North South Rail Line and South West Rail Link Extension Corridors

Strategic Environmental Assessment

Transport for NSW

August 2019

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Document control record

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Document control	
Report title	Strategic Environmental Assessment
Project number	240625
Client	Transport for NSW
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Executive summary

Transport for NSW proposes to protect two new land corridors in western Sydney for future rail infrastructure for passenger train services. The North South Rail Line corridor would provide a connection for passenger train services between the T1 Main Western Rail Line near St Marys and the T8 Main South Rail Line near Macarthur via the Western Sydney Airport, whilst the South West Rail Link Extension corridor would extend from Leppington Station to Western Sydney Aerotropolis, to connect with the North South Rail Line corridor. The corridors included here are known as the final recommended corridors. The final recommended North South Rail Line corridor and South West Rail Link Extension corridor are shown in Figure E-1.

These rail corridors are critical to meeting the New South Wales (NSW) Government's ambitions for a '30-minute city' in which people have access by public transport to education, jobs and services within 30 minutes regardless of where they live. The future North South Rail Line and South West Rail Link Extension infrastructure would connect residents in the emerging suburbs of the South West Growth Area with jobs and services in the new Western Economic Corridor, Western Sydney Airport, Western Sydney Aerotropolis, Liverpool, Greater Penrith, Campbelltown–Macarthur and Western Sydney Employment Area.

Investigations have been undertaken for the North South Rail Line and South West Rail Link Extension to identify suitable corridors of land to accommodate new railway infrastructure in the future. The purpose of this Strategic Environmental Assessment is to provide a strategic assessment of the impacts and benefits of providing future public transport infrastructure in the final recommended corridors, as well as an assessment of the benefits of protecting the corridors now. The Strategic Environmental Assessment has been prepared in accordance with the Department of Planning, Industry and Environment's *Planning Guideline for Major Infrastructure Corridors*. The assessment will be used by the Department of Planning, Industry and Environment to inform the statutory planning protection of the corridor.

This Strategic Environmental Assessment is not an application for approval to build or operate any transport infrastructure within the final recommended corridors. Rather, it is intended only to support the statutory process of protecting land so that it is available when required in the future for potential public transport use.

At the time of rail infrastructure delivery, an environmental impact statement for the proposed project would be prepared in accordance with the relevant environmental planning and approvals legislation.

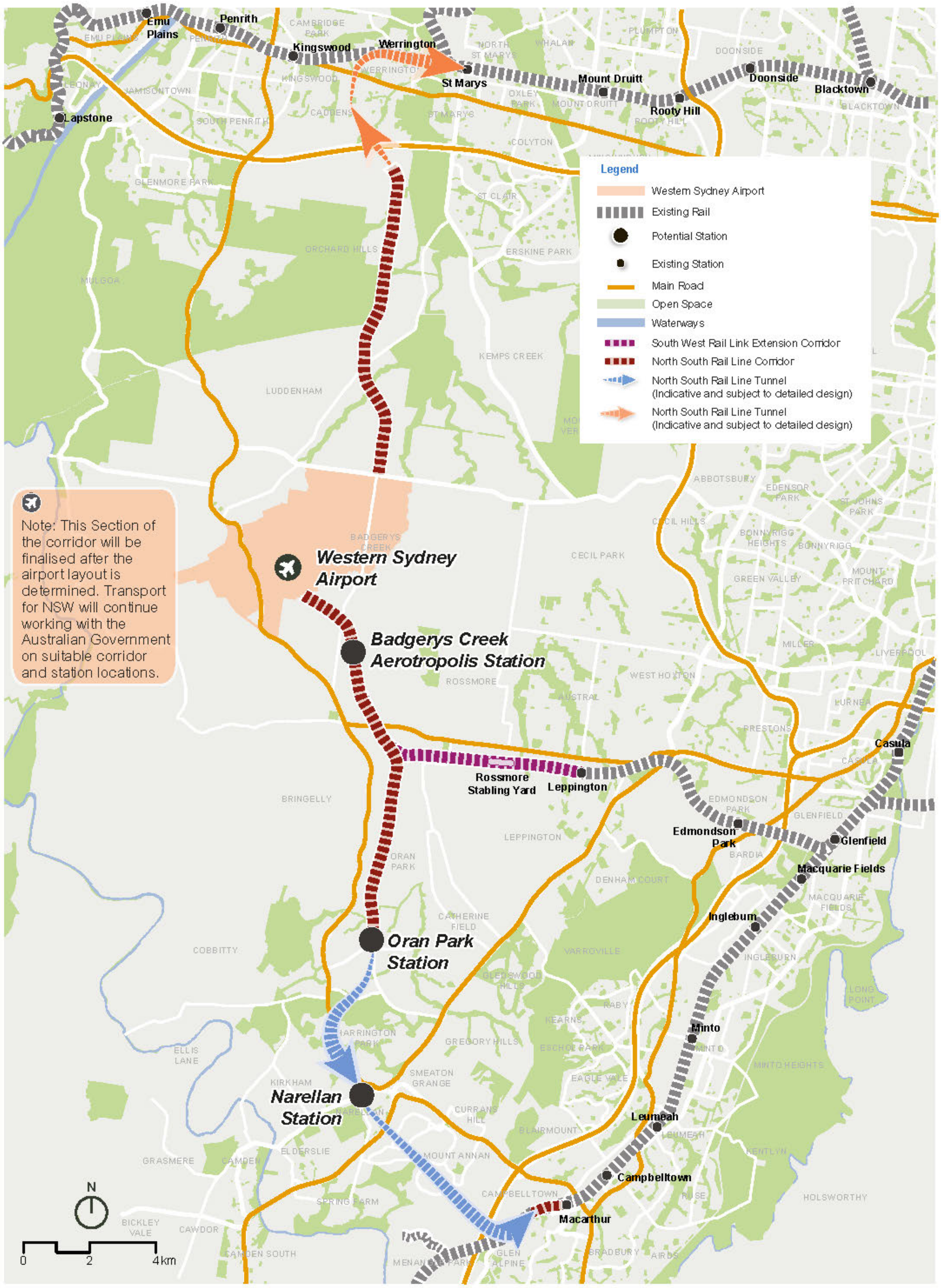

Figure E-1 The final recommended North South Rail Line and South West Rail Link Extension corridors

Need for the final recommended corridors

As western Sydney transitions through the emergence of the Western Parkland City into a Metropolitan City Cluster, the Western City District's population will grow by around 464,000 people. As documented in the *Western City District Plan* (Greater Sydney Commission, 2018b), this equates to an additional 184,500 homes required in the District by 2036. Together with the Central River City around Greater Parramatta, these two districts will grow by more than one million people over the next 20 years.

Much of the Western City District's future growth will be focused on the existing centres of Greater Penrith, Liverpool and Campbelltown–Macarthur. As part of this growth there is a commitment from the Australian Government to build a new Western Sydney Airport, which is expected to commence operations in 2026. The Western Sydney Airport will be the catalyst for a new Western Economic Corridor around the Western Sydney Aerotropolis, which is anticipated to provide unprecedented economic opportunities for western Sydney.

With the anticipated population growth in western Sydney, improved transport connections are required to enable the NSW Government's vision for a 30-minute city, where people live within 30 minutes of their jobs, education and health facilities, services and great places. The North South Rail Line and South West Rail Link Extension would be key north-south and east-west transport links that would connect people to jobs and places and provide greater education, employment and business opportunities to support the Western Economic Corridor. The need for the final recommended corridors is also underpinned by the *Greater Sydney Region Plan* (Greater Sydney Commission, 2018a) and the *Future Transport Strategy 2056* (Transport for NSW, 2018a).

It is important to ensure that appropriate provisions are made now to meet the future transport needs of not only western Sydney but also the wider Greater Sydney Region. Integrated transport planning decisions are required to consider the long-term requirements for both land use and transport.

Identifying and protecting the final recommended North South Rail Line and South West Rail Link Extension corridors now will make the best use of government resources by ensuring that sufficient land is available in the future for construction of rail infrastructure when it is needed.

Given the rapid expansion of development in western Sydney, early protection of corridors is vital to ensure that there is sufficient land available in the future when the construction of railway infrastructure is required. Corridor protection will inform future land use planning, minimise acquisition costs, avoid redundant development and enable consideration of the future rail infrastructure during land use planning so that impacts can be avoided, or appropriate mitigation measures can be implemented. Protection of the final recommended corridors also provides opportunities for land use and economic development that would perhaps not otherwise be realised. Additionally, protecting the final recommended corridors now will reduce disruption to communities and businesses in the future when the infrastructure is constructed.

The benefits of corridor protection are further reiterated in Infrastructure Australia's *Australian Infrastructure Plan and Corridor Protection: Planning and investing for the long term*.

Identifying and protecting corridors for the final recommended North South Rail Line and South West Rail Link Extension corridors is an important opportunity to undertake before development in the region reduces future opportunities for such a piece of infrastructure. It would also provide clarity for the Department of Planning, Industry and Environment, councils and developers, and provide greater certainty about land uses for existing and future residents in the area.

Protection of the final recommended North South Rail Line and South West Rail Link Extension corridors represents an integrated transport solution that balances infrastructure benefits and opportunities with land use and environmental impacts and meets the stated objectives of Australian and NSW strategic policies. Protecting the final recommended North South Rail Line and South West Rail Link Extension corridors well in advance of their construction would:

- Protect land from development that might preclude future rail infrastructure, or make it more difficult and/or expansive to build when it is required

- Provide residents, employers, councils, landowners, developers and government agencies with greater confidence that transport infrastructure can be built, and more certainty about where it will be located, so that new development can be planned around it
- Assist in the long-term planning of transport services and rolling stock investments
- Ensure that town centres and other employment centres are located and planned to optimise their access to public transport
- Allow appropriate land use restrictions and setbacks to be built into master plans and design codes to reduce potential noise and other environmental impacts on residences, schools, and other sensitive receptors
- Allow directly-affected landowners to factor transport corridors into their plans, and to dispose of land at their own volition
- Allow the Government to develop cost-effective, measured approaches to corridor land acquisition and management.

The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected following a comprehensive process that has involved community consultation, exploration of multiple alignments and the input of technical experts. Following investigations into existing natural and built constraints in the study area as well as public consultation, the final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to avoid or minimise environmental, social and economic impacts.

One of the key features of the final recommended North South Rail Line corridor is to tunnel between Oran Park and Macarthur. This feature has been incorporated into the final recommended North South Rail Line corridor to avoid potential impacts on existing landowners in this area as well as to avoid any impact on Harrington Forest, Australian Botanic Garden Mount Annan, schools, heritage items and local/State roads. However, the whole of life cost of tunnel rail infrastructure is substantially higher than for surface rail infrastructure.

The proposed surface corridor has been deliberately located to respond to existing topographical constraints as well as the presence of native flora and fauna, flood conditions and the local/State road network.

Due to the comprehensive corridor selection process that has been undertaken, it is considered that potential environmental impacts arising from corridor protection or future transport infrastructure have been minimised or avoided.

Methodology for selecting the final recommended corridors

The final recommended North South Rail Line and South West Rail Link Extension corridors have been identified following a comprehensive process that has involved community consultation, exploration of multiple alignments and analysis of existing natural and built constraints. The identification process has been in accordance with the process outlined in the Department of Planning, Industry and Environment's *Guideline for Major Infrastructure Corridors*. The process has involved:

- Reviewing government policies and strategies including the Future *Transport Strategy 2056* and the *Greater Sydney Region Plan*
- A constraints and opportunities analysis through community and stakeholder consultation to understand the context of the study area
- An options and alignment assessment utilising multi criteria analysis aimed at achieving the objectives whilst minimising social and environmental impacts.

The final recommended corridors have been selected to avoid or minimise environmental, social and economic impacts, as well as to respond to the projected future growth in population and travel demand in western Sydney.

The final recommended corridors

The final recommended North South Rail Line and South West Rail Link Extension corridors are shown in Figure E-1.

Between Lansdowne Road in Orchard Hills and the northern boundary of the Western Sydney Airport the final recommended corridor is at the surface. Much of this surface section of the final recommended corridor would be generally co-located with the proposed Outer Sydney Orbital corridor.

The final recommended North South Rail Line corridor continues at the surface between the southern boundary of the Western Sydney Airport and Oran Park, via the Western Sydney Aerotropolis. Between Oran Park and Glen Alpine the final recommended North South Rail Line corridor is in tunnel. The North South Rail Line returns to the surface within the existing T8 Main South Rail Line corridor at Glen Alpine and continues at the surface to Macarthur Station. A section of the existing rail corridor alongside Menangle Road to the west of Macarthur Station would need to be widened to accommodate the North South Rail Line.

North of Bringelly, the final recommended North South Rail Line corridor is generally 60 metres wide to accommodate up to four railway tracks, comprising two tracks in each direction. South of Bringelly, the final recommended North South Rail Line corridor is generally 40 metres wide to accommodate up to two railway tracks, comprising one track in each direction.

A tunnel has been incorporated into the final recommended North South Rail Line corridor south of Oran Park to avoid established areas and land uses, as well as to avoid impacts on:

- Crossings of several State roads including The Northern Road, Camden Valley Way, Camden Bypass and the Hume Highway
- Narellan Sports Hub
- Harrington Forest and associated recreational and conservations areas
- Australian Botanic Garden Mount Annan, William Howe Regional Park and the Scenic Hills
- Existing 330 kV transmission lines
- Items listed on the State Heritage Register including Orielton and the Sydney Water Supply Canal.

The North South Rail Line would potentially extend northwards beyond St Marys to Schofields and further investigations for this extension of the corridor are ongoing.

The final recommended South West Rail Link Extension corridor is at the surface between Leppington Station and where it meets the North South Rail Line at Western Sydney Aerotropolis. West of the existing Rossmore Stabling Yard, the final recommended South West Rail Link Extension corridor is generally 60 metres wide to accommodate up to four railway tracks, comprising two tracks in each direction. The final recommended South West Rail Link Extension corridor has been shifted slightly from the previous recommended corridor exhibited in 2015 and the exhibited corridor in 2018. The corridor alignment has been amended to improve operational efficiency and minimise impacts on existing property layouts.

The key potential environmental impacts of protecting the final recommended corridors and of the future rail infrastructure are described in the following sections.

Land use and property impacts

Land use and property impacts have been avoided by locating the southern section of the final recommended North South Rail Line corridor in tunnel where there is substantial urban development, transport infrastructure and social infrastructure at the surface. The final recommended corridors have been selected to maximise flexibility in the design and function of future precincts identified for growth in NSW Government strategic plans. The final recommended corridors would be generally located at least 400 metres away from major roads, enabling future local road networks to be designed to support residential and commercial precincts.

The final recommended North South Rail Line corridor south of Lansdowne Road, Orchard Hills, to the northern side of the Western Sydney Airport is partially co-located with the proposed Outer Sydney Orbital corridor, which would minimise land take for transport infrastructure in this area and reduce the potential for severance of properties.

Protecting the final recommended corridors now would enable planning authorities to optimise the integration of land use and future rail infrastructure when undertaking precinct planning processes and assessing development applications. This would help to ensure that new development surrounding the final recommended corridors is compatible with future rail infrastructure and appropriate for being serviced by rail. It would also help planning authorities to ensure that conflicts between new sensitive land uses and future rail infrastructure can be avoided, or mitigation measures can be incorporated where appropriate.

Prior to the construction of infrastructure in the final recommended corridors, an environmental impact statement would assess the potential impacts of the proposed infrastructure on nearby land uses and would detail measures to avoid or mitigate these impacts.

Economic impacts

The North South Rail Line would act as a catalyst for the new Western Economic Corridor. The provision of high capacity public transport would support the growth of the Western Economic Corridor by improving access to a wide range of jobs in new and existing centres and health and education assets at Campbelltown–Macarthur.

The future provision of public transport infrastructure in the final recommended corridors is expected to make a direct economic contribution to western Sydney and the broader Sydney Metropolitan region in terms of economic growth, employment and savings to the economy.

The final recommended corridors provide important opportunities to support existing and future housing and employment centres in western Sydney with potential for increased population and employment densities serviced by future mass transit infrastructure. Creating more and higher-value employment opportunities in western Sydney would help to manage travel demand from western Sydney and facilitate the 30-minute city.

If the final recommended corridors are not protected there would be higher future costs associated with land acquisition and relocating local infrastructure, utilities and services. If incompatible development were to occur within and around the final recommended corridors, then these costs could rise to a point where building rail infrastructure in the future becomes unviable, undermining the ability of the NSW Government to deliver cost effective public transport to western Sydney and leading to increased congestion of the road network.

Traffic and transport

Where the final recommended North South Rail Line corridor is in tunnel it would avoid impacts on several State roads including The Northern Road, Camden Valley Way, Camden Bypass and the Hume Highway. The final recommended corridors have been placed in cut to the greatest extent possible to minimise the impact on the likely future local road network. They are also generally located at least 400 metres from major roads as much as possible, enabling a future local road network to be designed that can support future residential and commercial precincts.

Where stations have been indicatively identified, they have been located to minimise impacts on the State road network, enabling local accessibility to the station and ensuring that land around the station can be suitably developed. Identified stations would be the subject of precinct planning that would take an integrated approach to land use and transport planning, to ensure that future stations are optimally connected with the local road network, to provide for bus interchange and to link to active transport networks. As precinct planning progresses along the final recommended corridors further opportunities for stations may be identified.

At the time of infrastructure delivery, the environmental impact statement for the proposed project would include a detailed assessment of any local road, bus and active transport networks that have been developed around the final recommended corridors. This would identify the roads to be maintained and therefore where grade separation is required. In these cases, the rail infrastructure would either be placed on viaduct or in cut.

The environmental impact assessment would also include consideration of construction and operational impacts on the existing transport networks, as well as setting out improvements to these networks that would be implemented to support the new station precincts.

Noise and vibration

There would be no noise impact associated with the protection of the final recommended corridors.

The final recommended North South Rail Line and South West Rail Link Extension corridors are located to reduce noise from the future rail infrastructure as much as possible by maximising the potential for future rail infrastructure to be in cutting.

Protecting the final recommended corridors now would enable planning authorities to consider the future rail infrastructure in precinct planning processes and when assessing development applications. This would help to ensure that new development surrounding the corridors is compatible with the future rail infrastructure and that future land use conflicts can be avoided, or mitigation measures can be incorporated where appropriate.

Prior to construction of the infrastructure an environmental impact statement would assess noise and vibration impacts of the infrastructure on adjoining and surrounding noise receptors and would detail measures to avoid or mitigate potential impacts.

Visual amenity, built form and urban design

Corridor protection would not have an impact on the landscape as it would not involve any physical works.

Where the final recommended North South Rail Line is in tunnel it would avoid visual impacts to sensitive receivers and significant landscapes at Harrington Forest, the Scenic Hills, Australian Botanic Garden Mount Annan, and William Howe Regional Park. Tunnel would require access and air circulation outlets to be provided above it. The location of these outlets would be determined during detailed design and documented in the environmental impact statement prior to delivery of the infrastructure.

The surface sections of the final recommended North South Rail Line and South West Rail Link Extension corridors are located to minimise future visual impacts on existing and possible future sensitive receivers by maximising the potential for future rail infrastructure to be in cut.

Protecting the final recommended corridors now would enable planning authorities to consider the future rail infrastructure in precinct planning processes and when assessing development applications. This would help to ensure that new development surrounding the corridors is compatible with the future rail infrastructure and that future land use conflicts can be avoided, or mitigation measures can be incorporated where appropriate.

Prior to construction of the infrastructure an environmental impact statement would assess visual and landscape impacts of the infrastructure and would detail measures to avoid or mitigate potential impacts.

Soil and water

Corridor protection would not have an impact on water resources as it would not involve any physical works. The final recommended corridors have been aligned to generally avoid flood prone land and are mostly located above the 1 in 100-year flood levels.

Soil conditions near the final recommended corridors are known to be subject to erosion and potential contamination, which can be mitigated through appropriate remediation and erosion and sediment control at the time that future infrastructure is required.

Prior to construction of the infrastructure an environmental impact statement would assess soil and water impacts of the infrastructure and would detail measures to avoid or mitigate potential impacts.

Biodiversity

Corridor protection would have no immediate impact on biodiversity. However, future construction and operation of rail infrastructure would result in potential future biodiversity impacts that would need to be considered as part of rail design and planning.

Within the former South West Growth Centre most vegetation is 'Biodiversity Certified', meaning its removal has already been assessed and offset. Non 'Biodiversity Certified' native vegetation that is directly impacted by the final recommended South West Rail Link Extension corridor is located within the South Creek riparian corridor and an associated tributary near Bringelly. Native vegetation north of the future Western Sydney Airport site is also not 'Biodiversity Certified'.

Potential ecological impacts that are likely to arise due to the removal of non-Biodiversity Certified native vegetation could include loss of habitat for existing biota, including some threatened species, as well as increased edge effects for retained vegetation.

Prior to construction of the infrastructure an environmental impact statement would include a detailed biodiversity impact assessment for construction and operational impacts in accordance with the *Biodiversity Conservation Act 2016*.

Detailed biodiversity investigations would also inform the preparation of a Biodiversity Offsets Strategy. Biodiversity offsets aim to be secured early to minimise future costs and provide biodiversity benefits prior to any impacts on habitat.

In addition to this, a future application would be referred to the Australian Government for assessment under the *Environment Protection and Biodiversity Conservation Act 1999*.

Heritage

The final recommended corridors have been selected to avoid direct impacts on known heritage items and conservation areas where possible. While the landscape is acknowledged to be of cultural and social significance to Aboriginal people, there are no identified areas of particular cultural or social significance within the final recommended corridors.

Where the final recommended North South Rail Line corridor is in tunnel it would avoid impacts on heritage values.

Prior to construction of the infrastructure an environmental impact statement would include a detailed heritage impact assessment for both Aboriginal heritage and European heritage, for construction and operational impacts. In relation to European heritage, design and construction measures would be identified to minimise any impacts on the curtilage, fabric or setting of the State Heritage Register listed 'Kelvin' group and local heritage items including the Luddenham Road Alignment, McGarvie-Smith Farm and the former Overseas Telecommunications Commission site.

Air quality

Protection of the final recommended corridors would have no air quality impacts. Construction of future infrastructure would generate temporary air quality and greenhouse gas impacts. While operation of future rail infrastructure is not expected to generate significant quantities of air emissions, tunnel would require access and air circulation outlets to be provided above it. The location of these outlets would be determined during detailed design and documented in the environmental impact statement prior to delivery of the infrastructure.

The future North South Rail Line and South West Rail Link Extension would provide important alternatives to current dependence on private vehicles for most trips. Trips taken by public transport instead of by private vehicles would avoid the air pollution and greenhouse gas emissions associated with private vehicle use.

Social impacts

The location of the final recommended corridors have been carefully selected to ensure that social benefits are maximised and impacts are avoided or minimised. To this extent, locating part of the final recommended North South Rail Line corridor in tunnel would minimise disruption to existing communities.

Protection of the final recommended North South Rail Line and South West Rail Link Extension corridors would maximise the opportunity to integrate future rail infrastructure into planned urban development and employment areas and to minimise impact to existing and future communities. Transport for NSW would continue to work with relevant agencies across the NSW Government to ensure that land use planning and transport planning processes are integrated and coordinated, so that social disruption in the future can be avoided.

Next steps

Feedback on the exhibited corridors has been assessed by Transport for NSW and the corridors refined or confirmed. The final recommended North South Rail Line and South West Rail Link Extension corridors will be assessed by the Department of Planning, Industry and Environment and considered for statutory planning protection. At the request of Transport for NSW, the Department of Planning, Industry and Environment is expected to make a recommendation to the Minister for Planning to protect the corridors within an environmental planning instrument. Once the corridor is protected, planning authorities will ensure that land use and transport planning processes around the final recommended corridors are integrated and coordinated.

Any future proposal to build and operate rail infrastructure in the final recommended corridors would be subject to a comprehensive environmental assessment in accordance with the provisions of the *Environmental Planning and Assessment Act 1979*. At that time, environmental impacts including in relation to noise, air quality, biodiversity and visual amenity, would be subject to technical expert assessment in accordance with the relevant procedures for State Significant Infrastructure. This would involve the preparation of an environmental impact statement.

Contents

Appendices

Appendix 1

Figures

Tables

Acronyms

Acronym	Description
2015 recommended corridor	A proposed rail corridor between Rossmore, Bringelly and Narellan that was publicly exhibited in 2015.
2018 exhibited corridors	The North South Rail Line and South West Rail Link Extension corridors recommended for protection in the draft Strategic Environmental Assessment that was publicly exhibited from 26 March 2018 to 01 June 2018
Final recommended corridors	The North South Rail Line and South West Rail Link Extension corridors recommended for protection in this final Strategic Environmental Assessment
L_{Aeq}	The 'equivalent noise level' is the summation of noise events and integrated over a selected period of time, which would produce the same energy as a fluctuating sound level. When A-weighted, this is written as the L_{Aeq}
L_{Amax}	The maximum sound pressure level measured over a given period. When A-weighted, this is usually written as the L_{Amax}
NSW	New South Wales
PM_{10}	Airborne particulate matter with an aerodynamic diameter of less than 10 µm
$PM_{2.5}$	Airborne particulate matter with an aerodynamic diameter of less than 2.5 µm

1 Introduction

The proposed North South Rail Line and South West Rail Link Extension will be critical to realising the NSW Government's vision of a 30-minute city. In particular, they would connect residents in the emerging suburbs of the South West Growth Area with jobs and services in the Western Sydney Aerotropolis.

Transport for NSW proposes to protect two land corridors in western Sydney for future rail infrastructure for passenger train services. The North South Rail Line corridor would provide a connection for passenger train services between the T1 Main Western Rail Line near St Marys and the T8 Main South Rail Line near Macarthur via the Western Sydney Airport. The South West Rail Link Extension corridor would extend from Leppington Station to Western Sydney Aerotropolis. Customers would be able to transfer between train services operating on the North South Rail Line and South West Rail Link Extension at Badgerys Creek Aerotropolis Station. The final recommended North South Rail Line and South West Rail Link Extension corridors for which Transport for NSW is now seeking statutory planning protection are known as the final recommended corridors and are shown in Figure 1-1.

Continuing rapid urban growth in western Sydney and ongoing planning for the Western Sydney Airport at Badgerys Creek by the Australian and NSW Governments has reinforced the need to protect long-term public transport corridors in western Sydney. Corridor protection would preserve land before any uplift associated with a corridor announcement occurs, so that the NSW Government can provide future generations with access to efficient transport connections. The North South Rail Line would be staged to align the delivery of major infrastructure with the need for transport connections.

In December 2012, the NSW Government released the *Long Term Transport Master Plan* for the State's transport system to 2031. It identified a need for a corridor between Penrith and Campbelltown/Macarthur. It was identified as a key transport corridor in western Sydney and one that is facing increased travel demand. It also indicated that a transport corridor connecting to the existing South West Rail Link could improve the performance of the Sydney transport network.

In 2014, the need for an extension of the South West Rail Link was further endorsed in the NSW Department of Planning and Environment's *A Plan for Growing Sydney* as a major transport project to support the connection of jobs and homes in western Sydney.

The North South Rail Line and the South West Rail Link Extension potential future infrastructure projects have continued to be identified in key strategic planning documents, including the *Future Transport Strategy 2056, Greater Sydney Region Plan* and *Western City District Plan* released in 2018.

This Strategic Environmental Assessment has been prepared to inform the process of protecting long-term corridors for the future delivery of transport infrastructure in western Sydney. The Department of Planning, Industry and Environment will be asked to prepare the legal framework that creates the statutory protection for the corridors.

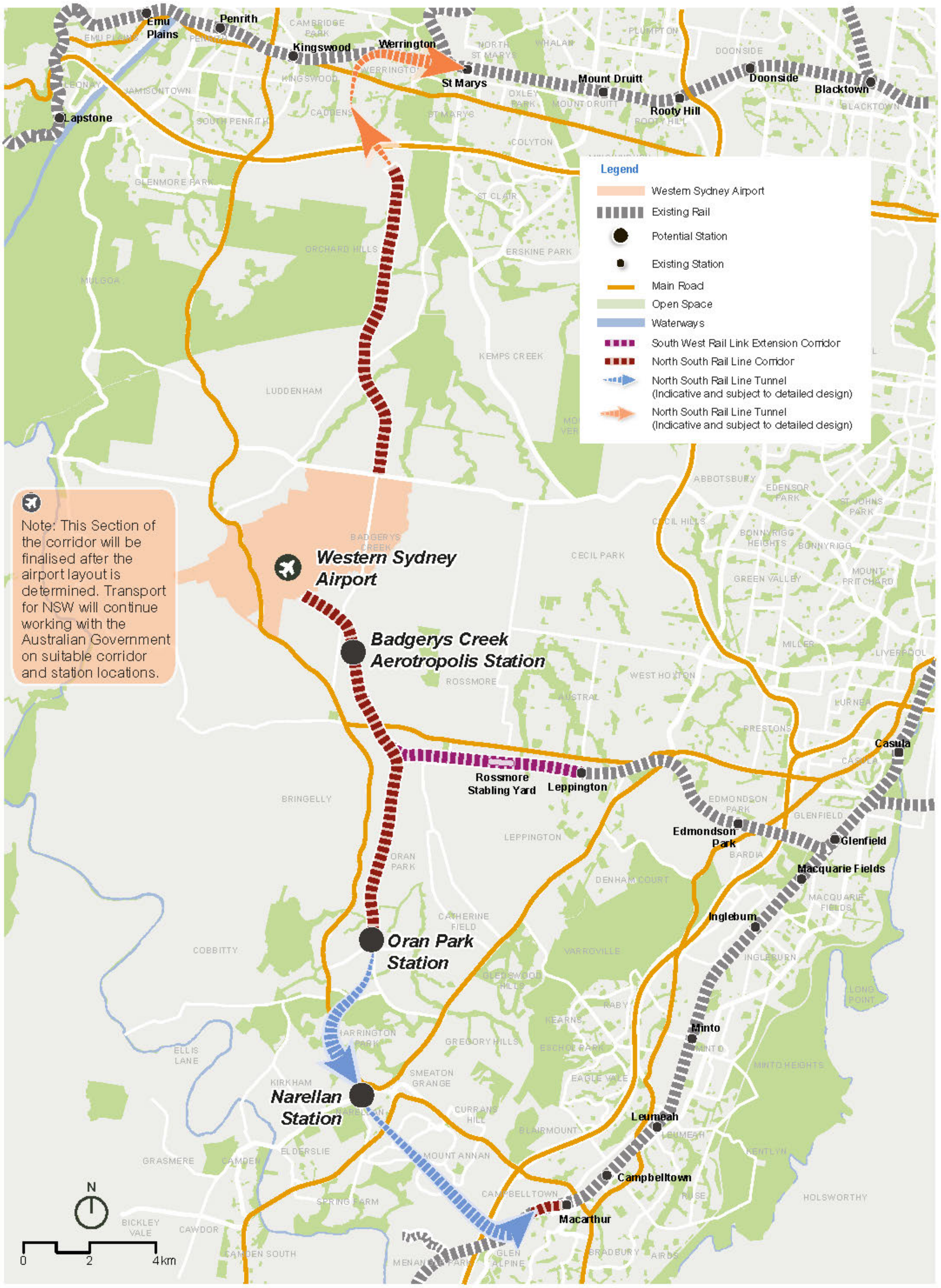

Figure 1-1 The final recommended North South Rail Line and South West Rail Link Extension corridors

1.1 Purpose of the Strategic Environmental Assessment

The purpose of this Strategic Environmental Assessment is to provide a strategic assessment of the impacts and benefits of protecting the North South Rail Line and South West Rail Link Extension corridors, which are intended to accommodate public transport infrastructure in the future.

This Strategic Environmental Assessment is not a statutory requirement under the *Environmental Planning and Assessment Act 1979* and is not an application for approval to build or operate infrastructure within the final recommended North South Rail Line and South West Rail Link Extension corridors. Rather, it is intended to form the strategic justification for the protection of the final recommended North South Rail Line and South West Rail Link Extension corridors.

It is intended only to support the protection of the corridors for potential future public transport infrastructure when it is required. At such time, design of the required infrastructure would be undertaken and an environmental assessment of the proposed project under the *Environmental Planning and Assessment Act 1979* (or the relevant legislation at that time) would be prepared.

If approved by the NSW Government, the final recommended corridors would be protected through the statutory environmental planning process. The process included consultation to provide the community, government agencies and other stakeholders with information about the proposed protection mechanism for the final recommended corridors and allowed the opportunity to provide feedback on their protection.

This Strategic Environmental Assessment has been prepared with consideration of the Department of Planning, Industry and Environment's *Planning Guideline for Major Infrastructure Corridors*, and the Strategic Environmental Assessment scope issued by the Department of Planning, Industry and Environment. Appendix 1 sets out this scope and indicates where it has been considered in the Strategic Environmental Assessment.

Transport for NSW has also had ongoing consultation with the Department of Planning, Industry and Environment to ensure that the Strategic Environmental Assessment will provide adequate consideration of environmental impacts to support the protection of the final recommended corridors.

With consideration of the above matters, the key objectives of this Strategic Environmental Assessment are to:

- Provide the strategic justification and need for the protection of the final recommended corridors
- Provide the evidence base to inform the creation of statutory planning mechanisms that protects land for future infrastructure
- Describe the baseline conditions of the final recommended North South Rail Line and South West Rail Link Extension corridors and surrounding areas with regard to key environmental aspects
- Provide an overview of the business requirements of the future infrastructure
- Document the corridor alignment identification and assessment process and the selection of the final recommended corridors
- Strategically assess the environmental, social and economic impacts of the final recommended North South Rail Line and South West Rail Link Extension corridors
- Recommend appropriate strategic mitigation and management measures to reduce the impacts of the final recommended North South Rail Line and South West Rail Link Extension corridors' future use on the surrounding community
- Identify the statutory planning outcomes desired to protect the final recommended North South Rail Line and South West Rail Link Extension corridors for the use of future infrastructure.

1.2 Objectives of corridor protection

The principal objective of protecting the final recommended North South Rail Line and South West Rail Link corridors is to make land available for the provision of future public transport infrastructure that would ultimately connect the key centres along the T1 Main Western Rail Line and Campbelltown–Macarthur on the T8 Main South Rail Line via the new Western Sydney Airport and the South West Growth Area. This connection would support efficient travel between homes and centres for work, retail, entertainment and key services.

The objectives of corridor protection are to:

- Provide adequate land for the construction and operation of future transport infrastructure so that public transport services can be provided to cater for future growth
- Provide certainty to the community, local councils and developers about the location of future transport infrastructure
- Allow for future land uses and investment decisions to be considered in relation to the future transport infrastructure
- Assist in the efficient and cost-effective delivery of transport infrastructure at the time it is needed.

This Strategic Environmental Assessment relates to the protection of corridors for the initial stage of a future western Sydney rail vision. Further rail corridors would also be investigated for protection including the future extension of the railway from St Marys to Schofields.

Strategic business requirements for the future public transport infrastructure were prepared by Transport for NSW to inform the corridor protection process. The strategic business requirements established minimum expectations and/or assumptions (in that they relate to the future delivery of a railway operating as part of the Sydney Rail network) in relation to the following matters:

- Key future connections to the broader transport network
- Location of potential stations at key existing and future centres
- Permissible horizontal and vertical alignments
- Maintenance and construction requirements
- Design assumptions for the proposed Outer Sydney Orbital and Western Sydney Airport, and known or expected major arterial road upgrades to be accommodated.

1.3 Overview of the final corridors recommended for protection

The final recommended corridors for protection are located in western Sydney and are shown in Figure 1-1. The corridors are described in detail in Section 5, but their key characteristics are briefly described below. The final recommended corridors are:

- North South Rail Line corridor – To provide a rail connection for passenger train services between the T1 Main Western Rail Line near St Marys and T8 Main South Rail Line near Macarthur
- South West Rail Link Extension corridor – To provide for an extension from Leppington Station to Western Sydney Aerotropolis. Customers would be able to transfer between train services operating on the North South Rail Line and South West Rail Link Extension at Badgerys Creek Aerotropolis Station.

The final recommended North South Rail Line corridor is proposed to be in tunnel between Oran Park and the T8 Main South Rail Line at Glen Alpine to avoid existing communities and bushland. This tunnel section of the final recommended North South Rail Line corridor would not require land at the surface to be protected.

Land at Oran Park and Narellan has been identified for potential future train stations and construction access.

The connection of the final recommended North South Rail Line corridor to the Western Sydney Airport has been confirmed with the Australian Government. The NSW Government would continue working with the Australian Government to identify suitable station locations to serve the Western Sydney Airport and the surrounding western Sydney suburbs.

The final recommended South West Rail Link Extension corridor is generally 60 metres wide to accommodate up to four railway tracks, comprising two tracks in each direction. In addition to the railway tracks, the 60-metre wide corridor is required to support ancillary infrastructure, such as signalling equipment, access roads allowing for maintenance access for the operator on both sides of the corridor and substations, as well as to provide for embankments, cuttings, retention structures and stormwater management structures where required.

The final recommended North South Rail Line corridor is also generally 60 metres wide to accommodate up to four railway tracks, comprising two tracks in each direction, between:

- Lansdowne Road, Orchard Hills, and the northern boundary of the future Western Sydney Airport site
- The southern boundary of the future Western Sydney Airport site and Bringelly.

The final recommended North South Rail Line and South West Rail Link Extension corridors would run in parallel between Badgerys Creek Aerotropolis Station and where the corridors diverge at Bringelly.

South of Bringelly, the final recommended North South Rail Line corridor is limited by tunnel south of Oran Park and so is generally 40 metres wide to accommodate up to two railway tracks, comprising one track in each direction. The 40-metre wide corridor also provides for ancillary infrastructure as well as for embankments, cuttings, retention structures and stormwater management structures where required.

The North South Rail Line returns to the surface within the existing T8 Main South Rail Line corridor at Glen Alpine and continues at the surface to Macarthur Station. A section of the existing rail corridor alongside Menangle Road to the west of Macarthur Station would need to be widened to accommodate the North South Rail Line (see Section 7.1.2.5).

1.4 Structure

The remaining part of this Strategic Environmental Assessment is structured as follows:

- Section 2: Outlines the strategic transport planning context and justifications for the final recommended corridors
- Sections 3 and 4: Describe the existing conditions and constraints along the final recommended corridors
- Section 5: Describes the process for identifying corridor alignments, selecting the final recommended corridors and the parameters of the final recommended corridors, including consultation undertaken to date in identifying and assessing the final recommended corridors
- Sections 6 and 7: Provide a strategic environmental assessment of the final recommended corridors in accordance with the scoping guideline issued by the Department of Planning, Industry and Environment
- Section 8: Provides a strategic environmental assessment of the overall impact of future rail infrastructure including potential cumulative impacts and an environmental risk analysis
- Section 9: Describes the corridor protection process
- Section 10: Describes the regulatory context for the delivery of future infrastructure
- Section 11: Consolidates a list of mitigation and managements measures
- Section 12: Provides conclusions and recommendations.

2 Strategic context

2.1 Statement of strategic need

The North South Rail Line corridor and the South West Rail Link Extension corridor are required to be protected prior to imminent land use development to provide for orderly, efficient and cost-effective growth across western Sydney.

As western Sydney transitions through the emergence of the Western Parkland City into a Metropolitan City Cluster, the Western City District's population will grow by around 464,000 people. As documented in the *Western City District Plan* (see Section 2.3.2) this equates to an additional 184,500 homes required in the District by 2036. Together with the Central River City around Greater Parramatta, these two districts will grow by more than one million people over the next 20 years.

