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ISP Preparatory Activities – Reinforcing Sydney, Newcastle and Wollongong Supply (Southern Ring)

June 2023

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Contents

Disclaimer 2

Executive Summary 4

1. Need for a Southern Ring – 500 kV Sydney Ring 5

2. Cost Estimate 7

3. Preliminary Engineering Design 8

4. Scope of Option 8

5. Desktop Easement Assessment 11

6. Preliminary Assessment of Environmental and Planning Approvals 12

7. Stakeholders Engagement 12

8. Risk 14

Executive Summary

This document provides updates for ISP Preparatory Activities, incorporating a revised cost estimate for the Sydney Southern Ring option. Below is a summary highlighting the key revisions.

In accordance with the 2022 Integrated System Plan (ISP), Transgrid has undertaken preparatory activities for Reinforcing Sydney, Newcastle and Wollongong Supply (RSNWS) (Southern Ring). The high-level network augmentation description is as follows:

- A new 500 kV double circuit from the existing Bannaby substation to a new substation in the locality of South Creek within western Sydney area
- Cut in existing lines 5A1/5A2, 32 and 38 into the new substation in the locality of South Creek (as above)
- Augmentation of Bannaby substation to accommodate the new 500 kV double circuit
- Augmentation of Sydney West substation to accommodate for additional 330 kV incoming feeder
- Replace a section of existing line 39 to double circuit to connect the new substation in the locality of South Creek to existing Sydney West substation

In the previous preparations for the ISP Preparatory Activities[1], the cost estimate for the southern ring ranged from $1.45bn (for Option 1) to $2.78bn (for Option 2). Transgrid have discounted Option 2 – a Kemps Creek substation expansion solution – due to cost, complexity, and potential impact on the local community. The discounted Kemps Creek substation option involves undergrounding an approximately 10 km section of the existing 330 kV circuit (Line 37) and utilizing the vacated corridor for constructing the new 500 kV circuit. The Option 1 solution – a new South Creek substation, is the preferred solution for further development.

This South Creek Substation option has been verified to be the least impactful and more cost-effective in terms of capital expenditure. Consequently, in this ISP Preparatory Activities, the upper range of the cost estimate has been eliminated, and we have provided a revised P50 cost estimate of $1.55bn for the South Creek substation option as outlined in the section 2 of this document. The indicative development corridor for the preferred option is illustrated in section 5, emphasizing the significance of securing easements around the Western Sydney Airport early for the successful execution of this project.

