50	Monitor
		Winter	0.0%	0.0%	0.0%		
Cheriton Avenue ZS	CJ1204	Summer	0.0%	2.4%	7.3%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
Cheriton Avenue ZS	CJ1245	Summer	38.4%	42.3%	49.2%	2.25	New Project
		Winter	0.0%	0.0%	0.0%		
Cheriton Avenue ZS	CJ1249	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Cheriton Avenue ZS	CJ1267	Summer	3.0%	5.9%	11.0%	0.50	Monitor
		Winter	0.0%	0.0%	0.0%		
Cheriton Avenue ZS	CJ1275	Summer	16.2%	19.4%	25.2%	1.15	New Project
		Winter	0.0%	0.0%	0.0%		
Claremont Meadows ZS	CS1213	Summer	0.8%	3.6%	8.6%	0.39	Monitor
		Winter	0.0%	0.0%	0.0%		
Claremont Meadows ZS	CS1247	Summer	10.0%	13.1%	18.6%	0.85	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Cranebrook ZS	C809	Summer	25.6%	29.1%	35.4%	1.62	HVC
		Winter	6.3%	9.2%	14.5%		
Cranebrook ZS	S785	Summer	24.6%	28.0%	34.3%	1.57	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Cranebrook ZS	S788/A	Summer	5.8%	8.8%	14.1%	0.64	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Dapto ZS	DP1206	Summer	0.0%	0.3%	5.2%	0.24	Monitor
		Winter	0.0%	0.0%	0.0%		
Dapto ZS	DP1210	Summer	0.0%	0.0%	3.9%	0.18	Monitor
		Winter	0.0%	0.0%	0.0%		
Dapto ZS	DP1243	Summer	0.0%	0.0%	4.8%	0.22	Monitor
		Winter	0.0%	0.0%	0.0%		
Dapto ZS	DP1269	Summer	0.0%	0.0%	0.4%	0.05	Monitor
		Winter	0.0%	0.0%	1.0%		
Doonside ZS	DS1205	Summer	18.8%	22.1%	28.0%	1.28	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1223	Summer	17.3%	20.6%	26.5%	1.21	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1226	Summer	9.1%	12.1%	17.6%	0.80	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1235	Summer	2.7%	5.5%	10.7%	0.49	Monitor
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1256	Summer	6.4%	9.4%	14.7%	0.67	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1257	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	0.0%		
Doonside ZS	DS1290	Summer	16.2%	19.4%	25.2%	1.15	Load Transfer

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	0.0%		
Dundas ZS	2806	Summer	34.1%	37.9%	44.6%	2.04	Cap Bank
		Winter	0.0%	0.0%	0.0%		
Dundas ZS	2815	Summer	15.0%	18.2%	23.9%	1.09	Monitor
		Winter	0.0%	0.0%	0.0%		
Dundas ZS	5495	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	0.0%		
Dundas ZS	F603	Summer	8.3%	11.3%	16.8%	0.77	Monitor
		Winter	0.0%	0.0%	3.2%		
East Richmond ZS	ER1222	Summer	33.7%	37.5%	44.1%	2.02	HVC
		Winter	2.5%	5.3%	10.5%		
East Richmond ZS	ER1232	Summer	24.6%	28.1%	34.3%	1.57	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Eastern Creek ZS	54665	Summer	0.0%	2.4%	7.4%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
Emu Plains ZS	C849	Summer	13.3%	16.4%	22.1%	1.01	HVC
		Winter	0.0%	0.0%	0.0%		
Emu Plains ZS	C852	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Emu Plains ZS	C854	Summer	0.0%	1.9%	6.9%	0.31	Monitor
		Winter	0.0%	0.0%	0.0%		
Emu Plains ZS	C869	Summer	0.0%	0.0%	0.0%	0.07	Monitor
		Winter	0.0%	0.0%	1.5%		
Fairfield ZS	FF1206	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Fairfield ZS	FF1239	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Glenmore Park ZS	S766	Summer	5.8%	8.8%	14.1%	0.64	New Project
		Winter	0.0%	0.0%	0.0%		
Glenmore Park ZS	S768	Summer	12.5%	15.6%	21.3%	0.97	Cap + Fdr
		Winter	11.7%	14.8%	20.4%		
Glenmore Park ZS	S769	Summer	7.2%	10.2%	15.5%	0.71	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Glenmore Park ZS	S772/A	Summer	21.3%	24.7%	30.8%	1.41	New Project
		Winter	0.0%	0.0%	0.0%		
Glenmore Park ZS	S776	Summer	9.0%	12.1%	17.5%	0.80	New Project
		Winter	0.0%	0.0%	0.0%		
Greystanes ZS	7974	Summer	0.0%	0.0%	1.0%	0.05	Monitor
		Winter	0.0%	0.0%	0.0%		
Greystanes ZS	7976	Summer	7.2%	10.2%	15.5%	0.71	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48159	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48161	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48178	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48189	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48196	Summer	25.0%	28.5%	34.7%	1.59	Existing Project
		Winter	0.0%	0.0%	0.0%		
Hinchinbrook ZS	48205	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Holroyd ZS	HR1206	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Holroyd ZS	HR1269	Summer	0.0%	0.0%	1.0%	0.05	Monitor
		Winter	0.0%	0.0%	0.0%		
Holroyd ZS	HR1273	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	0.0%		
Holroyd ZS	HR1276	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Homepride ZS	35444	Summer	4.6%	7.5%	12.7%	0.58	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Homepride ZS	A318	Summer	0.0%	0.0%	0.0%	0.12	Monitor
		Winter	0.0%	0.0%	2.7%		
Horsley Park ZS	8714	Summer	0.0%	0.0%	3.3%	0.15	Monitor