Much of Western City District's future growth will be focused on the existing centres of Greater Penrith, Liverpool and Campbelltown–Macarthur. The NSW Government has set targets for residential and employment growth and the land release program is already well underway, with the identification of the South West Growth Area and the Western Sydney Aerotropolis and ongoing precinct planning being undertaken by the NSW Government.

As part of this growth there is a commitment from the Australian Government to build a new Western Sydney Airport, which is expected to start operations in 2026. Initially the airport will cater for around five million air passengers per annum, with a focus on serving the needs of western Sydney. Patronage is expected to grow to ten million passengers per annum by 2030. Beyond the mid-2030s, rail connections to the Western Sydney Airport will be important to help meet expected growth as Kingsford Smith Airport approaches capacity in the 2040s.

The emerging economy of western Sydney can benefit from planned investment associated with the Western Sydney Airport to transform into a nationally significant health, education, trade, logistics, advanced manufacturing and science centre. The Western Sydney Aerotropolis will be the catalyst for a new Western Economic Corridor, which is anticipated to provide unprecedented economic opportunities for western Sydney.

The future delivery of the North South Rail Line and the South West Rail Link Extension will be of strategic benefit to the Greater Sydney Region as it is consistent with Australian and NSW Government policies for future development of western Sydney and would be a critical piece of transport infrastructure to achieve these policy outcomes and support the forecast population growth. The protection of the final recommended North South Rail Line corridor and the South West Rail Link Extension corridors would ensure there is land protected to deliver the future transport infrastructure.

2.1.1 Future transport task in western Sydney

With the anticipated population growth in western Sydney, improved transport connections are required to enable the NSW Government's vision for a 30-minute city, as set out in the *Greater Sydney Region Plan* (see Section 2.3.1) and the *Western City District Plan* (see Section 2.3.2), where the aim is for people to live within 30 minutes of jobs, education and services. The North South Rail Line will be designed to shape the Western Parkland City and extend the Western Sydney Aerotropolis catchment so that the Western Sydney workforce can access up to 200,000 jobs within 30 minutes of their home using public transport. The final recommended corridors would support the delivery of this city-shaping infrastructure in the future and connect Western Sydney Airport to the broader transport network on opening.

Infrastructure for road, public transport and utilities is key to supporting the growth in western Sydney and achieving the likely economic benefits due to planned investment in Western Sydney Airport. The Australian and NSW Governments have implemented a *Western Sydney Infrastructure Plan* as a first step, focussing on road connections throughout western Sydney.

A joint Australian and NSW Government *Western Sydney Rail Needs Study* (see Section 2.2.4) has also been prepared to inform the public transport connections needed throughout western Sydney. The North South Rail Line and South West Rail Link Extension are identified as key north-south and east-west transport links that would connect people to jobs and places, and provide greater education, employment and business opportunities to support the emerging Western Parkland City and new Western Economic Corridor.

In addition to this, the Outer Sydney Orbital and Western Sydney Freight Line will establish a transport structure for the Western City District providing for future road and freight movements.

2.1.2 Why protect public transport corridors now

It is important to ensure that appropriate provisions are made now to meet the future transport needs of not only western Sydney, but also the Greater Sydney Region, and this includes early protection of corridors for future transport infrastructure.

New communities in western Sydney are already being developed, and planning for additional new communities is underway. For instance:

- Oran Park had a population of 195 in 2011; this was nearly 5000 by 2016 and is expected to eventually be home to 25,000 residents by 2036.
- Planning is ongoing for the development of Sydney Science Park at Luddenham, which is expected to become an employment centre with 12,000 knowledge-based jobs and home to more than 10,000 residents.
- Planning investigations into the land release of 1500 hectares of land from Oran Park to Bringelly Road known as South Creek West were announced in November 2017, which will potentially provide for new communities comprising up to 30,000 homes.
- Planning for the Western Sydney Airport at Badgerys Creek is also progressing, and its development will be a catalyst for the development of the Western Economic Corridor including the Western Sydney Aerotropolis.
- The *Greater Sydney Region Plan* and *Western City District Plan* identify the investigation of a potential new growth area extending from the northern boundary of the Western Sydney Aerotropolis to the Castlereagh Motorway reservation north of Ropes Crossing. Confirmation and protection of a corridor for the St Marys to airport section of a future North South Rail Line and a St Marys to Schofields alignment within this potential growth area would facilitate strategic land use opportunities to provide housing and employment.

Protecting the final recommended corridors now would facilitate integrated land use and transport planning and prevent development in the interim from impacting the future delivery of cost-effective infrastructure. Integrating land use and transport planning will enable new precincts to be planned that will complement the future infrastructure, ensuring suitable development is located where it can be supported by future train services. Also, avoiding incompatible development along the protected corridors would reduce the potential for future disruption to communities and businesses during the construction phase.

Early protection of a corridor has several other benefits, including increased certainty for the community about the location of future infrastructure, enabling future infrastructure to be delivered at the time it is needed. Early protection of corridors therefore provides clarity and certainty for planning authorities, landowners, communities and businesses.

2.1.3 Why are the corridors designed to accommodate rail?

The final recommended corridors are intended to complement the existing transport network, and to provide for the optimal corridor in which passenger mass transit can be built when the need arises.

The *Western Sydney Rail Needs Study* (see Section 2.2.4) identifies that demand for train services on the T1 Main Western Rail Line is forecast to increase by 57 per cent and on the T8 Main South Rail Line by 119 per cent by 2056. These lines, which are already operating at close to capacity, will not cope with this level of passenger growth. Major upgrades and expansion of the rail network will be required to support anticipated future growth in western Sydney and early corridor protection would assist in ensuring that these upgrades can be undertaken as they are needed. However, detail of works required to integrate the future North South Rail Line with existing T1 Main Western Rail Line and T8 Main South Rail Line infrastructure is subject to project definition and detailed design processes, and so is not addressed in this Strategic Environmental Assessment.

The *Western Sydney Rail Needs Study* identifies a north-south rail corridor connecting Schofields with Macarthur via St Marys and the Western Sydney Airport as critical to integrated land use and transport planning for the future of western Sydney.

The final recommended North South Rail Line corridor represents the first important stage of protecting a north-south connection between Lansdowne Road, Orchard Hills, and Macarthur, via the future Western Economic Corridor and Western Sydney Aerotropolis. The final recommended North South Rail Line corridor includes the surface connection between Lansdowne Road and Western Sydney Airport, that is critical to realising the Australian Government's commitment (via the Western Sydney City Deal, see Section 2.2.3) to provide a rail connection to Western Sydney Airport on opening.

The NSW Government is separately investigating a corridor for future railway infrastructure between St Marys and Schofields. Statutory protection of a corridor between St Marys and Schofields will be sought once a suitable corridor has been identified.

The final recommended North South Rail Line and South West Rail Link corridors have been sized with sufficient width to enable the future development of an elevated rail flyover where the corridors merge at Bringelly. The need for such a structure would be determined at later design phases of the project.

Strategic modelling of the North South Rail Line's effect on the 30-minute city goal indicates that communities across the Western Parkland City (including centres and clusters such as Marsden Park and Campbelltown–Macarthur) will gain 30-minute city access to the Western Sydney Aerotropolis when integrated with other long-term network improvements, such as new mass transit corridors and improvements to the existing rail network. In addition, the North South Rail Line would increase the percentage of residents living within one kilometre of a train station, from 32 per cent in 2016 to 46 per cent in 2056.

The future North South Rail Line and South West Rail Link Extension would provide important alternatives to current dependence on private vehicles for most trips and contribute positively to the ongoing management of congestion on Sydney's road and rail networks as well as support travel to the Western Economic Corridor.

2.1.4 Strategic planning

Several Australian and NSW Government strategic policies have already begun to plan for the infrastructure that will be needed to support the Western Sydney Aerotropolis and the future growth of western Sydney.

The Australian Government has identified the importance of supporting future population growth, addressing congestion and supporting local and regional employment expansion in the *Australian Infrastructure Plan* (see Section 2.2.1). The need for early corridor protection and infrastructure provision is identified in the *Australian Infrastructure Plan*, and the benefits of early corridor protection have been further reiterated in the Infrastructure Australia's *Corridor Protection: Planning and investing for the long term.*

The Australian Government has reinforced the importance of planning for growth in western Sydney through investment in the Western Sydney Airport, the *Western Sydney Infrastructure Plan* (see Section 2.2.2) and *Western Sydney City Deal* (see Section 2.2.3).

These policies and investments demonstrate that the Australian Government supports corridor protection and is seeking to encourage early identification and protection of future infrastructure corridors.

The protection of the final recommended corridors is also underpinned by NSW Government policies and strategies. The need for a transport corridor connecting Penrith and Campbelltown–Macarthur was first identified in the NSW Government's *Long Term Transport Master Plan* and subsequently supported in the *State Infrastructure Strategy 2018-2038* (see Section 2.3.4) and *A Plan for Growing Sydney*. The Greater Sydney Commission's *Greater Sydney Region Plan* (see Section 2.3.1) and *Western City District Plan* (see Section 2.3.2) further set out the importance of coordinating land use and infrastructure initiatives across western Sydney, including by prioritising the identification and protection of infrastructure corridors.

In summary, the protection of the final recommended corridors is significant at both a national and State level as it is consistent with a well-defined policy direction as a major city-shaping project that responds to future population growth.

2.2 Australian Government policies

Australian Government policy relevant to the corridor study is predominantly focussed on infrastructure investment, with the Western Sydney Airport being one of the Australian Government's key investment commitments. From a national perspective, the protection of the final recommended corridors is of national significance as it will assist in the delivery of future infrastructure in accordance with the Australian Government's investment priorities.

2.2.1 Australian Infrastructure Plan

Infrastructure Australia is a statutory body that advises the Australian Government, investors and infrastructure owners on a wide range of infrastructure matters. One of Infrastructure Australia's current focus areas is on facilitating the delivery of quality public transport in Australia's cities to address urban congestion. To support this, Infrastructure Australia is recommending significant Australian Government investment in this area as well as more effective long-term planning for future project delivery.

Infrastructure Australia released the first *Australian Infrastructure Plan* in 2016. The plan makes several recommendations in relation to selecting and planning for infrastructure projects in the future and includes long-term corridor protection and opportunities for Australian Government funding for city-building public transport projects.

Of particular importance to the final recommended corridors, the *Australian Infrastructure Plan* specifically identifies that corridor protection is critical in translating long-term planning into infrastructure and that effective corridor protection mechanisms should be established to ensure the timely protection of surface, subterranean and air corridors for future infrastructure priorities. The *Australian Infrastructure Plan* notes that *"the failure to preserve corridors reduces the ability of governments to respond to infrastructure pressures and raises the cost of delivering future projects."*

The *Australian Infrastructure Plan* was informed by the Australian Infrastructure Audit carried out in 2015. The Audit examined the drivers of future infrastructure demand across each state in Australia, particularly population and economic growth. The Audit considered the principal drivers of infrastructure demand – population and economy, and made the following key findings that will influence future transport infrastructure demand in western Sydney:

- Population growth in Greater Sydney is expected to reach 6.25 million people in 2031, an increase of 1.6 million from 2011
- Demand for urban transport infrastructure is projected to increase significantly
- The cost of congestion in capital cities is expected to increase to around $53.3 billion in 2031, an increase of around 290 per cent on 2011 costs, in the absence of additional capacity and/or demand management. A significant proportion of this originates from the Sydney – Newcastle – Wollongong urban area where it is expected to cost around $14.8 billion by 2031
- Urban transport decisions need to complement land use decisions – there remains a risk that community resistance to land use change and higher densities will undermine the economic, social and environmental benefits of investment in urban transport.

Protection of the final recommended corridors is consistent with Infrastructure Australia's strategic policy objectives of supporting cost-effective infrastructure investment that will address urban congestion and ensure that urban transport decisions are integrated with land use planning processes.

2.2.2 Western Sydney Infrastructure Plan

Following the 2014 announcement that Badgerys Creek will be the site of the Western Sydney Airport, almost $3 billion over 10 years has been allocated jointly by the Australian and NSW Governments to the *Western Sydney Infrastructure Plan*. This plan contains a framework for investment in major road infrastructure upgrades to support the growth of the Western City District and involves transport links that will capitalise on the economic benefit of increased activity in the region. These works are currently underway and include:

- Upgrade of The Northern Road to a minimum of four lanes from Narellan to the M4
- Construction of a new M12 Motorway to the Western Sydney Airport, between the M7 Motorway and The Northern Road
- Upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way, with the design to allow reconfiguration to a six-lane road if needed in the future
- $200 million for local roads upgrades.

These road upgrades will support the local economy and liveability of western Sydney and indicate that both levels of government have recognised the importance of transport infrastructure in the region. Protection of the final recommended corridors would support this investment in the road infrastructure in western Sydney and would contribute to the overall improvement of the transport network in western Sydney.

The North South Rail Line would be complemented by a strategic bus network that will rely on improved road infrastructure. The bus network would be planned during the design stage of the future infrastructure to ensure it provides local feeder services for workers and residents to connect with the new rail network.

2.2.3 Western Sydney City Deal

The Western Sydney City Deal is a partnership between the Australian and NSW Governments to provide funding and policy support for the generation of economic growth, jobs and housing, reduce travel times and improve environmental outcomes. The Western Sydney City Deal includes a commitment from the Australian and NSW governments to deliver the first stage of the North South Rail Line to connect the existing metropolitan rail network at St Marys to the Aerotropolis Core via Western Sydney Airport. The Australian and NSW Governments will contribute up to $50 million each to a business case process, which will include investigation of integrated transport and delivery options for a full North South Rail Line from Schofields to Macarthur and a South West Rail Link Extension to connect Leppington to the Western Sydney Airport via an interchange at Western Sydney Aerotropolis.

The Australian and NSW Governments will be equal partners in funding the first stage of the North South Rail Line and have a shared objective to connect rail to Western Sydney Airport in time for opening, informed by a business case.

A key priority of the Western Sydney City Deal is to increase investment in infrastructure, particularly public transport projects that are intended to unlock the economic potential of the region, reduce congestion and support local needs.

The Western Sydney City Deal represents a clear policy commitment from both the Australian and NSW Governments to invest in western Sydney. The City Deal is intended to inform land use decisions over the next 20 years and will focus on local job opportunities, connectivity and liveability.

The protection of the final recommended corridors aligns with the intent and objectives of the City Deal to deliver future growth and development of western Sydney. Protection of the surface component of a corridor would enable the efficient future delivery of the first stage of the North South Rail Line.

2.2.4 Western Sydney Rail Needs Study

The *Western Sydney Rail Needs Study* was a joint investigation by the Australian and NSW Governments to determine the need, timing and service options for rail investment to support western Sydney and the future Western Sydney Airport. The study considered the proposed start of airport operations in the mid-2020s as well as the longer-term rail needs of western Sydney. The key objectives of the *Western Sydney Rail Needs Study* were to:

- Improve rail connectivity between western Sydney and the rest of Sydney
- Provide rail connectivity to the future Western Sydney Airport site
- Assess if and how passenger train services could be provided to the future Western Sydney Airport site.

The study identified and considered broad options to address these rail needs, and recommended options for more detailed assessment and development.

One recommendation from the *Western Sydney Rail Needs Study* is for a north-south connection between Schofields and Macarthur via St Marys and the Western Sydney Airport. The north-south link would represent a major investment into enhancing cross-regional rail capacity in western Sydney. This link would not only connect large areas of the Western Sydney Aerotropolis to the Western Sydney Airport, but also connect growth areas in the north-west, west and south-west. Importantly, this link would provide onward rail connections to strategic centres such as Penrith, Liverpool, Greater Parramatta and Campbelltown. The final recommended North South Rail Line corridor represents the first important stage of this north-south connection through the South West Growth Area and connecting to the T8 Main South Rail Line at Macarthur.

The *Western Sydney Rail Needs Study* determined that with standard growth forecasts for western Sydney, a north-south link would be economically viable in the 2030s. However, the future development of Western Sydney Airport and the city shaping planning work being undertaken by the Department of Planning, Industry and Environment in collaboration with the Greater Sydney Commission is driving population and economic growth in the region that would make the rail link beneficial earlier than that period.

To further improve its economic viability, the *Western Sydney Rail Needs Study* recognised that the full north-south link could be built in stages as western Sydney continues to grow and demand from Western Sydney Airport increases. It identified that the link north of Western Sydney Airport to St Marys would be a suitable first stage, with a subsequent extension to Schofields, due to the greater population densities in that region, and the potential to connect to the Sydney Metro Northwest and key employment centres in Sydney's north.

As noted in Section 2.2.3, a staged approach to the development of a north-south link is proposed so as to align the delivery of major infrastructure with the need for transport connections. The first stage of the North South Rail Line would connect the existing metropolitan rail network at St Marys to the Aerotropolis Core via Western Sydney Airport.

2.3 NSW Government strategic plans and policies

The NSW Government has released several strategic plans and policies to provide a framework for future land use planning and the development of transport infrastructure. Strategic plans and policies relevant to the final recommended corridors have been released by planning and transport agencies and are discussed in the following sections to demonstrate that the final recommended corridors are consistent with the overall strategic direction for NSW, as well as relevant land use and transport policy.

The NSW Government has identified the *Premier's Priorities*, a set of 12 strategic priorities for NSW that encompass a range of social, environmental and economic issues. Of particular relevance to the final recommended North South Rail Line and South West Rail Link Extension corridors is the goal of 'Delivering Infrastructure'. To fulfil this priority, an infrastructure investment program has been established so that key infrastructure programs may be undertaken to accommodate projected population growth, support liveable communities and create jobs.

The majority of infrastructure investment is directed to road and public transport projects, as the NSW Government is committed to reducing traffic congestion and increasing transport connectivity. The final recommended corridors are therefore consistent with these strategic objectives as a future railway will connect new urban areas in western Sydney to the existing Sydney Trains network, providing the future population with an alternative option to road transport. The purpose of protecting the corridors is to ensure that this critical infrastructure can be delivered in a timely and efficient manner when it is required.

2.3.1 Greater Sydney Region Plan

The *Greater Sydney Region Plan* (the Plan) is the NSW Government's strategic plan for the Greater Sydney Region to 2056. The *Greater Sydney Structure Plan 2056* is shown in Figure 2-1. The Plan divides the metropolitan region into the Eastern, Central and Western cities and is guided by 10 directions and 40 key objectives, with metrics to measure the achievement of each objective.

The Plan sets targets for dwellings and jobs and is also guided by the goal to create a 30-minute city to connect people to jobs, businesses, schools and services. To achieve this 30-minute city goal, the Plan has been prepared in coordination with the Transport for NSW *Future Transport Strategy 2056* and the Infrastructure NSW (2018) *State Infrastructure Strategy 2018-2038*. The Plan includes the final recommended North South Rail Line and South West Rail Link Extension corridors to be investigated in the next 10 years.

The Australian Government's investment in the Western Sydney Airport will see the emergence of a new Metropolitan City Cluster at the Western Sydney Aerotropolis. These new economic agglomerations, together with the need for planning and delivering a transport network to support the significant projected population growth, create the opportunity for a north-south mass transit corridor which would act as a catalyst for a new Western Economic Corridor. The delivery of the Western Economic Corridor is integral to creating more jobs and a diversity of jobs in the Western City District as well as greater education and business opportunities.

The Plan states that transit corridors will improve connectivity in the Eastern, Central and Western cities and notes that strategic land use and infrastructure planning across Greater Sydney can reinforce the opportunities created by existing and proposed mass transit systems by integrating land use and infrastructure planning.

The alignment of the final recommended North South Rail Line corridor would achieve the 30-minute city goal by providing a direct connection between the T1 Western Line, Western Sydney Airport and Western Sydney Aerotropolis. A future North South Rail Line would make strategic centres along the alignment accessible by public transport to provide people with access to jobs, shops and services. Later design phases of the project will investigate locating stations at separation distances that enable train services to operate at high average speeds.

The Plan emphasises that the proactive and early protection of corridors to protect longer-term linear infrastructure opportunities should be undertaken to provide greater clarity and certainty for landowners, communities and businesses.

The *Greater Sydney Region Plan* prioritises the growth of the Western City, advocating for transit-oriented development and the timely delivery of infrastructure to support new communities.

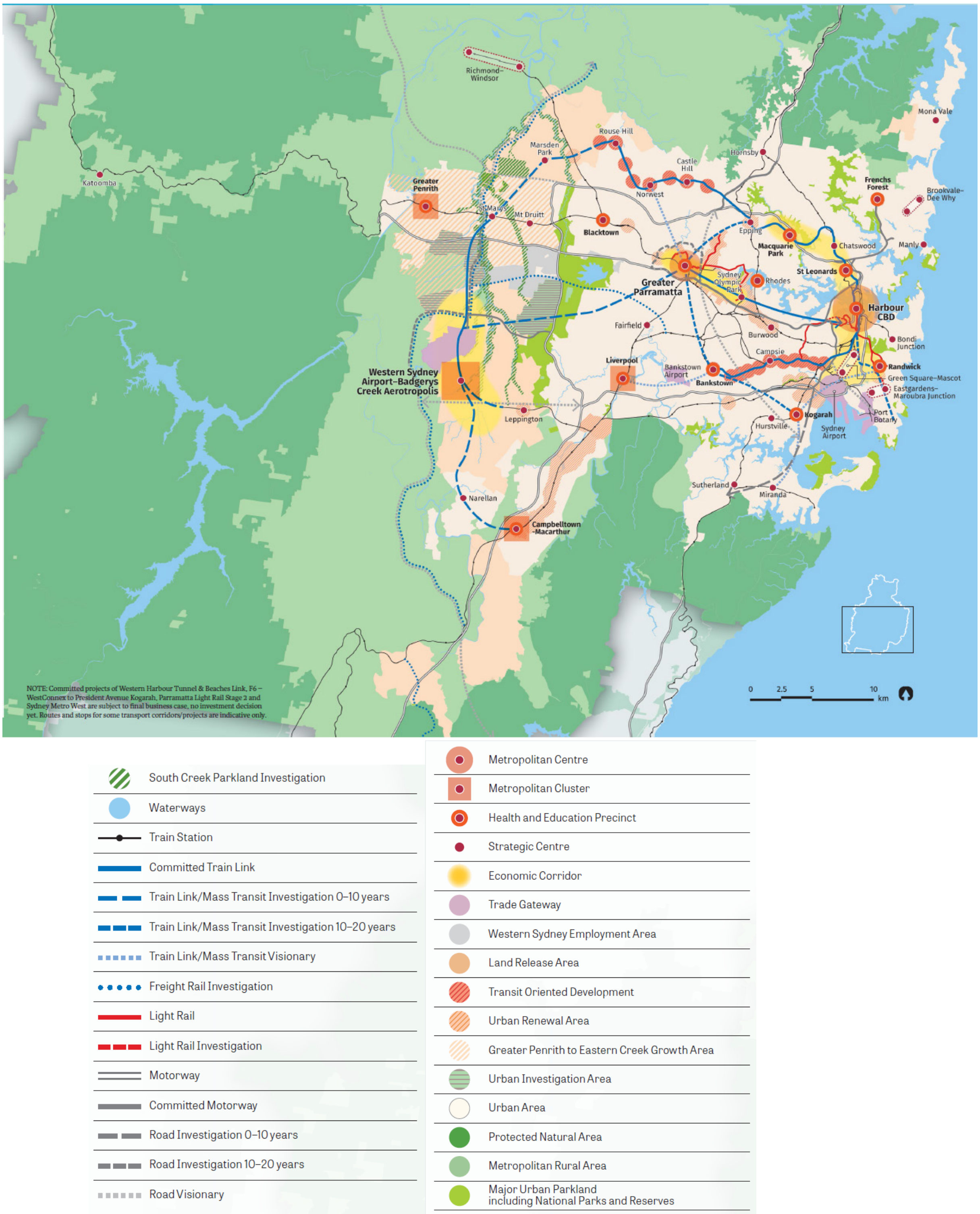

Figure 2-1 Greater Sydney Structure Plan 2056 – the three cities

Source: *Greater Sydney Region Plan* (Greater Sydney Commission, 2018a)

2.3.2 Western City District Plan

The *Western City District Plan* builds on the *Greater Sydney Region Plan* by outlining the strategic vision for the Western City District, encompassing the Blue Mountains, Camden, Campbelltown, Fairfield, Hawkesbury, Liverpool, Penrith and Wollondilly. The Western City District will be a polycentric Metropolitan City Cluster, with a strong relationship between Liverpool, Greater Penrith and Campbelltown–Macarthur, reinforced by the Western Sydney Aerotropolis and the Western Economic Corridor.

It is intended that this Metropolitan City Cluster will be well-connected by high quality public transport and that transport investments will provide major links for people and freight between the District's strategic centres and to Greater Sydney's north and south. An extract of the *Western City District Structure Plan* is shown in Figure 2-3.

The population of the Western City District is forecast to increase by about 464,000 people by 2036. As the overall population grows, it is also ageing. The number of residents aged over 85 is expected to grow by 206 per cent, while the number of single-person households is expected to grow by 72 per cent. Growth in these households is expected in the local government areas of Camden (238 per cent), Liverpool (91 per cent) and Wollondilly (87 per cent), although couples with children are expected to remain the dominant household type in the District. As a result, there will be comparatively fewer working-age people (20–64 years) living in the District.

These population and demographic changes mean that an additional 184,500 homes are required in the District by 2036, representing 25 per cent of total new housing across Greater Sydney. By 2036, the *Western City District Plan* therefore projects that there will be 572,500 dwellings in the Western City District.

As shown in Figure 2-2, the South West Growth Area and the Western Sydney Aerotropolis (formerly the Western Sydney Airport Growth Area) remain key growth areas in the Western City. Other areas of projected growth are around the Greater Macarthur Growth Area, Narellan, Bringelly and along the existing T1 Main Western Rail Line. This projected growth in the number of dwellings highlights the need for corridors to be protected, both to ensure that future infrastructure can be delivered and to provide certainty for local businesses and communities.

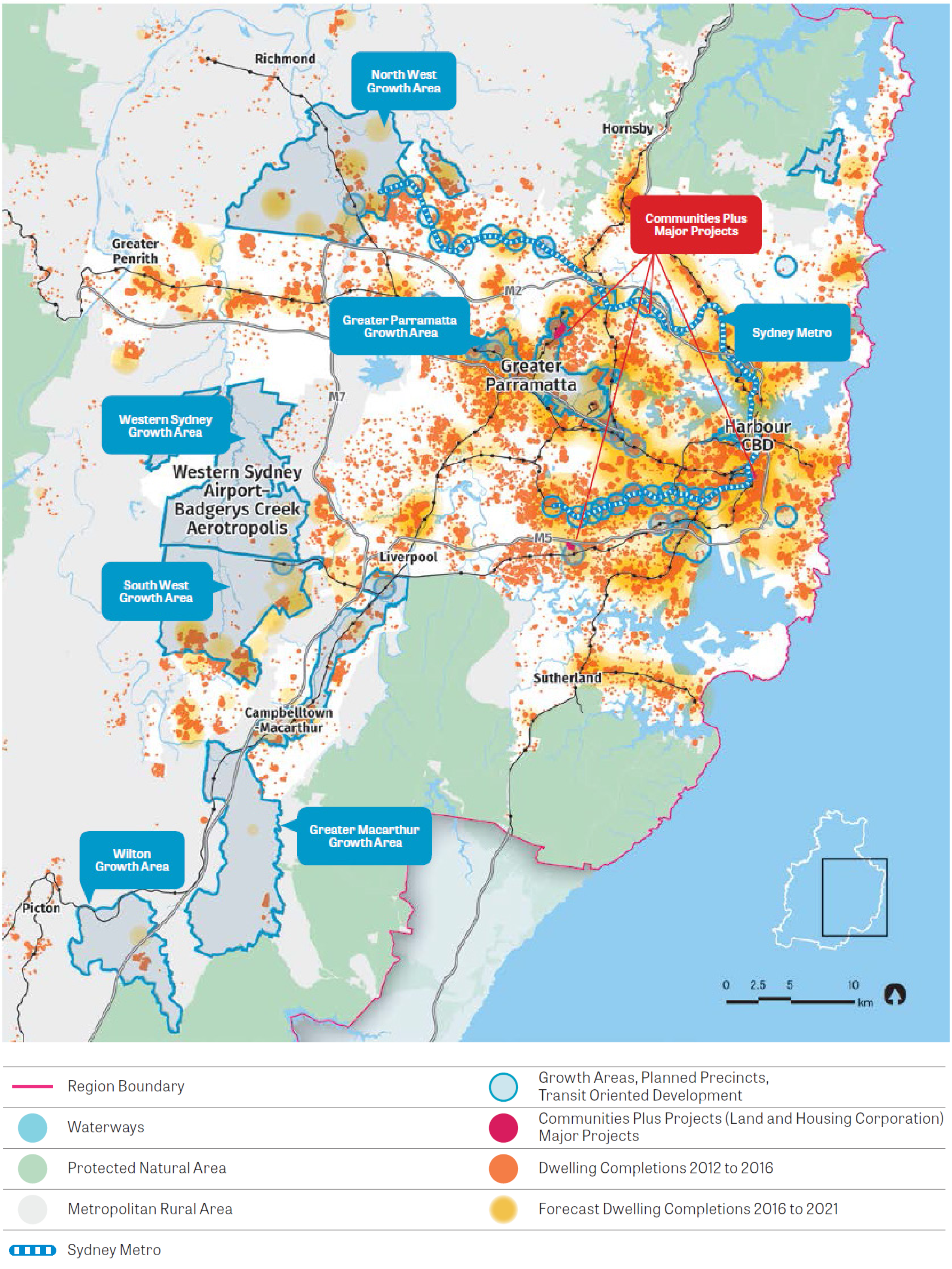

Figure 2-2 Historic and future housing supply

Source: *Greater Sydney Region Plan* (Greater Sydney Commission, 2018a)

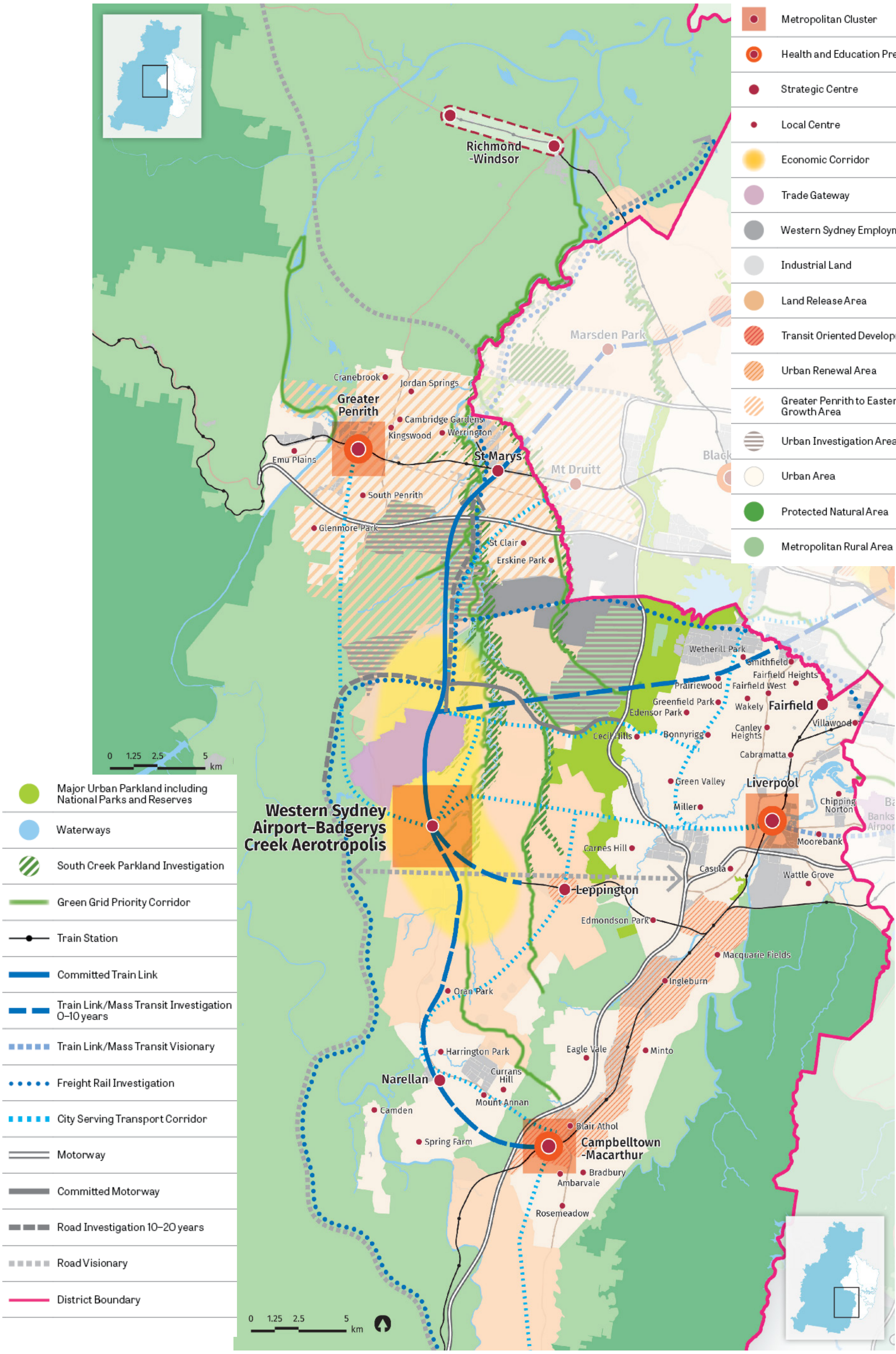

Figure 2-3 **Western City District Structure Plan**

Source: *Western City District Plan* (Greater Sydney Commission, 2018b)

The *Western City District Plan* also includes job targets that seek to significantly increase employment across the key centres of the Western City District, as shown at Table 2-1.

Table 2-1 Western City District job targets

Centre	Job target	
	2016	2036
Greater Penrith	33,400	44,000-45,000
St Marys	8300	10,000-11,500
Leppington	400	7,000-12,500
Narellan	10,600	14,000-16,500
Campbelltown–Macarthur	20,400	27,000-31,000

Source: *Western City District Plan* (Greater Sydney Commission, 2018b)

To accommodate this projected housing and job growth, the structure plan details the intended land use for the District as well as identify investigation areas for growth. These are shown in Figure 2-4 and Figure 2-5. These structure plans illustrate that future development will be concentrated between Campbelltown–Macarthur in the south and the new growth area for the Greater Penrith to Eastern Creek corridor in the north, as well as in land release areas, growth area investigations and the new Western Economic Corridor. The Western Sydney Aerotropolis and the South West Growth Area continue to be the key focus areas for future growth and will be aligned with the objectives and strategies of the *Greater Sydney Region Plan* and *Western City District Plan* to enhance liveability, sustainability and productivity.

Integration of land use and transport planning is identified as key to achieving objectives related to productivity under the *Western City District Plan*. The future North South Rail Line and South West Rail Link Extension are noted as major transit connections that have the potential to contribute to the structure of a compact and connected Western Parkland City.

One of the key priorities of the *Western City District Plan* is to establish the land use and transport structure to deliver a liveable, productive and sustainable Western City District. In this regard, the final recommended corridors are identified as a catalyst for the new Western Economic Corridor, centred on the Western Sydney Aerotropolis, which is integral to creating more jobs and a diversity of jobs in western Sydney.

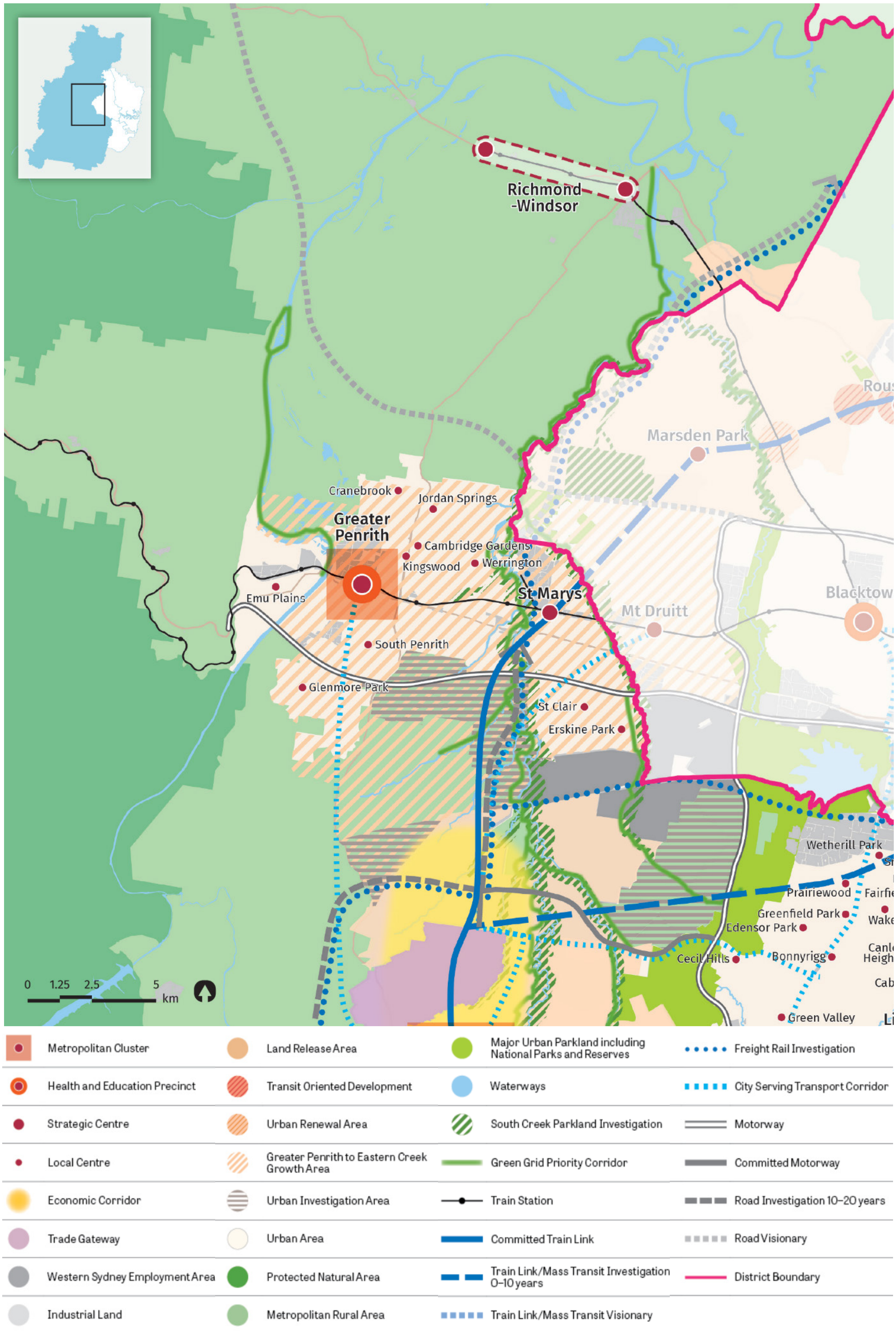

Figure 2-4 Western City District – urban area north

Source: *Western City District Plan* (Greater Sydney Commission, 2018b)

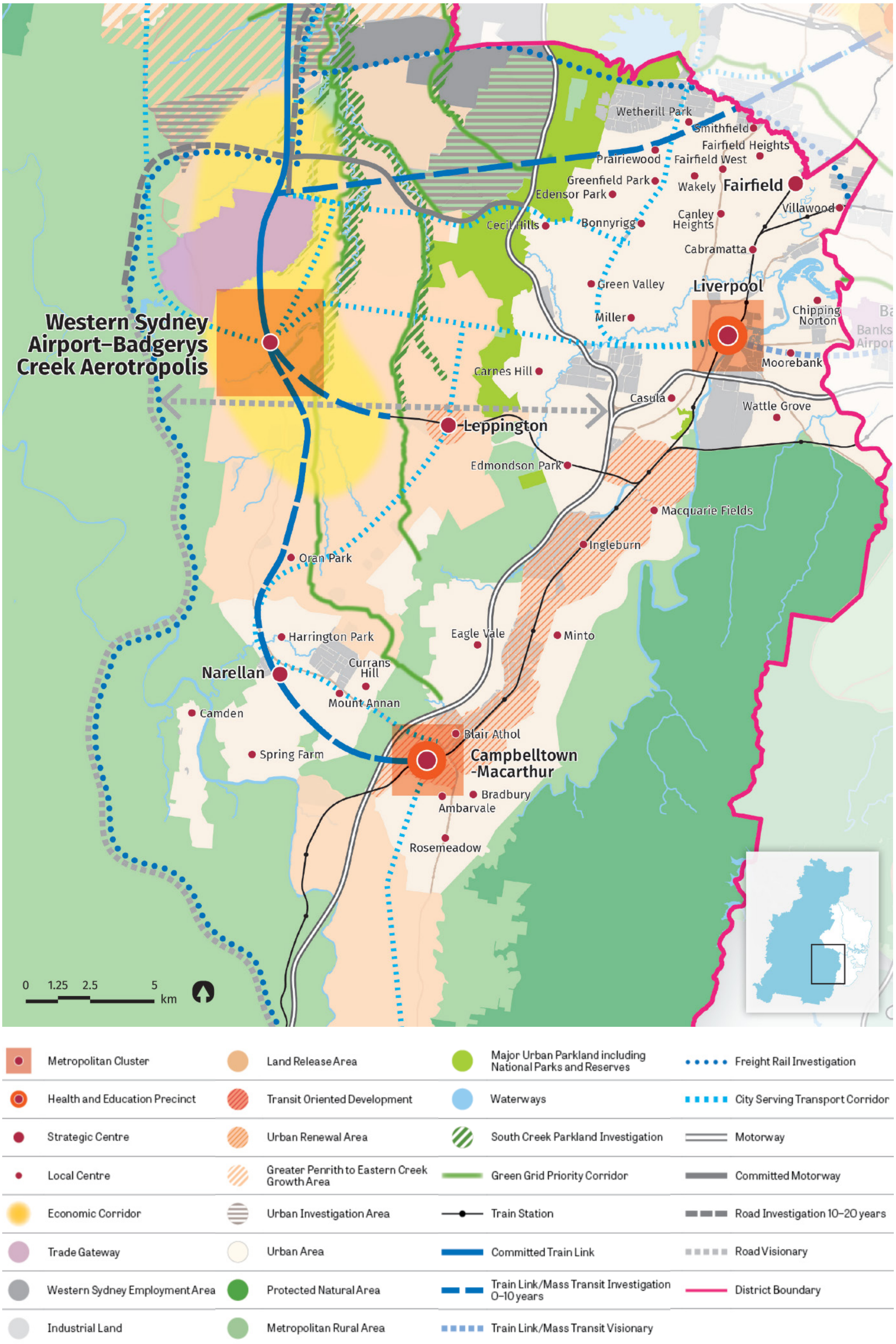

Figure 2-5 Western City District – urban area south

Source: *Western City District Plan* (Greater Sydney Commission, 2018b)

2.3.3 Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan

The *Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan* (Department of Planning and Environment, 2018) sets out the planning framework for future development around Western Sydney Airport. The plan defines nine precincts, with three precincts identified as the initial stages of development: Aerotropolis Core, Northern Gateway and South Creek. These precincts have been selected in recognition of the growth and open space opportunities enabled by major government infrastructure to support development, particularly the Western Sydney Airport, the proposed first stage of the North South Rail Line and the *Western Sydney Infrastructure Plan*.