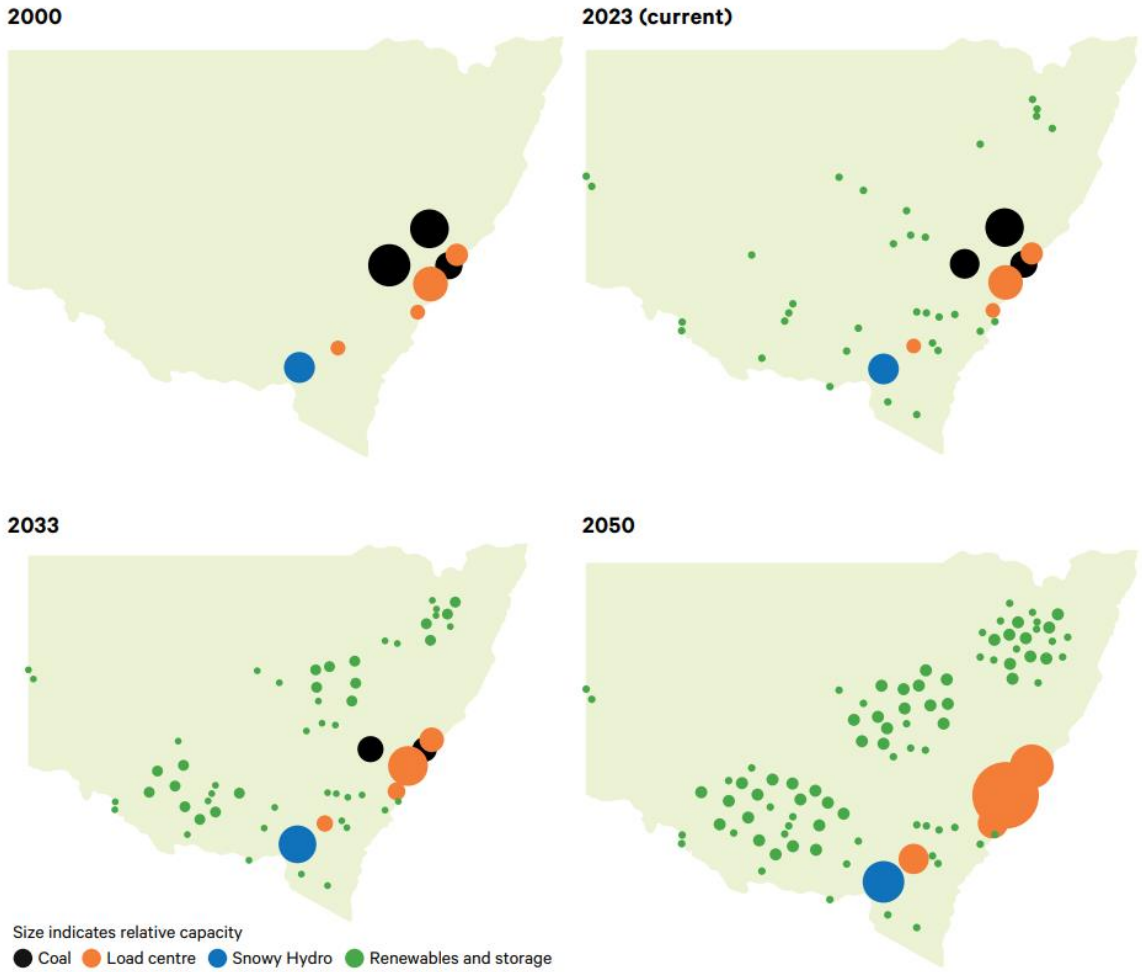
[1] ISP Preparatory Activities – Reinforcing Sydney, Newcastle and Wollongong Supply (Southern Ring), May 2023, AEMO.

1. Need for a Southern Ring – 500 kV Sydney Ring

The NSW electricity network is currently facing significant challenges, as it facilitates decarbonisation with the growth of large-scale renewables seeking connection to the grid and the accelerated retirement of traditional coal generation. In particular, two major power stations Eraring and Vales Point located within the critical Sydney Newcastle and Wollongong load centre area (SNW), with a combined capacity of around 4 GW, will retire by 2025 and 2029 respectively. The SNW area includes significant urban, commercial and industrial loads that comprise about three quarters of the demand for electricity in NSW and contributes towards a significant portion of the national GDP. There are currently no plans for new baseload generation in SNW to meet the local demand and it is therefore expected that demand will be met by generation from outside the area. Therefore, there is a need to increase the transmission capacity from other generators and Renewable Energy Zones (REZ) in regional NSW to the major load centres.

The geographic dispersion of renewable generators (see Figure 1) and the required growth of renewables to reliably and securely transition the NSW transmission network to net zero emission by 2050, necessitates new transmission infrastructure to efficiently transfer many GW of power across hundreds of kilometres.

Figure 1: The NSW power system in 2000, 2023 (current) and projected in 2033 and 2050 (conceptual image)



To reach these new renewable generators, we need new transmission connections from REZs to the 500 kV Energy Superhighway transmission backbone supplying SNW via a 500 kV ring, providing efficient security of supply from both the north and the south – with corridor diversity of supply to SNW. This Sydney Ring necessitates two projects to 'close the loop' – the first is the Hunter Transmission Project 1.0 (HTP 1.0) already underway that will connect Bayswater to Eraring at 500 kV, and the second is the Southern Ring to connect Bannaby to Sydney at 500 kV. The northern network option, HTP 1.0, is being progressed under the

Electricity Infrastructure Investment Act 2020 (NSW). The southern network option (Southern Ring) may proceed through the AEMO ISP and RIT-T framework.