Endeavour Energy

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	3.3%		
Huntingwood ZS	HT1238	Summer	0.0%	0.0%	0.0%	0.00	Monitor
		Winter	0.0%	0.0%	0.0%		
Huntingwood ZS	HT1246	Summer	4.8%	7.7%	12.9%	0.59	HVC
		Winter	0.0%	0.0%	0.0%		
Huntingwood ZS	HT1294	Summer	38.7%	42.6%	49.5%	2.26	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Huskisson ZS	HKF2	Summer	0.0%	0.0%	0.0%	0.38	Monitor
		Winter	0.4%	3.2%	8.3%		
Inner Harbour ZS	IHF2	Summer	0.0%	0.0%	0.0%	0.36	Monitor
		Winter	0.0%	2.8%	7.8%		
Inner Harbour ZS	IHJ2	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Jasper Rd ZS	55876	Summer	11.8%	14.9%	20.5%	0.94	Monitor
		Winter	0.0%	0.0%	0.0%		
Jasper Rd ZS	55885	Summer	7.2%	10.2%	15.6%	0.71	Monitor
		Winter	0.0%	0.0%	0.0%		
Jasper Rd ZS	55890	Summer	10.7%	13.8%	19.3%	0.88	Monitor
		Winter	0.0%	0.0%	0.0%		
Jordan Springs ZS	JS1122	Summer	16.7%	19.9%	25.7%	1.18	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Jordan Springs ZS	JS1152	Summer	0.0%	0.0%	4.3%	0.19	Monitor
		Winter	0.0%	0.0%	0.0%		
Jordan Springs ZS	JS1232	Summer	0.5%	3.3%	8.3%	0.38	Monitor
		Winter	0.0%	0.0%	0.0%		
Kellyville ZS	8641	Summer	12.2%	15.3%	21.0%	0.96	Monitor
		Winter	0.0%	2.0%	7.0%		
Kellyville ZS	8645	Summer	3.1%	5.9%	11.1%	0.51	Monitor
		Winter	0.0%	0.0%	0.0%		
Kellyville ZS	8652	Summer	6.8%	9.8%	15.1%	0.69	Monitor
		Winter	0.0%	0.0%	0.0%		
Kenthurst ZS	S735	Summer	0.0%	0.0%	2.0%	0.09	Monitor
		Winter	0.0%	0.0%	0.0%		
Kenthurst ZS	S740	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	1.6%		
Kenthurst ZS	S741	Summer	1.4%	4.3%	9.3%	0.43	Monitor
		Winter	0.0%	0.0%	0.0%		
Kingswood ZS	9015	Summer	8.1%	11.1%	16.5%	0.75	HVC
		Winter	0.0%	0.0%	0.0%		
Kingswood ZS	9019	Summer	0.0%	0.1%	5.0%	0.23	Monitor
		Winter	0.0%	0.0%	0.0%		
Kingswood ZS	9022	Summer	2.1%	4.9%	10.0%	0.46	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Kingswood ZS	9025/B	Summer	10.8%	13.9%	19.5%	0.89	New Project
		Winter	0.0%	0.0%	0.0%		
Kurrajong ZS	8798	Summer	0.0%	0.0%	1.0%	0.05	Monitor
		Winter	0.0%	0.0%	0.0%		
Kurrajong ZS	8802	Summer	15.4%	18.7%	24.4%	1.12	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Leabons Lane ZS	LL1222	Summer	50.8%	55.0%	62.5%	2.86	Existing Project
		Winter	0.0%	0.0%	0.0%		
Luddenham ZS	A096	Summer	38.1%	42.0%	48.9%	2.24	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1112	Summer	9.2%	12.2%	17.7%	0.81	New Project
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1142	Summer	4.2%	7.1%	12.3%	0.56	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1162	Summer	18.5%	21.8%	27.7%	1.27	Cap + Fdr
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1202	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1362	Summer	0.0%	0.0%	1.9%	0.09	Monitor
		Winter	0.0%	0.0%	0.0%		
Mamre ZS	MM1372	Summer	0.0%	0.0%	0.2%	0.01	Monitor
		Winter	0.0%	0.0%	0.0%		
Marayong ZS	1949/A	Summer	100.0%	105.6%	115.6%	5.28	HVC

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
		Winter	12.6%	15.8%	21.4%		
Marayong ZS	1957	Summer	6.3%	9.3%	14.6%	0.67	Monitor
		Winter	0.0%	0.0%	0.0%		
Marayong ZS	1958	Summer	11.3%	14.4%	20.0%	0.91	Existing Project
		Winter	0.0%	0.0%	0.9%		
Marayong ZS	1963	Summer	25.4%	28.9%	35.2%	1.61	HVC
		Winter	0.0%	0.0%	3.1%		
Minto ZS	J459	Summer	5.0%	7.9%	13.2%	0.60	Monitor
		Winter	0.0%	0.0%	2.5%		
Minto ZS	J465	Summer	30.0%	33.6%	40.1%	1.83	Monitor
		Winter	0.0%	0.0%	0.0%		
Minto ZS	J468	Summer	2.1%	4.9%	10.0%	0.46	Monitor
		Winter	0.0%	0.0%	0.0%		
Minto ZS	J473	Summer	0.0%	0.0%	2.4%	0.11	Monitor
		Winter	0.0%	0.0%	0.0%		
Minto ZS	J480/B	Summer	0.0%	0.0%	1.0%	0.05	Monitor
		Winter	0.0%	0.0%	0.0%		
Minto ZS	J483	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Mittagong ZS	MG1234	Summer	0.0%	0.0%	0.6%	0.03	Monitor
		Winter	0.0%	0.0%	0.0%		
Moorebank ZS	6431	Summer	16.7%	19.9%	25.7%	1.59	HVC
		Winter	25.0%	28.5%	34.7%		
Mungerie Park ZS	MR2225	Summer	1.9%	4.7%	9.8%	0.90	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Mungerie Park ZS	MR2298	Summer	4.5%	7.4%	12.7%	1.16	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Mungerie Park ZS	MR2299	Summer	13.9%	17.0%	22.7%	2.08	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Narellan ZS	27029/A	Summer	9.2%	12.2%	17.7%	0.81	Load Transfer
		Winter	0.0%	1.1%	6.0%		
Narellan ZS	27032	Summer	0.0%	0.0%	3.1%	0.14	Monitor
		Winter	0.0%	0.0%	0.0%		
Narellan ZS	55169	Summer	0.0%	2.4%	7.3%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
Nepean 11kV	NN1233	Summer	5.4%	8.3%	13.6%	0.62	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Nepean 11kV	NN1262	Summer	5.0%	7.9%	13.2%	0.60	Monitor
		Winter	0.0%	0.0%	0.0%		
Nepean 11kV	NN1277	Summer	8.3%	11.3%	16.8%	0.77	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Newton ZS	L533	Summer	13.7%	16.9%	22.6%	1.03	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Newton ZS	L540	Summer	21.6%	25.0%	31.1%	1.42	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Newton ZS	L543	Summer	0.0%	1.0%	5.9%	0.27	Monitor
		Winter	0.0%	0.0%	0.0%		
North Parramatta ZS	16653	Summer	0.0%	0.0%	0.6%	0.03	Monitor
		Winter	0.0%	0.0%	0.0%		
North Parramatta ZS	16660	Summer	6.0%	8.9%	14.2%	0.65	Monitor
		Winter	0.0%	0.0%	3.1%		
North Parramatta ZS	35388	Summer	0.0%	2.4%	7.3%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
North Richmond ZS	10287	Summer	3.1%	5.9%	11.1%	0.51	Load Transfer
		Winter	0.0%	0.0%	0.0%		
North Rocks ZS	8738	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Northmead ZS	NM1243	Summer	0.0%	0.8%	5.7%	0.26	Monitor
		Winter	0.0%	0.0%	0.0%		
Northmead ZS	NM1258	Summer	19.7%	23.0%	29.0%	1.33	Monitor
		Winter	0.0%	0.0%	0.0%		
Nowra ZS	NA1207	Summer	0.0%	0.0%	0.6%	0.03	Monitor
		Winter	0.0%	0.0%	0.0%		
Oran Park ZS	OP1232	Summer	31.3%	34.9%	41.5%	1.90	Existing Project
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25773	Summer	19.6%	22.9%	28.9%	2.64	22kV FDR