The structure plan for Stage 1 of the Western Sydney Aerotropolis is shown in Figure 2-6. Broad land uses are defined in the structure plan, which would be endorsed in a proposed State Environmental Planning Policy that would apply development controls for an urban development zone, infrastructure zone and environment zone.

The Aerotropolis Core and Northern Gateway precincts will be the focus of planning growth for the next five years while South Creek precinct will create the parkland spine to the Western Sydney Aerotropolis and the broader Western Parkland City. The three initial precincts have a target of creating 83,000 jobs:

- Aerotropolis Core: 60,000 jobs and 8000 homes
- Northern Gateway: 22,500+ jobs and 3400+ homes
- South Creek: 500 jobs and minimal homes.

The remaining precincts will contribute additional jobs, with job targets for these precincts to be confirmed.

Detailed precinct planning will begin with the three initial precincts, with consultation at the end of 2019. Detailed planning of the other precincts will commence later.

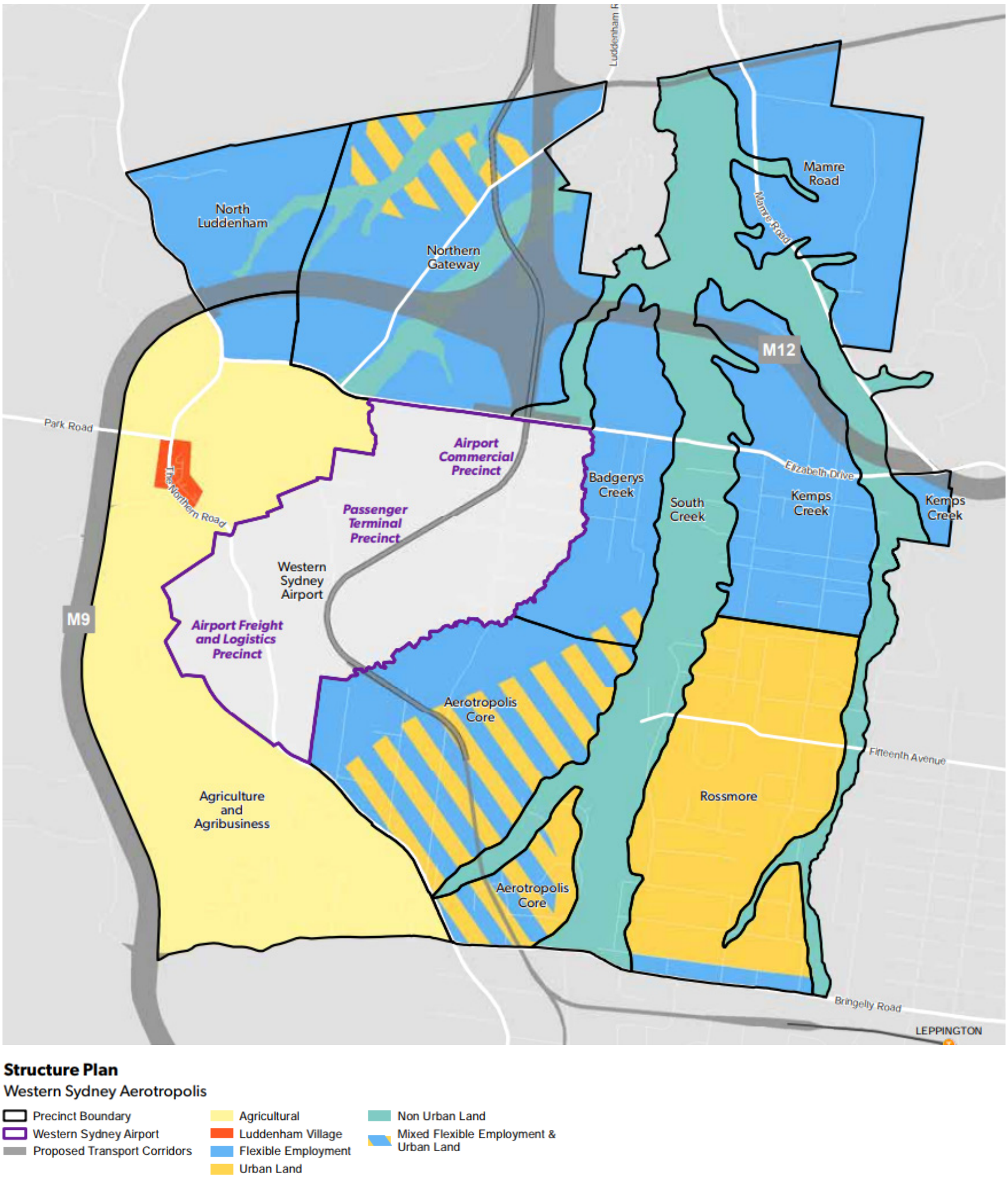

Figure 2-6 Western Sydney Aerotropolis structure plan

2.3.4 State Infrastructure Strategy 2018-2038

The *State Infrastructure Strategy 2018-2038* provides advice and recommendations for infrastructure projects and provides support for projects in key sectors including urban public transport. The *State Infrastructure Strategy 2018-2038* identifies corridor protection as a key action for delivering integrated infrastructure and land use. This infrastructure is considered to play a critical role in supporting Sydney's growing population and providing the mobility and connectivity needed to sustain economic growth and urban productivity. The final recommended North South Rail Line and South West Rail Link Extension corridors would allow for future delivery of railways in the metropolitan area in a timely and efficient manner and are consistent with the objectives outlined in the *State Infrastructure Strategy 2018-2038*.

2.3.5 Growth areas

The final recommended corridors affect three growth areas, being the Western Sydney Aerotropolis (shown in Figure 2-6) and the South West Growth Area and Greater Macarthur Growth Area (shown in Figure 2-7).

The Western Sydney Aerotropolis surrounds the Western Sydney Airport and is intended to provide opportunities for employment, additional dwellings and associated services. The Western Sydney Aerotropolis contains the former Broader Western Sydney Employment Area, which comprised around 4537 hectares of land identified for future employment uses including industrial, warehousing and offices, with the potential to generate around 57,000 jobs over the next 30 years.

The South West Growth Area (formerly the South West Growth Centre) will provide for a range of housing types that will benefit from being near to the future Western Sydney Airport and from major investments in transport infrastructure, including the upgrade of Camden Valley Way, Narellan Road and Bringelly Road. The former South West Growth Centre comprised around 117,000 hectares and established 18 precincts, which were intended to provide for around 110,000 dwellings and around 300,000 residents. Seven precincts have been rezoned for urban development and are in various stages of delivery.

Further rezoning of land within the precincts of the South West Growth Area and the Western Sydney Aerotropolis is expected to occur in the near future. Land Use and Infrastructure Implementation Plans are being developed by the Department of Planning, Industry and Environment, in consultation with Penrith City Council, Liverpool City Council, Campbelltown City Council and Camden Council for these growth areas and will be exhibited for community feedback. Public exhibition of the *Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan, Stage 1: Initial Precincts* occurred in 2018.

2.3.6 The Greater Macarthur Growth Area

The Greater Macarthur Growth Area is a series of precincts around the seven rail stations from Glenfield to Macarthur and the land release precincts of Menangle Park, Gilead and Appin (as shown in Figure 2-7), and extending down to Menangle Park and Wilton, that are intended to facilitate consolidated growth to provide additional dwellings, jobs, community infrastructure and services for current and future residents of the region. It is expected that the Greater Macarthur Growth Area will be able to accommodate new dwellings and 21,000 new jobs over the next 20 to 30 years. It is estimated that up to 35,000 dwellings will be provided within the individual precincts of Menangle Park, Mount Gilead and Wilton.

As part of the Greater Macarthur Growth Area, precinct plans for six of the seven urban renewal precincts between Glenfield and Macarthur have now been finalised by the Department of Planning, Industry and Environment, including for the Macarthur precinct. The precinct plans will guide future planning proposals within these precincts. Menangle Park and Mt Gilead precincts were rezoned during 2017. Other rezoning is expected to take place gradually. An accompanying Land Use and Infrastructure Strategy for the Greater Macarthur Growth Area is currently being prepared by the Department of Planning, Industry and Environment.

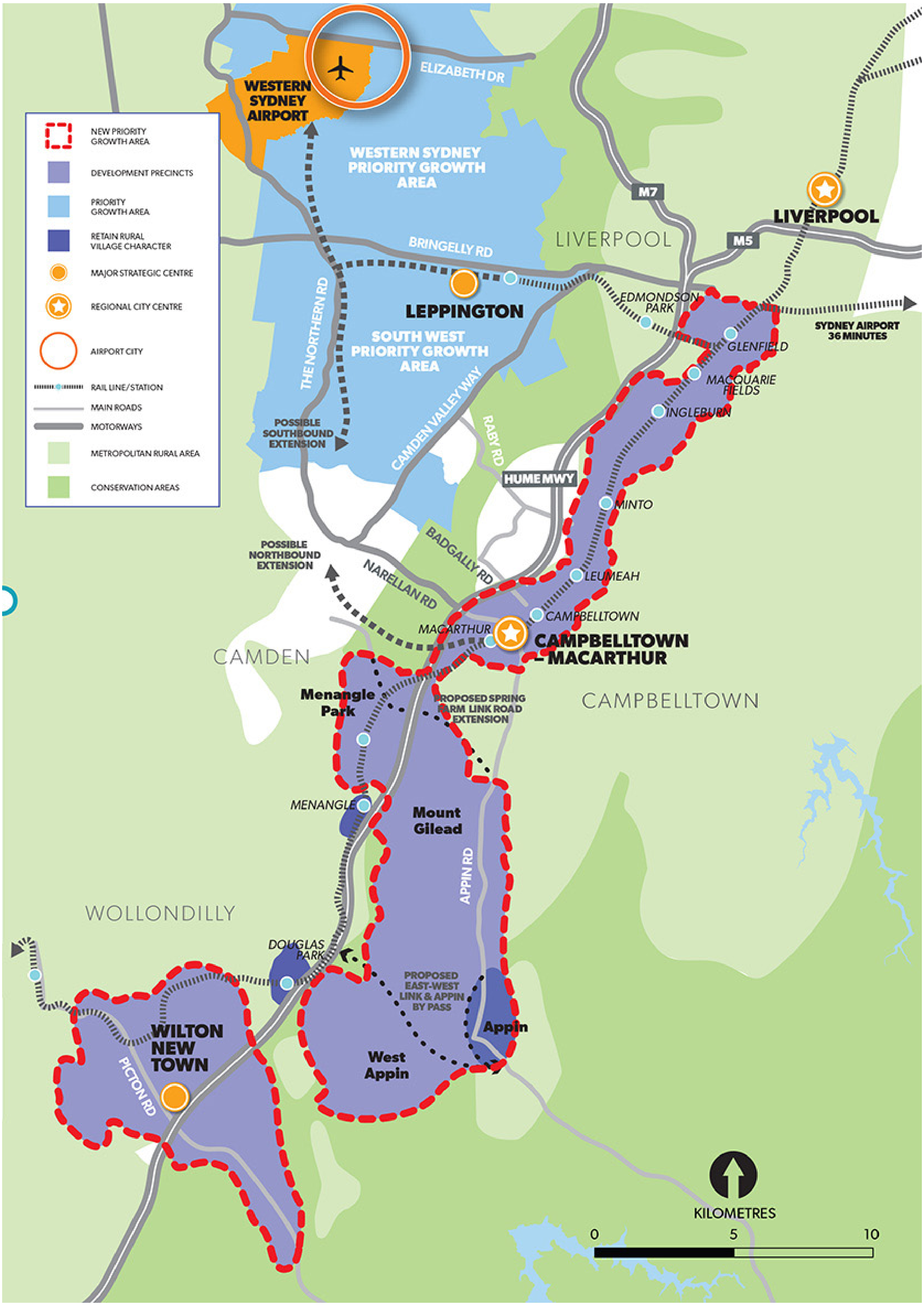

Figure 2-7 South West and Greater Macarthur Growth Areas

Source: http://www.planning.nsw.gov.au/Plans-for-your-area/Priority-Growth-Areas-and-Precincts/Greater-Macarthur-Priority-Growth-Area/Map

2.3.7 Local policies

Penrith City Council

Penrith City Council has prepared several strategic plans and studies that outline the future development of Greater Penrith. In January 2017, Penrith City Council released its *Economic Development Strategy*, which sets out a strategic framework to guide Council in supporting future economic development and encouraging faster and greater investment in jobs growth. The strategy has a goal for Penrith to create between 42,000 and 55,000 additional local jobs by 2031.

The strategy recognises the North South Rail Line as an essential catalyst to the economic development of the region, stating that the North South Rail Line is essential to grow jobs and related business activity sectors in Penrith. It notes that a North South Rail Line connection will improve access between Penrith, Liverpool and Campbelltown and create connections between the Penrith Health and Education Precinct, Western Sydney University and other employment centres. The Penrith Health and Education Precinct is positioned to be one of Australia's premier destinations for health, education and medical research and the Strategy explicitly notes that the North South Rail Line will create opportunities for greater jobs and urban densities in a new town centre. The Penrith Health and Education Precinct structure plan is shown at Figure 2-8.

In June 2017, Penrith City Council adopted the *Penrith Community Plan*. This 10-year plan contains long-term strategies to achieve seven community outcomes, one of which is for a strong focus on improving public transport. The plan includes a strategy for Penrith City Council to be an advocate for the North South Rail Line.

Figure 2-8 Penrith health and education precinct structure plan

Source: *Penrith Health and Education Precinct – Strategic Vision* (Penrith Business Alliance, 2011)

Liverpool City Council

Strategic planning for the Liverpool Local Government Area is being undertaken in cooperation with the Australian and NSW Government. Liverpool Council has released *Liverpool: The Airport City*, which outlines how the future of Liverpool will be influenced by the Western Sydney Airport and associated infrastructure delivery. Strategic planning in this part of Liverpool Local Government Area will therefore be driven by the *Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan*.

Campbelltown City Council

The *Campbelltown 2027 Community Strategic Plan* was adopted in 2017 and sets goals for the development of the Campbelltown Local Government Area over the next 10 years. The Community Strategic Plan emphasises Campbelltown's key role as a strategic centre, as identified by *A Plan for Growing Sydney* and the *Western City District Plan*. The *Community Strategic Plan* identifies that the strategic direction of Campbelltown City Council will align with the priorities outlined in the *Western City District Plan*. The *Community Strategic Plan* also notes that there is currently limited access to multimodal transport and that a key priority is enhanced connectivity, accessibility and movement through improved public transport. Corridor protection and future infrastructure will assist with this.

Camden Council

The *Camden Community Strategic Plan* was released in June 2017 and is the most recent strategic planning document released by Camden Council. The plan identifies that Camden Council strategic plans and policies are influenced by Australian and State strategic planning policy. The *Camden Community Strategic Plan* particularly notes that it is influenced by the *Western City District Plan*, the *Western Sydney Infrastructure Plan* and the *Western Sydney Rails Needs Scoping Study*. The final recommended North South Rail Line corridor is identified as one of the strategic priorities that Camden Council will be working towards.

2.4 Transport policies

2.4.1 Future Transport Strategy 2056

The *Future Transport Strategy 2056* is an update of the *Long Term Transport Master Plan* and is a suite of strategies and plans for transport and customer mobility to guide transport investment over the long term. The strategy notes that the Western Sydney Aerotropolis will require investment in a mass transit network to shape a sustainable urban form and to provide 30-minute access to centres. To support this, Transport for NSW commits to investigating within the next 10 years a north-south train link through the Western Sydney Airport between St Marys and Campbelltown–Macarthur, as well as a rail link between Leppington and the Western Sydney Aerotropolis. Initiatives for investigation are shown in Figure 2-9.

Figure 2-9 Initiatives for investigation (0–10 years)

Source: *Future Transport Strategy 2056* (Transport for NSW, 2018a)

The Strategy also identifies that corridor protection is critical to delivering the 30-minute city and outlines Greater Sydney Strategic Transport Corridors. A north-south corridor through the Western Sydney Airport is identified as a 'city-shaping' corridor and is shown in Figure 2-10.

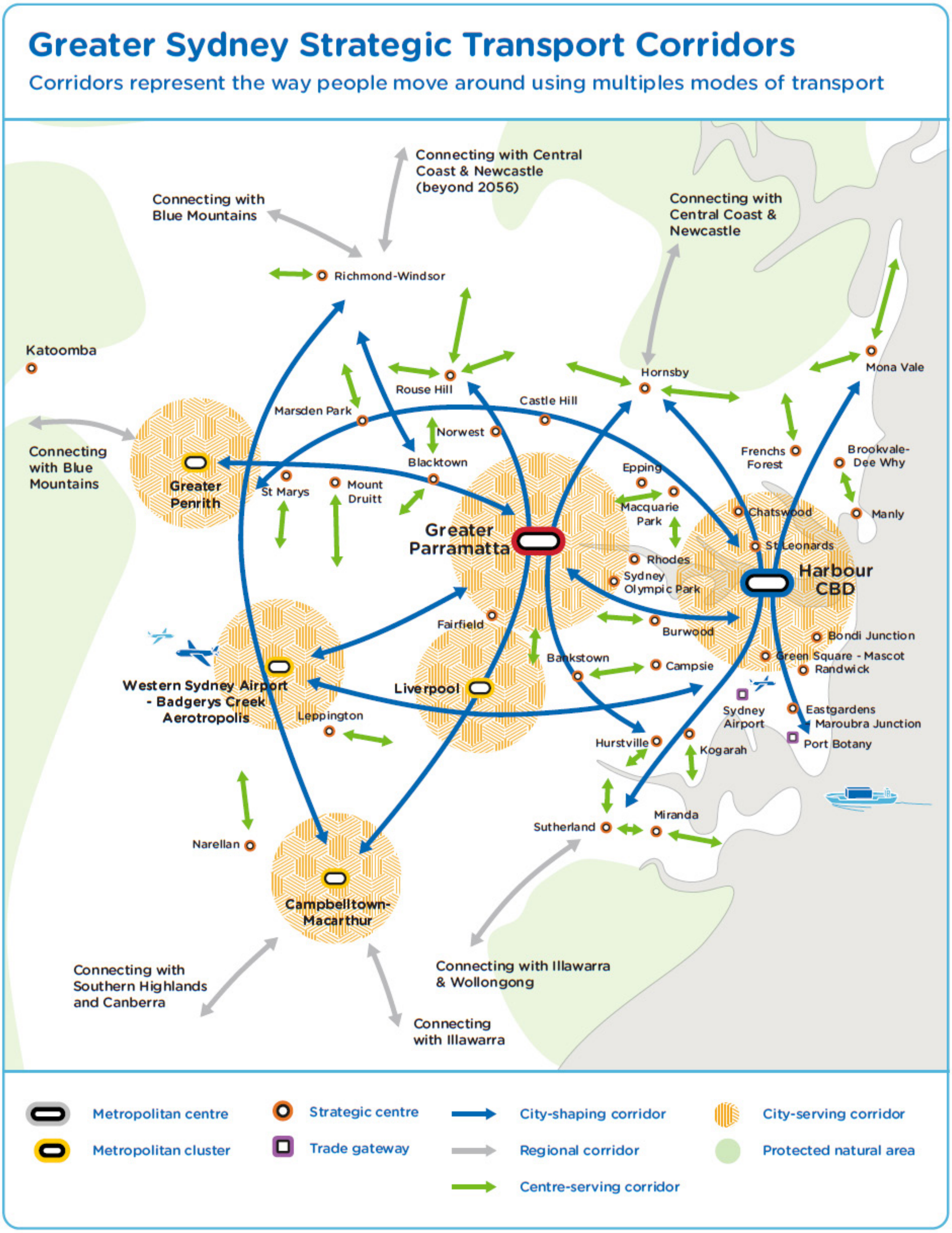

Figure 2-10 Greater Sydney strategic corridors

Source: *Future Transport Strategy 2056* (Transport for NSW, 2018a)

The visionary Greater Sydney mass transit network is shown in Figure 2-11 and illustrates a new train/mass transit corridor between the existing T1 Main Western Rail Line, the Western Sydney Airport, Leppington and Campbelltown–Macarthur. The final recommended corridors are consistent with the visionary network and early corridor protection would ensure that they can be delivered in the future.

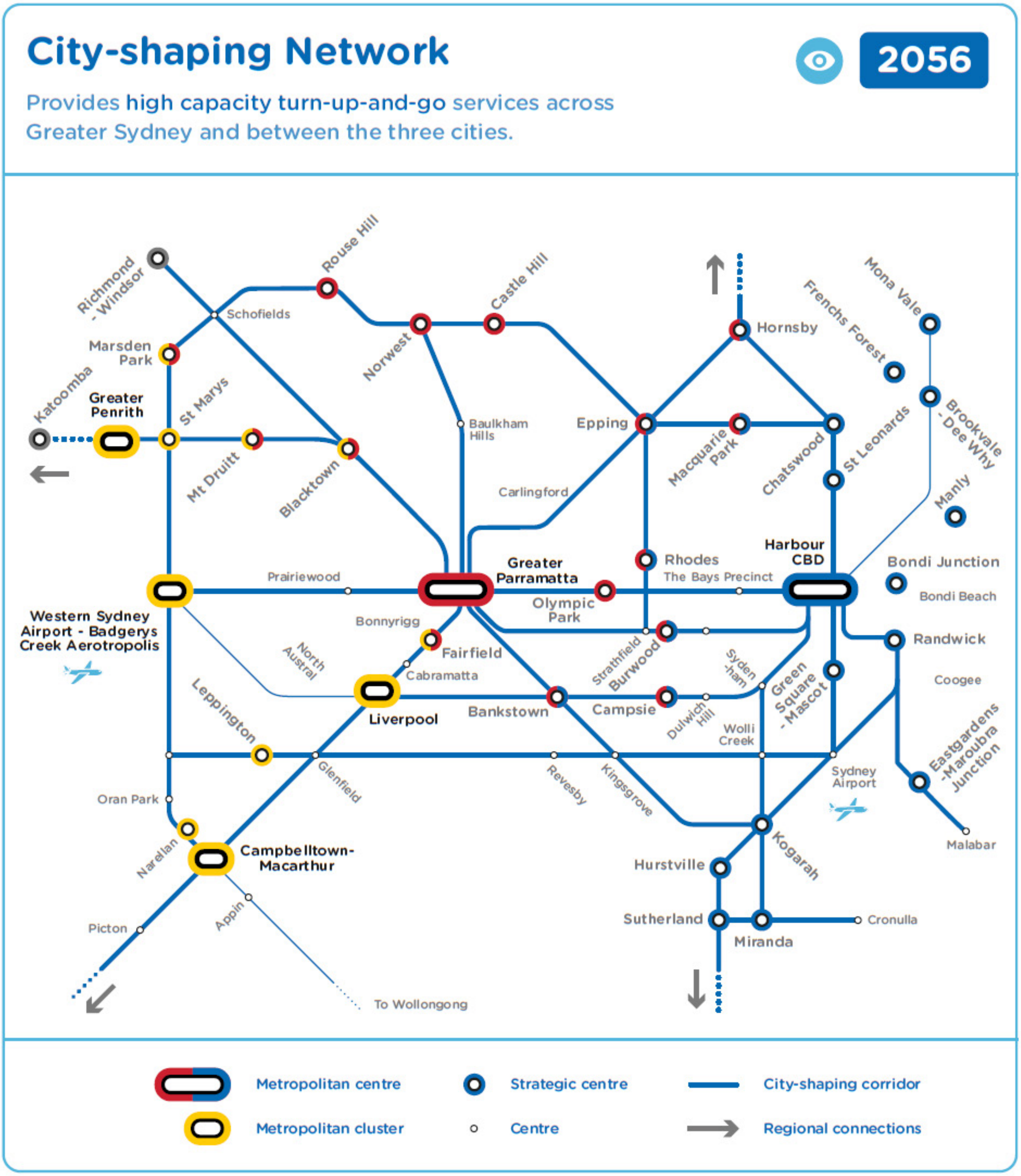

Figure 2-11 Greater Sydney mass transit/train network (visionary)

Source: *Future Transport Strategy 2056* (Transport for NSW, 2018a)

2.5 Strategic alternative to corridor protection

The North South Rail Line and South West Rail Link Extension are consistent with Australian Government infrastructure priorities and NSW Government strategic land use and long-term transport plans. They are also supported by the *Western Sydney Rail Needs Study*, which identifies them as critical city-shaping infrastructure to support the Western Economic Corridor and the establishment of the Western Sydney Aerotropolis.

If rail public transport infrastructure is not provided to meet the demand for transport connections, this demand is likely to be met by upgrades to existing road infrastructure including road widening, intersection upgrades and the provision of additional bus services to alleviate increasing road congestion. However, road infrastructure upgrades alone would be insufficient to fully cater for the future transport demand in western Sydney and would not fulfil the strategic objectives for the development of Greater Sydney as a liveable, productive and sustainable city where homes and jobs are located within 30-minutes.

Whilst the strategic planning policies described in Sections 2.2, 2.3 and 2.4 outline the need for future rail connections, this Strategic Environmental Assessment relates to the protection of the final recommended corridors only and does not make assumptions about what transport infrastructure would be provided within the corridors. The final recommended corridors have been designed to accommodate rail infrastructure due to its strict design requirements. However, the mode of transport which is delivered within the final recommended corridors will be subject to a future planning process and will respond to the need to integrate with existing transport networks, land use patterns and other factors which will influence project selection such as population growth, cost and environmental impacts. For these reasons, consideration of alternatives is limited to alternative corridor locations (see Section 5) and alternatives to the statutory protection of the final recommended corridors.

The only alternative to statutory corridor protection is the base case or 'do nothing' scenario, which would involve not protecting the final recommended corridors for a future railway. In this scenario, urban expansion in western Sydney would build out areas where a future railway could have been constructed, resulting in:

- Higher property acquisition costs at the time of infrastructure construction because of intensification of development, and changes in property values over time
- Significant community disruption through disturbance to new, denser, settlement patterns and potential separation of existing communities
- Higher compensation costs for relocation of community facilities, services and businesses
- Failure to integrate transport planning and land use planning.

The significant cost of land acquisition, always a major part of infrastructure projects, can often be a decisive factor in determining whether a project can proceed. A lack of strategic planning for corridors results in higher prices paid for land just prior to development that may delay infrastructure provision beyond when it is needed or jeopardise its delivery altogether. There would also be higher future costs associated with relocating incompatible development, local infrastructure, utilities and services.

As demonstrated in the relevant Australian Government, NSW Government and local strategic plans, a north-south rail connection will be key to supporting the future growth of western Sydney and failure to protect the final recommended North South Rail Line corridor could result in poor strategic planning outcomes ultimately undermining the delivery of the 30-minute city.

Compulsory acquisition of land at the last moment results in higher acquisition costs because landowners make investment decisions unaware of the future proposed use of the land. Compulsory acquisition in this instance can also cause significant social disruption and public concern. These factors are emphasised in the most recent *Australian Infrastructure Plan* as well as in the *Greater Sydney Region Plan* as a major driver for the need to undertake corridor protection for future infrastructure. With sufficient notice and good information, landowners can make informed investment and relocation decisions, reducing social disruption and financial hardship.

With consideration of the above matters, not protecting the final recommended corridors now could result in:

- Inadequate public transport provided in the future, due to the significant financial, economic, and social implications of constructing the public transport infrastructure
- Public transport that is provided in the future having significant additional environmental (e.g. noise), financial, economic, and social implications
- Public transport that is provided in the future in tunnel having significant additional financial costs due to the substantially higher whole of life cost of tunnel rail infrastructure compared to surface rail infrastructure. The much greater cost of developing rail infrastructure in tunnel can make rail projects unfeasible.

3 Existing conditions and constraints within the northern study area

The Western Sydney Airport is planned to support a Western Sydney Aerotropolis centred on North Bringelly. The closest rail links to the Aerotropolis are at Leppington in the east, Macarthur in the south and St Marys in the north. Planning documents have identified these locations as the most appropriate connections for a rail system through the Western Sydney Airport. The jointly funded Commonwealth/State *Western Sydney Rail Needs Study* confirmed the North South Rail Line linking St Marys with Macarthur and the South West Rail Link Extension to Leppington as the initial connections.

For the purposes of investigating a north-south train link through the Western Sydney Airport between St Marys and Campbelltown–Macarthur, a study area is defined in two sections separated by the Western Sydney Airport:

- A northern study area, from St Marys to the northern boundary of the Western Sydney Airport
- A southern study area, from the southern boundary of the Western Sydney Airport to Macarthur.

This section describes the existing land uses and environmental features within the northern study area for a north-south train link. Similar information for the southern study area for a north-south train link as well as a rail link between Leppington and the Western Sydney Aerotropolis is provided in Section 4.

The northern study area is generally defined as the area within about two kilometres either side of the 2018 exhibited corridor between St Marys and the northern boundary of the future Western Sydney Airport site. The northern study area is entirely within Penrith local government area and includes the suburbs of St Marys, Werrington, Kingswood, Claremont Meadows, Caddens, Orchard Hills, Luddenham, Badgerys Creek and Kemps Creek.

Figure 3-1 shows the northern study area and overlays the key environmental and physical constraints within this area.

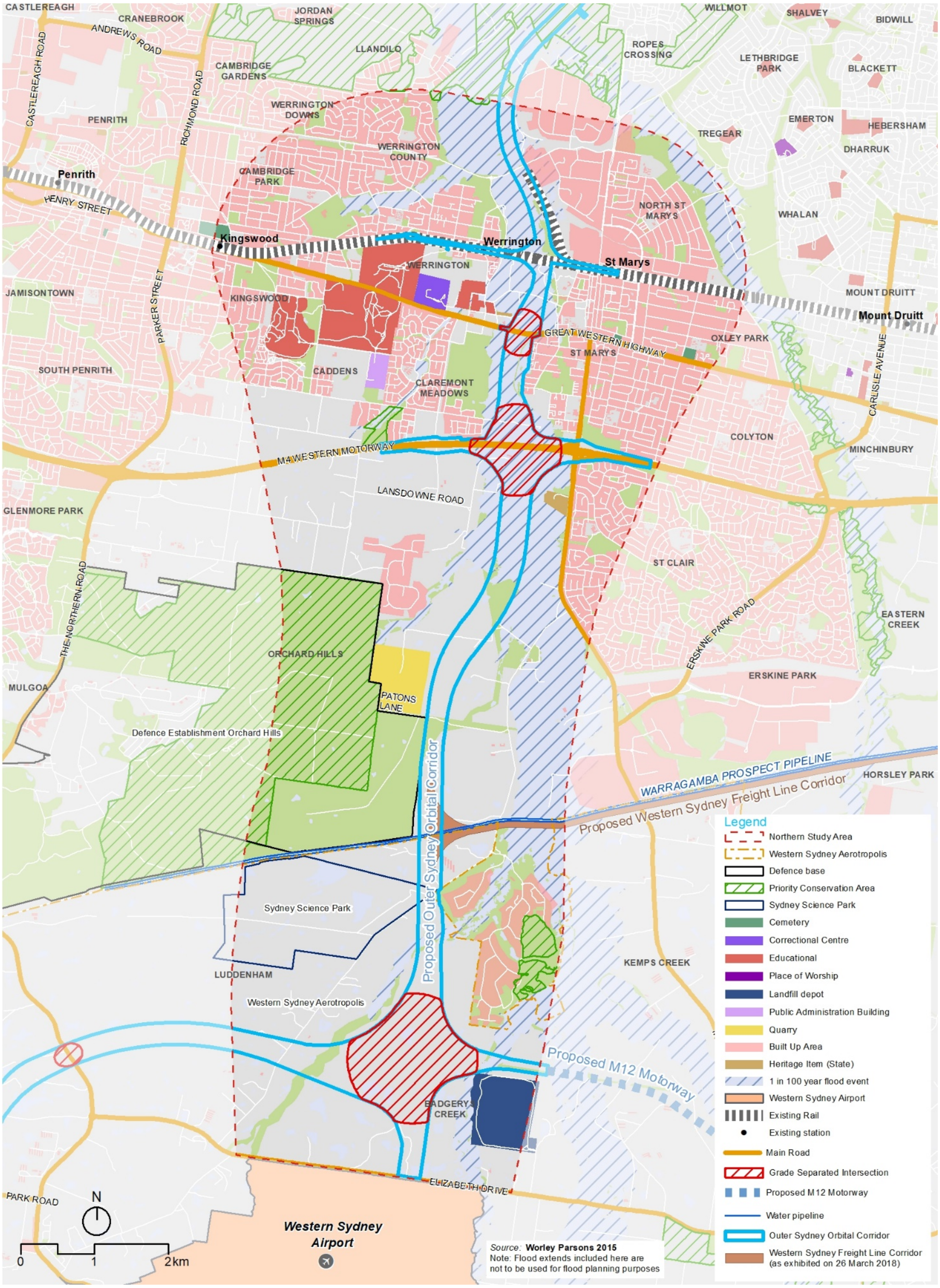

Figure 3-1 Constraints map of the northern study area

3.1 Topography and terrain

Topography and terrain are a potential constraint for rail infrastructure projects as they influence the ease of developing rail infrastructure at grade and on straight track, and the extent of any earthworks and engineering structures to enable this. Where rail infrastructure is developed in steep terrain it can also require additional works to stabilise slopes.

The topography of the northern study area is shown in Figure 3-2. Between St Marys and Werrington, the land is relatively flat with higher ground toward Claremont Meadows in the south. Elevations are generally stable toward Orchard Hills, with slightly lower areas occurring along Blaxland Creek, which is shown in Figure 3-3.

Through Orchard Hills and Badgerys Creek the valley and floodplain of South Creek and its tributaries dominates the topography.

The topography in the east and west of the northern study area are more elevated, reaching between 80 and 100 metres in height. Between Orchard Hills and Luddenham, the northern study area is gently undulating.

The topography and terrain within the northern study area has not made a significant contribution in selecting the location of the final recommended corridor.