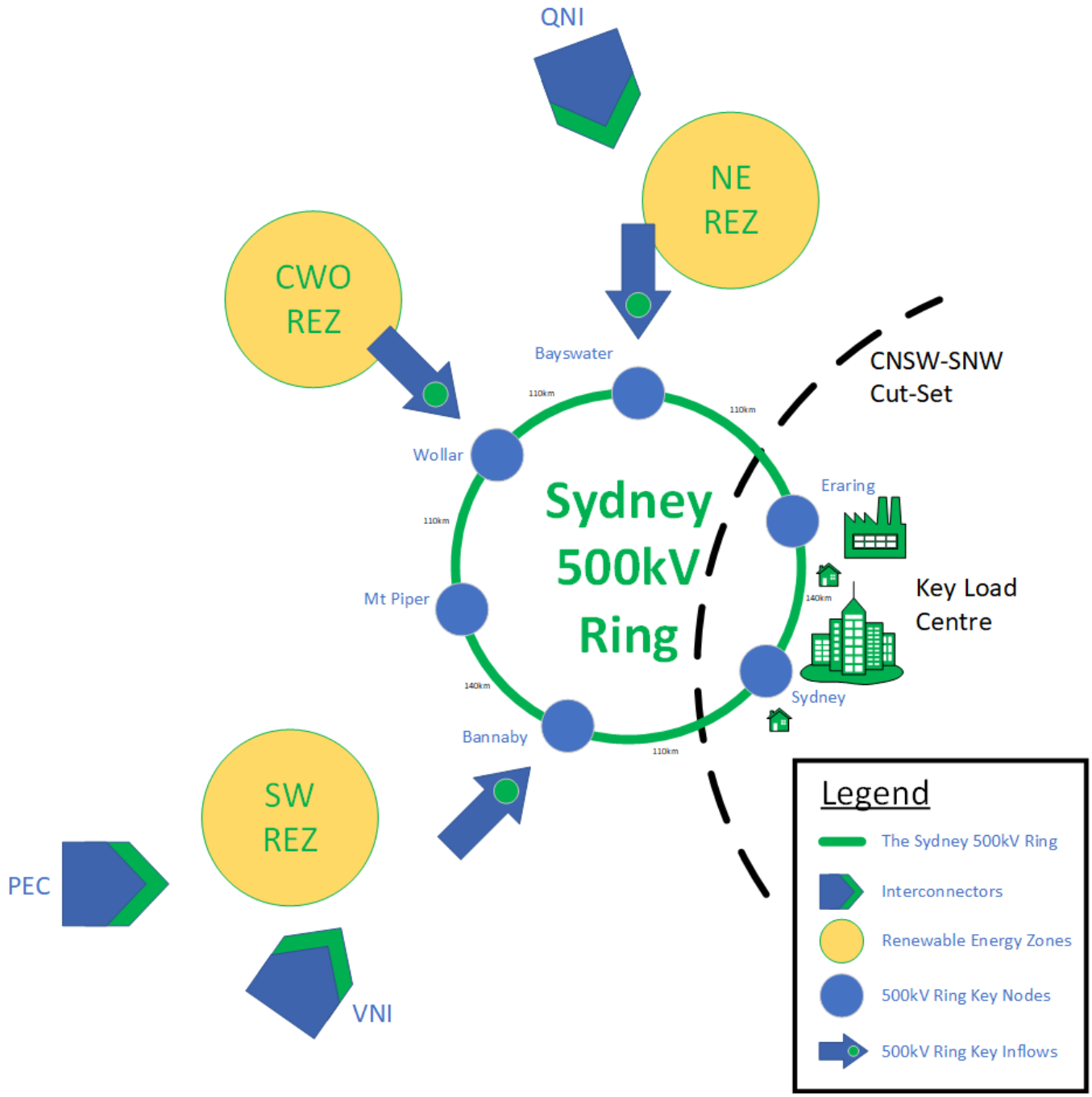
Figure 2: The NSW 500 kV Energy Superhighway

Figure 3 indicates the key Central NSW to Sydney-Newcastle-Wollongong (CNSW-SNW) cut-set across which 4 GW of combined coal retirements of Eraring and Vales Point (circa 2025-26 and 2029) are triggering a need to increase transmission capacity to secure supply to both Sydney and Newcastle under peak demand conditions. SNW demand is itself increasing significantly with a new airport and other load growth exceeding 1 GW.

The current cut-set limit with respect to N-1 contingencies is 6,125 MW and the HTP 1.0 is expected to increase it significantly to approximately 11,000 MW. However, AEMO in ensuring an N-1 secure operating state following the loss of a single 500 kV circuit on the HTP 1.0 line, would be looking to the next most significant credible contingency, which would be the loss of the second circuit of the HTP 1.0 500 kV line, thus reducing the cut-set limit significantly (due to a loss of both 500 kV circuits through the cut-set).