Location	FDR Name	Extent of Primary Feeder Overload (% above normal cyclic rating)				Reduction Required (MVA)	Potential Solution
		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25774	Summer	0.0%	0.0%	1.1%	0.10	Monitor
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25777	Summer	26.2%	29.7%	36.0%	3.29	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25780	Summer	0.0%	2.5%	7.5%	0.69	Monitor
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25781	Summer	0.0%	0.0%	3.3%	0.30	Monitor
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25782	Summer	3.9%	6.8%	12.0%	1.10	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25783	Summer	17.2%	20.5%	26.3%	2.41	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	25784	Summer	18.3%	21.6%	27.5%	2.51	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Parklea ZS	41361	Summer	0.0%	0.9%	5.8%	0.53	Monitor
		Winter	0.0%	0.0%	0.0%		
Penrith 11kV	PH1234	Summer	0.0%	0.1%	5.0%	0.23	Monitor
		Winter	0.0%	0.0%	0.0%		
Penrith 11kV	PH1286	Summer	0.0%	2.6%	7.6%	0.35	Monitor
		Winter	0.0%	0.0%	0.0%		
Penrith 11kV	PH1293	Summer	29.9%	33.5%	40.0%	1.83	Cap + Fdr
		Winter	0.0%	0.0%	0.0%		
Penrith 11kV	PH1297	Summer	0.0%	0.0%	0.7%	0.03	Monitor
		Winter	0.0%	0.0%	0.0%		
Prestons ZS	25740	Summer	2.1%	4.9%	10.0%	0.46	Existing Project
		Winter	0.0%	0.0%	0.0%		
Prestons ZS	25746	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Prestons ZS	53803	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Prospect ZS	B201	Summer	3.6%	6.5%	11.7%	0.53	Monitor
		Winter	0.0%	0.0%	0.0%		
Prospect ZS	B202	Summer	0.0%	0.0%	4.8%	0.22	Monitor
		Winter	0.0%	0.0%	0.0%		
Prospect ZS	B217	Summer	0.0%	0.7%	5.6%	0.26	Monitor
		Winter	0.0%	0.0%	0.0%		
Quakers Hill ZS	B709	Summer	0.6%	3.4%	8.4%	0.38	Monitor
		Winter	0.0%	0.0%	0.0%		
Quakers Hill ZS	B710	Summer	0.0%	0.0%	3.4%	0.16	Monitor
		Winter	0.0%	0.0%	0.0%		
Quakers Hill ZS	B713	Summer	12.2%	15.3%	21.0%	0.96	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Quarries ZS	27500	Summer	107.0%	112.8%	123.1%	5.63	HVC
		Winter	91.5%	96.9%	106.4%		
Riverstone ZS	A046	Summer	15.3%	18.5%	24.2%	1.11	Existing Project
		Winter	0.0%	0.0%	0.0%		
Riverstone ZS	A051	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Rooty Hill ZS	T883	Summer	0.0%	0.0%	1.9%	0.09	Monitor
		Winter	0.0%	0.0%	0.0%		
Rooty Hill ZS	T888/B	Summer	9.9%	13.0%	18.5%	0.85	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Rooty Hill ZS	T890	Summer	0.0%	2.5%	7.5%	0.34	Monitor
		Winter	0.0%	0.0%	0.0%		
Rooty Hill ZS	T894	Summer	14.3%	17.4%	23.2%	1.06	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Rosehill ZS	RS1233	Summer	0.0%	0.0%	0.0%	0.31	Monitor
		Winter	0.0%	1.8%	6.8%		
Rydalmere ZS	RD1292	Summer	15.3%	18.5%	24.3%	1.11	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Schofields ZS	SC1204	Summer	0.1%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Schofields ZS	SC1208	Summer	30.2%	33.8%	40.4%	1.85	Existing Project
		Winter	0.0%	0.0%	0.0%		
Seven Hills ZS	8610	Summer	24.3%	27.8%	34.0%	1.56	Load Transfer