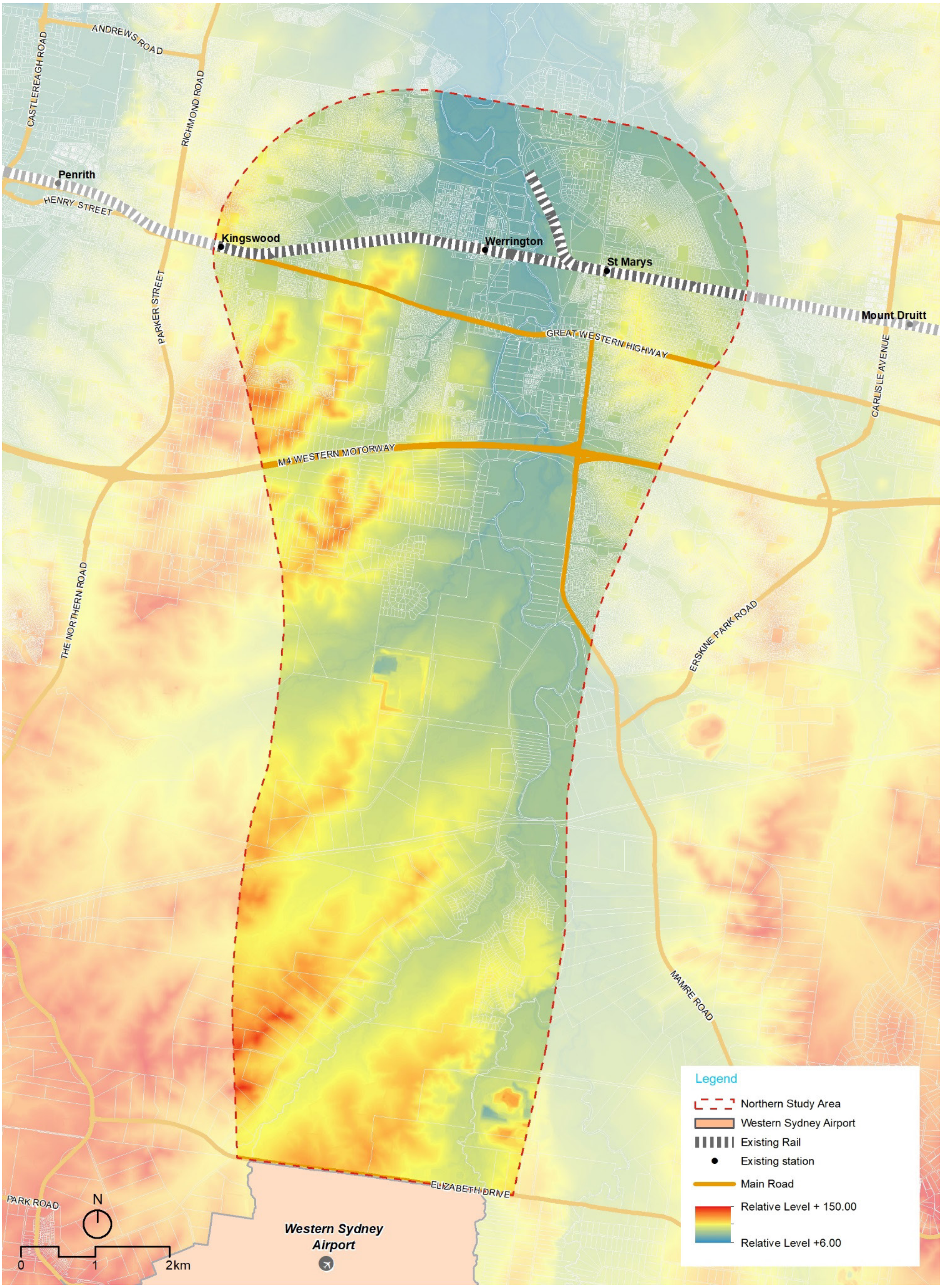

Figure 3-2 Topography of the northern study area

3.2 Hydrology

Hydrology is a potential constraint for rail infrastructure projects as there are additional design matters to consider when developing rail infrastructure on flood prone land or across waterways. Rail infrastructure developed in low-lying areas and across waterways has the potential to affect flood behaviour. Also, developing rail infrastructure on alluvial soils can result in more costly design and construction requirements.

Hydrology within the northern study area is shown in Figure 3-3.

The northern study area is located within the Hawkesbury-Nepean catchment. Watercourses and associated low-lying floodplain areas across the northern study area are primarily associated with South Creek and its tributaries. South Creek is a 400-square-kilometre creek system that has its headwaters in the Camden area and flows 70 kilometres north to the Hawkesbury River. Major tributaries of South Creek within the northern study area include Ropes Creek and Kemps Creek. Minor tributaries within the northern study area, include:

- Werrington Creek
- Byrnes Creek
- Claremont Creek
- Blaxland Creek
- Cosgroves Creek
- Badgerys Creek.

These watercourses are shown in Figure 3-3.

Flooding events have occurred in the South Creek catchment in the past due to local catchment runoff breaking out of the main channel and spilling into the surrounding floodplain. The *Updated South Creek Flood Study* (Worley Parsons, 2015) identified that the greatest extent of flooding within the northern study area occurs at the confluence of Blaxland Creek and South Creek on the southern side of the M4 Western Motorway in Orchard Hills. The *Penrith Local Environmental Plan 2010* identifies a flood area associated with South Creek that extends up to about 600 metres across the floodplains within the northern study area.

Several large agricultural dams are in the northern study area at Luddenham, Badgerys Creek and Kemps Creek, particularly in areas just north of the future Western Sydney Airport site. Of particular note is a dam on Kemps Creek just upstream of its confluence with South Creek, which controls inflow to South Creek from the east of the catchment.

The location of existing waterways and flood plains has been a key consideration in the selection of the final recommended corridor to ensure that impacts on waterways and potential flood impacts are minimised.

Figure 3-3 Hydrology of the northern study area

3.3 Geology and soils

Geology and soils are a potential constraint for rail infrastructure projects as they are a key factor influencing the ease of constructing cuttings and tunnelling. Soil conditions can also be a constraint for developing surface rail infrastructure, for example low strength soils that are subject to shrinking and swelling can increase the cost and duration of construction.

The Penrith 1:100 000 Geological Map shows that the geology of the northern study area is characterised by Triassic sedimentary rocks of the Wiannamatta Group and Hawkesbury Sandstone. The Wiannamatta Group in this area comprises Bringelly Shale underlain by Ashfield Shale units. The Wiannamatta Group is in turn underlain by Hawkesbury Sandstone.

Bringelly Shale can include shale, carbonaceous claystone, claystone, laminate and fine to medium-grained lithic sandstone.

The Narellan Lineament is the predominant geological feature within the northern study area. The Narellan Lineament is a north to south running surface expression of a deep seated, nearly vertical normal fault in the basement structure. It is comprised of fine-grained sand, silt and clay.

Dykes trending in a north-east direction near the M4 Western Motorway are indicated on the Penrith 1:100 000 Geological Map.

Bringelly Shale is generally low strength shale prone to slaking and weathering to highly reactive silty clay. The Bringelly Shale is likely to present difficulty due to its chemical and physical reactivity to changes in environment.

The underlying Ashfield Shale is a generally more competent rock.

There is no known occurrence of acid sulfate soils within most of the northern study area. However, there may be localised occurrences of potential or actual acid sulfate soils, and disturbance of such materials may result in environmental risks. Private dams can also be categorised as having a ‘high probability’ for the occurrence of acid sulphate soils. Severe environmental risks may occur if bottom sediments in the dams (and likely along drainage channels leading to dams) are disturbed.

Saline soils have been identified within the northern study area, particularly around Badgerys Creek (Department of Infrastructure and Regional Development, 2016).

A search of the List of NSW Contaminated Sites Notified to Environment Protection Authority (as of 10 November 2017) did not identify any known contaminated sites within 500 metres of the surface sections of the 2018 exhibited corridor.

Geological conditions will inform the design of future infrastructure within the final recommended corridor but do not represent a significant constraint for the location of the corridor.

3.4 Hydrogeology and groundwater

Hydrogeology and groundwater are a potential constraint for rail infrastructure projects where cutting or tunnel are proposed if there is potential for interference with aquifers. Alternative tunnel design and construction methods may be required where there is potential for cutting and tunnel to impact aquifers.

There are two known aquifer systems in the northern study area:

- An unconfined aquifer within localised quaternary alluvium deposits, located around main creeks and drainage features
- A confined aquifer that intersects the Bringelly Shale at around 20 metres below ground surface.

There is thought to be limited hydraulic connection between the unconfined and confined aquifers, as the porosity of the Bringelly Shale is low and likely hosts water in weathered interfaces.

The local direction of groundwater flow is likely to be dictated by the local surface waterbodies and presence of alluvium. Monitored well logs indicate that groundwater is around three to seven metres below surface level. The primary aquifers near the 2018 exhibited corridor are predominantly within the shallow alluvial deposits and porous rock aquifers.

Recharge of the groundwater is from rainfall infiltration, infiltration of stream runoff water in upper catchments and by inter-aquifer connectivity. There is some recharge of deep Hawkesbury sandstone aquifers from the overlying Wianamatta shales in areas with adequate fractures. However, the Hawkesbury aquifers are thought to recharge primarily through lateral groundwater flow.

Groundwater is typically characterised by low yields from the Hawkesbury Sandstone and alluvium with variable water quality. The aquifers are utilised primarily for livestock, domestic, recreation, and minor irrigation and is not used as a drinking water source. The groundwater quality is variable with quality typically decreasing with depth, which reflects the residence time of the groundwater. The quality of the groundwater is considered fresh around 600 – 800 µs/cm^2. However, it is brackish in several areas.

The salinity of groundwater found within the Wiannamatta Shale is too high for irrigation or stock watering purposes. The salinity is thought to be an attribute of the shales formed under brackish marine conditions.

Groundwater data from wells within Bringelly Shales at the Western Sydney Airport indicate that the groundwater has elevated background concentrations of lead, zinc and copper. Total nitrogen and phosphorus concentrations were all above freshwater criteria for lowland rivers with some exceedances of the irrigation criteria. There are also some samples with elevated concentrations of nitrate above freshwater criteria and sulphate above human health drinking criteria.

Recreational water quality criteria and aesthetic human health criteria were generally exceeded by more than an order of magnitude for chloride and sodium. A comparison of the electrical conductivity results for groundwater with the surface water results indicates that groundwater salinity concentrations are generally an order of magnitude higher on average than surface water concentrations. This suggests that the overall contribution of groundwater to surface water inputs is small. The high electrical conductivity values also support a low groundwater flow environment, which supports the assumption of low rainfall recharge to groundwater.

Elevated total dissolved solids values mean that the groundwater can be categorised as being unsuitable for watering all stock types.

Based on this data, it is concluded that:

- Groundwater in this area has low beneficial use potential for stock and potable purposes
- Groundwater contributions to surface water are expected to represent a minor proportion of the overall surface water flows in the area
- In terms of groundwater management, salinity, metals (particularly cadmium, copper, lead and zinc), sulphate, total nitrogen and phosphorus may require further consideration if discharge to surface water is being considered.

Hydrogeology and groundwater conditions will inform the location and design of future underground infrastructure components (e.g. tunnels) but do not represent a significant contributor for the location of the final recommended corridor.

3.5 Land use and property

Land use and property are a potential constraint for rail infrastructure projects, particularly at the surface. Where rail infrastructure is developed at the surface it replaces the existing land use on the directly impacted land and generally prevents the use of that land for other purposes. There may be social and economic impacts associated with acquiring property to enable the future development of rail infrastructure. Also, many land uses are sensitive to the potential noise and vibration of train operations and visual impacts of rail infrastructure. Where railway stations are proposed, land use needs to be integrated to optimise access to the station and opportunities for customers to transfer to other transport modes.

As outlined in the sections below, existing and future land use patterns, as well as areas of major established development and infrastructure, were key constraints that influenced the selection of the final recommended corridor. Avoiding or minimising impacts on properties was also a significant consideration in the location of the final recommended corridor.

3.5.1 Existing land use patterns

Land uses at key locations in the northern study area are described in the following sections.

St Marys Town Centre

St Marys Town Centre is one of the two main retail/commercial centres in the Penrith local government area. The town centre is bounded by the T1 Main Western Rail Line to the north and the Great Western Highway to the south. The Queen Street shopping strip forms the central spine of the town centre, with street car parking provided on the blocks at the rear of the shops.

The town centre is described in the *St Marys Town Centre Strategy* (Penrith City Council, 2006) and a more recent study by SGS Economics and Planning (2013) as an older style district-sized commercial centre with a total commercial and retail floor area of about 80,000 square metres. The main catchment area for the town centre is the suburbs of St Marys, Colyton, Oxley Park and Claremont Meadows, Erskine Park, Ropes Crossing and St Clair.

St Marys Station comprises two island platforms joined by an elevated footbridge that provides access to Harris Street and Station Street to the north and south of the station respectively. Commuter car parking is provided immediately north of the station and includes a multi-storey above ground car park. There is a bus interchange next to the station on Station Street.

The south and east precincts of Dunheved Business Park are located on the northern side of the T1 Main Western Rail Line at St Marys and comprise a mix of industrial premises. The relatively new residential release area of Ropes Crossing is located north of Dunheved.

Penrith Health and Education Precinct

The Penrith Health and Education Precinct is located on the Great Western Highway extending between Werrington and Kingswood, interspersed with residential and local commercial, industrial and retail development. The precinct includes Nepean Hospital, Western Sydney University Penrith campus and Nepean College of TAFE Allied Health Facility. The Sydney Medical School Nepean is at Nepean Hospital and is one of eight clinical schools of the University of Sydney. Western Sydney University includes a 58-hectare business park, Werrington Park, which is in the early stages of being developed.

Primary and secondary schools near the precinct include Wollemi College, Penrith Valley Learning Centre and Kurrambee School.

Other land uses that adjoin the precinct include Cobham Juvenile Detention Centre and the Western Sydney Records Centre operated by State Records, which includes the Western Sydney Reading Room and Government Records Repository.

The Penrith Health and Education Precinct has potential for very significant growth and is currently undergoing land use planning.

Caddens and Claremont Meadows

Caddens and Claremont Meadows are residential subdivisions bounded by the Great Western Highway to the north, South Creek to the east, the M4 Western Motorway to the south and Kingswood to the west. These suburbs are being developed in stages, with development of Caddens lagging that of Claremont Meadows. The developed areas of both suburbs are typical of residential subdivisions in western Sydney and are characterised by detached dwellings on relatively small lots. Claremont Creek runs in a north-easterly direction through Claremont Meadows and is a wide grassed channel that is subject to regular mowing. There are rows of trees and shared pedestrian and cycle paths along the edges of the green corridor.

Orchard Hills

Orchard Hills occupies the centre of the northern study area, extending from the M4 Western Motorway south to the Warragamba-Prospect Pipeline. *Penrith Local Environmental Plan 2010* sets in place planning controls that aim to promote Orchard Hills as a rural landscape buffer area by protecting prime agricultural land and the scenic landscape quality of the area. However, a *Housing Acceleration Program* managed by Penrith City Council has recently endorsed planning for a residential precinct in Orchard Hills north of the M4 Western Motorway. Areas of Orchard Hills north of Blaxland Creek comprise rural lifestyle properties that are typically characterised by large residential dwellings on landscaped lots, including The Vines subdivision. Land use between Blaxland Creek and the Warragamba-Prospect Pipeline is characterised by a mix of agricultural and rural residential land uses and a waste management facility at a former quarry site. Agricultural land uses include an equestrian property and The Bill Spilstead Complex for Canine Affairs operated by Dogs NSW.

Defence Establishment Orchard Hills

The Defence Establishment Orchard Hills site is owned by the Department of Defence and is primarily used for munitions storage, maintenance and testing. The site is about 2000 hectares in area and is bounded by The Northern Road to the west and the Warragamba-Prospect Pipeline to the south. Blaxland Creek runs in a north-easterly direction through the site. Much of the site contains native vegetation, particularly in the north-eastern corner of the site and along Blaxland Creek. This vegetation includes endangered ecological communities and is described in more detail in Section 6.7.

Luddenham, Badgerys Creek and Kemps Creek

Luddenham, Badgerys Creek and Kemps Creek are at the southern section of the northern study area, between the Warragamba-Prospect Pipeline and the southern boundary of the northern study area at Western Sydney Airport. Existing land use is predominantly agricultural and includes a few equine and poultry facilities and market gardens. There is a waste management facility on the eastern side of Badgerys Creek.

The University of Sydney owns and operates two commercial farms in Badgerys Creek and Kemps Creek that provide teaching and learning opportunities and generate funds to support education and research. McGarvie Smith Farm and Fleurs Farm comprise 344 hectares of beef cattle fattening enterprises, with limited use by teaching and research staff.

A rural residential estate, Twins Creek Estate, is being developed around the Twins Creek Golf Course and Country Club in the north-eastern corner of Luddenham.

3.5.2 Zoning and development

Current land use zones in the northern study area are shown in Figure 3-4 and described in the following sections.

St Marys to Orchard Hills

Land throughout St Marys, Werrington, Kingswood and Claremont Meadows mainly comprises General (R1), Low (R2), Medium (R3) and High Density (R4) Residential land, with pockets of Public Recreational (RE1) throughout each suburb. St Marys Town Centre is zoned Mixed Use (B4), with Dunheved Business Park zoned General Industrial (IN1).

Land in the Penrith Health and Education Precinct is predominantly Infrastructure (SP2 Educational Establishment) and Business Park (B7).

South Creek through this area is zoned Environmental Conservation (E2) and is within a green corridor zoned Public Recreation (RE1).

Orchard Hills

The northern part of Orchard Hills is predominantly zoned Primary Production Small Lots (RU4) and Rural Landscape (RU2).

Defence Establishment Orchard Hills is zoned Special Activities (SP1 Defence) and Environmental Conservation (E2). Warragamba-Prospect Pipeline is zoned Infrastructure (SP2 Water Supply System).

South Creek and its tributaries are zoned Environmental Conservation (E2). Land at the confluence of South Creek and Blaxland Creek, which includes Mamre Homestead, is zoned Public Recreation (RE1).

Luddenham and Badgerys Creek

Sydney Science Park in Luddenham is zoned Business Park (B7), Mixed Use (B4) and Public Recreation (RE1) to reflect the master plan for this site. Land in Luddenham to the east and west of the site is predominately zoned Rural Landscape (RU2). Twins Creek Estate is zoned Environmental Living (E4).

Land in Badgerys Creek to the north of Elizabeth Drive is zoned Rural Landscape (RU2). As elsewhere in the northern study area, South Creek and Badgerys Creek are zoned Environmental Conservation (E2).

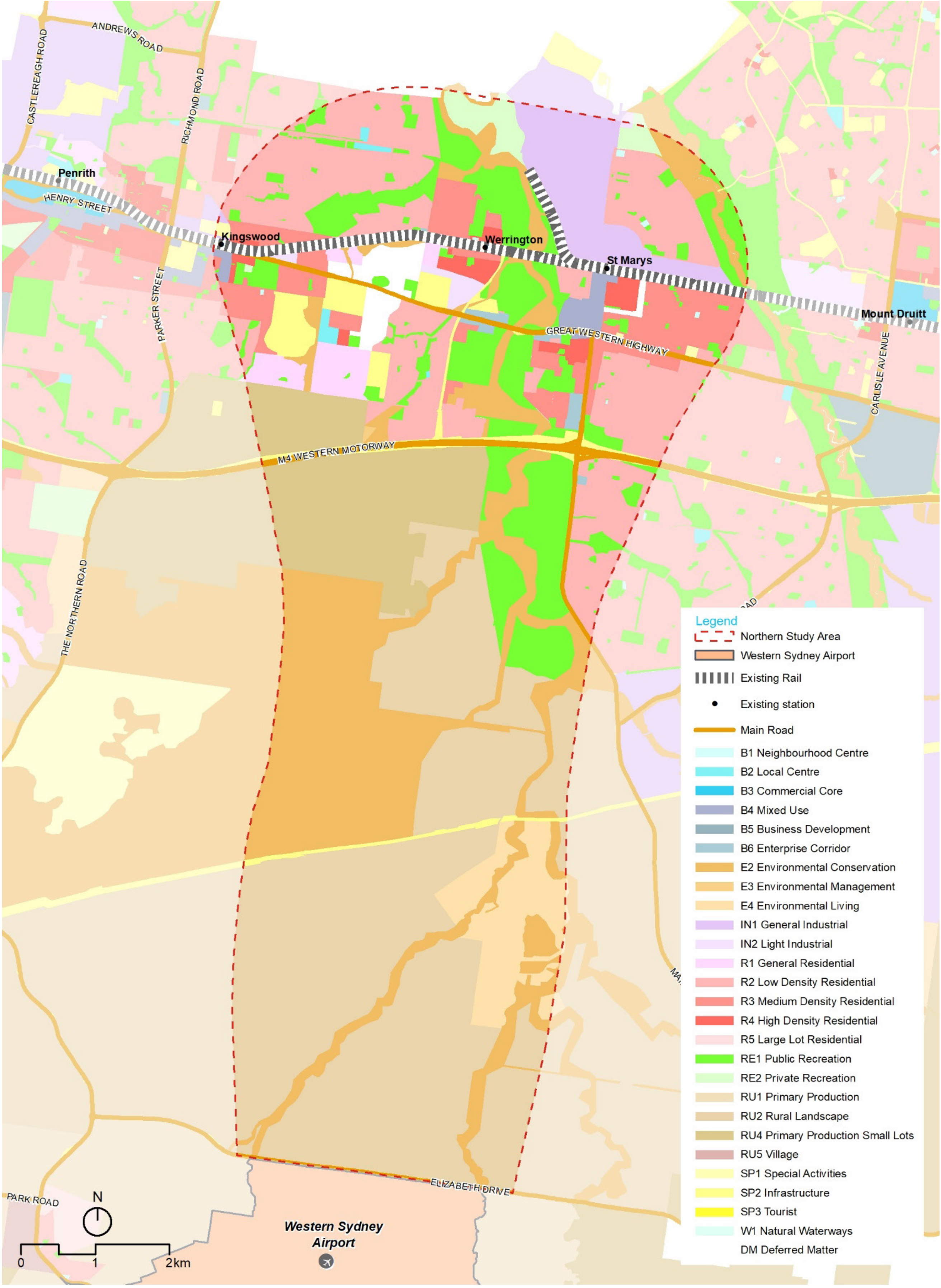

Figure 3-4 Land use zones in the northern study area

3.5.3 Road infrastructure

Key road infrastructure in the northern study area is shown in Figure 3-5.

The M4 Western Motorway is the main road link between Inner West Sydney and western Sydney. The motorway crosses the northern study area in an east-west direction between Claremont Meadows and Orchard Hills. There is a motorway interchange just to the west of the northern study area at The Northern Road.

The Great Western Highway is located to the north of the M4 Western Motorway and crosses the northern study area in an east-west direction. It provides a link between St Marys Town Centre and the Penrith Health and Education Precinct, and to Parramatta and Penrith centres.

Other classified roads in the northern study area are identified in the *Schedule of Classified Roads and State and Regional Roads* (Roads and Maritime Services, 2017a) and include:

- Mamre Road, which crosses the eastern side of the northern study area in a north-south direction and provides a link between St Marys Town Centre, Erskine Park and Kemps Creek
- Elizabeth Drive, which forms the southern boundary of the northern study area.

The Northern Road is located outside the northern study area; however, it requires mention due to its importance to the area's road network. The Northern Road runs in a north-south direction to the west of the northern study area and provides a link between Penrith and Campbelltown centres.

3.5.4 Rail infrastructure

The T1 Main Western Rail Line crosses the northern extent of the northern study area and runs in an east-west direction providing a link between Penrith, Blacktown, Parramatta and Sydney Central Business District. St Marys, Werrington and Kingswood stations are located in the northern study area. The T1 Main Western Rail Line is used by both passenger and freight trains.

St Marys Station includes a bus interchange with bus services mainly operating to Penrith and Mount Druitt. Most of these bus services act as feeders to the rail network. Some destinations that bus services connect to include the Penrith Health and Education Precinct and Erskine Park employment area. Western Sydney University operates its own shuttle bus service to link Penrith campus to Kingswood Station.

Two feeder bus services operate from Werrington Station to Penrith. Werrington Station is located between St Marys and Kingswood Station, and can be accessed via Railway Street to the south, or Kazanis Court to the north. Commuter carparks are located on each side of the rail corridor. Bus services run from Kazanis Court, to Penrith and Cambridge Gardens via St Marys and Cambridge Park. Kiss and ride facilities are located on Railway Street, south of Werrington Station.

Kingswood Station is located to the west of the northern study area, forming part of the T1 Main Western Rail Line. Commuter car parks are located on either side of the rail corridor, which can be accessed via the Great Western Highway in the south, or Richmond Road in the north. There are two bus interchanges located on either side of the station, located on Park Avenue and the Great Western Highway.

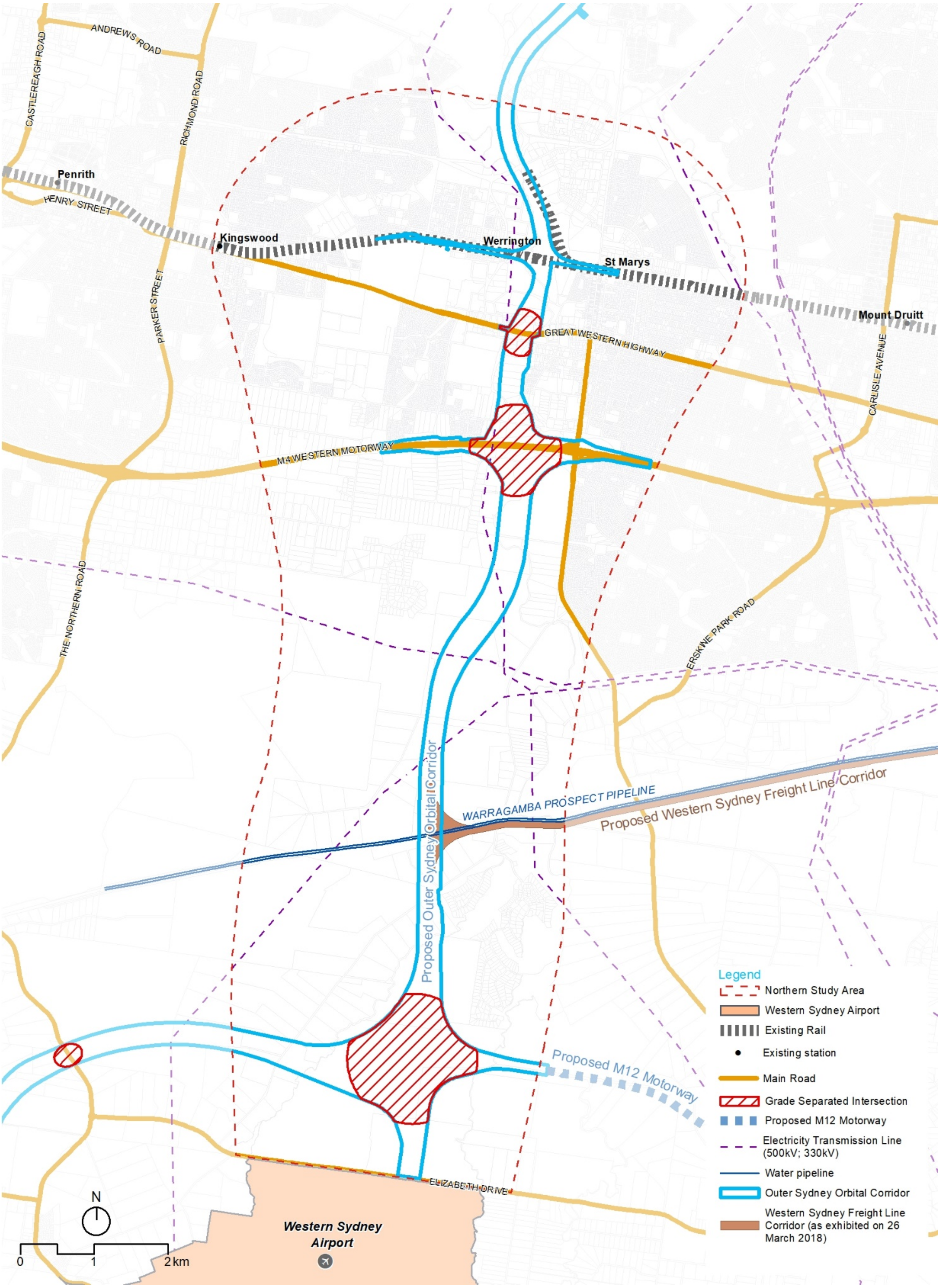

Figure 3-5 Existing and planned infrastructure and utilities in the northern study area

3.6 Utilities

Utilities are a potential constraint for rail infrastructure projects as relocating utilities can increase the cost of construction. Additional engineering structures may be required to avoid impacts to utilities, for example by grade separating rail infrastructure from utilities that intersect rail corridors. Utility crossings of rail corridors can also reduce the ease of rail maintenance works, for example if power isolations are required.

Major local utilities in the northern study area are described in Table 3-1 and shown in Figure 3-5. The location of existing utilities in the study area will be a key consideration for the location of the design of infrastructure within the final recommended corridor but did not represent a constraint that significantly influenced the location of the corridor.

Table 3-1 Major utilities in the northern study area

Location	Utility	Description
Werrington to Kemps Creek	500kV	High voltage electricity transmission lines that traverse the northern study area in a north-south direction, following the South Creek riparian corridor through Orchard Hills
Orchard Hills	330kV	High voltage electricity transmission lines that traverse the northern study area in an east-west direction from Erskine Park to Defence Establishment Orchard Hills and to south of Defence Establishment Orchard Hills
Orchard Hills, Luddenham and Kemps Creek	Warragamba-Prospect Pipeline	Twin pipes that cross the northern study in an east-west direction on the surface. The pipes form the suburb boundary between Orchard Hills in the north and Luddenham and Kemps Creek in the South. The pipes go underground to the west of the northern study area under The Northern Road

Local utilities in the northern study area include local distribution networks for electricity, potable water, sewage and gas.

3.7 Aboriginal heritage

Aboriginal heritage items are a potential constraint for rail infrastructure projects and impact on these items should be avoided wherever possible. The locations of previously identified Aboriginal heritage items are recorded on the Aboriginal Heritage Information Management System, which is a database of Aboriginal objects and Aboriginal Places maintained by the Office of Environment and Heritage. Aboriginal artefacts are more likely to be in certain landscapes, such as along watercourses, and these landscapes can also form a constraint.

A search of the Aboriginal Heritage Information Management System was undertaken on 17 November 2017. The search found a total of 105 items of Aboriginal heritage recorded within the northern study area. The known distribution of Aboriginal sites within the northern study area is largely clustered around waterways and road verges. This distribution reflects locations that have been the subject of targeted Aboriginal heritage investigations for the purposes of development, for example, roadways (and particularly State roads subject to upgrade investigations), greenfield sites such as the future Western Sydney Airport and recently developed urban land.

The Deerubbin Local Aboriginal Land Council has representation for the northern study area. The Darug People's Advisory Committee also has an interest in the northern study area.

Aboriginal heritage constraints did not significantly restrict the location of the final recommended corridor.

3.8 European heritage

European heritage items are a potential constraint for rail infrastructure projects and impact on these items should be avoided wherever possible. European heritage items are recorded on the World Heritage List, National Heritage List, Commonwealth Heritage List, State Heritage Register or local environmental planning instruments according to the significance of the item.

European heritage items in the northern study area that are listed on the State Heritage Register or in *Penrith Local Environmental Plan 2010* are identified in Table 3-2 and shown in Figure 3-6 and Figure 3-7.

Table 3-2 State and local heritage items in the northern study area

Item name	Address	Significance	Item no.
Mamre	181–275 Mamre Road, Orchard Hills	State	00264
St Marys Railway Station	Corner Station and Queen Streets, St Marys	State	01249
Rose Cottage and early slab hut	Corner of Water Street and Tennant Road, Werrington	State	01392
Penrith General Cemetery	Land bounded by Copeland and Phillips Streets, Richmond Road and Cox Avenue, Kingswood	Local	97
Kingswood Public School	46–54 Second Avenue, Kingswood	Local	98
Federation house and garden	6 First Street, Kingswood	Local	100
St. Phillip's Anglican Church	32 Bringelly Road, Kingswood	Local	101
Brick farmhouse	80–88 Caddens Road, Orchard Hills	Local	155
Orchard Hills Uniting Church	3 Frogmore Road, Orchard Hills	Local	156
Weatherboard cottage	71 Parker Street, Penrith	Local	175
"Mimosa", dwelling, fence and garden	13 Pages Road, St Marys	Local	219
"Mimosa", stables (former)	11 Pages Road, St Marys	Local	220
Moore Cottage	8 Sainsbury Street, St Marys	Local	221
"Margaret Farm", house, barn and tannery site	Pages Road, Barker, Wilson and Schleicher Streets, St Marys	Local	226
Memorial cairn	181–275 Mamre Road, Orchard Hills	Local	229
Leeholme Horse Stud Rotunda	391–395 Mamre Road, Orchard Hills	Local	232
Brick cottage	100–104 Saddington Street, St Marys	Local	234
"Thompson's Tannery" site, tannery pits (former) and well	94 Saddington Street, St Marys	Local	235
"Werrington House", dwelling, driveway and garden	108 Rugby Street, Werrington County	Local	248
Brick cottage	38 Gidley Street, St Marys	Local	298
"Bronte", villa	50 Gidley Street, St Marys	Local	299
"Mourilyan"	329–333 Great Western Highway, St Marys	Local	300
St Mary Magdalene Church, Hall, Cemetery and grounds	299–311 Great Western Highway, St Marys	Local	301
St Marys General Cemetery	175–191 Great Western Highway, St Marys	Local	303

Item name	Address	Significance	Item no.
Milestone	Great Western Highway (between Marsden Road and Day Street), St Marys	Local	304
St Marys Council Chambers (former)	2–6 Mamre Road, St Marys	Local	305
St Marys Public School	2-6 Princess Mary Street, St Marys	Local	307
Wagon Wheel Hotel	449 Great Western Highway, St Marys	Local	308
Brick cottage	18 Princess Mary Street, St Marys	Local	309
Victoria Park and memorial	Bounded by Great Western Highway, Pages Road, Putland and Princess Mary Streets, St Marys	Local	310
“Werrington Park House”, garden and poplar avenue	653–729 Great Western Highway, Werrington	Local	315
Wool Pack Inn (ruin)	556 Great Western Highway, St Marys	Local	654
Water reservoir	197–207 Castle Road, Orchard Hills	Local	657
Teacher’s residence (former)	56 Second Avenue, Kingswood	Local	670
Brick cottage	40 Gidley Street, St Marys	Local	797
Weatherboard cottage	20 Princess Mary Street, St Marys	Local	798
Weatherboard cottage	22 Princess Mary Street, St Marys	Local	799
Gothic revival cottage	24 Princess Mary Street, St Marys	Local	800
Brick cottage	31–33 Pages Road, St Marys	Local	801
Bennett Wagon	Pioneer Park, Great Western Highway, St Marys	Local	805
Shop	373 Great Western Highway, St Marys	Local	806
The Fleurs Radio Telescope site	885(a) Mamre Road, Kemps Creek	Local	832
Luddenham Road Alignment	Luddenham Road, Luddenham	Local	843
“Lindfield”	182–188 Caddens Road, Orchard Hills	Local	845
Canine Council dwelling	391–395 Mamre Road, Orchard Hills	Local	846
McGarvie-Smith Farm	1793–1951 Elizabeth Drive, Badgerys Creek	Local	857
Milestone	Great Western Highway, Claremont Meadows	Local	859
Milestone	Great Western Highway, Kingswood	Local	860
Milestone	Great Western Highway, Kingswood	Local	861
Milestone	Great Western Highway, Colyton	Local	862
Thompson’s Tannery site (former)	Saddington Street, St Marys	Local	A236

There are no World Heritage, National Heritage or Commonwealth Heritage listed items located within or in proximity to the northern study area.

Sydney Water’s section 170 Heritage and Conservation Register includes one item, Orchard Hills Reservoir (register number 4575813), present within the northern study area.

European heritage constraints did not significantly restrict the location of the final recommended corridor in the northern study area.

Figure 3-6 European heritage items in the northern study area

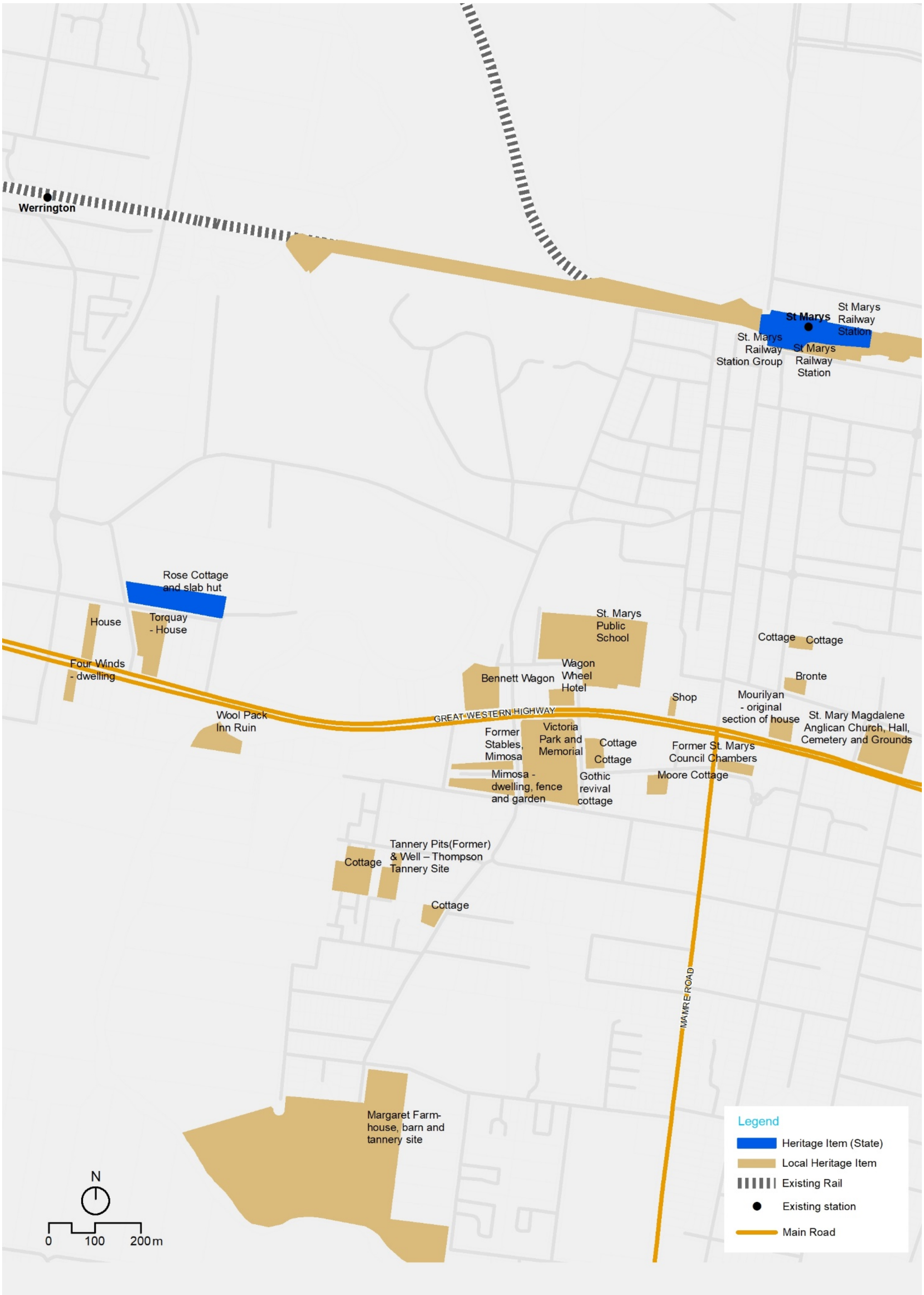

Figure 3-7 European heritage items near St Marys Town Centre

3.9 Biodiversity

Biodiversity is a potential constraint for rail infrastructure projects and impact to significant vegetation and fauna habitat such as land clearing should be avoided wherever possible. Biodiversity of significance is protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and NSW *Biodiversity Conservation Act 2016*, which require detailed assessment of impacts to threatened species and ecological communities.

Around Orchard Hills, Luddenham and Badgerys Creek the northern study area is characterised by a predominantly cleared and disturbed rural landscape with interspersed stands of native vegetation, mostly located around the riparian areas. The biodiversity of these areas was assessed in 2013 as part of the *Broader Western Sydney Employment Area – Ecology Study* (Eco Logical, 2013). Eco Logical identified that the vegetation communities in their study area include subsets of the Cumberland Plain Woodland Critically Endangered Ecological Community, as well as other native ecological communities and isolated native flora species.

Any vegetation that would be impacted by the future development of a rail line would be the subject of an ecological assessment at the planning approval phase. In accordance with relevant legislation that applies at the time, biodiversity offsets are likely to be required to mitigate any unavoidable vegetation removal required to develop a rail line.

There are three locations in the northern study area that are mapped as priority conservation lands in the *Cumberland Plain Recovery Plan* (Department of Environment, Climate Change and Water, 2010):

- An area of vegetation alongside Claremont Creek on the northern side of the M4 Western Motorway in Claremont Meadows
- Some vegetation areas within the Defence Establishment Orchard Hills site
- An area of vegetation between Pennard Crescent and South Creek in Twins Creek Estate in Luddenham.

The plan emphasises the importance of priority conservation lands to the long-term protection of Cumberland Plain ecology.