Under peak demand conditions, all existing generations within SNW are likely already being dispatched. Therefore, following the first contingency, no generation would be available within SNW for AEMO to redispatch. This introduces a greater reliance on transfer through the cut-set to prevent the need for AEMO to require pre-emptive load shedding in Sydney and Newcastle to return the system to a secure operating state.

Figure 3: Key CNSW-SNW cut-set across The Sydney 500kV Ring representing critical SNW load centre



The Sydney 500 kV Ring, completed through both the HTP 1.0 and the Sydney Southern Ring project, would mitigate this risk of load shedding by bringing geographically diverse 500 kV supply points into SNW. If coal generation retires earlier than expected, NSW may need to bring forward the planned in-service dates of these two projects to reduce the risk of SNW load shedding.

This Southern Ring Preparatory Activities document supports the next steps in 'closing the loop' of the 500 kV Sydney Ring.

2. Cost Estimate

Cost estimate was undertaken as a part of the preparatory activities. The inputs to the estimate include areas such as desktop environmental and property assessments, preliminary engineering designs and indicative

localities for transmission line and substation. At this stage of the estimating process, it is considered that the estimate has an accuracy of -30% to +40%.

The P50 cost estimate for Reinforcing Sydney, Newcastle and Wollongong Supply (southern Ring) is $1.55bn (un-escalated $2022/23). The detailed cost breakdown is shown in the table below.

Table 1. Cost breakdown of Sydney Southern Ring

Description	Costs ($M)
Transmission Line Cost	481
Substation Cost	283
Easement cost, Lines Land cost, Substation	218
Bio-diversity cost (TL)	274
Site Establishment Costs (Camp Costs)	120
Overall Project Raw Cost	1,376
Total project cost – P50	1,546

3. Preliminary Engineering Design

Concept engineering designs were undertaken as a part of the preparatory activities. The high-level development methodology included:

- Desktop transmission line corridor and substation locality identification utilising constraint mapping analysis
- Desktop geotechnical assessment of the identified areas
- Development of concept engineering designs such as electrical connection diagrams and substation layouts. Desktop assessment of transmission line tower and foundation requirements were also undertaken
- Safety in Design (SiD) Workshops were undertaken to identify and address safety risks of the concept designs

4. Scope of Option

The estimated $1.55bn cost ($2022/23) includes the high-level scope below:

- Substation Works:
  - Construct a new South Creek 500/330 kV substation with 2 x 1500 MVA transformers and the associated 500 kV and 330 kV switchbays
  - Augment the existing Bannaby and Sydney West substations
- Line Works:
  - Construct a 500 kV double circuit overhead line from Bannaby to South Creek with approximate length of 114 km alongside a section of line 39 (from Bannaby to Greendale area)
  - Cut the new South Creek substation into line 5A1/5A2, 32, 39 and 38
  - Rebuild the section of existing line 39 from South Creek to Sydney West to double circuit

The indicative development of South Creek substation and existing Bannaby substation are outlined in the diagrams below:

Orange colour represents 330 kV buses and lines and blue colour represents 500 kV buses and lines. The augmentation in Bannaby substation is highlighted by red colour.