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		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	0.0%		
Seven Hills ZS	8617	Summer	0.0%	0.0%	3.2%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Shellharbour ZS	SHA2	Summer	34.4%	38.2%	44.9%	2.05	Cap + Fdr
		Winter	0.0%	0.0%	0.0%		
Sherwood ZS	9050	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Sherwood ZS	9056	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Smithfield ZS	49917	Summer	0.0%	0.0%	0.0%	0.00	Monitor
		Winter	0.0%	0.0%	0.1%		
Smithfield ZS	49918	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Smithfield ZS	68204	Summer	0.0%	0.0%	1.0%	0.05	Monitor
		Winter	0.0%	0.0%	0.0%		
South Granville ZS	SG1220	Summer	0.0%	2.7%	7.7%	0.35	Monitor
		Winter	0.0%	0.0%	0.0%		
South Granville ZS	SG1250	Summer	0.0%	0.0%	3.1%	0.14	Monitor
		Winter	0.0%	0.0%	0.0%		
South Marsden park ZS	SQ1142	Summer	6.1%	9.1%	14.4%	0.66	Load Transfer
		Winter	0.0%	0.0%	0.0%		
South Windsor ZS	SZ1112	Summer	29.2%	32.8%	39.3%	1.80	Cap + Fdr
		Winter	0.0%	0.0%	0.0%		
South Windsor ZS	SZ1122	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	2.8%		
South Windsor ZS	SZ1132	Summer	7.5%	10.5%	15.9%	0.73	Existing Project
		Winter	0.0%	0.0%	3.3%		
South Windsor ZS	SZ1152	Summer	17.5%	20.8%	26.6%	1.22	Existing Project
		Winter	5.0%	7.9%	13.2%		
South Windsor ZS	SZ1242	Summer	27.5%	31.1%	37.5%	1.71	New Project
		Winter	0.0%	0.0%	0.0%		
South Windsor ZS	SZ1322	Summer	23.3%	26.8%	32.9%	1.51	New Project
		Winter	0.0%	0.0%	0.0%		
South Windsor ZS	SZ1332	Summer	0.0%	0.0%	2.0%	0.09	Monitor
		Winter	0.0%	0.0%	0.0%		
South Windsor ZS	SZ1352	Summer	18.1%	21.4%	27.3%	1.25	New Project
		Winter	0.0%	0.0%	0.0%		
South Wollongong ZS	SWE2	Summer	0.0%	2.3%	7.3%	0.33	Monitor
		Winter	0.0%	0.0%	0.0%		
Springwood ZS	19856	Summer	24.5%	27.9%	34.1%	3.12	22kV FDR
		Winter	0.0%	0.0%	0.0%		
Springwood ZS	19857	Summer	112.1%	118.0%	128.6%	11.76	22kV FDR
		Winter	39.2%	43.0%	50.0%		
Springwood ZS	35696	Summer	3.5%	6.4%	11.5%	0.53	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Unanderra ZS	UNJ2	Summer	17.5%	20.8%	26.7%	1.22	Cap + Fdr
		Winter	0.0%	0.0%	0.0%		
Werrington ZS	35763	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
Werrington ZS	35767	Summer	0.0%	0.0%	0.9%	0.04	Monitor
		Winter	0.0%	0.0%	0.0%		
Werrington ZS	41531	Summer	8.3%	11.4%	16.8%	0.77	HVC
		Winter	0.0%	0.0%	0.0%		
Werrington ZS	41535	Summer	6.7%	9.6%	15.0%	0.68	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Werrington ZS	41537	Summer	0.0%	0.0%	0.0%	0.62	Load Transfer
		Winter	5.4%	8.3%	13.6%		
West Castle hill ZS	19816	Summer	24.5%	28.0%	34.2%	1.56	New Project
		Winter	0.0%	0.0%	0.1%		
West Castle hill ZS	27187	Summer	17.7%	20.9%	26.8%	1.23	New Project
		Winter	0.0%	0.0%	0.0%		
West Castle hill ZS	27191	Summer	50.0%	54.2%	61.7%	2.82	New Project
		Winter	0.0%	0.0%	0.0%		
West Castle hill ZS	27194	Summer	15.8%	19.0%	24.8%	1.13	New Project
		Winter	0.0%	0.0%	0.0%		
West Castle hill ZS	S327	Summer	39.4%	43.2%	50.2%	2.30	New Project