Biodiversity and vegetation within the northern study area are shown in Figure 3-8. Avoiding the vegetation in the identified priority conservation lands contributed to the location of the final recommended corridor in the northern study area.

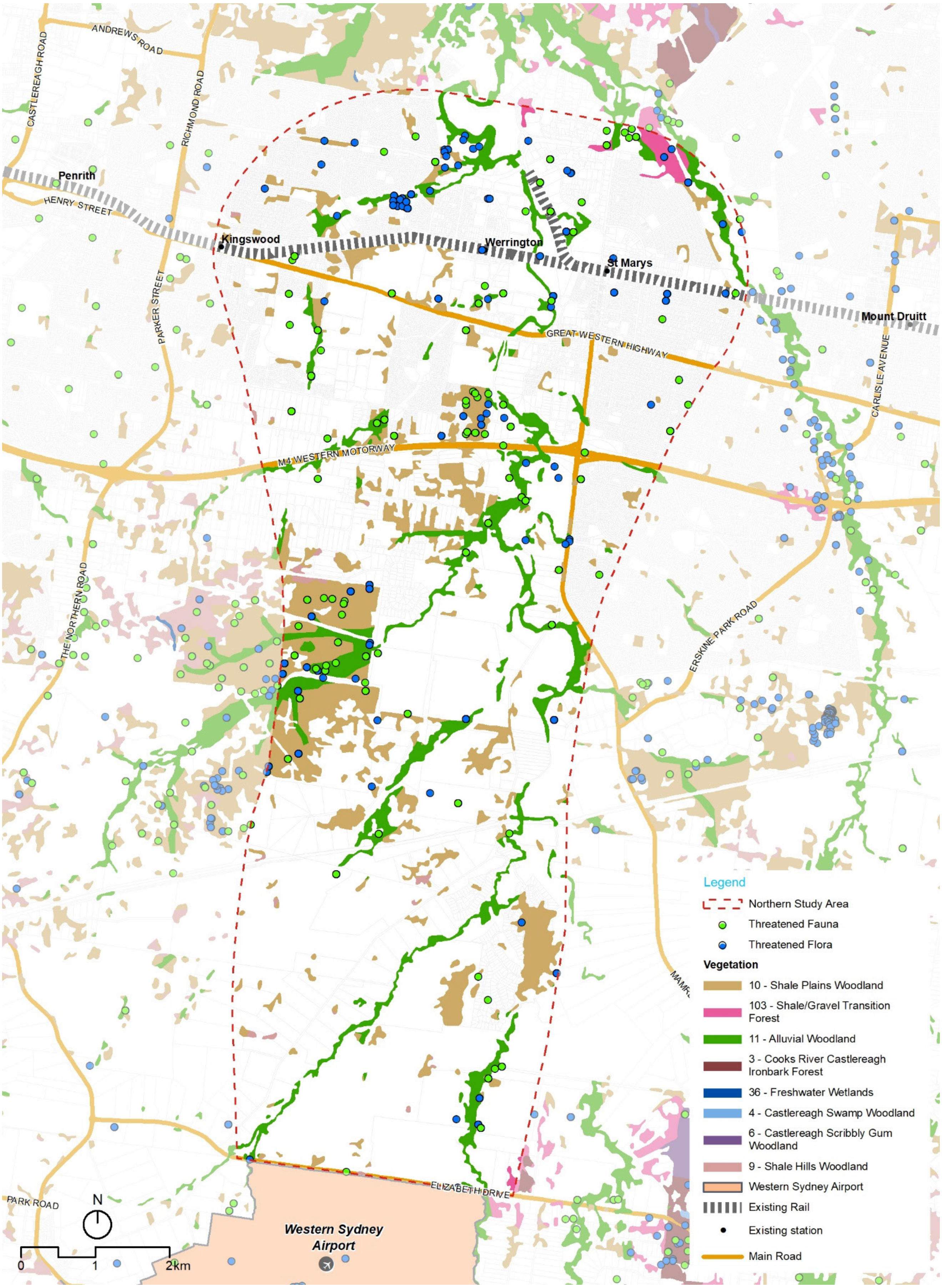

Figure 3-8 **Biodiversity in the northern study area**

3.9.1 Vegetation and habitat

Eco Logical (2013) identified seven native vegetation communities within the Broader Western Sydney Employment Area, all of which are listed as either vulnerable or endangered under the *Biodiversity Conservation Act 2016*:

- Alluvial Woodland, an endangered ecological community
- Castlereagh Scribbly Gum Woodland, a vulnerable ecological community
- Castlereagh Swamp Woodland, an endangered ecological community
- Cooks River Castlereagh Ironbark Forest, an endangered ecological community
- Shale/Gravel Transition Forest, an endangered ecological community
- Shale Hills Woodland, a critically endangered ecological community
- Shale Plains Woodland, a critically endangered ecological community.

Additionally, three of these vegetation communities potentially meet the definition of Cumberland Plain Woodland and Shale /Gravel Transition Forest, which is listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

The most substantial wildlife movement corridor through the northern study area lies within the vegetated riparian areas of South Creek and it is likely that a range of terrestrial and aquatic fauna groups could utilise this corridor for habitat and movements through the area. To support this, the riparian corridor of South Creek is mapped as 'Regional Biodiversity Corridor 5' under the *Biodiversity Investment Opportunities Map, Mapping Priority Investment Areas for the Cumberland Subregion* (Office of Environment and Heritage 2015).

3.9.2 Flora and fauna

Eco Logical (2013) conducted a search of the NSW Wildlife Atlas and identified 169 records of six separate threatened species within the Broader Western Sydney Employment Area:

- *Dillwynia tenuifolia*, listed as vulnerable under the *Biodiversity Conservation Act 2016*
- Juniper leaved Grevillea (*Grevillea juniperina subsp. Juniperina*), listed as vulnerable under the *Biodiversity Conservation Act 2016*
- *Hypsela sessiliflora*, listed as extinct under the *Environment Protection and Biodiversity Conservation Act 1999*
- Nodding Geebung (*Persoonia nutans*), listed as endangered under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*
- Spiked Rice-flower (*Pimelea spicata*), listed as endangered under the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*
- *Pultenaea parviflora*, listed as endangered under the *Biodiversity Conservation Act 2016* and vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*.

Eco Logical (2013) also identified 16 threatened fauna species that have been recorded within the Broader Western Sydney Employment Area, including:

- One amphibian species, Green and Golden Bell Frog (*Litoria aurea*), which is listed as endangered under the *Biodiversity Conservation Act 2016* and vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*
- Three bird species, Square-tailed Kite (*Lophoictinia isura*), Varied Sittella (*Daphoenositta chrysoptera*) and Little Eagle (*Hieraaetus morphnoides*), all of which are listed as vulnerable under the *Biodiversity Conservation Act 2016*
- Five migratory bird species identified in the *Environment Protection and Biodiversity Conservation Act 1999*

- Six bat species listed as vulnerable under the *Biodiversity Conservation Act 2016*, one of which is the Grey-headed Flying-Fox (*Pteropus poliocephalus*) which is also listed as vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*
- One invertebrate species, Cumberland Plain Land Snail (*Meridolum corneovirens*), which is listed as endangered under the *Biodiversity Conservation Act 2016*.

Further detailed analysis of potential impacts to threatened flora and fauna would be required as part of any future approval process for rail infrastructure.

3.10 Landscape and visual

Landscape and visual impacts are a potential constraint for rail infrastructure projects as new rail infrastructure can substantially change the visual amenity of a locality and adversely affect sensitive visual receivers. Sensitive landscapes can include areas of elevated topography, patches of remnant vegetation, waterways and associated floodplains, rural landscapes and heritage sites such as historic rural estates or heritage conservation areas.

The northern study area straddles the fringe of metropolitan Sydney's urban development and includes some areas that are undergoing rapid urban transformation. The landscapes either side of the M4 Western Motorway differ due to the higher level of development to the north of the motorway relative to areas to the south of the motorway.

The landscape to the north of the M4 Western Motorway is characterised by low-density residential dwellings in St Marys, Claremount Meadows, Caddens and Kingswood, with some medium density residential development around the edges of St Marys Town Centre including south of the Great Western Highway. The Penrith Health and Education Precinct has a campus style landscape with wide open spaces between commercial buildings, particularly at Western Sydney University Penrith campus, Nepean College of TAFE Allied Health Facility and Werrington Park.

The landscape to the south of the M4 Western Motorway is a mix of acreage residential development and farm land, as well as undeveloped land in the northern and eastern parts of the Defence Establishment Orchard Hills site. Acreage residential development in the area comprises The Vines subdivision in Orchard Hills and Twins Creek Estate in Luddenham. These developments are characterised by large dwellings on landscaped lots.

The landscape of farm land in Orchard Hills, Luddenham and Badgerys Creek is mostly grazing land with native vegetation generally only remaining along the banks of creeks and low-lying areas and some roadsides.

Key contributors to the natural landscape and visual character of the northern study area include Defence Establishment Orchard Hills and South Creek. The undeveloped areas in the northern and eastern parts of the Defence Establishment Orchard Hills site comprise one of the largest areas of native vegetation in western Sydney. South Creek forms a green north-south corridor through the northern study area, particularly through St Marys where parks and recreational facilities are located next to the creek. These two items form a constraint on the location of the final recommended corridor. Elsewhere, the northern study area is likely to undergo substantial change as western Sydney develops, which limits the significance of landscape and visual character as a constraint on the location of the final recommended corridor.

3.11 Noise

Noise is a potential constraint for rail infrastructure projects where construction works and rail operations are proposed in proximity to sensitive noise receivers including residential dwellings and educational, health and community facilities. Also, there is potential for ground-borne noise and vibration where sensitive land uses are located over shallow tunnel.

Background noise levels in the northern study area are currently influenced by a range of noise sources. These include localised sources such as motor vehicles, public transport, construction activities, residential properties, farming and agricultural activities and some commercial and industrial activities.

The planned urban development of land within the Western Sydney Aerotropolis would increase background noise levels over time, including air traffic noise associated with Western Sydney Airport and road traffic noise associated with increased traffic volumes on the upgraded arterial road network. Ultimately, the areas around Orchard Hills, Luddenham and Kemps Creek, which currently reflect noise levels associated with a rural environment, would be expected to experience typical suburban background noise levels.

Noise sensitive receivers throughout the northern study area include existing residences, educational facilities, places of worship, aged-care facilities and other community facilities such as areas of open space used for recreation.

Existing and future noise conditions were not a significant constraint on the location of the final recommended corridor.

3.12 Air quality

Air quality is a potential constraint for rail infrastructure projects where construction works are proposed in proximity to sensitive noise receivers including residential dwellings and educational, health and community facilities. Potential air quality impacts include dust emissions from construction work sites.

Existing sensitive receivers near the above ground section of the 2018 exhibited corridor, such as residential dwellings, are generally limited to areas around the northern parts of Orchard Hills. Further urban development of Orchard Hills, Luddenham and Kemps Creek may occur in the future, which would result in more sensitive receivers within the northern study area.

Existing air emissions sources in the northern study area include:

- Emissions from traffic on the State road network comprising the Great Western Highway, M4 Western Motorway, The Northern Road, Mamre Road and Elizabeth Drive – as well as emissions from traffic on regional and local roads. It is expected that traffic generated air emissions will increase commensurately with the increase in traffic forecast to occur as the Western Sydney Aerotropolis is developed and planning for a new growth area for the Greater Penrith to Eastern Creek Corridor progresses.
- Emissions from existing rural industries – including horse studs in Kemps Creek, quarries and waste management facilities. In the longer term it is expected that air emissions from rural industries would reduce as these land holdings are developed in accordance with the South West Growth Area.

Existing and future air quality conditions were not a significant constraint on the location of the final recommended corridor.

3.13 Socioeconomic

Socioeconomic factors are a potential constraint for rail infrastructure projects as they can be a key factor influencing the local demand for public transport and, therefore, the timing of infrastructure development.

The key socioeconomic characteristics of the northern study area are described in the following sections. The existing and future demographic composition of the study area has informed the location of the final recommended corridor to the extent that the corridor has been located to minimise impacts on social infrastructure and services.

3.13.1 Population and demographics

At the 2016 Census, there were 37,381 people living in St Marys, Werrington, Kingswood, Claremont Meadows, Caddens, Orchard Hills, Luddenham, Badgerys Creek and Kemps Creek (Australian Bureau of Statistics 2016). Most of these residents resided in St Marys and Kingswood. Results of the 2016 Census demonstrated a 12 per cent increase in residents since the 2011 Census, reflecting recent residential development occurring within the northern study area.

Family households in Australia (including couples without dependent children) are projected to increase from 6.0 million in 2011 to between 8.7 and 8.8 million in 2031, remaining the most common household type in Australia (Australian Bureau of Statistics, 2015). Within the northern study area, 72 per cent of households at the 2016 Census were families, which is similar to the Greater Sydney statistical area with a family household composition of 74 per cent.

3.13.2 Housing

At the 2016 Census there were 13,653 dwellings within the northern study area. Of these dwellings, 68 per cent had three or more bedrooms, compared to 60 per cent of dwellings in the Greater Sydney statistical area.

3.13.3 Employment and economic base

Within the northern study area, 92 per cent of the total labour force were employed in 2016, which is similar to the 94 per cent of the labour force employed in the Greater Sydney statistical area.

Of the employed people in the northern study area, road freight transport was a leading industry of employment across the entire study area in the 2016 Census. Other leading industries of employment were more localised and included hospitals and aged care residential services in most suburbs in the northern portion of the study area, while higher education and State government administration specifically featured as leading industries in Caddens. In the southern portion of the study area, outdoor vegetable growing was a leading industry of employment in Badgerys Creek and Kemps Creek. Primary education, takeaway food services and supermarket and grocery stores also featured in the leading industries of employment across much of the study area.

In 2013, the NSW Government released the *Broader Western Sydney Employment Area Structure Plan* to identify opportunities for employment generating development within the Broader Western Sydney Employment Area. The plan highlights the demand for employment within the Broader Western Sydney Employment Area to 2046 and forecasts the opportunity for the area to generate around 57,000 jobs (Department of Planning and Environment, 2013). The NSW Government has reviewed the opportunities for employment-generating development in the area as part of the *Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan*. As noted in Section 2.3.3, the plan includes a target for the three initial precincts of the Western Sydney Aerotropolis to create 83,000 jobs, with remaining precincts will to contribute additional jobs.

4 Existing conditions and constraints within the southern study area

This section describes the existing land uses and environmental features within the southern study area for a north-south rail link between the south of the Western Sydney Airport site to Macarthur as well as a passenger rail link between Leppington and the Western Sydney Aerotropolis. References to Section 3 are provided where the existing conditions and/or constraints are similar to those in the northern study area.

The southern study area is generally defined as the area within about two kilometres either side of the 2018 exhibited recommended North South Rail Line corridor and the final recommended South West Rail Link Extension corridor. The southern study area is within the Liverpool, Camden and Campbelltown local government areas and includes the suburbs of Bringelly, Rossmore, Leppington, Catherine Field, Oran Park, Cobbitty, Harrington Park, Smeaton Grange, Narellan, Currans Hill, Spring Farm, Blairmount, Mount Annan and Macarthur.

Figure 4-1 shows the southern study area and overlays the key environmental and physical constraints within this area which have informed the location of the final recommended corridors.

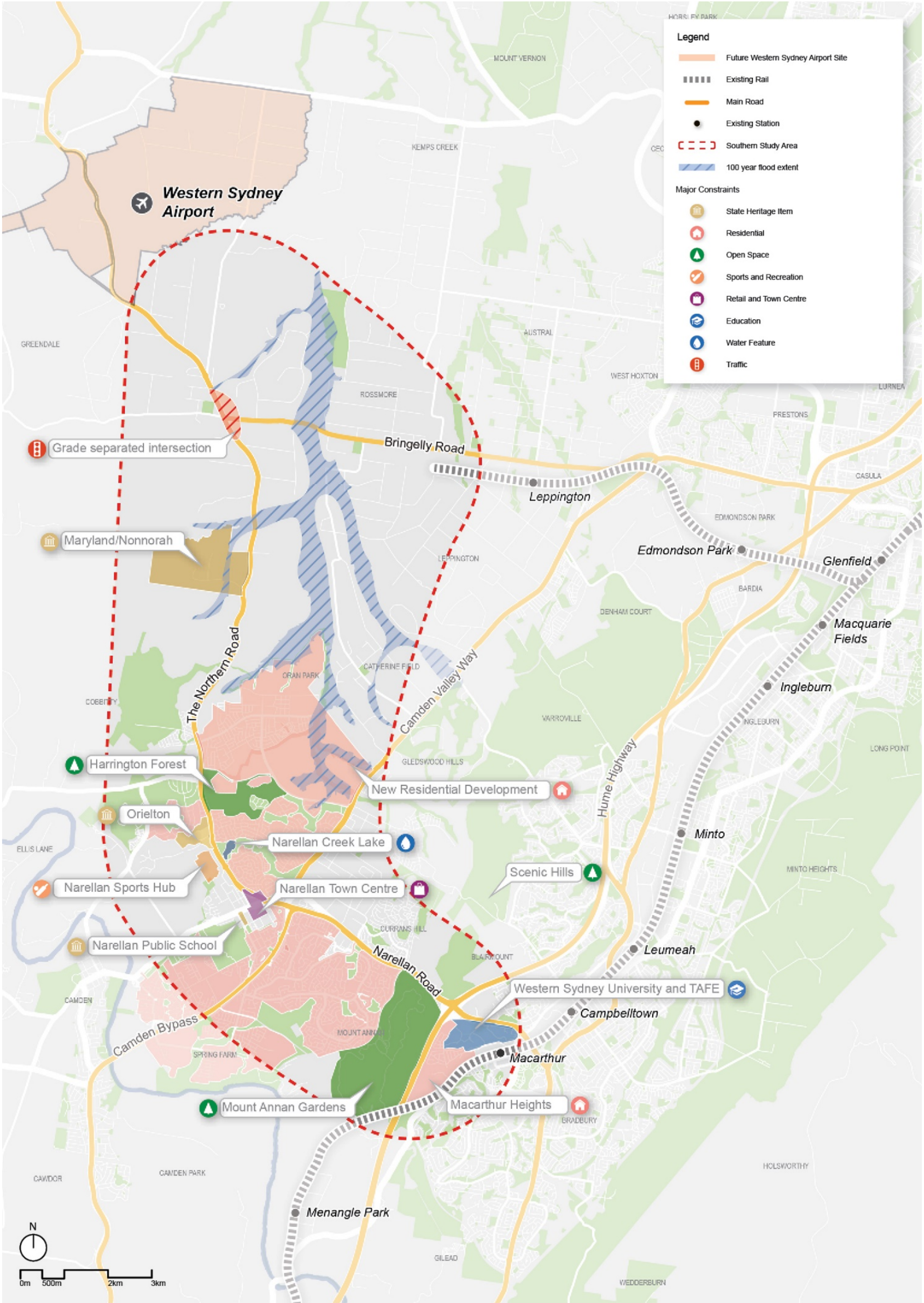

Figure 4-1 **Constraints map of the southern study area**

4.1 Topography and terrain

The existing topography of the southern study area is shown in Figure 4-2. Between Leppington and Bringelly the land is gently undulating with higher ground at Leppington/Rossmore and Bringelly divided by low lying land of the South Creek and Lowes Creek riparian areas. The intersection of Bringelly Road and The Northern Road is a high point, with land to the west of The Northern Road generally more undulating and higher than the lower, flatter land in the east near South Creek.

North of Oran Park the landform is lightly undulating with a series of relatively minor ridgelines generally running in a south-west to north-east direction. South Creek is east of Oran Park Town Centre and forms the low point in the area.

Heading south, the major topographical feature is the ridgeline south of Oran Park, which has a maximum height of around 140 metres. The land falls away quickly to the south, by as much as 70 metres, to Narellan Creek.

South-east of Narellan the topography is characterised by landforms rising to the east to high points in the Scenic Hills and Australian Botanic Garden Mount Annan, of up to 190 metres. The landform also rises to the east and south-east towards Spring Farm up to 160 metres, before dipping down towards the Nepean River in the south and Campbelltown–Macarthur in the east.

The topography and terrain within the southern study area made a significant contribution to selection of the location of the final recommended corridors, and future infrastructure within the corridors would be designed to respond to the existing topographical conditions.

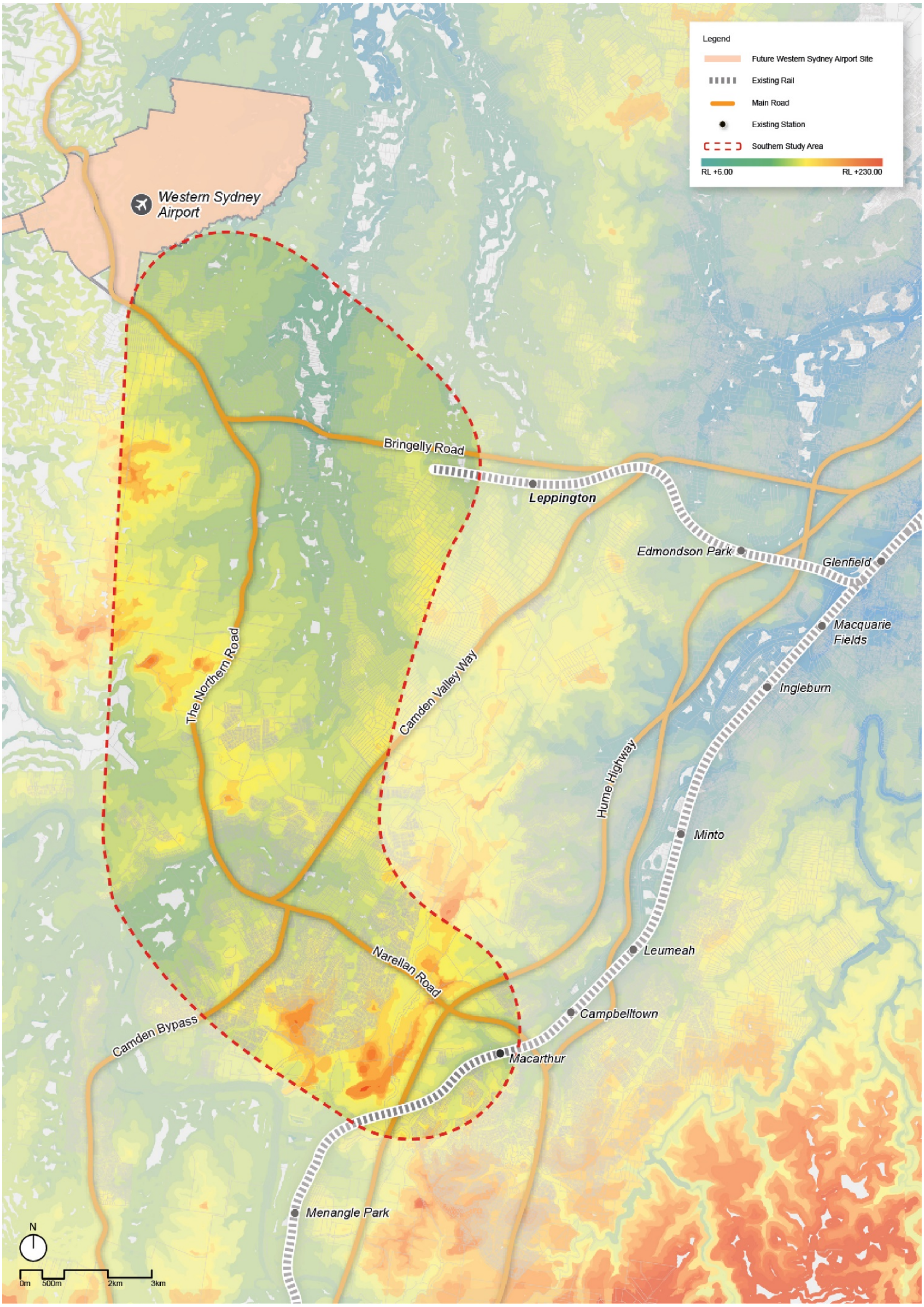

Figure 4-2 Topography of the southern study area

4.2 Hydrology

The key hydrological feature in the southern study area is South Creek, a 400 square kilometres creek system that has its headwaters in the Camden area and flows 70 kilometres north to the Hawkesbury River. The upper South Creek catchment extends south from the Western Sydney Airport and collects water from watercourses through the South West Growth Area which forms the southern extent of the South Creek catchment. The main tributaries of South Creek within the southern study area are:

- Badgerys Creek, which forms the southern boundary of the Western Sydney Airport site
- Thompsons Creek, north of Bringelly Road
- Lowes Creek, South of Bringelly Road
- Rileys Creek, east of South Creek
- Kemps Creek, east of South Creek.

South of the Western Sydney Airport, South Creek is generally narrow and well-defined, with low flows and limited flooding impacts but it extends to around 600 metres wide near Rossmore.

There are several confluences to Lowes Creek around 1.5 kilometres to the south of Bringelly Road, leading to a significant east-west flood plain connecting into the north-south South Creek flood plain. The flood extent of the upper South Creek catchment is a significant constraint influencing the location of the final recommended North South Rail Line and South West Rail Link Extension corridors, shown in Figure 4-3.

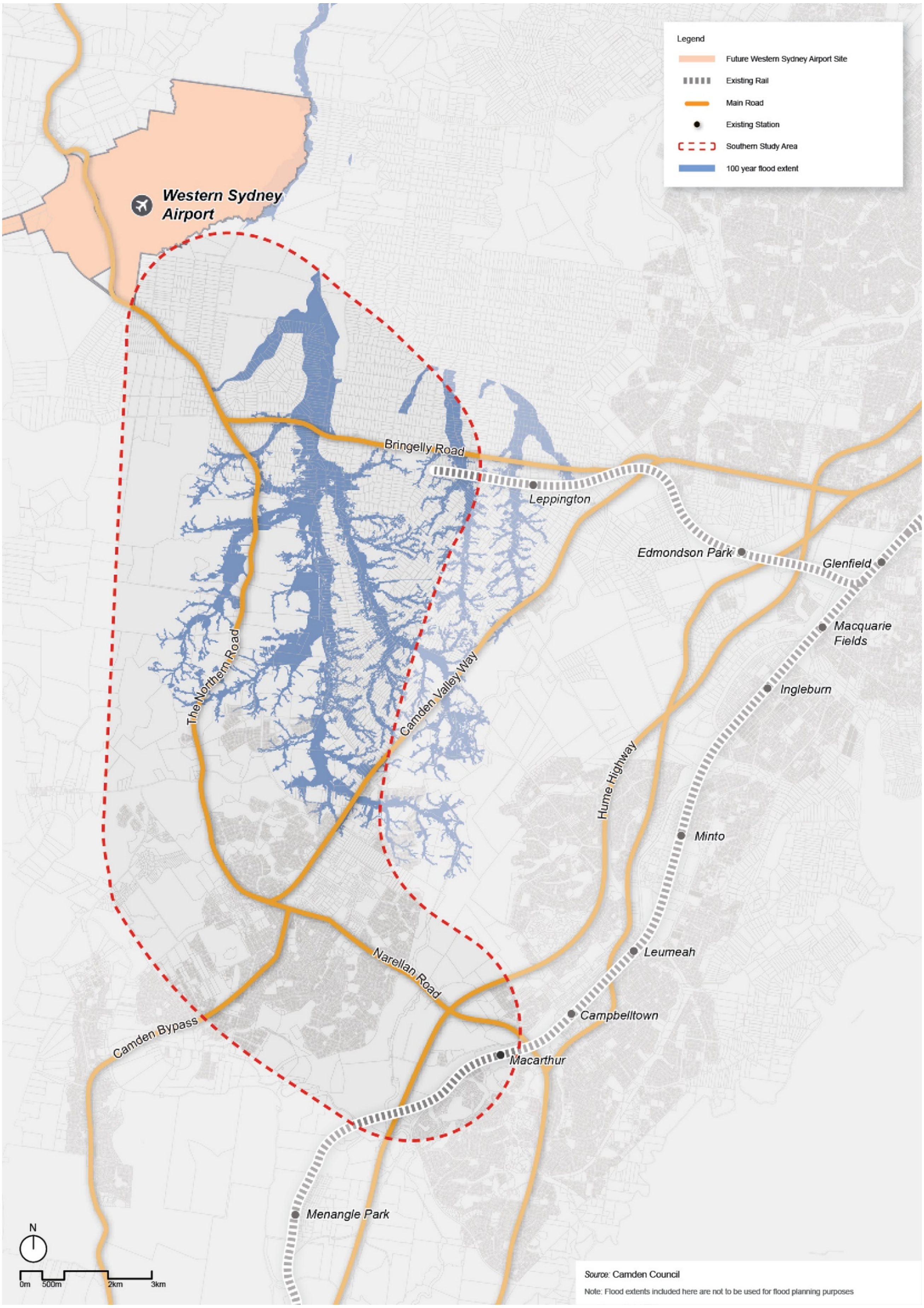

Figure 4-3 Hydrology of the southern study area

Several large dams for agricultural irrigation are located between The Northern Road and Catherine Fields Road around 1.5 to 3.0 kilometres north of Oran Park. These dams control inflow to South Creek from the west of the catchment and also provide a significant flood storage function. There are also a small number of other dams associated with agricultural uses within this area.

Due to the heavily developed nature of the suburbs surrounding Narellan, the surface water system in the southern part of the study area is a combination of natural channels and engineered channels. Narellan Creek flows in an east-west direction through Harrington Park, with several artificial water bodies created within Harrington Park to capture urban runoff and control inflow to this creek. This surface water system in Narellan, and the residential suburbs around Narellan, ultimately discharge into the Nepean River, south and south-west of the Narellan Town Centre. The Narellan Creek floodplain represents a significant hydrological constraint to the construction of the future infrastructure.

East of Narellan, the Scenic Hills provide a natural catchment boundary. East of the Scenic Hills, a series of watercourses convey water towards Bow Bowing Creek. North of Campbelltown, and through the built-up areas north of Campbelltown, the creek has been largely channelised. Ultimately, the creek/channel conveys water into the Georges River, east of Campbelltown.

The Sydney Water Supply Channel runs generally north-south between Narellan and Macarthur and is an important part of the Sydney's water supply system. While it is not a natural hydrological feature, it is visible as a prominent watercourse in the landscape. (Also, see Section 4.8 for detail of the channel's heritage significance.)

The location of existing waterways and flood plains has been a key consideration in the selection of the final recommended corridors to ensure that impacts on waterways and potential flood impacts are minimised.

4.3 Geology and soils

The bedrock geology in the southern study area is generally comprised of Wiannamatta Group Bringelly shales which are typically a repeating sequence of claystone, siltstone and laminate, except for parts of the Narellan and South Creek corridors which are comprised of quaternary alluvial sediments.

Key structural features in the southern study area include:

- Narellan Lineament – which continues from the northern study area
- Camden Syncline – a broad north-northeast plunging structure, the western limb is truncated by the north-south trending faults and fold of the Lapstone Structural Complex. Late Permian to mid-Triassic sedimentary succession thickens towards the axis of the Camden Syncline. It is likely a depocentre of basin evolution during the Late Permian to early Triassic (Bray et al, 2010). The eastern limb of the syncline has a series of NW-SW trending anticlines and synclines superimposed
- Rossmore Anticline – is a local feature that runs northwest to south east and is around three kilometres long
- Luddenham Dyke – is a Jurassic aged olivine basalt dyke that is 8.5 kilometres long, 10-12 metres thick, and dips to the south-west at around 850 metres
- Woronora Anticline – a northwest to southeast oriented anticline.

The structures associated with the Camden Syncline are likely to influence tunnel design. Specialised tunnelling methodologies and/or additional structure support may be required across this feature. Additionally, the Narellan Lineament should be considered as it is a relatively extensive structural feature.

The southern study area shares the same constraints associated with Bringelly Shale and risks of acid sulfate soils as documented in Section 3 for the northern study area.

No known contaminated sites are located within 500 metres of the final recommended North South Rail Line and South West Rail Link Extension corridors south of the Western Sydney Airport.

Geological conditions will inform the design of future infrastructure within the final recommended corridors but do not represent a significant constraint for the location of the corridors.

4.4 Hydrogeology and groundwater

Hydrogeology and groundwater in the southern study area is generally as described in Section 3.4 for the northern study area.

4.5 Land use and property

As outlined in the sections below, existing and future land use patterns, as well as areas of major established development and infrastructure, were key constraints that influenced the selection of the final recommended corridors. Avoiding or minimising impacts on properties was also a significant consideration in the location of the final recommended corridors.

4.5.1 Existing land use pattern

South West Growth Area

Around Bringelly and Rossmore existing land use is comprised of a mixture of market gardens, rural industries and rural-residential properties. Land use to the west of South Creek is predominantly rural in character, with a rural-residential subdivision at Kelvin Park and Bringelly village (located at the intersection of Bringelly Road and The Northern Road) providing local retail facilities. There is also a small existing neighbourhood centre at Rossmore located north of Bringelly Road, and Rossmore Public School on the south side of Bringelly Road.

There are a small number of large-scale land uses within this part of the southern study area that vary from this prevailing land use pattern. Rossmore Stabling Yard is located east of Rossmore, and a 55 hectare brick and paver production facility is located around 750 metres to the west of Bringelly village. Near the Western Sydney Airport boundary is a shale quarry and waste management facility on Badgerys Creek Road, as well as several intensive agriculture facilities, including chicken farms.

South of Bringelly the land use is primarily agricultural, with low-intensity farming activities representing few land use constraints, and several large irrigation ponds.

Land from Oran Park south takes on a more urban character, with more significant land use constraints. Oran Park is located between The Northern Road and Catherine Field and is currently being developed as a major residential suburb with a mixed-use town centre, comprising retail, commercial and civic uses. The Oran Park Master Plan is shown in Figure 4-5.

Development of land within Oran Park is currently occurring at the town centre and to the west and south-west of the town centre. Areas to the north of the town centre are currently undergoing design and planning for residential and commercial development, as well as community infrastructure. It is noted that the development application for the expansion of the Oran Park High School and Primary School at 400F The Northern Road, Oran Park was exhibited from 20 April 2017 until 5 June 2017. The expansion of the high school will comprise alterations and additions to the existing school, as well as five new buildings.

The current development status of precincts in the former South West Growth Centre is shown in Figure 4-4.

Generally, land in the southern study area is undergoing a transition from agricultural to urban uses. While future rail infrastructure would contribute to this change in land use, the change is likely to occur regardless.

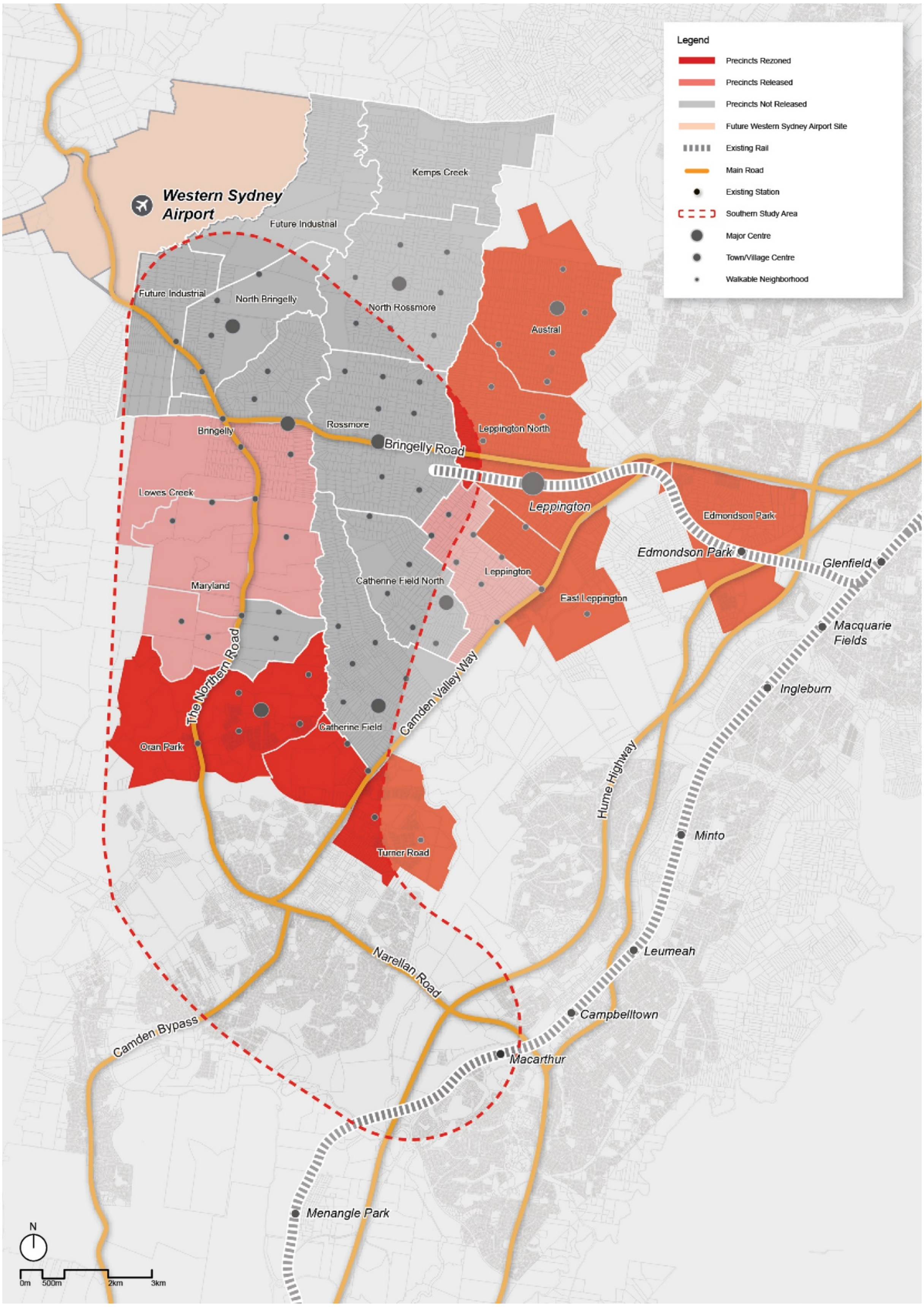

Figure 4-4 Development status of precincts in the former South West Growth Centre

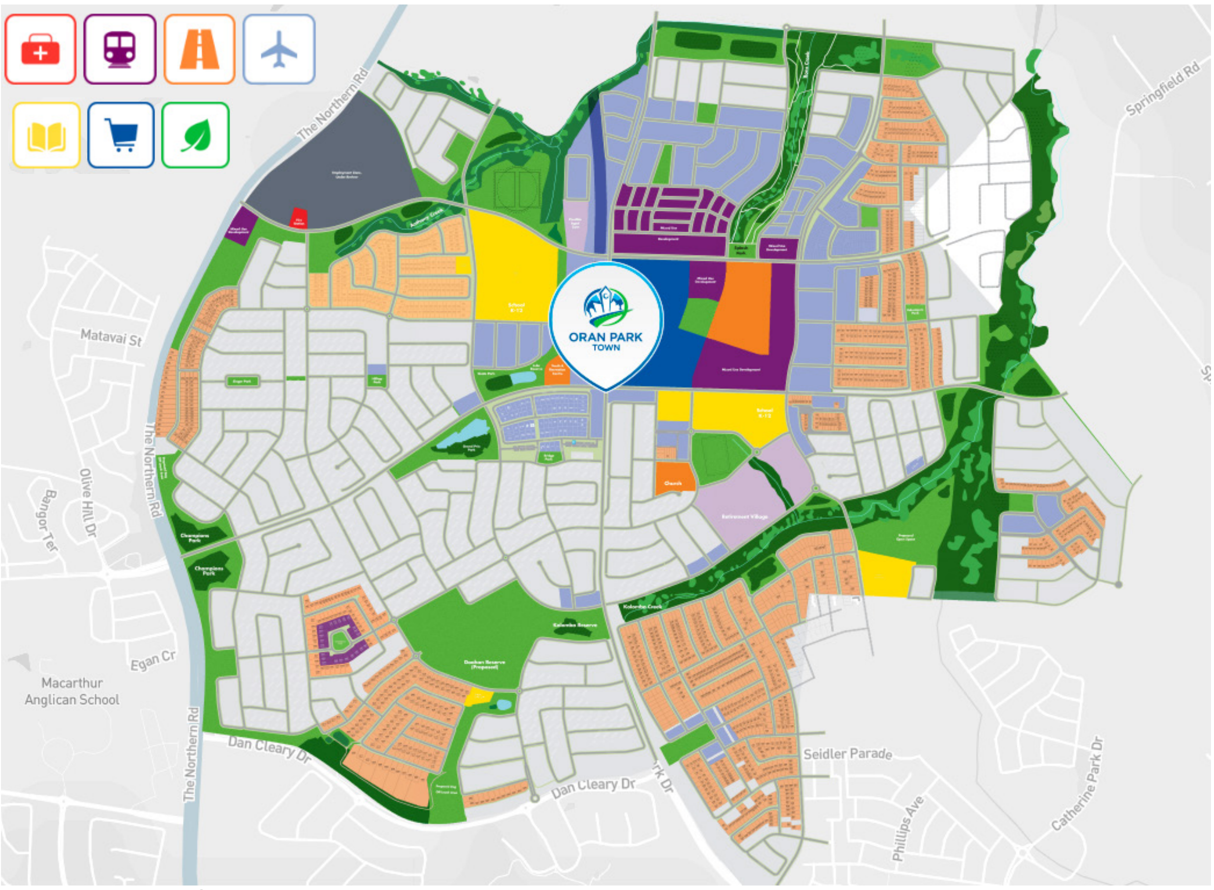

Figure 4-5 Oran Park Master Plan

Source: http://www.oranparktown.com.au/masterplan/

Harrington Park

The established residential suburb of Harrington Park is located three kilometres to the south of Oran Park with around 2,500 dwellings, recreational and civic facilities and a shopping centre. Harrington Park adjoins the Narellan Town Centre which is located to the south.