Figure 4: Indicative development of South Creek Substation

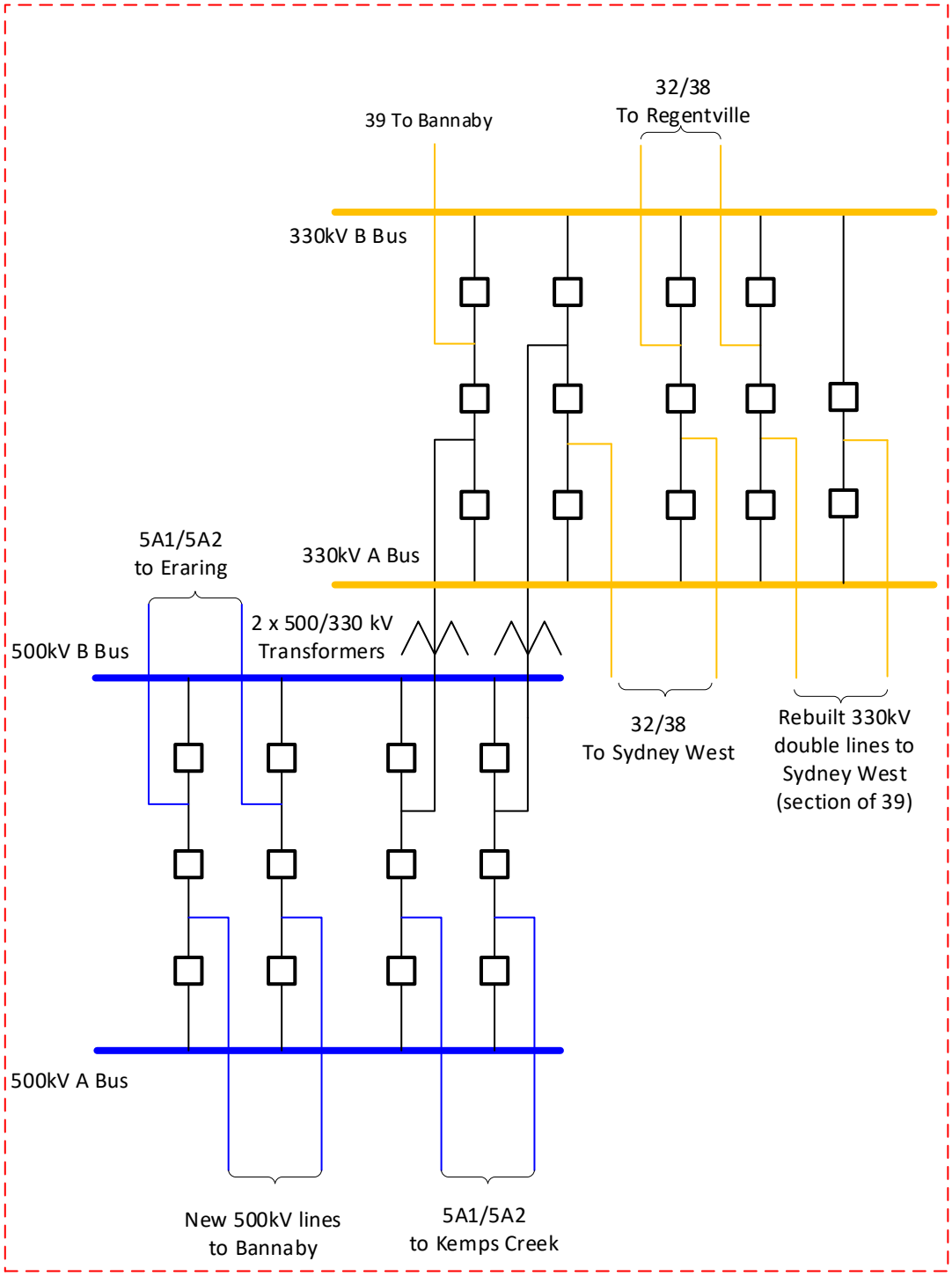
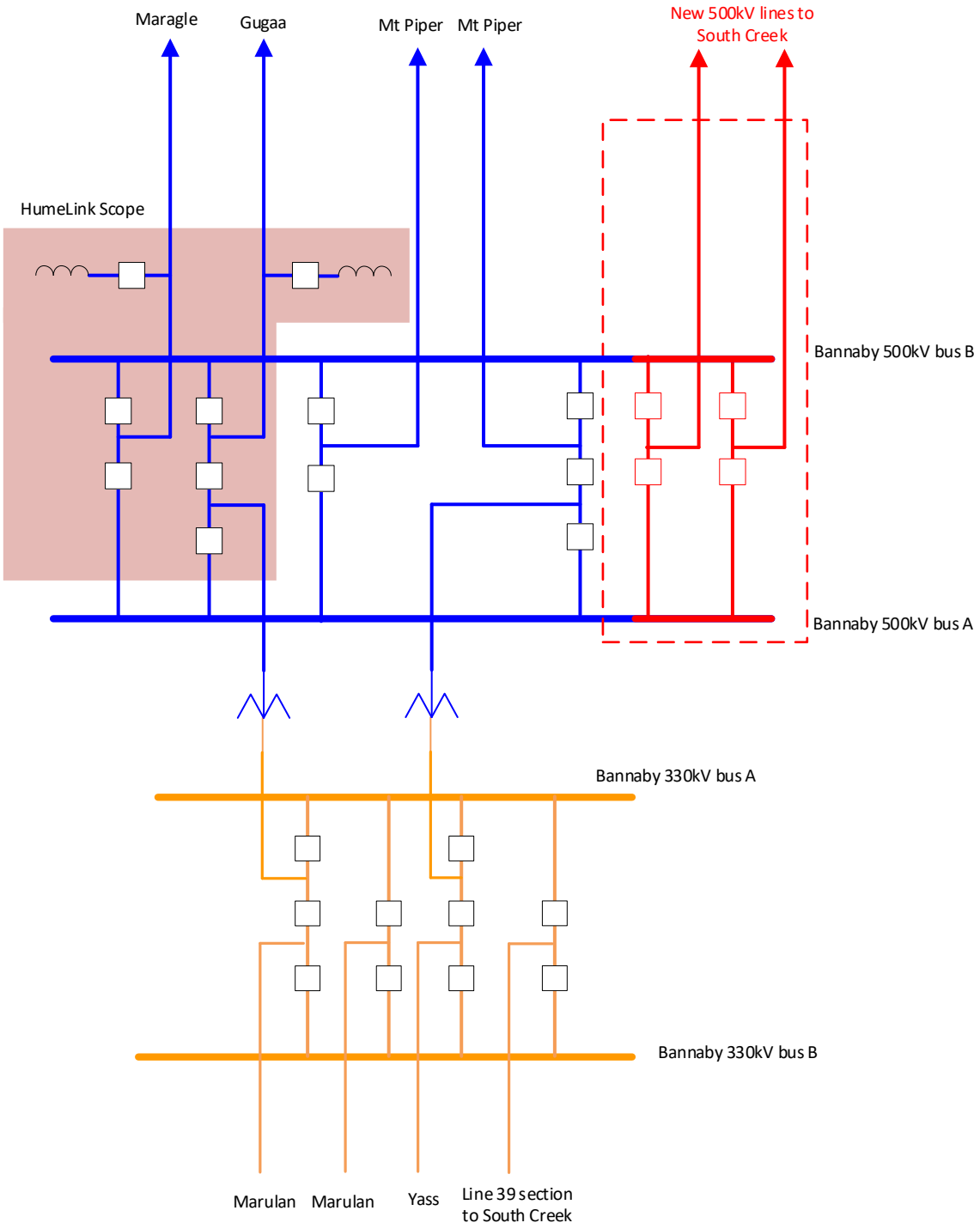