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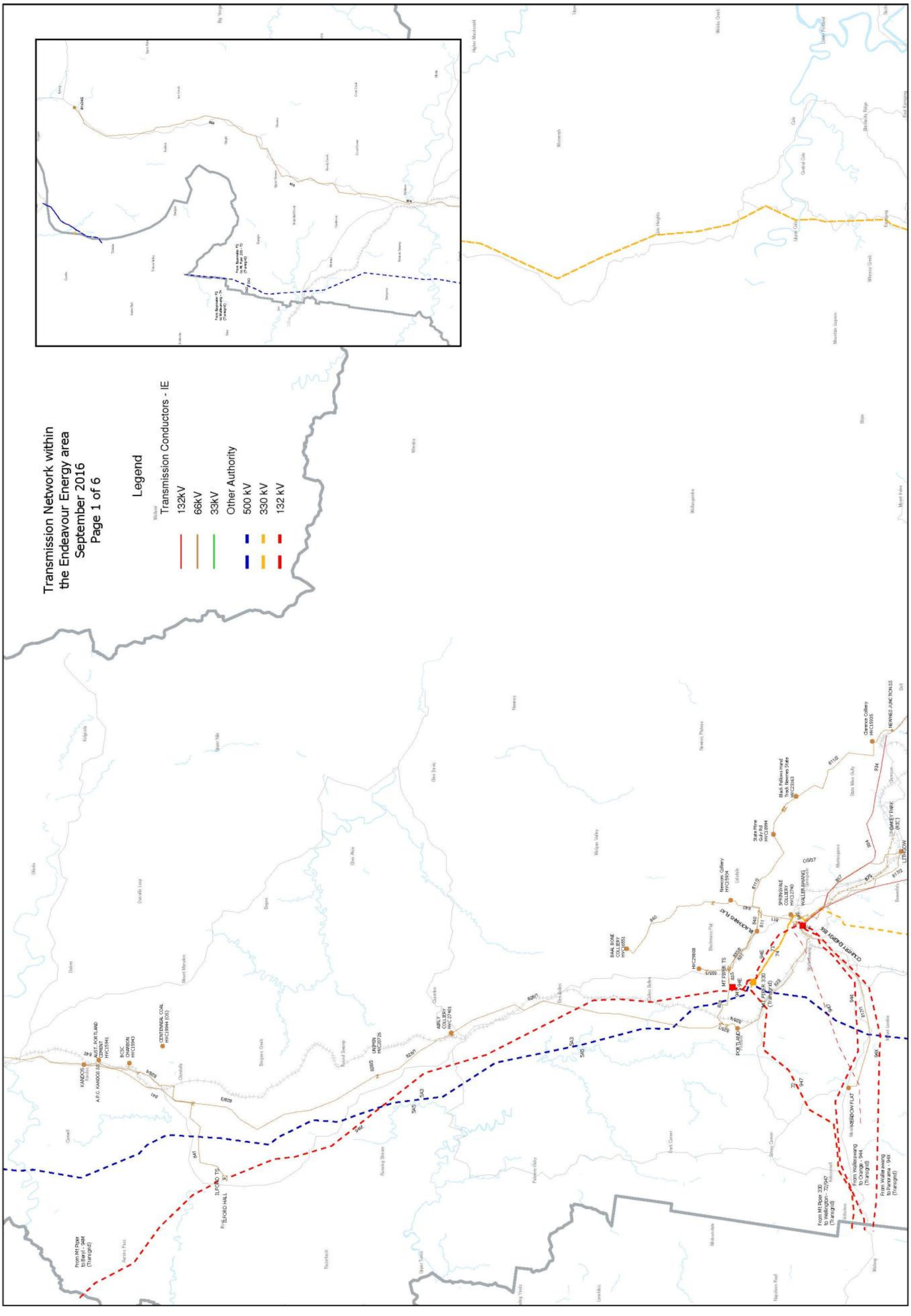
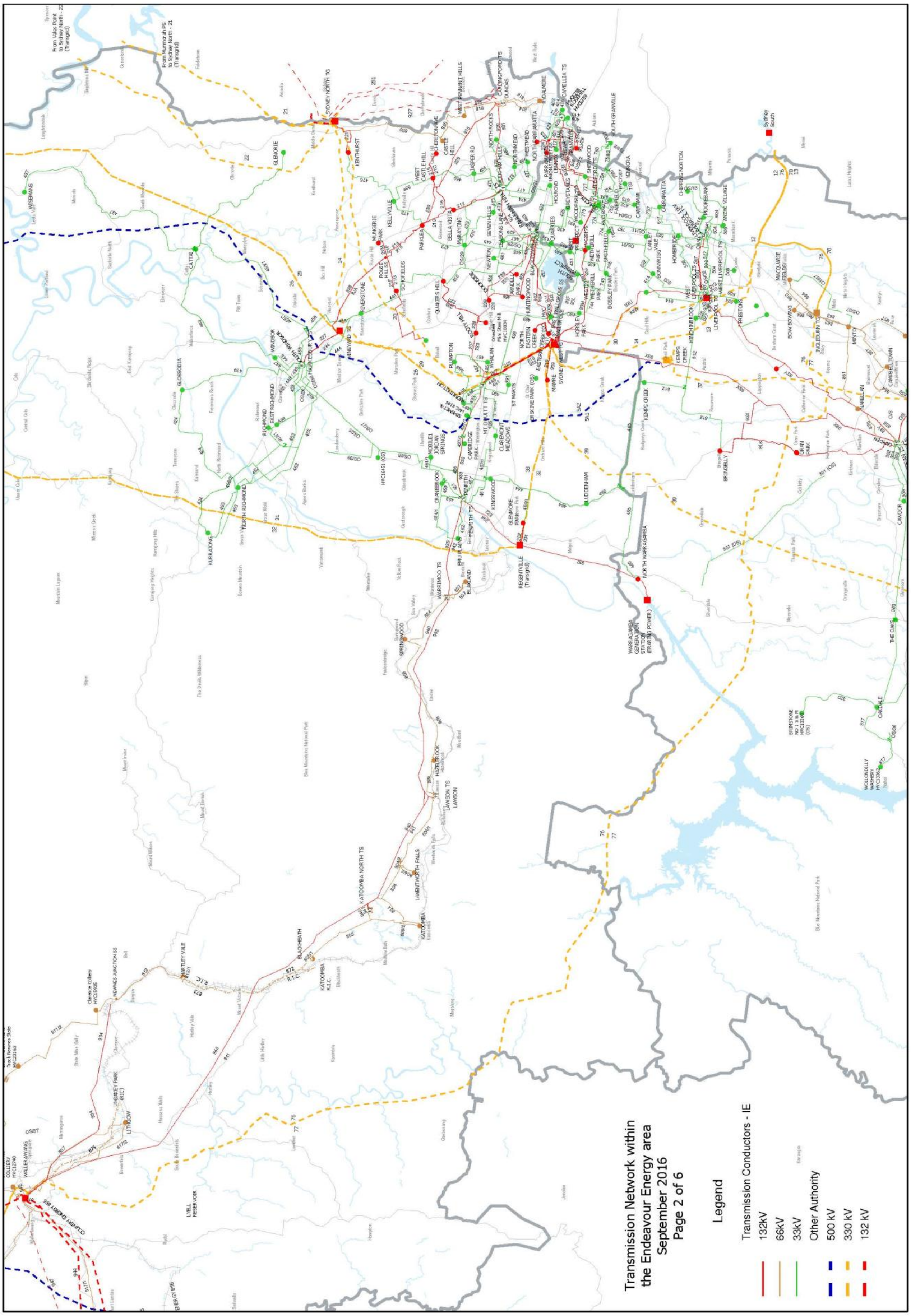
		Season	Actual 16/17	Year 2	Year 3		
		Winter	0.0%	0.0%	0.0%		
West Castle hill ZS	S336	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
West Liverpool 11kV	WL1217	Summer	0.0%	0.6%	5.5%	0.25	Monitor
		Winter	0.0%	0.0%	0.0%		
West Liverpool 11kV	WL1236	Summer	14.6%	17.8%	23.5%	1.07	Load Transfer
		Winter	0.0%	0.0%	0.0%		
West Parramatta ZS	WP1209	Summer	0.0%	0.0%	1.6%	0.07	Monitor
		Winter	0.0%	0.0%	0.0%		
West Parramatta ZS	WP1212	Summer	12.7%	15.8%	21.5%	0.98	Do nothing
		Winter	0.0%	0.0%	0.0%		
West Parramatta ZS	WP1241	Summer	8.1%	11.1%	16.5%	0.76	Do nothing
		Winter	0.0%	0.0%	0.0%		
West Pennant hills ZS	X866	Summer	3.1%	6.0%	11.1%	0.51	Monitor
		Winter	0.0%	0.0%	0.0%		
West Pennant hills ZS	X867	Summer	1.9%	4.8%	9.9%	0.45	Monitor
		Winter	0.0%	0.0%	0.0%		
West Pennant hills ZS	X871	Summer	0.0%	0.0%	3.3%	0.15	Monitor
		Winter	0.0%	0.0%	0.0%		
West Wetherill park 11kV	WX1244	Summer	0.0%	0.0%	0.0%	0.05	Monitor
		Winter	0.0%	0.0%	1.0%		
Westmead ZS	WM1112	Summer	0.0%	1.1%	6.0%	0.27	Monitor
		Winter	0.0%	0.0%	3.6%		
Westmead ZS	WM1152	Summer	150.0%	157.0%	169.4%	7.75	HVC
		Winter	129.0%	135.4%	146.8%		
Westmead ZS	WM1212	Summer	66.7%	71.3%	79.6%	6.57	HVC
		Winter	126.0%	132.3%	143.6%		
Wetherill Park ZS	WQ1253	Summer	12.5%	15.6%	21.3%	0.97	HVC
		Winter	8.3%	11.3%	16.8%		
Wetherill Park ZS	WQ1275	Summer	8.3%	11.3%	16.8%	0.77	Load Transfer
		Winter	0.0%	0.0%	4.7%		
Wetherill Park ZS	WQ1290	Summer	0.0%	2.8%	7.8%	0.36	Monitor
		Winter	0.0%	0.0%	0.0%		
Whalan ZS	WH1294	Summer	6.9%	9.9%	15.2%	0.70	Monitor
		Winter	0.0%	0.0%	0.0%		
Windsor ZS	WD1225	Summer	7.3%	10.2%	15.6%	0.71	Existing Project
		Winter	0.0%	0.0%	0.0%		
Windsor ZS	WD1247	Summer	5.4%	8.3%	13.6%	0.62	Existing Project
		Winter	0.0%	0.0%	0.0%		
Windsor ZS	WD1251	Summer	41.7%	45.6%	52.7%	2.41	Existing Project
		Winter	0.0%	0.0%	0.0%		
Windsor ZS	WD1258	Summer	20.4%	23.8%	29.8%	1.36	Existing Project
		Winter	0.0%	0.0%	0.0%		
Wisemans ZS	D813	Summer	1.7%	4.5%	9.6%	0.44	Load Transfer
		Winter	0.0%	0.0%	0.0%		
Woodpark ZS	M166	Summer	0.0%	0.0%	0.3%	0.01	Monitor
		Winter	0.0%	0.0%	0.0%		