Between Harrington Park and Oran Park there are several new residential precincts comprising the Harrington Grove Estate. Further development within Harrington Grove continues with new residential areas being developed west of The Northern Road (comprising the Laurina and Michelia precincts), south of Cobbitty Road (comprising Wildfire and Precinct J precincts) and west of the intersection of Oran Park Drive and Camden Valley Way (comprising the Magnolia Precinct). The *Harrington Grove Development Structure Plan* is shown in Figure 4-6.

These new residential precincts around Oran Park and Harrington Grove, as well as the existing residential area of Harrington Park, represent key land use constraints that contributed to the decision in late 2015 by the Minister for Transport to commit to tunnel south of Oran Park.

Figure 4-6 Harrington Grove Development Structure Plan

Source: http://masterplan.harringtongrove.com.au

Narellan

Narellan is a focal point of the regional road network, and is centred on a large enclosed shopping mall, with several low-density housing estates surrounding the town centre. A 50-hectare business and light industrial precinct forms the north-west sector of the suburb and is long-standing but not intensively developed. The new industrial estate of Smeaton Grange is located northeast of the town centre. North of Narellan Town Centre Council is the new Narellan Sports Hub, which will comprise major recreational facilitates catering for a wide-range of sports. Development along the Northern Road continues to expand north of Bunnings, with site preparation for work for an approved residential subdivision currently underway.

Land uses south and east of the Narellan Town Centre are dominated by the established residential suburbs of Narellan Vale, Mount Annan and Currans Hill. East of Smeaton Grange and Currans Hill, the land use is dominated by low scale agricultural activities, including pasture. St Gregorys College is the only non-agricultural land use within the Scenic Hills. East of the Scenic Hills are the residential and industrial areas that form the western edge of Campbelltown.

Spring Farm is a new residential suburb located south of Narellan Vale. South of Spring Farm is the Jacks Gully Waste Management Facility and the Glenlee Colliery, which is currently the subject of a planning proposal for industrial development.

East of Mount Annan and Spring Farm is the Australian Botanic Garden Mount Annan. The Australian Botanic Garden (south of Narellan Road) and the Scenic Hills (north of Narellan Road) are significant landscapes that are zoned for protection. The north-western part of the Australian Botanic Garden contains the Macarthur Centre for Sustainable Living, which is a joint initiative by the Royal Botanic Gardens & Botanic Gardens Trust as well as Campbelltown, Camden and Wollondilly councils.

Campbelltown–Macarthur

Beyond the Australian Botanic Garden Mount Annan is the Hume Highway, and then the Western Sydney University Campbelltown campus, which is part of the Campbelltown–Macarthur urban area and is currently being developed by Landcom as a new residential suburb of Macarthur Heights. The current *Macarthur Heights Master Plan* is shown at Figure 4-7. There is also a development site located adjacent to Macarthur Station, which is currently being developed for higher density residential.

The existing T8 Main South Rail Line forms the eastern boundary of the Western Sydney University Campbelltown campus. North of the Western Sydney University Campbelltown campus is the TAFE NSW Campbelltown College and Narellan Road.

Campbelltown–Macarthur is identified as part of the Metropolitan City Cluster in the *Western City District Plan*, due to the presence of knowledge economy jobs, transport options and other employment opportunities. While Campbelltown and Macarthur are two major centres with different characteristics and functions, they are often regarded as complementary. Macarthur provides a major destination for retail, tertiary education and health services while Campbelltown is the major business and cultural centre, with a mix of commercial, cultural, retail, civic and open space activities.

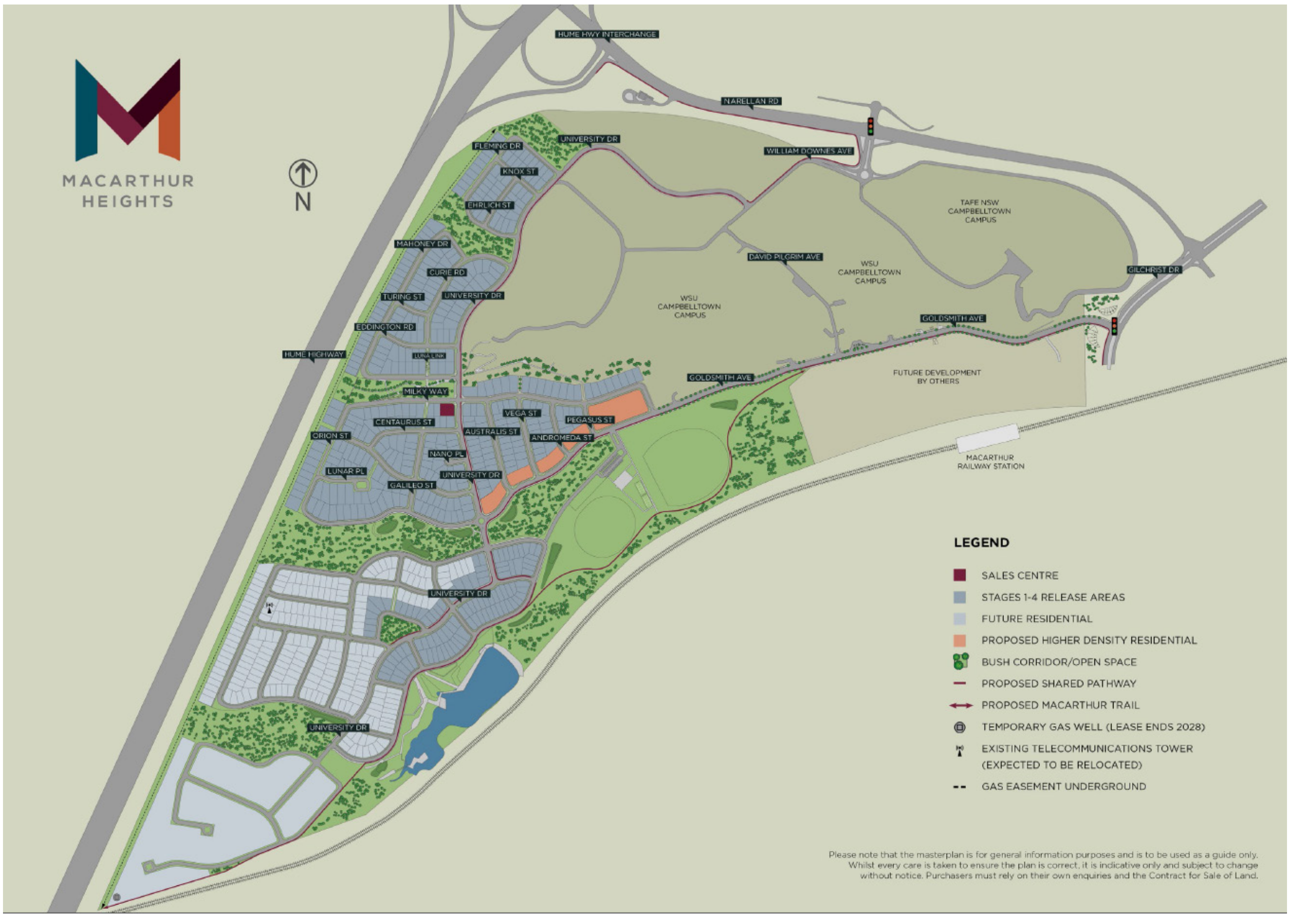

Figure 4-7 Macarthur Heights Master Plan

Source: http://www.landcom.com.au/assets/Projects/Macarthur-Heights/MacHeights-Masterplan.pdf

4.5.2 Zoning and development planning

Current land use zones are shown in Figure 4-8 and are described in the following sections.

South West Growth Area

Land through Rossmore and Bringelly is predominantly zoned Primary Production (RU1) and Rural Small Holdings (RU4) under the *Camden Local Environmental Plan 2010* (south of Bringelly Road) and the *Liverpool Local Environmental Plan 2008* (north of Bringelly Road). The Bringelly village centre is zoned B1 Neighbourhood Centre. Land to the north of Oran Park is predominantly zoned RU1 Primary Production. These areas are in South Creek West, which was announced by the Minister for Planning on 22 November 2017 as being released for rezoning under the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*. Precinct planning for Lowes Creek Maryland Part Precinct is ongoing.

Land north of Bringelly Road includes two large former Australian Government-owned sites that are zoned (SP2) Telecommunications and Defence respectively.

Oran Park is predominantly zoned General Residential (R1) under the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*, with some land also zoned Local Centre (B2), Medium Density Residential (R3), Environmental Living (E4), Public Recreation (RE1) and Private Recreation (RE2). The area north of Oran Park in the Pondicherry Precinct is about to be rezoned. Land within the Catherine Field (Part) precinct directly to the south-east of Oran Park was rezoned in December 2013 and is now predominantly zoned Low Density Residential (R2).

State and regional roads, including The Northern Road and Bringelly Road are zoned Infrastructure (SP2) 'Classified Road'.

Harrington Park and Narellan

Land to the south of Oran Park, including Harrington Grove, Harrington Park and Narellan, are zoned under the *Camden Local Environmental Plan 2010*. Harrington Grove and Harrington Park are predominantly zoned Low Density Residential (R2), with some small areas of Medium Density Residential (R3) distributed throughout the suburb and pockets of Environmental Living (E4) and Large Lot Residential (R5) located on the periphery. Areas of Harrington Grove and Harrington Park are also zoned for Environmental Conservation (E2), Public Recreation (RE1) and Neighbourhood Centre (B1).

Narellan has two designated industrial precincts located to the north-west and north-east of the Narellan Town Centre which are zoned General Industrial (IN1). Land within the Narellan Town Centre is generally zoned Local Centre (B1) and Business Development (B5), with areas of Low Density Residential (R2) and Medium Density Residential (R3) to the south, south-west and south-east of the town centre. The established residential suburbs around Narellan are generally zoned as Low Density Residential (R2) with small pockets of Medium Density Residential (R3). Spring Farm is zoned General Residential (R1).

State and regional roads, including The Northern Road, Camden Bypass, Camden Valley Way and Narellan Road, are zoned Infrastructure (SP2) 'Classified Road'.

Campbelltown–Macarthur

The Australian Botanic Garden Mount Annan is within the Camden and Campbelltown local government areas and is zoned for special uses under both the relevant local environmental plans. East of the Hume Highway, Macarthur Heights is Zoned Medium Density Residential (R3). The T8 Main South Rail Line is zoned Railway Corridor (SP2).

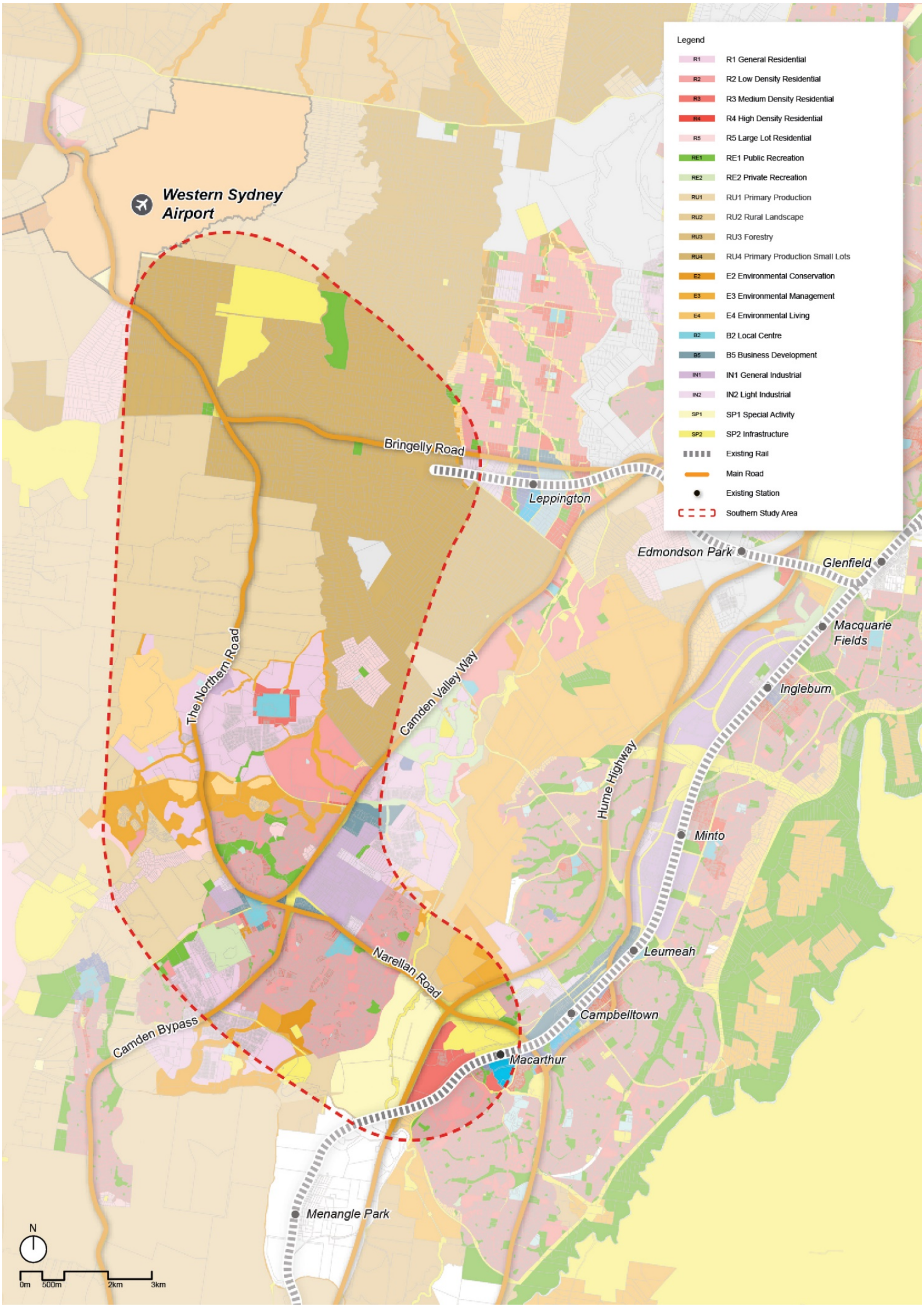

Figure 4-8 Land use zones in the southern study area

4.5.3 Road infrastructure

Key road infrastructure in the southern study area is shown in Figure 4-9.

Classified roads in the southern study area are identified in the *Schedule of Classified Roads and State and Regional Roads* (Roads and Maritime Services, 2017a) and include:

- Bringelly Road, which is the key east-west road connecting Leppington with The Northern Road through Rossmore and Bringelly. Bringelly Road currently accommodates around 10,000 vehicles per day, of which around 10-15 per cent are heavy vehicles. Projected future traffic volumes along Bringelly Road are about 25,000 – 30,000 vehicles per day. Transport for NSW is currently upgrading Bringelly Road as part of the *Western Sydney Infrastructure Plan* (Roads and Maritime Services, 2017b). About 10 kilometres of Bringelly Road from Camden Valley Way to The Northern Road is being widened from a two-lane road to a minimum four-lane road, with potential for future expansion to six lanes. Construction is expected to continue through 2020.
- The Northern Road is the key north-south road link running between Narellan and Londonderry. The Northern Road currently accommodates around 15,000 vehicles per day (south of Bringelly Road), of which around 10 per cent are heavy vehicles. Projected future traffic volumes along The Northern Road are about 25,000 vehicles per day. Transport for NSW is currently upgrading The Northern Road as part of the *Western Sydney Infrastructure Plan* (Roads and Maritime Services, 2017b) to a four-lane road between Harrington Park and Bringelly, with potential for future expansion to six lanes. Construction is expected to continue until 2019-2020. The upgrade works include a grade-separated intersection between Bringelly and The Northern Road.
- Narellan Road is the major east-west link between Narellan and the Hume Highway and the urban area of Campbelltown–Macarthur. Narellan is a major focal point in the regional road network, being located at the intersection of The Northern Road, Camden Valley Way, Narellan Road and the grade-separated Camden Bypass. Narellan Road is highly constrained especially during peak periods when extensive queues can form. Narellan Road is currently the subject of an upgrade program by Roads and Maritime Services, which will include improvements to the grade separated interchange between Narellan Road and the Hume Highway. Due to the constrained nature of Narellan Road, long-term road network planning envisages additional east-west links including upgrades to Badgally Road (through the Scenic Hills) and a Spring Farm Parkway connecting Camden Bypass through Spring Farm to the Hume Highway near Menangle Park.

While the State road network is being upgraded now to accommodate future projected growth within the South West Growth Area (and elsewhere in western Sydney), much of the future local road network within the South West Growth Area is still at the planning stage. However, existing local roads will be retained wherever possible and appropriate, and this approach will inform the land use planning process for each precinct.

The upgrades of Bringelly Road and The Northern Road have included the construction of new (or upgraded) intersections that will define the future key connections with the local road network. The location of these intersections has informed the identification process for the final recommended North South Rail Line and South West Rail Link Extension corridors in terms of considering possible interactions with the likely future local road network.

4.5.4 Existing rail infrastructure

The South West Rail Link currently terminates at Leppington. The South West Rail Link consists of two tracks from Glenfield through Edmondson Park station to the city side of Leppington Station, then four tracks through Leppington Station. About 1.5 kilometres to the west of Leppington Station, the tracks converge to two tracks into Rossmore Stabling Yard. The width of the existing rail corridor west of Leppington Station is generally 60 metres, but increases to 160 metres at Rossmore Stabling Yard. Rossmore Stabling Yard has capacity for 20 eight-car suburban trains. The existing rail corridor generally makes provision for the extension of the South West Rail Link west of Leppington Station as far as Rossmore Stabling Yard.

Macarthur currently forms the southern extent of the electrified Sydney Trains suburban network, and is operated as part of the T5 Cumberland Line (which terminates at Campbelltown station) and the T8 Main South Rail Line, which terminates at Macarthur Station.

South of Macarthur Station the T8 Main South Rail Line continues as the Southern Highlands Line, which forms part of the intercity network (but is not part of the electrified Sydney Trains network).

The existing Glenlee Colliery (and proposed Glenlee industrial precinct) is currently connected by a rail siding to the T8 Main South Rail Line.

In addition to the T8 Main South Rail Line, the Southern Sydney Freight Line occupies part of the existing rail corridor commencing at Macarthur Station. The Southern Sydney Freight Line is a dedicated freight line (single track) next to the T8 Main South Rail Line (located north/west of the T8 Main South Rail Line) between Sefton Park Junction and south of Macarthur Station. The Southern Sydney Freight Line is operated by the Australian Rail Track Corporation.

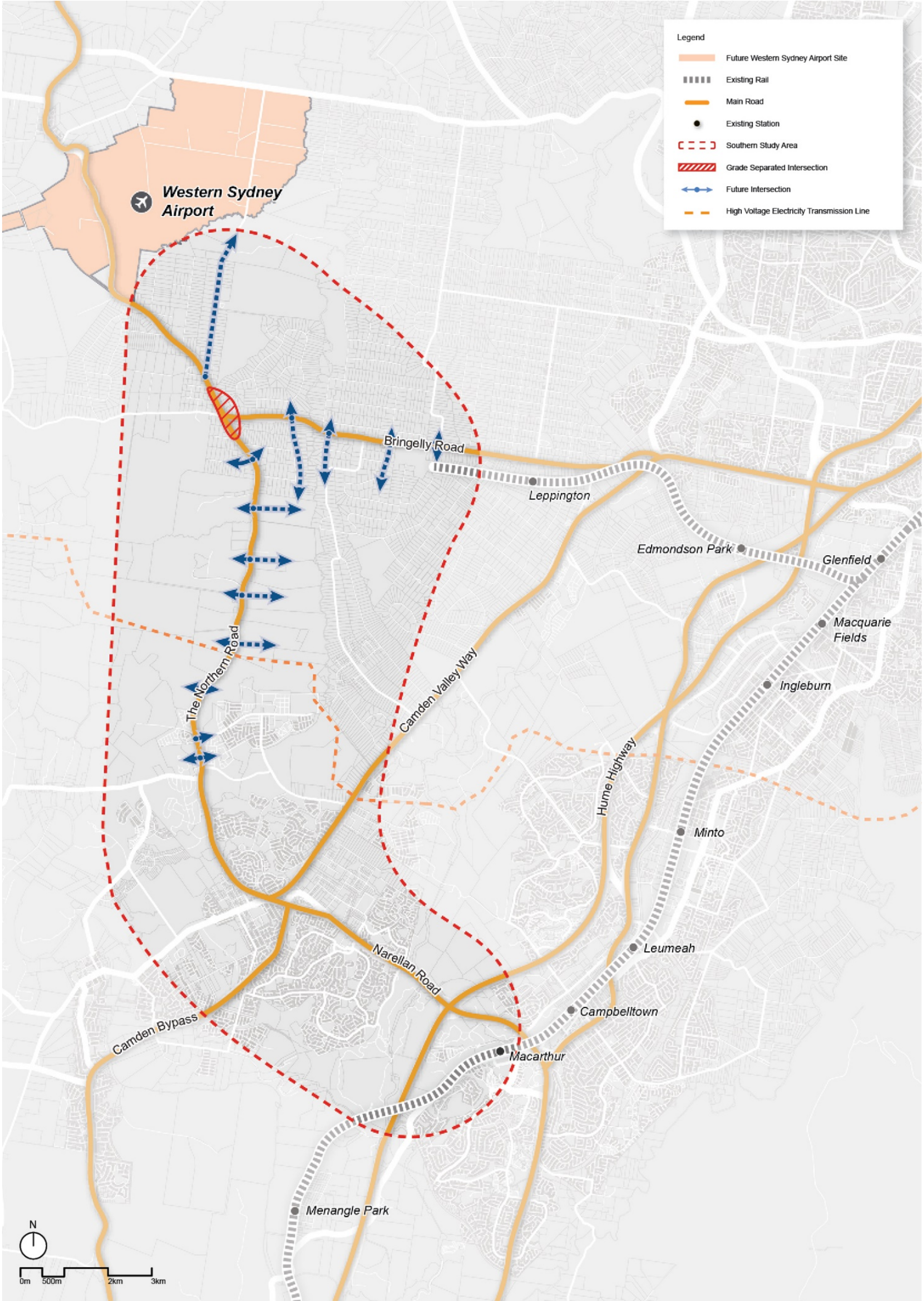

Figure 4-9 Existing infrastructure and utilities in the southern study area

4.6 Utilities

Major utilities in the southern study area are described in Table 4-1 and shown in Figure 4-8. Existing utilities influenced the location of the final recommended corridors in some areas, such as Oran Park, and will be a key consideration in the design of future rail infrastructure within the corridors.

Table 4-1 Major utilities in the southern study area

Location	Utility	Description
Catherine Field to Oran Park	330kV	High voltage electricity transmission lines that traverse the southern study area in a north-south direction through Catherine Field and Oran Park, before turning to the west immediately north of Oran Park Town Centre.
Curran Hills to Mount Annan	330kV	High voltage electricity transmission lines that traverse the southern study area in a north-south direction generally through the Australian Botanic Garden Mount Annan and east of Currans Hill.
Spring Farm	Nepean Zone Substation	Nepean Zone Substation is located on Glenlee Road near Springs Road. Several smaller voltage electricity transmission lines converge on the substation.
Blair Athol	Campbelltown Zone Substation	Campbelltown Zone Substation is located near the corner of Narellan Road and Blaxland Road.
Blairmount to Mount Annan	Sydney Water Supply Canal	The Sydney Water Supply Canal traverses the southern study area in a generally north-south direction through the Australian Botanic Garden Mount Annan and the Scenic Hills. The canal serves an important water supply function between the southern drinking water catchments and Prospect Reservoir. The canal is listed on the State Heritage Register.

4.7 Aboriginal heritage

As with the northern study area, the known distribution of Aboriginal sites within the southern study area is largely clustered around waterways and roads. A search of the Aboriginal Heritage Information Management System found a total of 295 items of Aboriginal heritage recorded within the southern study area.

At Narellan, there is a cluster of Aboriginal heritage sites around Gundungarra Reserve, William Howe Regional Park, The Australian Botanic Garden Mount Annan and the Western Sydney University Campbelltown campus. There are also a small number of sites located through the Scenic Hills.

The Gandangara Local Aboriginal Land Council and Tharawal Local Aboriginal Land Council have representation for the southern study area. The Darug People’s Advisory Committee also has an interest in the southern study area.

Aboriginal heritage constraints did not significantly constrain the location of the final recommended corridors.

4.8 European heritage

European heritage items in the southern study area that are listed on the State Heritage Register or in a local environmental plan are identified in Table 4-2 and shown in Figure 4-10.

Table 4-2 State and local heritage items in the southern study area

Item name	Address	Significance	Item no.
Glenlee	Glenlee Road, Menangle Park	State	00009
Upper Canal System (Pheasants Nest Weir to Prospect Reservoir)	Prospect	State	01373
Kelvin Park Group	30 The Retreat, Bringelly	State	00046
Denbigh	421 The Northern Road, Cobbitty	State	01691
Orielton	181 – 183 The Northern Road, Harrington Park	State	01693

Item name	Address	Significance	Item no.
Camden Park Estate and Belgenny Farm	Elizabeth Macarthur Avenue, Camden South	State	01697
Kirkham stables and precinct	Kirkham Lane, Narellan	State	01411
Harrington Park	1 Hickson Circuit, Harrington Park	State	01773
Studley Park	Camden Valley Way, Narellan	State	00389
Rossmore Public School	629 Bringelly Road, Rossmore	Local	I138
Bellfield Farm Group	33 Rossmore Avenue, Rossmore	Local	61
Church of the Holy Innocents Group	Church Street, Rossmore	Local	60
Bringelly Public School	1205 The Northern Road, Bringelly	Local	7
Former Overseas Telecommunications Commission site	Badgerys Creek Road, Bringelly	Local	5
Water tanks and water supply to the Overseas Telecommunications Commission site	Badgerys Creek Road	Local	4
Mount Pleasant rural dwelling	3 Shannon Road, Bringelly	Local	6
Camden Park Estate	445 Remembrance Driveway, Camden Park	Local	I53 and I54
Burton Arms Inn	332 Camden Valley Way, Narellan	Local	I132
Struggletown Conservation Area	Narellan	Local	
Ben Linden historic house	311 Camden Valley Way, Narellan	Local	I131
Smeaton Grange homestead and landscape	1 Sedgwick Street, Smeaton Grange	Local	I140
Narellan Public School	290 Camden Valley Way, Narellan	Local	I130
St Thomas' Cemetery and Church	6 Richardson Road and 1A Wilson Crescent, Narellan	Local	I134 and I136
Menangle Gate Lodge	60 Woodbridge Road, Menangle	Local	I99

There are no World Heritage, National Heritage or Commonwealth Heritage listed items located within or in proximity to the southern study area.

European heritage constraints had a moderate influence on the location of the final recommended corridors.

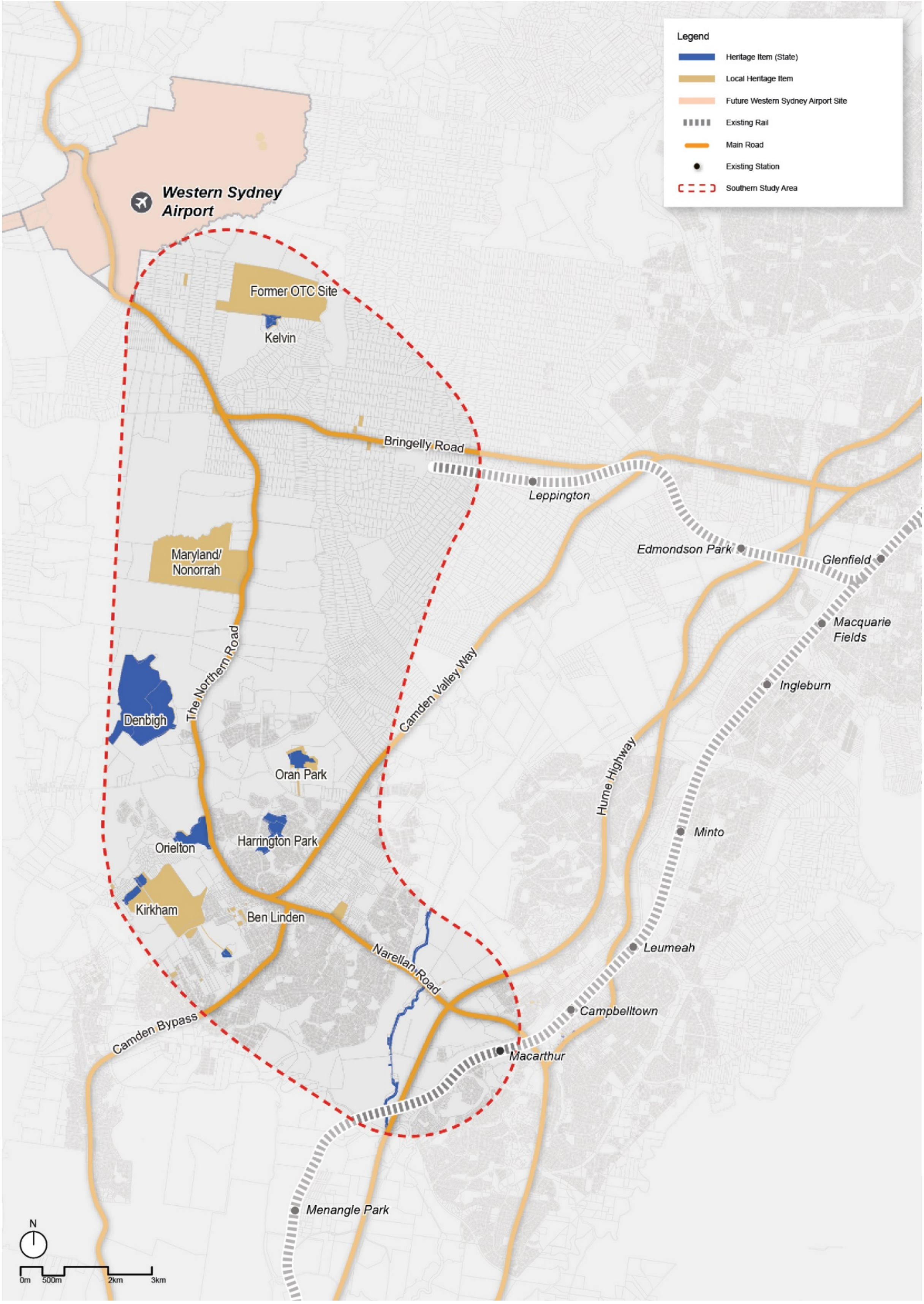

Figure 4-10 European heritage items in the southern study area

4.9 Biodiversity and vegetation

Around Rossmore, Bringelly and Maryland the area is characterised by a predominantly cleared and disturbed rural landscape with interspersed stands of native vegetation, predominantly located around the riparian areas. Vegetation communities include subsets of the Cumberland Plain Woodland Endangered Ecological Community, as well as other native ecological communities and isolated native flora species.

This part of the southern study area is entirely within the South West Growth Area, which is subject to an order of the Minister for the Environment conferring biodiversity certification (biocertification) through the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006* under the *Biodiversity Conservation Act 2016*.

Biodiversity certification removes the need for further threatened species assessments before development in areas identified in the order as ‘certified’. Riparian areas along the South Creek watercourse and major tributaries are excluded from the certified area, and any proposal to impact on vegetation within these areas would require separate ecological assessment.

Areas in the southern study area that have been biocertified are shown in Figure 4-11.

South of Oran Park, approval of residential development at Harrington Grove was granted by the Australian Government’s Department of the Environment, Water, Heritage and the Arts in 2009 on land that was described as Harrington Forest, which contained areas of Cumberland Plain Woodland.

Numerous conditions of consent regarding biodiversity were implemented, including establishment of conservation covenants that must provide protection and active management of the Cumberland Plain Woodland offset areas, in perpetuity. The conservation covenants are registered on land identified as ‘community reserve’, ‘council reserve’ and ‘cultural landscape’.

Harrington Forest is mapped as Priority Conservation Lands in the *Cumberland Plain Recovery Plan* (Department of Environment, Climate Change and Water, 2010). Management of the Cumberland Plain Woodland must complement the *Cumberland Plain Recovery Plan* and must also be in accordance with the Harrington Park Voluntary Planning Agreement with the NSW Department of Planning (reference 15266/15343/80056275). The existing Cumberland Plain Woodland and associated ecosystems of Harrington Forest are protected and managed as part of the consent conditions for Harrington Grove.

South of Narellan, native vegetation is generally sparse and heavily disturbed. This native vegetation is confined largely to parks and reserves including William Howe Regional Park, and along the limited number of naturalised riparian corridors. The largest stands of native vegetation are located within the Australian Botanic Garden Mount Annan.

While undeveloped for urban uses, only isolated and fragmented patches of native vegetation are present within the Scenic Hills.

East of the Hume Highway, native vegetation remains generally sparse and the urban landscape is heavily disturbed and generally limited to isolated fragments.

As the study area is located within predominantly biocertified land, the presence of biodiversity and vegetation is not a significant constraint on the location of the corridors.

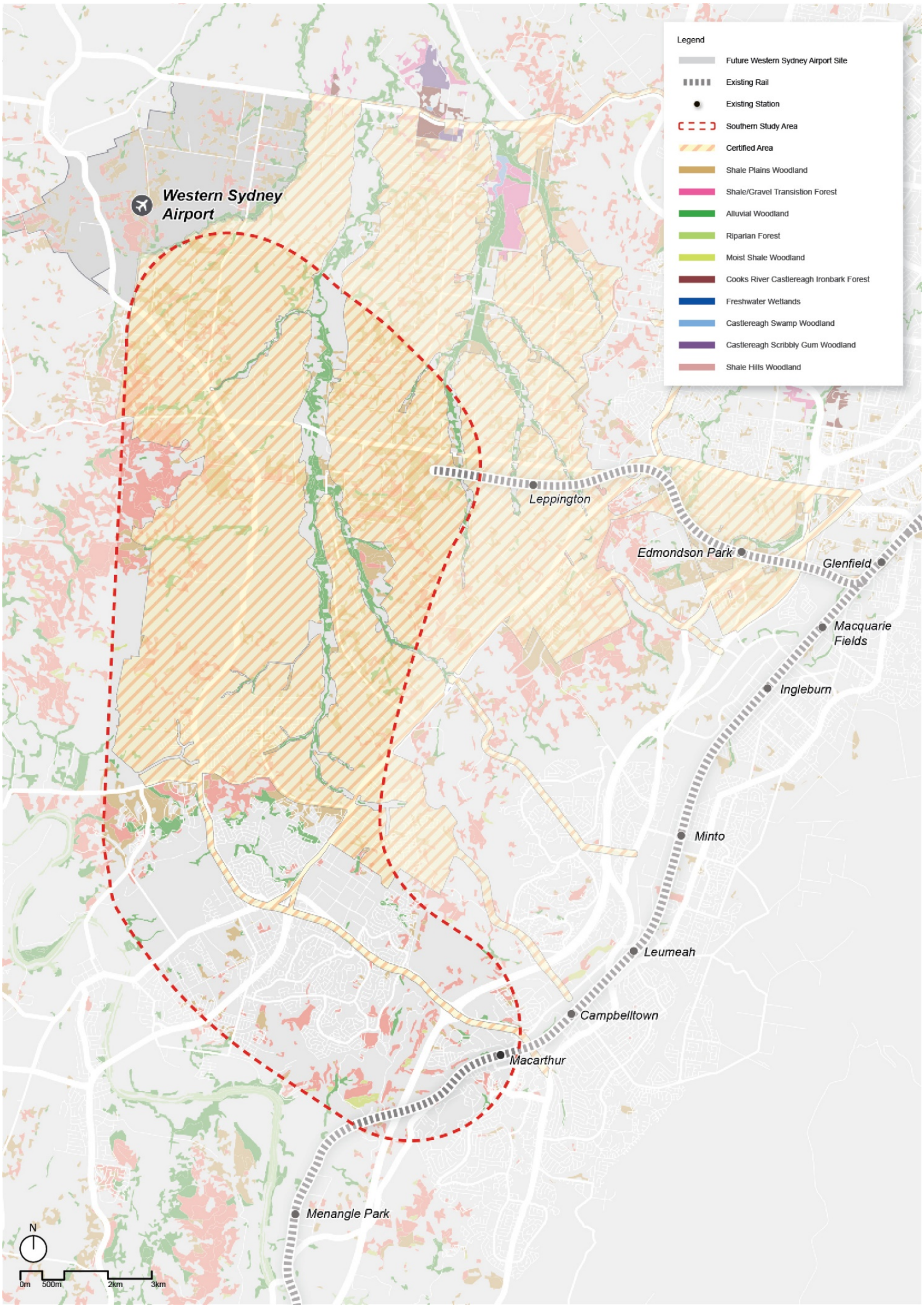

Figure 4-11 Biocertified areas in the southern study area

4.9.1 Vegetation and habitat

The southern study area is a moderately populated part of Sydney, which is largely urbanised and highly disturbed due to a history of agricultural activity. Most land within the southern study area is cleared and contains exotic pastures, with only occasional areas of native vegetation. The main habitat types in the southern study area include:

- Grassy woodlands associated with stands of Shale Plain Woodland and Shale Hills Woodland
- Riparian forests associated with narrow bands of vegetation mapped as Alluvial Woodland along some creeks and waterways
- Open grasslands associated with cleared grazing land and other agricultural land uses
- Aquatic habitats within perennial and ephemeral creeks.