Figure 5: Indicative development of Bannaby Substation



The indicative transmission line data is displayed in Table 2.

Table 2. Indicative transmission line data (percent on 100 MVA base at 500kV or 330kV)

Circuit	Length (km)	R (%)	X (%)	B (%)	R0 (%)	X0 (%)	B0 (%)
Bannaby to South Creek 500kV Double Circuit	114	0.0872	1.151	131.2	1.105	3.856	77.99
South Creek to Sydney West 330kV Double Circuit	7.1	0.021	0.202	2.91	0.1841	0.6843	1.822

The thermal ratings for the 500 kV lines are based on the quad ACSR/GZ Orange 438 mm^2 conductors with 95 ^{0}C design temperature. The thermal ratings are shown in Table 3.

Table 3. Thermal ratings for Bannaby to South Creek 500kV double circuit transmission line

Season	Time	Normal (MVA)
Summer	Day	3,291
	Night	3,330
Autumn and Spring	Day	3,291
	Night	3,442
Winter	Day	3,637
	Night	3,713

5. Desktop Easement Assessment

Desktop transmission line corridor identification and assessment were undertaken as part of the preparatory activities.

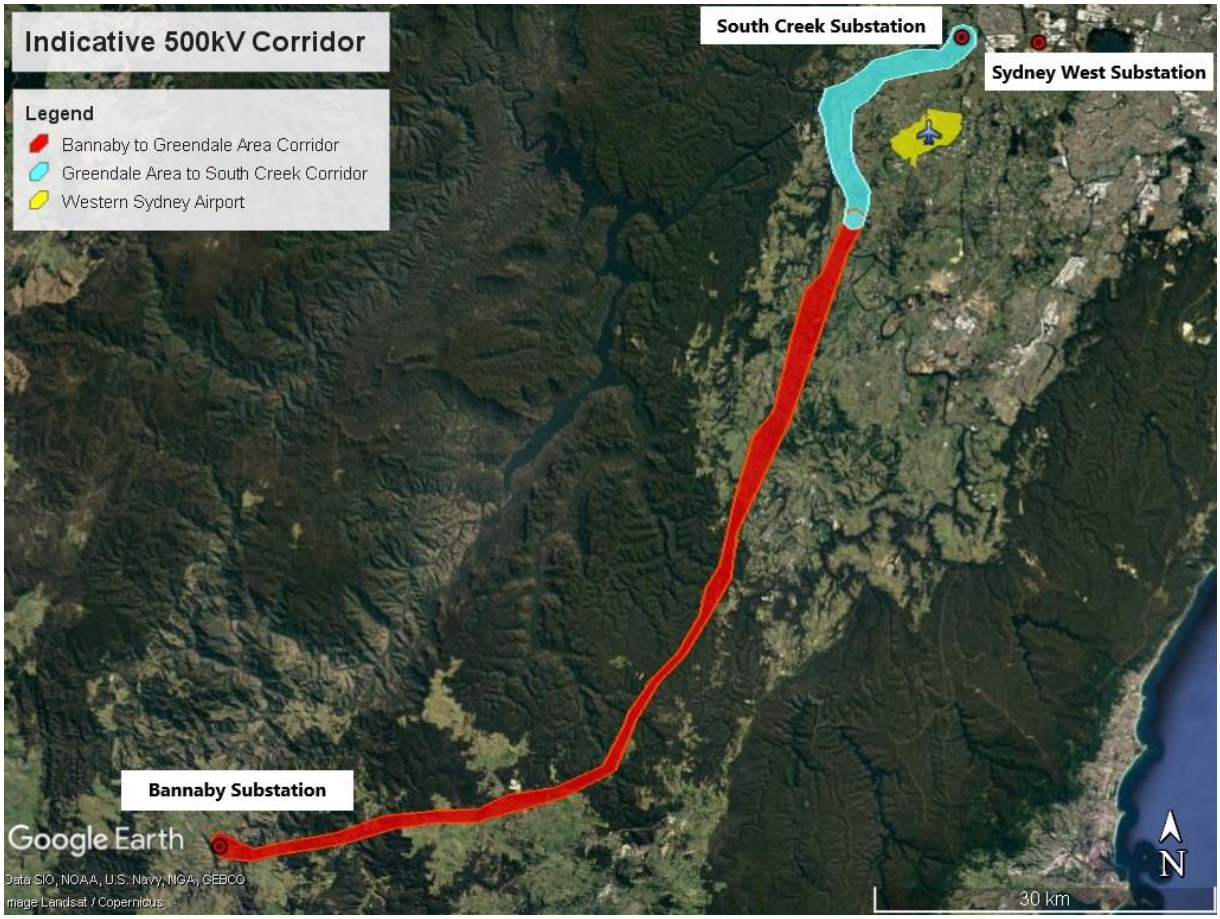
The high-level methodology of corridor identification and assessment includes:

- Options identification:
  - Establish tiered constraints for identification of transmission line corridors
  - Tiered assessments include items such as environment, property and stakeholder criteria
  - Determining options for potential transmission line corridors as per the defined tiered constraints
- Options assessment and evaluation:
  - Assess, evaluate and select corridors for use as part of the preparatory activities

Following the aforementioned methodology, an alternative option into existing Kemps Creek 500 kV substation was evaluated. It was determined limited viable line routes are available without elevated costs and greater community impacts to achieve an overhead solution for both the 500 kV double circuit from Bannaby 500 kV substation and associated requirement for 330 kV reinforcement to Sydney West Bulk Supply Point. Due to these considerations, the overhead line option into South Creek substation is the preferred option. The indicative 500 kV double circuit corridor for the preferred option is presented in Figure 6 below.

The indicative 500 kV corridor leverages off the already established corridor for 330 kV line 39 from Bannaby Substation to near Greendale area (approximate route length of 90 km). However, from Greendale area to South Creek Substation (approximate route length of 24 km), the corridor is strategically diverted to navigate around the Western Sydney Airport with considerations of residential properties, homesteads, flight path, height restrictions and aerotropolis development. Securing easements for the designated teal corridor (from near Greendale to South Creek) will be crucial in the development of Sydney Southern Ring.