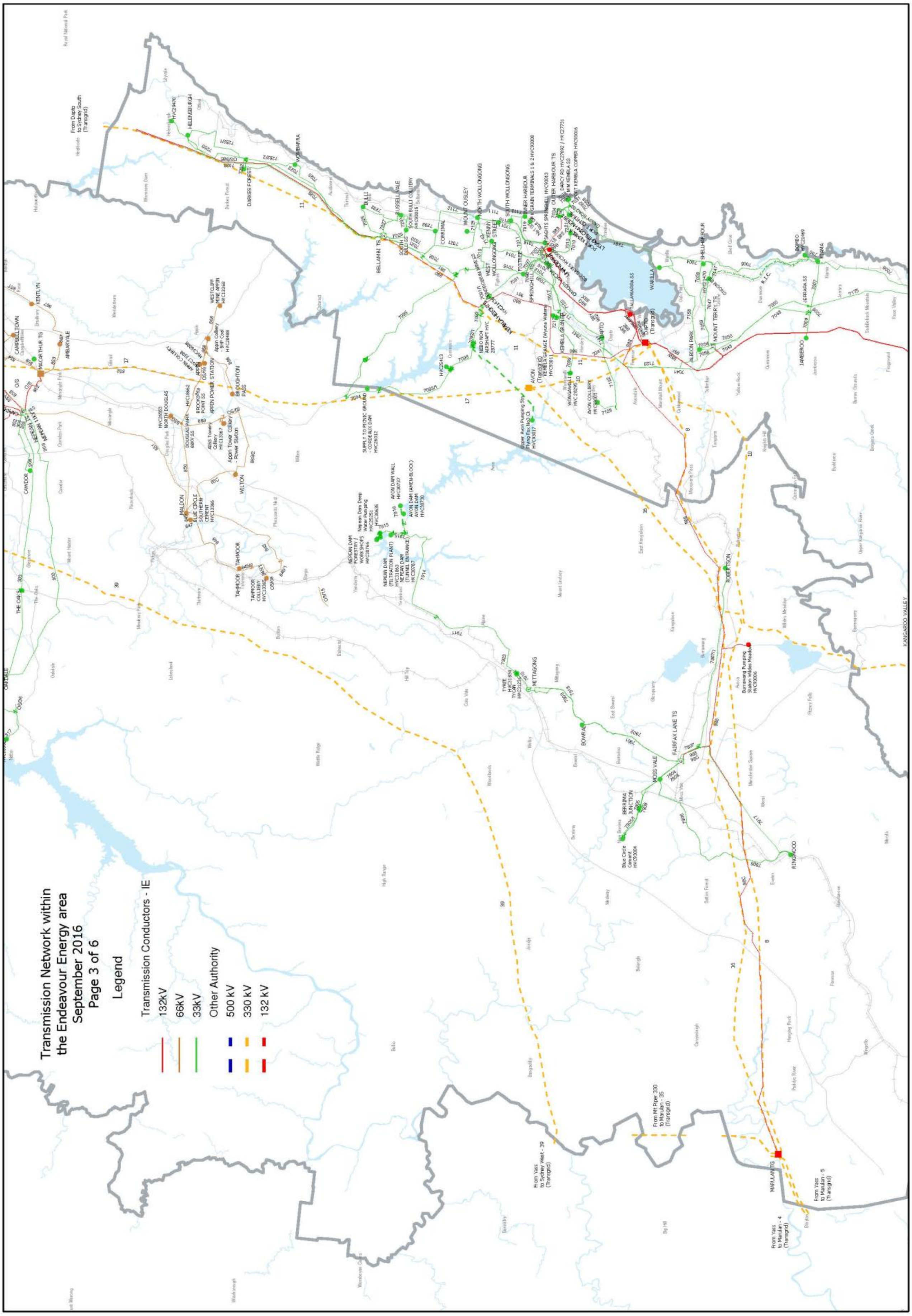
APPENDIX F: REGIONAL DEVELOPMENT PLANS

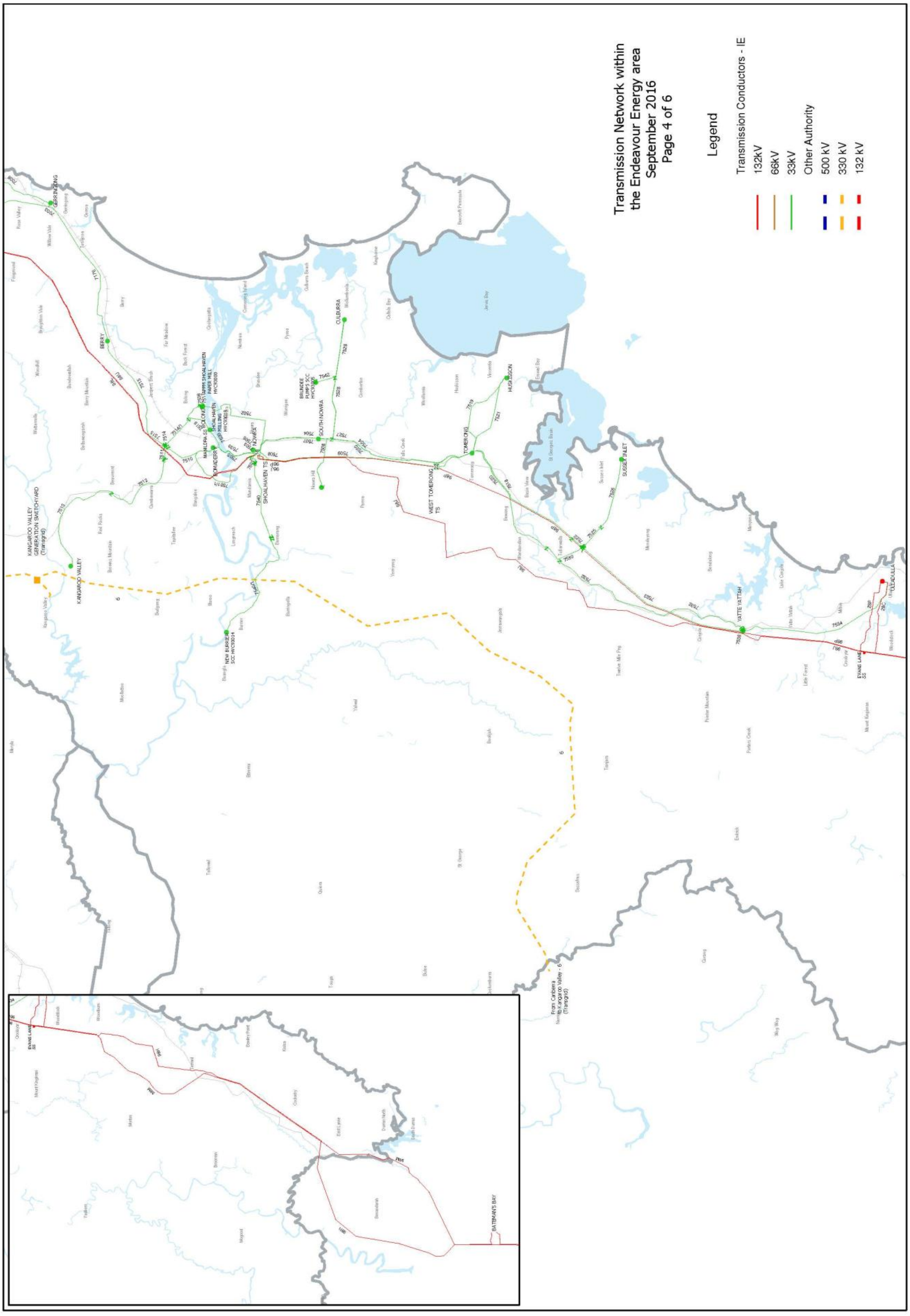
This section provides maps of Endeavour Energy's sub-transmission lines, zone substations and transmission-distribution connection points to assist with the identification