Protected ecological communities in the southern study area include:

- Alluvial Woodland, which is an endangered ecological community
- Shale Hills Woodland, which is associated with Cumberland Plain Woodland and is classified as a critically endangered ecological community
- Shale Plains Woodlands, which is associated with Cumberland Plain Woodland and is classified as a critically endangered ecological community.

Additionally, the Cumberland Plain Woodland associated vegetation communities meet the definition of Cumberland Plain Woodland and Shale /Gravel Transition Forest, which is listed under the *Environment Protection and Biodiversity Conservation Act 1999*.

Most of the remaining native vegetation in the southern study area is highly fragmented and predominantly confined to riparian areas of South Creek and its tributaries.

The most substantial wildlife movement corridor through the southern study area lies within the vegetated riparian areas of South Creek and it is likely that a range of terrestrial and aquatic fauna groups utilise this wildlife corridor for habitat and movements through the area. To support this, the riparian corridor of South Creek is mapped as 'Regional Biodiversity Corridor 5' under the *Biodiversity Investment Opportunities Map, Mapping Priority Investment Areas for the Cumberland Subregion* (Office of Environment and Heritage, 2015).

4.9.2 Flora and fauna

Forty-three threatened flora species have been recorded within 20 kilometres of the southern study area. Two threatened species are recorded in the southern study area, being the Magenta Lilly Pilly and Spiked Rice-flower. The Magenta Lilly Pilly is listed as vulnerable under the *Biodiversity Conservation Act 2016*, while the Spiked Rice-flower is protected under both the *Biodiversity Conservation Act 2016* and *Environment Protection and Biodiversity Conservation Act 1999*. The remaining species that could potentially be present in the southern study area are considered to have a low possibility of occurring.

Fifty-five threatened fauna species have been recorded within 20 kilometres of the southern study area, the majority of which are forest dependent. Of these:

- Only three species are expected to occur within the southern study area, being the Cumberland Plain Land Snail, Southern Myotis and Greater Broad Nosed Bat
- Sixteen species are terrestrial mammals, comprising nine microchiropteran bats, plus the Grey-headed Flying-fox, the Koala, Yellow-bellied Glider, Squirrel Glider, Eastern Pygmy-possum, Brush-tailed Rock-wallaby and Spotted-tailed Quoll. These species are unlikely to occur within the southern study area due to the limited amount of habitat for these species
- Three species are amphibians, being the Red-crowned Toadlet, Giant Burrowing Frog and Green and Golden Bell Frog. There are no records of these species occurring within the southern study area

- Two species are reptiles, being the Broad-headed Snake and the Rosenberg's Goanna. These species are unlikely to occur within the southern study area due to the limited amount of habitat for these species
- Thirty-three species are birds and could occur within the southern study area on a temporary basis. However, the southern study area is unlikely to constitute a significant habitat for these species due its fragmented nature and lack of native forest.

Several other species are considered to have a moderate possibility of occurrence, due to habitat availability and high instance of records in the area.

4.10 Landscape and visual character

The southern study area is located at the fringe of metropolitan Sydney urban development and within an area undergoing rapid urban transformation. It is currently characterised by low-density residential dwellings interspersed with medium-scale commercial and retail development as well as large areas of undeveloped and rural land. The existing built form and rural landscape interfaces are shown in Figure 4-12 to Figure 4-17. Existing residential land use follows a precinct pattern of development.

The existing landscape around Rossmore, Maryland and Bringelly is predominantly rural, characterised by existing farm land, market gardens and rural-residential dwellings, as shown in Figure 4-12 and Figure 4-13. These areas form part of the South West Growth Area and are expected to be subject to future rezoning to provide for urban development that will transform the visual context and character of the landscape.

The existing landscape around Greendale is characterised by pastoral and market gardening land uses. This area adjoins the South West Growth Area and there are long-term plans for urban development to occur that would substantially transform this existing rural landscape.

From Oran Park through Narellan to Macarthur the landscape comprises new and established urban development that transitions between residential, industrial and commercial development, as shown in Figure 4-14 to Figure 4-17. Oran Park and Macarthur will continue to transition to a predominantly urban character associated with NSW strategic planning policies for these areas, while the established town centre of Narellan continues to develop.

In addition to this, the vegetation and parkland of the Scenic Hills, Australian Botanic Garden Mount Annan and William Howe Regional Park are significant landscape features that separate Campbelltown and Macarthur from the urban areas around Narellan.

Due to the expected change in the character of the area, landscape and visual character is not a significant constraint on the location of the final recommended corridor. Where significant landscapes exist, the design of future rail infrastructure will take these into account.

Figure 4-12 Rural property near Rossmore

Figure 4-13 Rural area, Maryland

Figure 4-14 Oran Park

Figure 4-15 Macarthur

Figure 4-16 Narellan Town Centre

Figure 4-17 Oran Park Town Centre

4.11 Noise

Background noise levels in the southern study area are influenced by a range of noise sources. These include localised sources such as motor vehicles, public transport, construction activities, residential properties, farming and agricultural activities and some commercial and industrial activities.

The continuing urban development of land within the Western Sydney Aerotropolis and South West Growth Area will increase background noise levels over time. Increased noise levels could be from traffic noise associated with increased traffic volumes on the upgraded arterial road network, in particular Bringelly Road and The Northern Road. Ultimately, the areas around Rossmore, Bringelly, Maryland and Oran Park, which currently reflect noise levels associated with a rural environment, would be expected to experience typical suburban background noise levels.

Noise sensitive receivers throughout the southern study area include existing residences, educational facilities, places of worship, aged-care facilities and other community facilities such as areas of open space used for recreation.

Existing and future noise conditions were not a significant constraint on the location of the final recommended corridors.

4.12 Air quality

Existing sensitive receivers around Rossmore and Bringelly are generally limited to schools and residential dwellings. These areas are expected to be of substantially higher density in the future when development of the South West Growth Area occurs. Existing higher density residential areas extend south from Oran Park through Narellan to Macarthur.

Existing air emissions sources include:

- Emissions from traffic on the State road network comprising Bringelly Road, The Northern Road, Camden Valley Way, Camden Bypass, Narellan Road and the Hume Highway – as well as emissions from traffic on local roads. It is expected that traffic generated air emissions will increase commensurately with the increase in traffic forecast to occur as the South West Growth Area continues to be developed
- Emissions from industrial areas at Narellan, Smeaton Grange and Campbelltown
- Emissions from existing rural industries – including chicken farms at Badgerys Creek, quarries and associated extractive materials manufacturing, for example, tiles, and waste management facilities. In the longer term it is expected that air emissions from rural industries would reduce as these land holdings are developed in accordance with the South West Growth Area.

In addition to the existing air emissions sources, it is expected that from the mid-2020s the Western Sydney Airport would also be a significant contributor to the emission of air pollutants in south-west Sydney.

Existing and future air quality conditions were not a significant constraint on the location of the final recommended corridors.

4.13 Socioeconomic

The key socioeconomic characteristics of the northern study area are described in the following sections. The existing and future demographic composition of the study area has informed the location of the final recommended corridors to the extent that the corridors has been located to minimise impacts on social infrastructure and services.

4.13.1 Population and demography

At the 2016 Census, there were around 68,000 residents living within Mount Annan-Currans Hill, Elderslie-Harrington Park and Cobbitty-Leppington (Australian Bureau of Statistics, 2016). The majority of these resided in the area between Narellan and Macarthur. This is an increase of nearly 50 per cent on the population of the area since the 2011 Census, reflecting the large scale of recent residential development within the southern study area.

Eighty-seven per cent of households in the vicinity of the southern study area were families (including couples without dependent children), compared to only 74 per cent of households within the Greater Sydney statistical area.

The former South West Growth Centre is expected to accommodate around 290,000 residents once all precincts are released and developed.

4.13.2 Housing

At the 2016 Census there were around 22,000 dwellings within Mount Annan-Currans Hill, Elderslie-Harrington Park and Cobbitty-Leppington. Of these dwellings, 96 per cent had three or more bedrooms, compared to 65 per cent of dwellings in the Greater Sydney statistical area.

The former South West Growth Centre was expected to provide for around 108,000 new dwellings to be accommodated over the life of precinct delivery. The final number of dwellings delivered is likely to change as a result of more detailed precinct planning and changes in residential development patterns and market preferences over time. In particular, the *Priority Growth Areas Housing Market Needs Analysis Final Draft* (Department of Planning and Environment, 2015) identified that there continues to be strong demand for new residential products in the South West Growth Area as well as a response by developers to meet the market in terms of housing diversity and affordability issues resulting in a broader range of product which includes small lot housing and unit/apartments.

The report identifies that while medium sized lots (350 square metres to 450 square metres) are still the dominant type of lot produced (in part for planning reasons), small lots (250 square metres to 350 square metres) are the most popular in the market, selling swiftly on release. Where they are able, developers are consequently incorporating higher proportions of small lot housing into the overall residential mix.

The report concludes that a structural change in market preference and demand supports a case for a review and increase of residential density levels, with those precincts already benefiting from keen market interest and those focused around train stations being logical priorities for denser residential product. Therefore, it is reasonable to conclude that future population densities will ultimately be achieved in the South West Growth Area in excess of the initial population targets.

4.13.3 Employment and economic base

As of the 2011 Census, 12,100 persons were employed in the southern study area, excluding Macarthur. Of the employed people in the southern study area, leading industries of employment across the entire study area in the 2016 Census included supermarket and grocery stores, hospitals, primary education, road freight transport, takeaway food services and house construction.

The South West Growth Centre Structure Plan 2006 identified over 1,300 hectares of dedicated employment land, with additional employment and business areas to be located within new town centres created throughout the region. Leppington was identified as a ‘Major Town Centre’ in the South West Growth Centre Structure Plan, while Oran Park, Rossmore and Bringelly were identified as ‘Town/Village Centres’. Employment targets for the South West Growth Area and Western Sydney Aerotropolis are provided in the *Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan* and summarised in Section 2.3.3.

Oran Park has already exceeded its expectations in terms of employment generating retail development and major social infrastructure, with the relocation of Camden Council’s civic centre.

The development of the South West Growth Area will result in a change in the types of employment occurring in the southern study area, with agricultural employment gradually declining as both a share of total employment and in absolute terms.

5 Corridor identification and consultation

This section outlines the key steps in the process of identifying the final recommended North South Rail Line and South West Rail Link Extension corridors and provides a description of the final recommended corridors. This section:

- Describes business requirements, including corridor widths, strategic connections to the existing rail network and strategic design requirements
- Describes the key consultation phases undertaken throughout the corridor identification process, as outlined in Figure 5-1
- Provides a detailed description of the final recommended North South Rail Line and South West Rail Link Extension corridors.

In 2014, the investigation of the North South Rail Line corridor north of the Western Sydney Airport was delayed to coordinate it with announcements about the new Western Sydney Airport, a jointly funded Commonwealth/State *Western Sydney Rail Needs Study* and planning for both the Outer Sydney Orbital and the Western Sydney Airport. Where there are differences between the development and consultation of the northern and southern sections of the North South Rail Line corridor these are outlined in the sections below.

The corridor alignment through Western Sydney Airport was determined by a separate process led by the Australian Government. The final recommended North South Rail Line corridor shown in this Strategic Environmental Assessment is consistent with the Australian Government's alignment.

Early 2014	Commence corridor investigation
March 2014	Identify study area
April 2014	Western Sydney Airport announced
June 2014	Consult on corridor study area
August 2014	Corridor study area extended between Narellan and Macarthur
June 2015	Consult on recommended corridor between Leppington, Bringelly, Oran Park and Narellan
	Rail corridor between Brigelly, Western Sydney Airport and St Marys coordinated with Outer Sydney Orbital consultaion
November 2015	Tunnel section identified between Oran Park and Narellan
September 2016	Western Sydney Rail Needs Discussion Paper released
November 2017	Consult on Draft Future Transport Strategy 2056 and Draft District Plans — the need for NSRL and SWRLE corridors is identified
November 2017	Feedback from consultations and outcomes of technical investigations to define the location of recommended corridors
March 2018	Consult on recommended South West Rail Link Extension corridor from Leppington to North Bringelly and the North South Rail Line corridor from St Marys to Macarthur
Jul 2018 - Apr 2019	Refinement of exhibited South West Rail Link Extension and North South Rail Line corridor based on feedback from consultation
Next step	Lodge final Strategic Environmental Assessment with the Department of Planning, Industry and Environment

Figure 5-1 Key consultation phases

5.1 Initial investigation

Transport for NSW commenced corridor investigations in early 2014 and identified the potential for the South West Rail Link corridor to be extended northwards to the T1 Main Western Rail Line via a potential future Western Sydney Airport site, which at that time had not been confirmed, and to the south via Oran Park and Narellan. Initial consultation in 2014 also identified the strategic benefits of extending the corridor to the T8 Main South Rail Line near Macarthur.

The investigation process took into consideration data relating to demographics, future population forecasts, employment growth, development trends and travel patterns across western Sydney to establish key priorities for future rail connections. The process is outlined in the following sections.

5.1.1 Business requirements and design principles

A strategic business requirements specification for future transport infrastructure was developed to inform the development and assessment of the corridors. The strategic business requirements established assumptions and expectations for the following matters:

- Corridor widths, including:
  - Generally, a 60-metre corridor providing for twin track passenger railway with provision for future quadruplicating of the railway, and including allowance for station platforms and paid areas, but not for station concourses, buildings, or interchange or car parking facilities
  - Ancillary infrastructure, such as signalling equipment, access roads allowing for maintenance access for the operator on both sides of the corridor and substations, are to be accommodated within the corridor
  - Between Bringelly and Macarthur it is intended to provide for two tracks, so a 40-metre corridor width is to be adopted
- Likely future rolling stock and operating speeds, which influence the design (see strategic design principles below)
- Stabling, maintenance and construction requirements:
  - Sufficient space at an appropriate location will be required for a secure train facility to perform all necessary stabling, inspections, repairs, maintenance, cleaning (inside and out), administration and operations control for all trains serving the corridor. The exact requirements of stabling facilities will depend on the outcomes of detailed operational assessment. Some potential exists for expansion of the Rossmore Stabling Yard, and this has been allowed for
  - Sites of various sizes are needed for future construction. Primarily, these would be adjacent to specific work areas near structures, adjacent to main roads or under/ overpasses, and at the location of new stations and/or tunnel portals. Along the corridor, additional temporary construction compounds and access would be required
- Station locations to be informed by long-term strategic plans (see Section 2)
- Expected major arterial road upgrades to be accommodated (see Section 2)
- Identification of other key constraints expected to influence the corridor location and shape (see Section 3).

Building on the strategic business requirements specification, several planning and design principles were developed to inform the identification and analysis of the rail corridor alignments, they include:

- Strategic design principles:
  - Corridor design standards as detailed in Table 5-1
  - The corridors should facilitate integrated rail operations for customers
  - The corridors should be at-grade wherever possible; elevated track and tunnels should be minimised
  - Platforms should allow for 12-carriage suburban train sets and preferably be 245-metre long island platforms

- The corridor should facilitate efficient and cost-effective delivery and operation of the future infrastructure. Construction risks associated with future infrastructure delivery should be minimised and/or manageable
- Earthworks and engineering structures should be minimised, and optimised across the length of the corridors
- The corridors should facilitate future network expansion
- The corridors should promote efficient operation and maintenance of rail infrastructure

- Strategic planning principles:
  - The corridors should facilitate station locations that provide opportunities for integrated land use development around them
  - The corridors should provide opportunities for well-located stations that serve their identified or assumed role in the transport network appropriately. A station spacing of 2.5 to four kilometres should be the target station spacing where achievable
  - Stations should be situated in cuttings to minimise impact on surrounding road networks and development, also reducing amenity impacts
  - Stations should be located on straight track, and where possible the straight track at stations should extend beyond the platform ends to allow station locations to be optimised up or down the line in response to land use planning outcomes.

Table 5-1 Corridor design criteria

Criteria	Value
Design speed	125 kilometres per hour
Curvature (minimum)	800 metres
Gradient (maximum)	1.5 per cent
Surface station gradient	0.5 per cent
Underground station gradient	0.0 per cent

5.1.2 Initial public consultation

In 2014, Transport for NSW consulted with stakeholders and the community on a corridor study area to help identify the constraints and opportunities. The consultation program was supported by an advertising campaign to raise awareness and to encourage community participation by attending a community information drop in session and providing feedback. Other consultation activities included meetings with key stakeholders including industry groups, local councils, and major landowners. Key outcomes from these preliminary consultations were:

- That the North South Rail Line corridor north of the Western Sydney Airport should be deferred and its consideration coordinated with that of the Western Sydney Airport and Outer Sydney Orbital
- A study area was identified south of Narellan towards the T8 Main South Rail Line near Macarthur.

5.1.3 Corridor identification and assessment process

The corridor identification and assessment process are summarised in Figure 5-2. The process focussed on identifying and assessing the best possible at-grade or surface corridors to meet the strategic business requirements. Consultation within government and other key stakeholders was ongoing through the process.

Rail corridor alignments were developed following detailed mapping and assessment of land use, environmental, infrastructure and other constraints. The process of refining and assessing potential corridor alignments took into consideration feedback, comments and suggestions captured during public consultations with other NSW Government agencies, stakeholders and the community (see Section 5.4 for further details of the consultation undertaken.

Potential corridor alignments progressed through a review and filtering process to identify major flaws or non-compliances in relation to strategic business requirements and design principles. The alignments were then put through a qualitative assessment to generate a short-list of suitable alignments.

The final stages of the assessment involved a multi-criteria assessment that was used to rank alignments on the short list. The criteria covered transport, land use planning and environmental criteria.

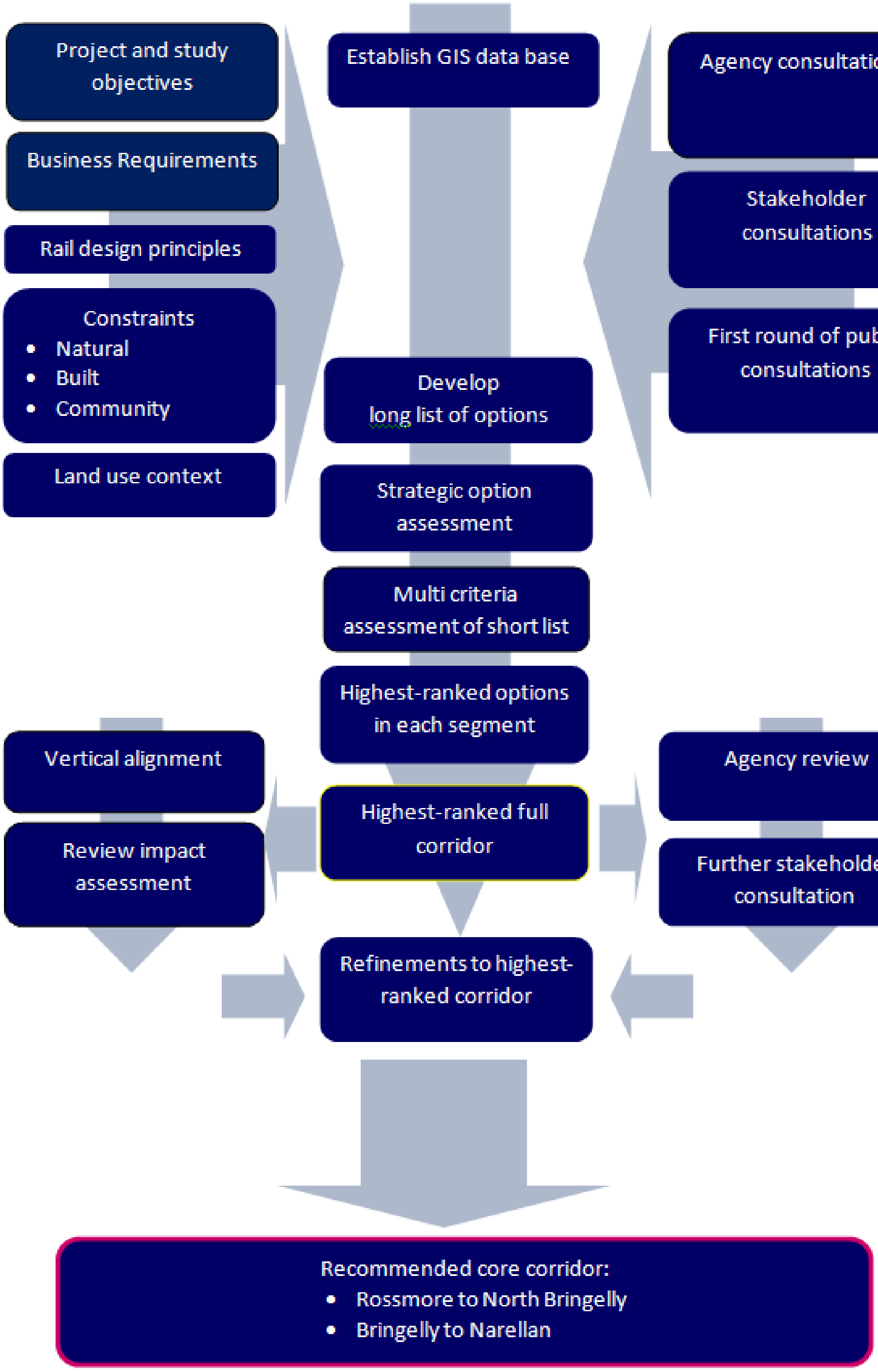

Figure 5-2 Corridor identification study approach

5.2 The 2015 recommended corridor

The highest-ranked corridor between Rossmore, Bringelly and Narellan was displayed for community consultation in 2015. This corridor is known as the '2015 recommended corridor' and is shown in Figure 5-3. Study areas were also identified north of the Western Sydney Airport and south of Narellan T8 Main South Rail Line.

Consultations consisted of briefings to councils, stakeholders and key interest groups, drop-in sessions for the general community, and a broad community awareness campaign through printed and electronic media, inviting feedback. Landowners within the 2015 recommended corridor were offered one-on-one briefings.

More than 1500 submissions were received from landowners, the broader community, councils, stakeholders, industry and interest groups, and other government agencies during and after the community consultation period.

Nearly all the submissions received in relation to the 2015 recommended corridor between Oran Park and Narellan were opposed to a surface corridor and suggested a tunnel section to avoid existing and planned housing. Many submissions argued that the extent and speed of urban development in these areas meant that it was too late to find a surface corridor. The overwhelming view was that a suitable surface corridor could not be identified without unacceptable socio-economic, environmental and financial impacts on the local community.

The 2015 recommended corridor was reviewed in light of the feedback obtained during the community consultation period. A summary of the key issues raised in submissions on the 2015 recommended corridor is provided in Table 5-2, including how the issues were considered in the refinement of the corridors. The key refinements made to the 2015 recommended corridor as a result were:

- West of the Rossmore Stabling Yard the South West Rail Link Extension corridor was straightened to reduce rail operating and maintenance costs, and to improve the opportunity for a possible future Rossmore Station
- A commitment made by the NSW Government on 23 November 2015 that any future rail line between Oran Park and Harrington Park would be in tunnel. A potential future tunnel south of Oran Park would be limited to a single track in each direction and could comprise either one twin track tunnel or two single track tunnels.

The decision to consider tunnel south of Oran Park significantly reduced the direct impacts on existing and proposed land uses south of Oran Park, and reduced impacts on significant environmental and heritage constraints in this area. Many submissions advocated for a tunnel south of Oran Park, and the decision to commit to this is a key measure taken in response to the concerns raised by the community. However, the whole of life cost of tunnel rail infrastructure is substantially higher than for surface rail infrastructure.

A tunnel also means that an alternative station location could be identified closer to Oran Park Town Centre. The proposed station location is now immediately west of the future town centre (see Section 7.1.2.3 and Figure 7-2 for land use details of Oran Park Station).

The proposed location of future stations at Oran Park and Narellan provide fixed points for a future tunnel connection. At this stage, the location of tunnel between Oran Park and Narellan and further south to Macarthur is indicative only. To identify a future tunnel location, significant geotechnical investigations are required together with detailed engineering design. This work is required closer to the time when rail infrastructure is needed.

Table 5-2 Key issues raised in submissions on the 2015 recommended corridor

Issue raised in submissions	How issues were addressed	Reference
Impacts on vegetation immediately west of Rossmore Stabling Yard	Vegetation on this property has already been bio-certified under the State Environmental Planning Policy (Sydney Region Growth Centres) 2006.	Section 4.9 Section 7.7
Corridor alignment and station location between Rossmore	Corridor has been realigned to improve operations and share property impacts.	Section 7.1

Issue raised in submissions	How issues were addressed	Reference
Stabling Yard and South Creek, and related property impacts		
The need and potential for a three-way junction at Bringelly	A three-way junction at Bringelly is unlikely to be required based on likely future operational services. The final recommended corridors do not allow for a three-way junction at Bringelly.	Section 5.3.2.2
The crossing of Bringelly Road	The crossing location minimises impacts on Bringelly Road.	Section 7.3
Crossing of flood storage dams	Flood storage dams have been avoided by relocating Oran Park Station further to the west.	Section 7.6
Interactions of the rail corridor with Jersey Road	The corridor has been designed to require only a single crossing of Jersey Road.	Section 7.3
Implications for housing delivery at Oran Park	The corridor has been moved into areas subject of future precinct planning, and away from areas where it will impact on the short-term delivery of housing at Oran Park.	Section 7.1
Impacts on Anglicare Chesalon retirement village at Oran Park	This section of the corridor is now in tunnel and moved to the west and will not impact on the Anglicare Chesalon retirement village.	Section 7.1
Impacts on existing landowners and/or residents in Oran Park	This section of the corridor is now in tunnel and will not impact on existing landowners and/or residents in Oran Park.	Section 7.1
Impacts on existing residences and subdivisions under development in Harrington Grove	This section of the corridor is now in tunnel and will not impact on existing landowners and/or residents in Harrington Grove.	Section 7.1
Impacts to Harrington Forest	This section of the corridor is now in tunnel and will not impact on Harrington Forest.	Section 7.7
Impacts to the Orielton Homestead	This section of the corridor is now in tunnel and will not impact on the Orielton Homestead.	Section 7.8
Impacts to the future Narellan Sports Hub	This section of the corridor is now in tunnel and will not impact on the Narellan Sports Hub.	Section 7.1
Impacts to businesses fronting The Northern Road and within the Narellan industrial area	The construction of tunnel and a new Narellan Station will still provide an opportunity to revitalise the Narellan industrial area. Until the land is required for construction of the infrastructure, existing businesses will be able to continue operating.	Section 7.1

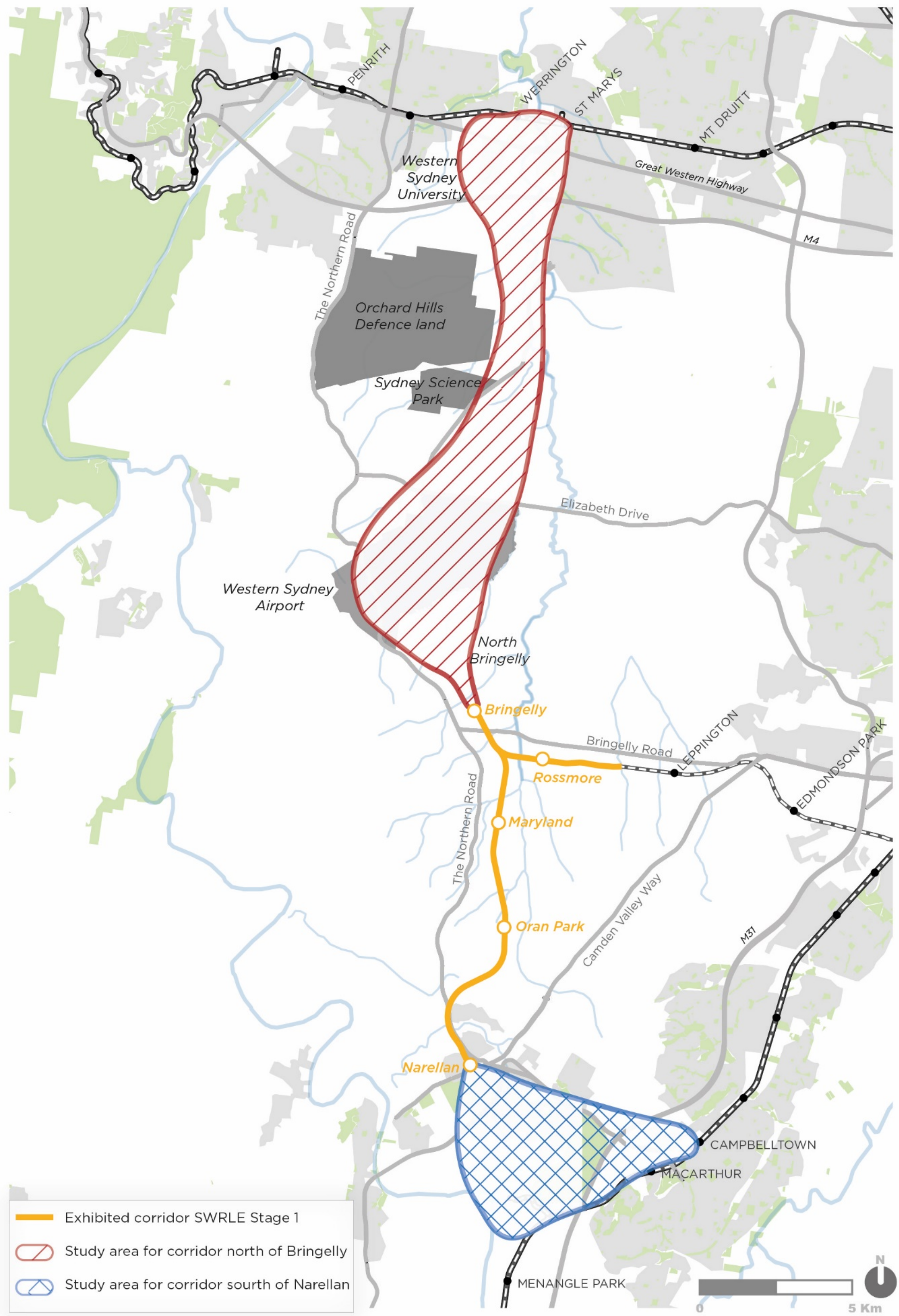

Figure 5-3 2015 recommended corridor

Source: Transport for NSW (2015)

5.3 The 2018 exhibited corridors

The North South Rail Line and South West Rail Link Extension corridors were the subject of further public consultation from 26 March 2018 to 1 June 2018. These corridors are known as the '2018 exhibited corridors' and are shown in Figure 5-4.

The 2018 exhibited North South Rail Line corridor provided connections between the T1 Main Western Rail Line near St Marys, Western Sydney Airport, Oran Park, Narellan and the T8 Main South Rail Line near Macarthur. The 2018 exhibited South West Rail Link Extension corridor extended from Leppington to Badgerys Creek Aerotropolis Station to interchange with the North South Rail Line. The 2018 exhibited corridors are described in detail below.

5.3.1 North South Rail Line northern section

A 60-metre wide corridor was exhibited for the North South Rail Line between St Marys and the Western Sydney Airport.

The 2018 exhibited North South Rail Line corridor proposed tunnel from St Marys to Orchard Hills. No land take was required at the surface in this section of the 2018 exhibited North South Rail Line corridor. Further land may be required in the future to facilitate stations and interchange facilities and the construction and operation of the future rail infrastructure.

The 2018 exhibited North South Rail Line corridor surfaces near Lansdowne Road, Orchard Hills. The surface rail corridor would then follow a southerly direction, partially co-locating with the proposed Outer Sydney Orbital corridor, through agricultural land, passing to the east of Erskine Park Quarry and Stockdale Road and crossing over Blaxland Creek.

Just north of the Warragamba-Prospect Pipeline the 2018 exhibited corridor curves slightly to the west and then continues across the twin pipes to enter the Sydney Science Park site. The 2018 exhibited corridor passes through the eastern section of the Sydney Science Park site and then curves towards the east where it crosses Cosgroves Creek.

On the southern side of Cosgroves Creek, the 2018 exhibited corridor continues in a southern direction to the west of Badgerys Creek. The corridor enters the future Western Sydney Airport site just east of the intersection of Elizabeth Drive and Badgerys Creek Road.

5.3.2 North South Rail Line southern section and South West Rail Link Extension

5.3.2.1 Rossmore to Bringelly

The 2018 exhibited South West Rail Link Extension corridor would accommodate a future railway from the existing Rossmore Stabling Yard, extending west and north-west, before terminating at Badgerys Creek Aerotropolis Station.

The 2018 exhibited corridor proposes a 60-metre wide corridor to accommodate up to four railway tracks (two in each direction).

5.3.2.2 Bringelly to Badgerys Creek Aerotropolis Station

The 2018 exhibited North South Rail Line and South West Rail Link Extension corridors merge west of South Creek and south of Bringelly Road, away from the Bringelly and Rossmore town centres.

The 2018 exhibited corridors run in parallel from where they merge at Bringelly to Badgerys Creek Aerotropolis Station. At Badgerys Creek Aerotropolis Station customers would be able to transfer between train services operating to Rossmore and Oran Park.

5.3.2.3 Bringelly to Oran Park

From Bringelly, the 2018 exhibited North South Rail Line corridor travels due south to Oran Park. The 2018 exhibited corridor was proposed to be 40 metres wide, with the capacity for two railway tracks (one in each direction).

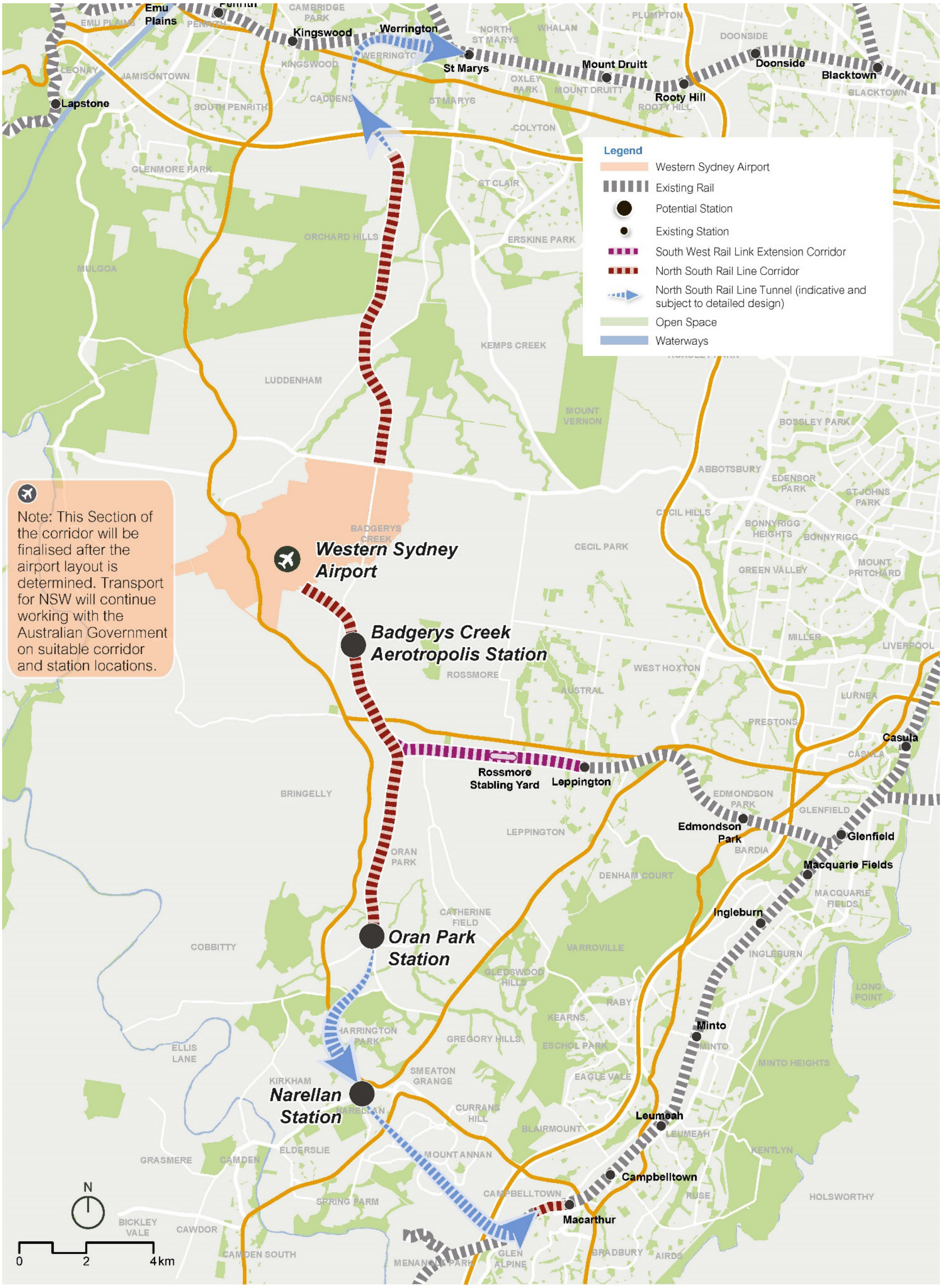

Figure 5-4 2018 exhibited North South Rail Line and South West Rail Link Extension corridors

5.3.2.4 Oran Park to Macarthur

The tunnel section of the 2018 exhibited North South Rail Line corridor from Oran Park to Macarthur was indicatively identified only. From Oran Park it headed south to Narellan Station, then south-east before emerging to the surface within the existing rail corridor near Macarthur Station. However, the location of Narellan Station was specified, together with an associated construction site.

The tunnel section of the 2018 exhibited North South Rail Line corridor would generally not require land take at the surface, except for station, portal and construction sites at Narellan and Macarthur. It is likely that the proposed tunnel would be bored at depths exceeding 30 metres in most places.

The southernmost end of the 2018 exhibited North South Rail Line corridor near Macarthur Station was above ground and was predominantly located within the existing T8 Main South Rail Line corridor. A section of the existing rail corridor alongside Menangle Road to the west of Macarthur Station would need to be widened to accommodate the North South Rail Line.

No additional stations were identified between Narellan and Macarthur. South of Narellan, the potential impacts on existing residential areas because of any future station development would be significant.

5.3.3 Railway stations

Station locations need to align with the overall precinct planning objectives, taking into account factors such as transfers between modes and lines, as well as urban planning for existing or new town centres, local transport access, future property ownership boundaries and topography. Stations within urban areas are preferably on viaduct or situated in cuttings to minimise impact on surrounding road networks and development, also reducing amenity impacts.

Further detailed understanding of station drivers (including the role and function of a particular station based on elements including station catchments and passenger demand, as well as the broader network operational analysis), will allow further refinement of station characteristics including platform size and station access points.

With consideration of these design principles, future station design is likely to reflect recent station developments in Sydney, such as Edmondson Park Station, shown in Figure 5-5.

The corridor width can accommodate a standard station layout and station locations can ‘slide’ along the corridor to meet the final desired locations. Urban design and place making opportunities immediately around stations will also be considered. The number and location of stations will be considered as part of business case development for the future rail lines.

Figure 5-5 Edmondson Park Station

5.4 Consultation – 2018 exhibited corridors

5.4.1 Community and stakeholder consultation – Recommended corridors March 2018 – June 2018

On 26 March 2018 the Government announced a series of recommended transport corridors for Western Sydney, including the North South Rail Line and South West Rail Link Extension.

Potentially impacted property owners, the community and stakeholders were invited to provide comment on the recommended corridors between 26 March 2018 and 1 June 2018.