Figure 6 The indicative 500kV double circuit corridor for Sydney Southern Ring's preferred option



6. Preliminary Assessment of Environmental and Planning Approvals

The primary environmental approval required for the project may include an Environmental Impact Statement (EIS) to be prepared and approved. This may also include:

- Engaging with the community and government agencies; this may include NSW government bodies such as Department of Planning & Environment (DPE)
- Refining the concept designs of the project to avoid or minimise impacts and to incorporate community feedback
- Assessing the impacts of the project in accordance with any relevant Government legislation, policies and guidelines
- Integrating the findings of any engagement and the assessment of the impacts of the project

It is noted that the planning and approval requirements applicable to the project may change overtime due to:

- General changes in planning and environmental legislation or policy
- Specific changes in planning and environmental legislation or policy that may be targeted at facilitating planning and/or delivery of the project

7. Stakeholder Engagement

Direct community engagement including local government and council engagement have not been undertaken as part of the preparatory works. However, a multitude of stakeholder requirements have been

included in the tiered constraints and used as part of the desktop transmission line corridor identification process based on the available information. Examples of the tiered constraints used include known townships, residential areas, airports, defence owned land, areas of international and national environmental significance, aboriginal and heritage areas, commonwealth land, important agricultural areas, mine sites and zones and existing infrastructure.

This section describes Transgrid's community engagement policy and route selection principles for Sydney Southern Ring.

7.1. Transgrid's Community Engagement Policy

Transgrid's commitment:

We recognise the vital role that landowners and the community have in the planning and delivery of our projects and network operations.

- We work with the communities in which we operate in a meaningful, accountable, responsive and equitable way through effective and inclusive practices.
- We are dedicated to continuously improving our engagement, in our decision making and delivering community benefits.
- We seek to minimise the social impacts of our projects and operations. We will do this by engaging with all our communities to understand what matters most, to build trust and beneficial relationships.
- We strive to build positive and lasting relationships with our local communities and create long-term benefits to our customers, community and the environment as part of our commitment to building a sustainable future.

7.2. Route Selection Principles

Transgrid is responsible for developing the preferred route for Sydney Southern Ring.

Community and stakeholder engagement will be critical throughout the route selection process. There are four key principles which should guide Transgrid's selection process for linear or site-based transmission infrastructure options. These are:

- Prudent and efficient network – Transgrid is required by energy regulators to deliver prudent and efficient transmission network projects. This is a key requirement for project funding
- Triple bottom line decision considerations – Balanced with the need to deliver a prudent and efficient network, is the need to achieve a favourable social outcome when developing new electrical transmission infrastructure. Transgrid is committed to a route selection process that considers all aspects of a project such as community and/or social impacts, environmental considerations and technical feasibility. This includes ensuring that relevant information (technical, environment, social and cost) is integrated and coordinated to achieve the most appropriate outcome
- Opportunity for community input to improve decision-making – Community consultation is a key part of the route/site selection process. Consultation should aim to be open, iterative, and well-documented to enable stakeholders, the community, and landowners to have input into relevant stages of the process and improve decision-making
- Best practice approach – Transgrid continually undertakes new electrical infrastructure projects to ensure NSW's energy supply into the future. Transgrid is committed to applying a consistent and best practice approach, and recognises that a fair, efficient route selection process is in the best interests of consumers and communities

8. Risk

Risk assessments were undertaken as part of the preparatory activities. The risk assessment process identified several risks and an extract of these risks is as follows:

- The scope of RSNWS (Southern Ring) can be impacted by current and future major projects, regulatory approval processes, and community feedback. These issues are to be closely monitored to ensure successful project delivery
- Uncertainty surrounding sizing and location of future generation developments, both known and unknown. Corridors may be constrained due to generation development growth leading to increase project cost
- Community feedback and sentiment may impact on the project including but not limited to the locality of the transmission lines, substations, project duration and cost estimate
- All works were based on available desktop information only. Future site investigation and verification works may impact on the outcomes identified as part of the feasibility works. These include but not limited to cost estimates, transmission route locations and substation locality
- Increased build out of the areas surrounding the Western Sydney Airport (WSA) development will further constrain opportunities to secure suitable easements for an overhead solution. The recommendation is to commence development of appropriate corridor and route selection with the intention of securing easements at the earliest opportunity, particularly out of South Creek substation site to the west and south circumnavigating the WSA development area