of the location of the constraints in the network discussed in this report.



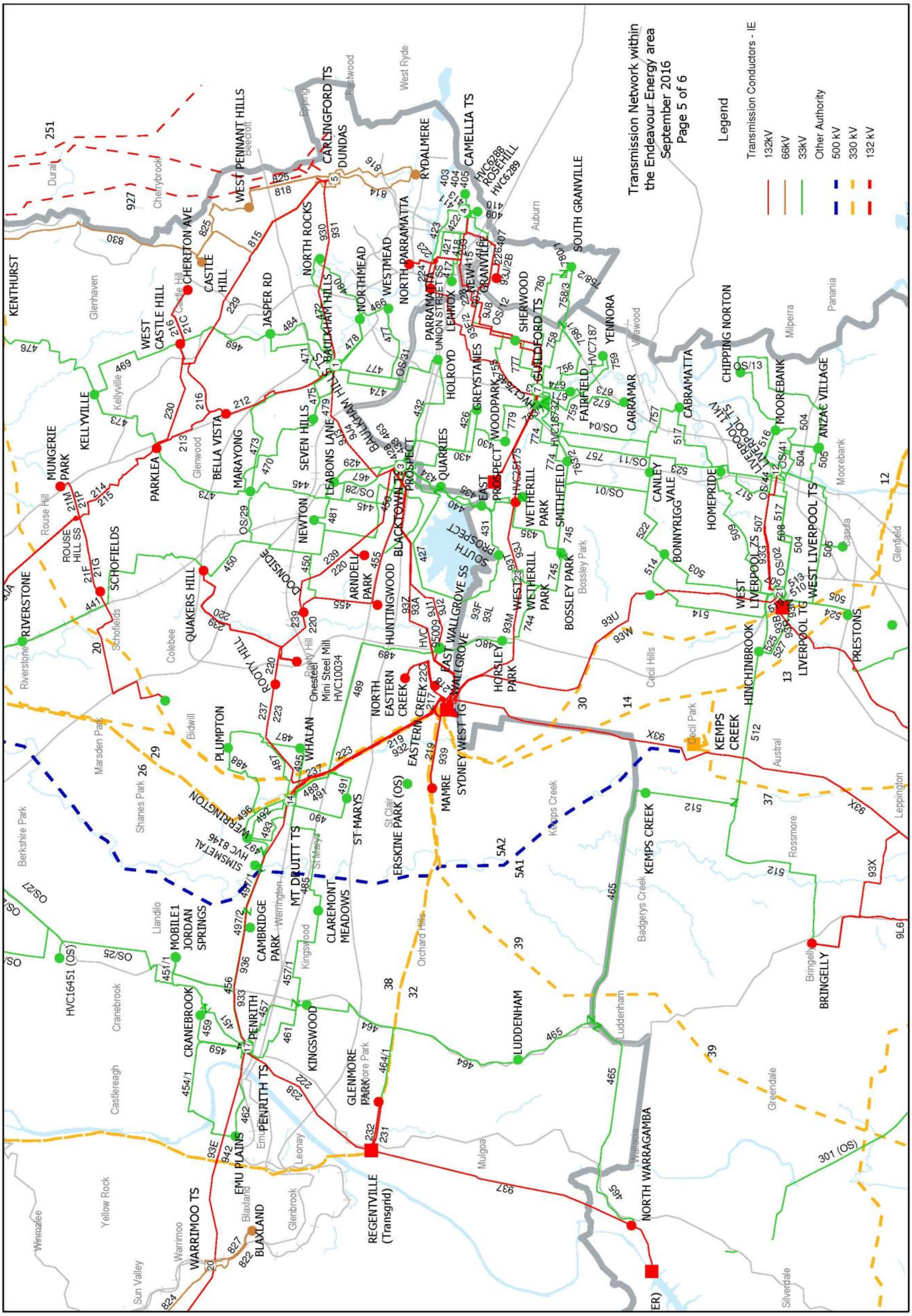
Transmission Network within
the Endeavour Energy area
September 2016
Page 1 of 6
Legend
Transmission Conductors - IE
132kV
66kV
33kV
Other Authority
500 kV
330 kV
132 kV

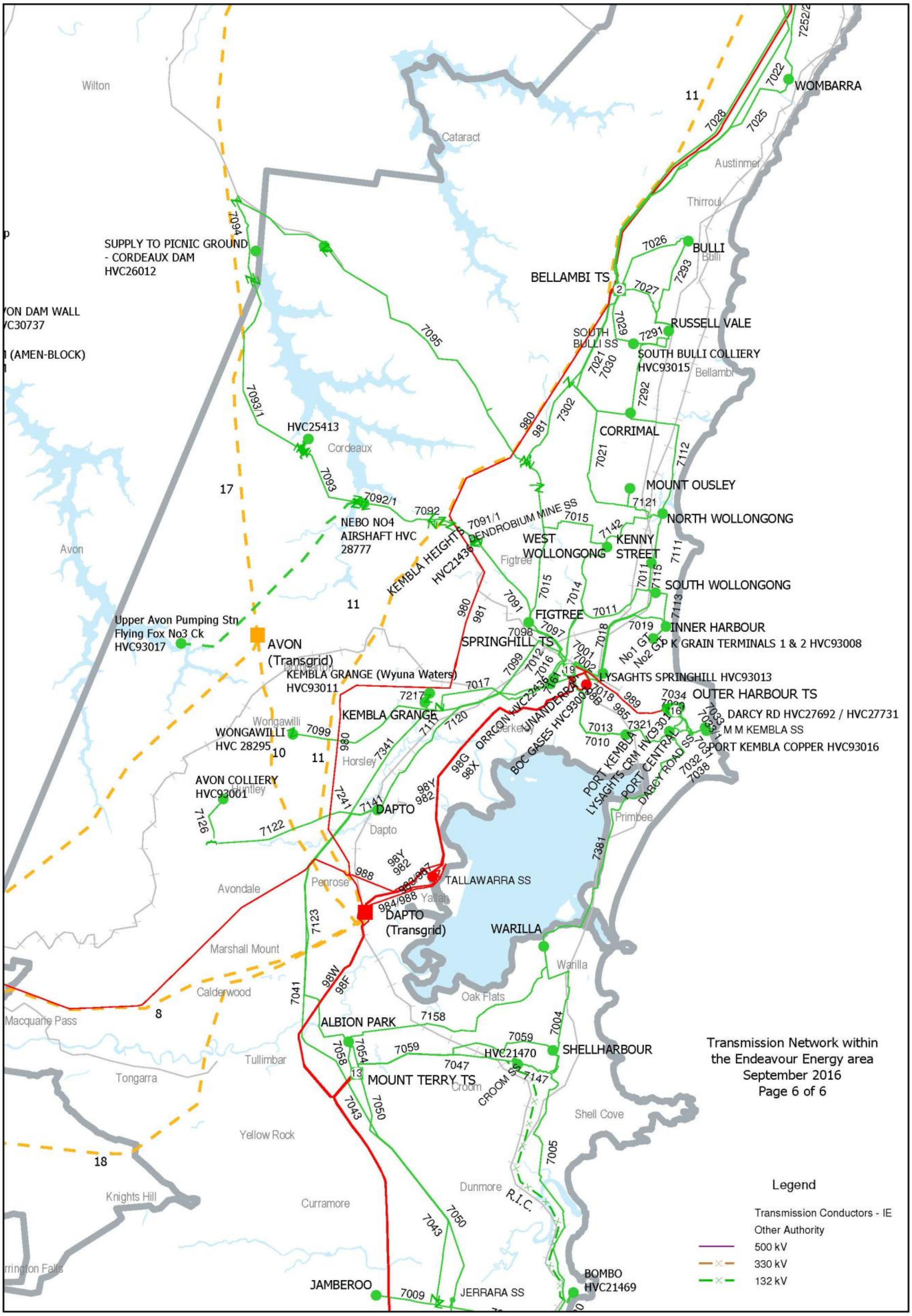

Transmission Network within
the Endeavour Energy area
September 2016
Page 2 of 6
Legend
Transmission Conductors - IE
132kV
66kV
33kV
Other Authority
500 kV
330 kV
132 kV


Transmission Network within
the Endeavour Energy area
September 2016
Page 3 of 6
Legend
Transmission Conductors - IE
132kV
66kV
33kV
Other Authority
500 kV
330 kV
132 kV



Transmission Network within
the Endeavour Energy area
September 2016
Page 4 of 6
Legend
Transmission Conductors - IE
132kV
66kV
33kV
Other Authority
500 kV
330 kV
132 kV


Transmission Network within
the Endeavour Energy area
September 2016
Page 5 of 6
Legend
Transmission Conductors - IE
132kV
66kV
33kV
Other Authority
500 kV
330 kV
132 kV



Endeavour Energy

APPENDIX G: GLOSSARY

Abbreviation/Phrase	Definition
AEMC	The Australian Energy Market Commission is the rule maker and developer for Australian energy markets
AER	Australian Energy Regulator
DAPR	Distribution Annual Planning Report prepared by a Distribution Network Service Provider under clause 5.13.2 of the National Electricity Rules
DNSP	A Distribution Network Service Provider who engages in the activity of owning, controlling, or operating a distribution system, such as Endeavour Energy, Ausgrid and Essential Energy
GJ gigajoule	One gigajoule = 1000 megajoules. A joule is the basic unit of energy used in the gas industry equal to the work done when a current of one ampere is passed through a resistance of one ohm for one second
GWh gigawatt hour	One GWh = 1000 megawatt hours or one million kilowatt hours
HV high voltage	Consists of 22kV, 12.7kV and 11 kV distribution assets (also referred to as medium voltage in some sections of this report)
HVC	High voltage customer
kV kilovolt	One kV = 1000 volts
kW kilowatt	One kW = 1000 watts
kWh kilowatt hour	The standard unit of energy which represents the consumption of electrical energy at the rate of one kilowatt for one hour
LV low voltage	Consists of 400V and 230 volt distribution assets
Major Event Day	Any day that exceeds a daily SAIDI threshold
MW megawatt	One MW = 1000 kW or one million watts
MWh megawatt hour	One MWh = 1000 kilowatt hours
NER	National Electricity Rules
Primary distribution feeder	Distribution line connecting a sub-transmission asset to either other distribution lines that are not sub-transmission lines, or to distribution assets that are not sub-transmission assets. An example is the first distribution feeder out of a zone substation
RIT-D	Regulatory Investment Test for Distribution
Sub-transmission	Any part of the electricity network which operates to deliver electricity from the transmission system to the distribution network and which may form part of the distribution network, including zone substations
Sub-transmission system	Consists of 132kV, 66 kV and 33 kV assets
V volt	A volt is the unit of potential or electrical pressure
W watt	A measurement of the power present when a current of one ampere flows under a potential of one volt