Consultation activities were undertaken during this period in conjunction with the exhibition of corridors proposed for the Outer Sydney Orbital and the Bells Line of Road – Castlereagh Connection. These consultation activities are described in the following sections.

Property owner consultation

The project team visited 510 potentially impacted owner-occupied properties in person to deliver an information pack that was relevant and specific to each property. The pack included a personalised letter, fact sheets and impact maps. 700 letters were also sent to other property owners located in the recommended corridors. These visits and packs also provided information on dates of community drop in sessions, outlined the various methods available to have your say and provide feedback.

Project "Have Your Say" communication tools

Community and stakeholders were provided with the opportunity to have their say on the recommended corridors via the following methods throughout the consultation period:

- Community infoline, enquiries email and mailing address – These details were included on all written communications that were distributed to the community. During the consultation period Transport for NSW received and responded to over 940 phone calls, 576 emails and 131 letters
- Project webpage – The project webpage included a summary of the proposed corridors, information on how to provide feedback and supporting information such as details of the community drop-in session, Frequently Asked Questions, draft strategic environmental assessments and maps for consultation. During the consultation period there were 60,845 hits to the project webpage
- Collaborative mapping tool – An interactive online map, accessed via the project webpage, allowed the community and stakeholders to view proposed corridor locations and to provide their feedback. More than 4,352 comments were received using the online map.

Email blast

At the commencement of the consultation period an email blast was sent to registered and key stakeholders to inform them of the commencement of consultation and to direct them to the project webpage.

Project newsletter

A project newsletter was distributed to more than 1500 properties near the proposed recommended corridors. The project newsletter was also included in the information packs provided to potentially impacted property owners and was made available in community drop-in sessions.

Advertisements

Advertisements were placed in local newspapers in March and April 2018 to inform the community about the recommended corridors and the methods available to provide comment. These included:

- The Western Weekender
- Hawkesbury Gazette
- Penrith Press
- Rouse Hill Times

- Blacktown Advocate
- St Marys Mount Druitt Standard
- The District Report
- Macarthur Chronicle
- Liverpool Leader
- Fairfield Advance.

Community drop-in sessions

Thirteen community drop-in sessions were held during the consultation period. Notification of the community drop-in sessions was provided via the information pack provided to potentially impacted property owners, in an email notification to registered stakeholders, in advertisements and on the Transport for NSW Corridors webpage.

Community drop-in sessions featured comprehensive display materials and were attended by project team members from Transport for NSW, technical specialists and property consultants and at times representatives for the Department of Planning, Industry and Environment; providing an overview of the project and opportunities for the community to ask questions and provide feedback from technical experts.

Details of the community drop-in sessions are summarised in Table 5-3.

Table 5-3 Community drop-in sessions

Venue	Date	Corridor/s	Approximate number of attendees
Kurrajong	4 April 2018	Bells Line of Road – Castlereagh Connection	200
Horsley Park	5 April 2018	Outer Sydney Orbital Western Sydney Freight Line	100
Luddenham	7 April 2018	North South Rail Line Outer Sydney Orbital	200
Camden	10 April 2018	North South Rail Line Outer Sydney Orbital	400
North Richmond	11 April 2018	Bells Line of Road – Castlereagh Connection	400
Bringelly	12 April 2018	North South Rail Line South West Rail Link Extension	200
Castlereagh	16 April 2018	Outer Sydney Orbital Bells Line of Road – Castlereagh Connection	250
Llandilo	24 April 2018	Outer Sydney Orbital Bells Line of Road – Castlereagh Connection	200
Camden	1 May 2018	North South Rail Line Outer Sydney Orbital	250
Guildford	3 May 2018	Western Sydney Freight Line	20
Berkshire Park	8 May 2018	Outer Sydney Orbital Bells Line of Road – Castlereagh Connection	200
St Marys	14 May 2018	North South Rail Line Outer Sydney Orbital Bells Line of Road – Castlereagh Connection	150
Oakville	16 May 2018	Outer Sydney Orbital	250

Most of the drop-in sessions became public meetings when the crowd numbers reached the capacity of the venue.

One-on-one contact with potentially impacted property owners
The project team were available to discuss one-on-one with potentially impacted property owners. More than 250 one-on-one meetings were held during the consultation period.

Key stakeholder meetings
Meetings were held with key stakeholders including:

- Wollondilly Shire Council
- Campbelltown City Council
- Fairfield City Council
- Camden Council
- Penrith Council
- Community Action Groups and Community Resident Associations.

A range of Government authorities and agencies were consulted before and throughout the consultation period. This included the Department of Infrastructure, Transport, Cities and Regional Development.

5.4.2 Key considerations for the 2018 exhibited corridors

A summary of the key design issues raised in submissions on the 2018 exhibited North South Rail Line and South West Rail Link Extension corridors is provided in Table 5-4. Section 5.5 outlines how these issues have been addressed.

Table 5-4 Key issues raised in submissions on the 2018 exhibited corridors

Area of concern	Issues raised in submissions	Reference
Property and local character impacts at Orchard Hills	Request to put the North South Rail Line in the Outer Sydney Orbital corridor Request to extend the Werrington tunnel southwards to minimise impacts on Orchard Hills	Section 5.5.1
Southern tie-in of Western Sydney Airport to the proposed North South Rail Line alignment	Request to take the rail corridor through vacant blocks not homes and to better utilise the large lots in North Bringelly	Section 5.5.2
South West Rail Link Extension	Property owners who were not previously impacted by the 2015 recommended corridor but newly impacted by the 2018 exhibited corridor requesting a return to the 2015 recommended corridor Various property owners requesting reduced impacts on their properties	Section 5.5.3
Alternative routes	Various submissions requested alternative routes for the North South Rail Line	Section 5.5.5
Station locations	Submissions requesting or supportive of stations at particular locations	Section 5.5.6

5.5 Refinement of the 2018 exhibited corridors

Following exhibition of the 2018 exhibited corridors and consultation undertaken with affected property owners, several refinements have been made to the 2018 exhibited corridors.

5.5.1 Orchard Hills

Seventy to eighty per cent of submissions received about the North South Rail Line corridor were from communities near Orchard Hills, including a petition with 271 signatures. Most the submissions were concerned with property impacts and a reduction in the amenity of the area. Several submitters made specific requests for changes to the position on the corridor, these included:

- Move the corridor eastwards into the proposed Outer Sydney Orbital corridor
- Extend the tunnel under Western Sydney University Penrith campus southwards.

As part of the review of submissions the position of the tunnel portal at Orchard Hills was considered. The review suggested that the tunnel would need to extend approximately two kilometres further south, almost to Patons Lane. This is due to the topography and the geotechnical conditions associated with a creek.

Consideration was also given to moving the North South Rail Line corridor to share the Outer Sydney Orbital corridor. The Outer Sydney Orbital corridor is in the South Creek floodplain with the infrastructure on long viaducts. While this co-location of infrastructure would consolidate the property and environmental impacts of the transport infrastructure, it is unlikely to provide a suitable environment for railway stations as the walk-up catchment would be compromised by the South Creek floodplain. This would limit opportunities for stations between Western Sydney Airport and St Marys and provide poor access to public transport to those communities emerging in this area.

Due to these submissions, further refinement has been undertaken at Orchard Hills. The final recommended corridor straightens the alignment to reduce the impacts on property.

There were several submissions, including from Penrith City Council, advocating for the land use opportunities that a new station at the University of Western Sydney Penrith campus would provide. However, further analysis as part of the business case activities needs to be undertaken weighing up the land use benefits against the increased capital and operational costs.

5.5.2 North Bringelly

Several suggestions were made to adjust the 2018 exhibited North South Rail Line corridor at North Bringelly, primarily to minimise property impacts. The following options were identified by the community:

- Shifting the corridor north to use vacant blocks
- Straightening the alignment to provide a direct route to North Bringelly
- Co-locating the corridor with The Northern Road corridor
- Tunnelling under North Bringelly.

All the above options have been considered against the following factors:

- Property impacts: Including the total number of impacted properties and newly impacted properties
- Engineering/rail operations: Based on maintaining acceptable vertical and horizontal geometry
- Preferred station location: Based on preferred location for a station to support the Western Sydney Aerotropolis.

During the consideration of the alternative options there was consultation with potentially impacted landowners.

A few submissions identified that the 2018 exhibited corridor would impact some agricultural business activities. Since the 2018 exhibition of the North South Rail Line corridor, the Department of Planning, Industry and Environment has released the *Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan, Stage 1: Initial Precincts*. This plan proposes flexible employment precincts in the area south of the airport. The uses within these flexible employment precincts would not be as sensitive to the impacts of rail infrastructure as the current uses. In addition, the precinct planning for this area could be integrated with the rail corridor. Therefore, the additional capital and operational costs associated with putting the rail infrastructure in tunnel to avoid land use impacts at the surface are not justifiable.

Several alternative alignments identified by the community for the North South Rail Line corridor south of the airport were analysed by developing them into engineered alignments and evaluating their impacts. The options assessed are shown in Figure 5-6 together with the 2018 exhibited corridor and include:

- Green Option: Minimal changes to the 2018 exhibited corridor, shifting the southern exit of the Western Sydney Airport further south
- Pink Option: Shifting the 2018 exhibited corridor further north but adopting a more southern bearing of the Western Sydney Airport southern exit
- Blue Option: A straightened alignment with the 2018 exhibited corridor shifted to the south-west and adopting a more southern bearing of the Western Sydney Airport southern exit.

Rail operation and engineering assessment

A comparison of the above options indicates that all are feasible from an engineering and operations perspective. Due to the introduction of back-to-back curves and the tighter curvature, the Pink Option is not preferred from an operations perspective, however, this is considered to be a minor issue.

Badgerys Creek Aerotropolis Station location

The Green and Pink options would enable Badgerys Creek Aerotropolis Station to be located on large land holdings central to the Western Sydney Aerotropolis. The Blue Option would require the station to be located on fragmented land to the west or flood affected land to the south, neither being central to the Western Sydney Aerotropolis.

Property impact assessment

The Green Option would have minor additional property impacts in terms of the numbers of properties affected, only two additional properties would be directly impacted compared to the 2018 exhibited corridor.

The Pink Option would have minor additional property impacts in terms of the number of properties affected, impacting four new properties which are not impacted by the 2018 exhibited corridor. However, the Pink Option would result in no newly impacted dwellings.

The Blue Option would result in significantly more properties in total being impacted than the 2018 exhibited corridor, including a large proportion of newly impacted properties as well as more dwelling impacted properties. The Blue Option has the highest overall property impacts and is not supported on that basis.

The assessment undertaken concluded that there are only minor differences between the Green and Pink options. However, the Pink Option results in slightly poorer rail engineering and operational characteristics, whilst also resulting in a higher number of newly impacted properties compared to the 2018 exhibited corridor. On balance, the Pink Option was therefore considered to perform marginally worse than the 2018 exhibited corridor.

The analysis confirmed that the three options investigated would not reduce the overall impact to properties and still achieve the required engineering standards.

In conclusion, the alternative alignments presented in submissions are not considered to offer a better engineering, land use and environmental outcome when compared with the 2018 exhibited corridor.

The final recommended corridor includes a minor change to the alignment of the 2018 exhibited corridor immediately south of the airport. This change was made to ensure that the corridor ties into the rail corridor through the airport while minimising property impacts. The modification entirely overlaps a small portion of the Green Option where it adjoins the airport.

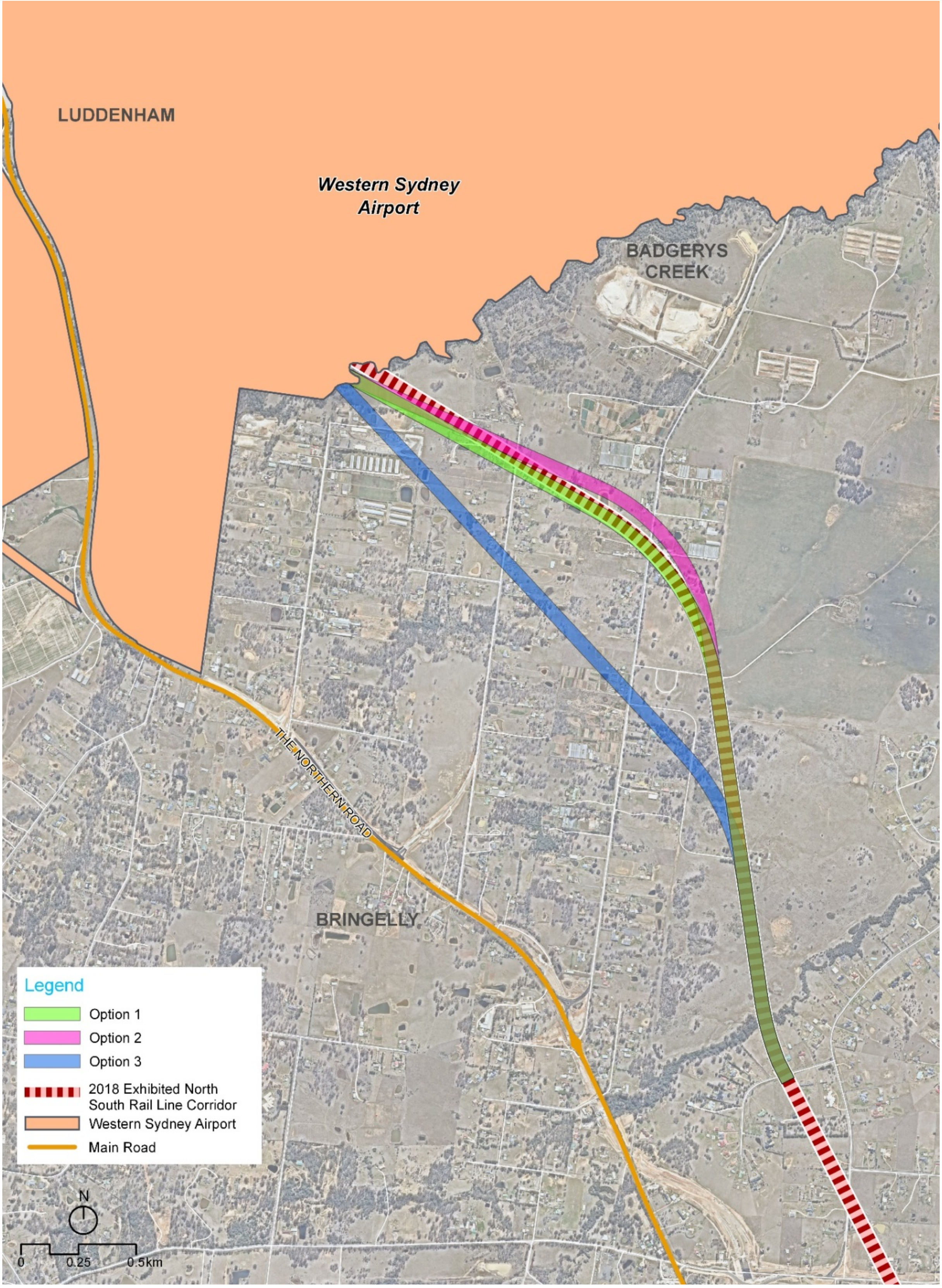

Figure 5-6 2018 exhibited North South Rail Line corridor refinement options

5.5.3 Oran Park Station

The final recommended North South Rail Line corridor has been moved east of the 2018 exhibited corridor by up to about 20 metres at Oran Park Station to avoid impacts to recent development in Oran Park town centre. About one kilometre of the corridor has been shifted eastward from north of Dick Johnson Drive to the Oran Park tunnel portal.

The location of Oran Park Station has been confirmed between Dick Johnson Drive in the north and Holden Drive in the south in the final recommended North South Rail Line corridor (see Figure 7-2).

South of Oran Park Station, the final recommended corridor has been extended by about 70 metres to include land between Peter Brock Drive and just north of Sargent Street. This minor extension of the corridor would provide a construction work site for the tunnel. It would also ensure that development does not occur at the surface that is incompatible with the future construction and operation of the tunnel where it is nearest to the surface.

The tunnel depth and alignment south of Oran Park Station will be the subject of further refinements to avoid impacts on existing development.

5.5.4 South West Rail Link Extension

After the 2015 exhibition there was a comprehensive process of considering alternative options for the South West Rail Link Extension corridor in response to submitters concerns and evaluating the impacts. This resulted in an alignment that shared property impacts between Allenby Road and Masterfield Street. Some of those who submitted on the 2015 exhibition did not submit on the 2018 exhibition as they considered that their 2015 submission has been addressed by the 2018 exhibited corridor.

Following the 2018 exhibition, both the new submissions and those from the 2015 exhibition were analysed. The amendments proposed to the 2018 exhibited corridor between Rossmore and Bringelly are very similar to the amendments assessed following the 2015 exhibition.

The submissions identified three potential refinements to the alignment of the exhibited South West Rail Link Extension corridor:

- Option 1: Revert to the 2015 recommended corridor (shown in pink in Figure 5-7)
- Option 2: Move the 2018 exhibited corridor to the south near the intersection of McCann Road and Allenby Road (green in Figure 5-7)
- Option 3: Narrow and shift the 2018 exhibited corridor south (red in Figure 5-7).

Figure 5-7 2018 exhibited South West Rail Link Extension corridor refinement options

The submissions were reviewed by representatives of TfNSW, including personnel who reviewed the 2015 submissions, to ensure consistency of approach. The assessment process followed the same method as that used to assess the 2015 recommended corridor to arrive at the 2018 exhibited corridor.

Each of the options was assessed in a multi-criteria analysis, and the only differences identified of any significance were in terms of property impacts, rail operations, and station location and function (see discussion below).

Property impacts

The major findings of the assessment in relation to property impacts are, compared to the 2018 exhibited corridor:

- Option 1 (the 2015 recommended corridor) would impact the fewest existing properties, as well as the fewest dwellings
- Options 2 and 3 would result in more properties in total being impacted than Option 1 but affect fewer properties than the 2018 exhibited corridor. Option 2 would also impact fewer dwellings than the 2018 exhibited corridor but still more than Option 1
- Options 2 and 3 would affect fewer properties than the 2018 exhibited corridor, but still impact a larger number of the properties with lower affectation than Option 1.

Rail operation and engineering assessment

The rail operation and engineering assessment was focused on identifying any overriding risks or disadvantages of each of the options in terms of rail engineering, construction and operation. The assessment was that there were no new considerations for rail operation and engineering beyond those assessed in the review of submissions on the 2015 recommended corridor previously. Overall, it was considered that each of the options could facilitate the delivery of a constructible and operable rail corridor, subject to detailed design.

The previous comparison of the 2015 recommended corridor and the 2018 exhibited corridor concluded that the 2015 recommended corridor, including a slight deviation to the south, was marginally inferior to the 2018 exhibited corridor, which is straight. The inference was drawn that Options 2 and 3, which also included a slight deviation, remained inferior to the 2018 exhibited corridor but that at this level of design the difference would be minimal.

Station impact assessment

The potential location and role of Rossmore Station is likely to be subject to review given recent strategic developments. As a result, the assessment has placed less emphasis on the need to provide optimum access to a Rossmore Station. Rather, it has been confirmed that each of the options being assessed has the potential to provide a suitable location for Rossmore Station on a straight length of track.

It has been assumed that the location of any station can only be confirmed in light of strategic direction and detailed land use planning, and that in the interim one location cannot be assumed, especially if that assumed location is likely to lead to adopting a corridor that has more severe property impacts than an alternative.

The assessment undertaken concluded that the 2015 recommended corridor had fewer property impacts than the 2018 exhibited corridor, option 2 or 3, but has inferior rail engineering and operation characteristics. Options 2 and 3 are considered to reduce the overall property impacts significantly compared to the 2018 exhibited corridor, whilst minimising the rail engineering and operational disadvantages of the 2015 recommended corridor.

Due to the reduced corridor reservation associated with Option 3, it is acknowledged that the property impacts associated with this option are less than Option 2, due to the reduced overall footprint of the corridor.

As a result of this assessment, the recommendation is Option 3, a localised narrowing of the 2018 exhibited corridor to reduce the impacts on existing dwellings but retaining similar rail operation and engineering characteristics.

5.5.5 Alternative routes

Several submitters identified alternative routes and/or projects that should be considered by Transport for NSW. All these submissions will be responded to in the Submissions Report. Campbelltown City Council's submission included a request to realign the North South Rail Line corridor to Menangle Park before terminating at Macarthur station. Transport for NSW has committed to evaluating this as part of the strategic business case for the project.

5.5.6 Station locations

Submissions requested stations at the following locations: Bringelly, Erskine Park, Harrington Park, Kingswood, Maryland, Mount Annan, Narellan, Rossmore, St Clair and the University of Western Sydney Penrith campus. These station locations will be considered as part of the business cases being undertaken for the project. Further information regarding the business cases is included in Section 5.8.

5.6 Description of the final recommended corridors

The final recommended corridors are described below.

5.6.1 North South Rail Line

The final recommended North South Rail Line corridor would generally be 60-metre wide between Lansdowne Road and the northern boundary of the Western Sydney Airport.

From Lansdowne Road, the final recommended North South Rail Line corridor would follow a southerly direction, co-locating with the proposed Outer Sydney Orbital corridor, through agricultural land, passing to the east of Erskine Park Quarry and Stockdale Road and crossing over Blaxland Creek.

Just north of the Warragamba-Prospect Pipeline the final recommended North South Rail Line corridor would curve slightly to the west and then continue across the twin pipes to enter the Sydney Science Park site. It would pass through the eastern section of the Sydney Science Park site and then curve towards the east where it crosses Cosgroves Creek.

On the southern side of Cosgroves Creek, the final recommended corridor would continue southward to the west of Badgerys Creek. The corridor enters the Western Sydney Airport just east of the intersection of Elizabeth Drive and Badgerys Creek Road.

South of the Western Sydney Airport, a 60-metre wide corridor would connect to the Western Sydney Aerotropolis at Badgerys Creek Aerotropolis Station.

At Badgerys Creek Aerotropolis Station, customers would be able to transfer to train services operating to Rossmore on the South West Rail Link Extension.

South of Badgerys Creek Aerotropolis Station, the final recommended North South Rail Line and South West Rail Link Extension corridors would proceed in parallel in a 60-metre wide corridor to where the corridors diverge at Bringelly.

South of where the final recommended corridors diverge at Bringelly, the final recommended North South Rail Line corridor would provide for two tracks in a 40-metre wide corridor at grade to Oran Park, and subsequently in tunnel that would return to the surface where it connects to the T8 Main South Rail Line just south of Macarthur Station.

5.6.2 South West Rail Link Extension

The final recommended South West Rail Link Extension corridor would accommodate a future railway from the existing Rossmore Stabling Yard, extending west to meet the final recommended North South Rail Line corridor at Bringelly. The final recommended corridor is generally 60 metres wide with some localised narrowing to accommodate up to four railway tracks (two in each direction).

Beyond Bringelly, the final recommended corridor would proceed in a northerly direction parallel to the final recommended North South Rail Line corridor before terminating at Badgerys Creek Aerotropolis Station.

At Badgerys Creek Aerotropolis Station, customers would be able to transfer to train services operating to Oran Park and St Marys on the North South Rail Line.

5.7 Future consultation

Further consultation will be undertaken as the project proceeds towards delivery. Any future proposal to build and operate a rail line in the corridors would be required to be subject to a comprehensive environmental assessment in accordance with the provisions of the *Environmental Planning and Assessment Act 1979*. At this time, environmental impacts in relation to noise, air quality, impact on native flora and fauna and visual amenity would be subject to technical expert assessment in accordance with the procedure for State Significant Infrastructure, resulting in the preparation of an environmental impact statement. Comprehensive community and stakeholder consultation would be carried out in the preparation and assessment of the environmental impact statement.

5.8 Business cases

A business case is being prepared for the North South Rail Line project. The strategic business case will consider the full rail line from Schofields to Macarthur. It will consider both the numbers of stations and the general location of the stations. It will also make recommendations on the staging and timing of the rail infrastructure.

The final business case of the first stage will consider the rail line from St Marys to the Aerotropolis Core via Western Sydney Airport. This business case will be undertaken by Sydney Metro and include consideration of a number of alignment options between St Marys and Lansdowne Road, including a Werrington alignment and an alignment generally consistent with the Outer Sydney Orbital corridor.

6 Environmental assessment of the northern study area

This section provides a strategic assessment of each of the potential environmental impacts associated with protection of the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport. An assessment is provided for the following environmental factors:

- Land use and property impacts
- Economic impacts
- Traffic and transport
- Noise and vibration
- Visual amenity, built form and urban design
- Soil and water
- Biodiversity
- Heritage
- Air quality
- Social impacts.

6.1 Land use and property impacts

This section identifies the existing land uses and potential property impacts within and next to the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport. It describes how potential impacts have been avoided, minimised or offset to reduce any impact associated with the protection of the final recommended North South Rail Line corridor. This section also considers possible future land use changes or opportunities due to potential future infrastructure within the final recommended North South Rail Line corridor, and any measures to minimise any future impacts.

The final recommended North South Rail Line corridor overlaying land use in the northern study area is shown in Figure 6-1.

6.1.1 How impacts have been avoided

The potential land use impacts of a future north-south rail link would be minimised by co-locating parts of the final recommended North South Rail Line corridor with the proposed Outer Sydney Orbital and Western Sydney Freight Line corridors, as shown in Figure 6-1.

The potential co-location of future road and rail infrastructure should minimise land taken for transport infrastructure compared to it being developed in separate corridors. It should also reduce the occurrence of property severance. Co-location of road and rail infrastructure would also combine the potential future noise, air quality and visual impacts of the construction and operation of this infrastructure, which should reduce the number of potentially impacted sensitive receivers compared to this infrastructure being developed in separate corridors.

6.1.2 Property impact assessment

Property impacts would occur within and surrounding the surface section of the final recommended North South Rail Line corridor due to the construction and operation of the North South Rail Line. Specific impacts at key locations along the final recommended corridor are described in the following sections.

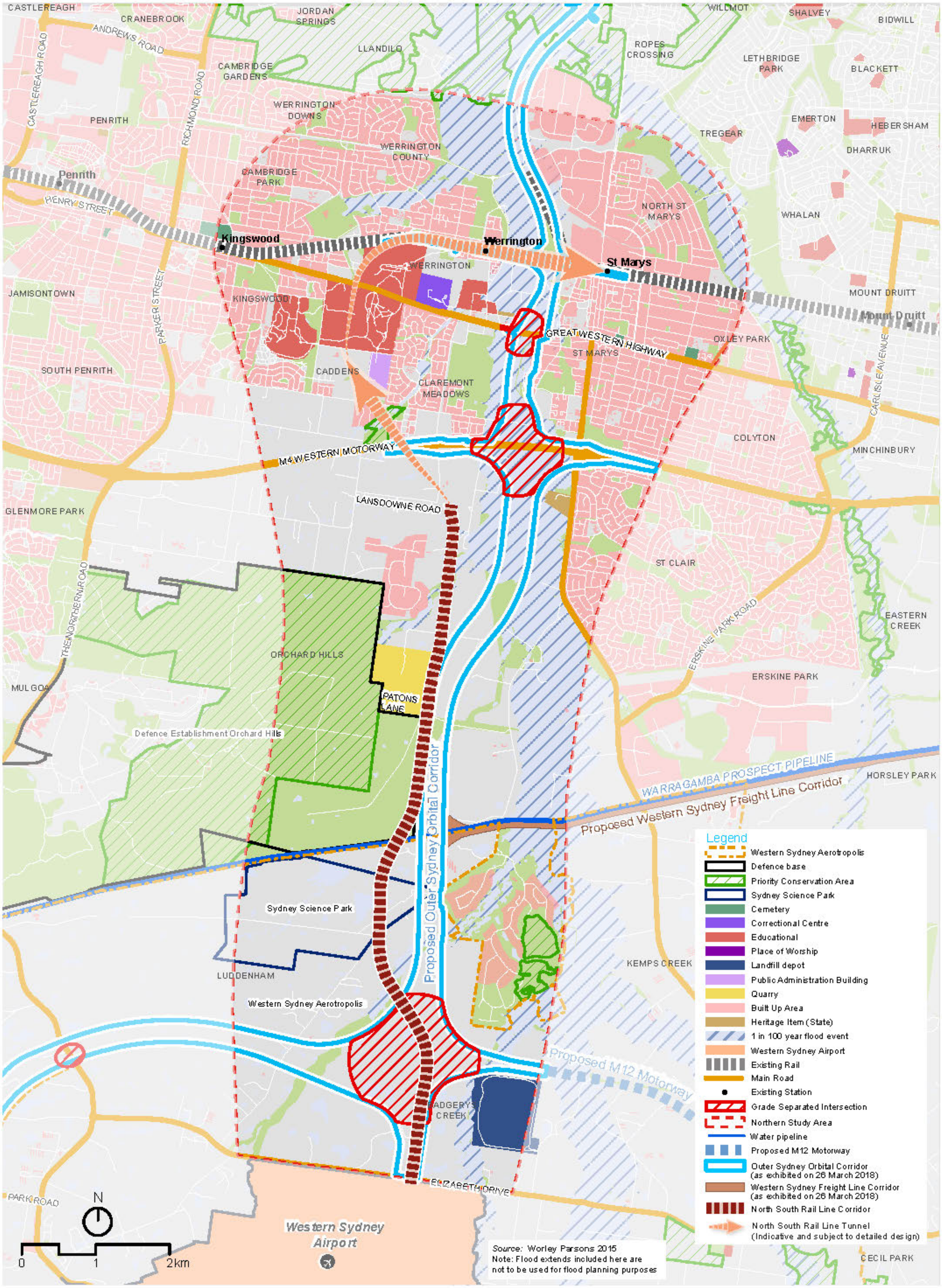

Figure 6-1 Final recommended North South Rail Line corridor overlaying land use in the northern study area

Lansdowne Road, Orchard Hills, to Badgerys Creek

The final recommended North South Rail Line corridor between Lansdowne Road, Orchard Hills, and the Western Sydney Airport would directly impact 27 properties, most of which are rural residential and agricultural properties in Orchard Hills, Luddenham and Badgerys Creek. Most of these properties are located within proposed or potential urban development areas and are expected to experience major land use changes in the future.

As discussed in Section 2.3, land between Orchard Hills and Badgerys Creek has been identified for future urban development as part of the Western Sydney Aerotropolis and planning for a new growth area for the Greater Penrith to Eastern Creek Corridor.

Given the major future land use change that may occur around the directly impacted properties, an assessment of the viability of continuing the current land use on residual land parcels has not been carried out. It is expected that residual parcels would be amalgamated as part of a possible future precinct planning and development process.

Land use between Lansdowne Road, Orchard Hills, and Badgerys Creek would also be impacted by other proposed and potential new transport corridors that have also been identified for this area including:

- Outer Sydney Orbital corridor
- Western Sydney Freight Line corridor
- M12 Motorway
- The Northern Road upgrade
- Elizabeth Drive improvement works.

The potential land use impacts of these transport corridors are proposed to be minimised by in part locating the final recommended North South Rail Line within the proposed corridor being investigated for the Outer Sydney Orbital at Orchard Hills and Badgerys Creek, as shown in Figure 6-1 . Twelve of the 27 properties directly impacted by the final recommended North South Rail Line corridor between Orchard Hills and Badgerys Creek are also directly impacted by the proposed Outer Sydney Orbital corridor.

The potential co-location of future road and rail infrastructure would minimise land take for transport infrastructure compared to it being developed in separate corridors. It would also reduce the occurrence of property severance. Co-location of road and rail infrastructure would also combine the potential future noise, air quality and visual impacts of the construction and operation of this infrastructure, which would reduce the number of potentially impacted sensitive receivers compared to this infrastructure being developed in separate corridors.

The *Western City District Plan* and *Future Transport Strategy 2056* provide a coordinated approach to planning for urban development areas and transport corridors within the growth areas, including land between Orchard Hills and Badgerys Creek. This coordinated approach will minimise the future potential land use impacts of the North South Rail Line by ensuring that the development of land near the corridor is compatible with a future railway.

Sydney Science Park, Luddenham

Sydney Science Park is located within the Western Sydney Aerotropolis at Luddenham. The planned research and development centre covers 280 hectares on a site that is bounded by the Warragamba-Prospect Pipeline to the north, Twins Creek Estate to the east, and rural residential properties to the west. The proposed Outer Sydney Orbital Motorway would run along the eastern boundary of the site.

The development of Sydney Science Park is focused on providing education, research and development facilities, science-based companies and employment opportunities, and some mixed residential and student accommodation within the town centre (Elton Consulting, 2013). The Sydney Science Park Master Plan is shown in Figure 6-2. The master plan includes the final recommended North South Rail Line corridor.

Figure 6-2 Sydney Science Park Master Plan

Source: Penrith City Council (2015b) Planning Proposal – Sydney Science Park Volume 1

Western Sydney Airport

The Western Sydney Airport will deliver up to 3200 jobs during construction and about 9000 airport jobs during operation over the next 20 years. The Airport is expected to support about 28,000 jobs by 2031, which will grow to nearly 48,000 by 2041. This includes 5600 jobs in manufacturing, 6450 in retail and 5600 in professional, scientific and technical services.

At full operation, the airport will create at least 60,000 jobs, as well as logistics, trade, aerospace and defence, advanced manufacturing and tourism. The ultimate ambition is for Western Sydney Airport to be the catalyst for the development of the Western Sydney Aerotropolis.

6.1.2.1 Future railway stations

Potential railway stations will be investigated along the final recommended North South Rail Line corridor. The consideration will require a strong focus on integrating land use and transport planning to ensure land uses near stations are compatible with the potential noise, traffic and visual impacts of stations and opportunities for transport interchange are maximised.

6.1.2.2 Crown land

No Crown land is impacted by the final recommended North South Rail Line corridor between Lansdowne Road, Orchard Hills, and the Western Sydney Airport.

6.1.3 Mitigation measures

Transport for NSW will continue to be involved in land release and precinct planning processes to ensure that new land uses are compatible with a future railway. Potential land use controls for inclusion in the relevant environmental planning instrument are discussed in Section 9, and will be subject to consultation with the relevant councils, the Department of Planning, Industry and Environment and the broader community.

To minimise land use conflicts associated with amenity impacts of the future infrastructure components and railway operations, planning authorities will consider locating employment, industrial and regional open space uses adjacent to the final recommended North South Rail Line corridor.

6.2 Economic impacts

This section provides an overview of the potential economic impacts and opportunities that may be created by future infrastructure in the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport. This section also considers economic impacts of future North South Rail Line infrastructure on the wider region, with a view to short, medium and long-term impacts.

6.2.1 Expected economic benefits

The future provision of public transport infrastructure and services within the final recommended North South Rail Line corridor is expected to be a catalyst to the transformation of western Sydney into the Western Economic Corridor envisaged in the *Greater Sydney Region Plan* and *Western City District Plan*. Future North South Rail Line infrastructure will form the backbone of the public transport system in the Western Economic Corridor by enabling the movement of large numbers of people efficiently and effectively. The North South Rail Line will be a major contributor to the sustainable and efficient economic development of the Western Economic Corridor by bringing people closer to jobs, health and education services and leisure activities.

The final recommended North South Rail Line corridor would facilitate future public transport infrastructure connecting to key existing and planned housing and employment centres, as well as providing for potential further expansion and additional public transport connections. In particular, the final recommended North South Rail Line corridor responds to the need to connect workers and residents to the Western Economic Corridor including to the Western Sydney Airport and Western Sydney Aerotropolis. The potential future provision of public transport infrastructure to these centres would have several benefits for employment capacity and the economy:

- Delivering additional development capacity for employment-generating land uses
- Delivering additional dwellings in transit-oriented development around new transport nodes, increasing the demand for local employment-supporting services
- Increasing the broader population catchment able to access the region for employment by public transport, increasing the ability of businesses to access potential employees and customers.

According to the *State Infrastructure Strategy Update 2014* (Infrastructure NSW, 2014), congestion costs Sydney around $5 billion a year, and is set to grow to $8 billion a year by 2020 if no mitigating action is taken. Major expansions of the public transport network such as a future North South Rail Line will provide the key to mitigating the future cost of congestion.

The *Western Sydney Rail Needs Study* has identified the need for additional rail investment in western Sydney over the longer term to address capacity constraints on the existing rail network, expand the coverage of the network and shape the development of western Sydney. The provision of rail in western Sydney will cater for the forecast population growth, offer opportunities for the development of increased housing supply, increase access to jobs and provide the necessary transport infrastructure to support the growth of the region over the coming decades.

New rail links in western Sydney will drive employment and mitigate the need to travel east towards the Harbour CBD. Rail links, with complementary land use planning, can provide local jobs based around new and existing centres with increased accessibility. Western Sydney Airport will also help generate jobs directly and indirectly related to its construction and operation phases.

The *Western Sydney Rail Needs Scoping Study* specifically discusses the options for a rail public transport connection to the Western Sydney Airport. Western Sydney Airport will deliver a major economic boost to the region and an effective public transport connection is seen to be key to the success of the airport, as well as to support the forecast growth of western Sydney.

The Western Sydney Airport is expected to generate 9000 direct jobs by the early 2030s and this is expected to increase to 60,000 jobs by 2063. In addition to this, Western Sydney Airport is expected to directly generate $77 million, and $145 million for the rest of Sydney by the 2030s. By 2063, Western Sydney Airport will boost the western Sydney economy by $1.5 billion a year and $4.6 billion Sydney-wide.

Based on these forecast economic benefits, a rail connection will enable the successful operation of the future Western Sydney Airport. The *Western Sydney Rail Needs Scoping Study* notes that areas of economic activity in western Sydney have the potential to grow due to the Western Sydney Airport; however, businesses often cite poor transport connections as a barrier to relocating to western Sydney. As a result, an efficient and reliable public transport network is needed to bring homes and businesses closer together. In response to this, the *Western Sydney Rail Needs Scoping Study* identifies that corridor protection is a key component of planning for western Sydney and the Western Sydney Airport as it will provide certainty to communities and businesses in the area and reduce costs for the delivery of potential rail infrastructure.

6.2.2 Potential economic impacts of ‘no corridor’

Potential negative impacts of failing to protect the final recommended North South Rail Line corridor include:

- Increase in costs if the absence of a surface corridor results in greater use of tunnel, which has substantially higher whole of life costs than rail infrastructure developed at the surface. The much greater cost of developing rail infrastructure in tunnel can make rail projects unfeasible
- Increase in property acquisition costs arising from underlying land value increases and additional cost associated with uncontrolled land improvements
- Increase in relocation and mitigation costs and social disruption associated with relocating residents, businesses and infrastructure located within the final recommended North South Rail Line corridor and additional mitigation costs associated with land uses and local infrastructure located next to the corridor
- Inefficient land use arising from a lack of information regarding long term planning for a transport corridor
- Poor integration of road and public transport networks
- Increased risk of project delays and incurring additional acquisition, construction and operational costs where future constraints prevent the delivery of the best available alignment for future infrastructure.

These negative impacts would likely result in delays to the delivery of future infrastructure, leading to increased road traffic congestion and increased travel times for the future residents of south-west Sydney. As such, while there are some short-term impacts from protecting the corridor at this time, these are considered to be outweighed by the longer-term impacts of not protecting the corridor.

Should the North South Rail Line not proceed, the impacts would be felt across Western Sydney as demand for public transport services increase. It is anticipated that long-term capacity constraints would encourage further dependence on private car use, worsening on-road congestion and hindering Greater Sydney’s desired liveability outcomes. Already, on a typical weekday, over seven million vehicle trips are made across Greater Sydney, with this volume likely to grow unless step changes are made to expand public transport services and infrastructure in Western Sydney, where it is most needed.

The North South Rail Line focuses on an integrated and vision-led transport and land use approach that differs from the ‘predict and provide’ method, where transport investments principally respond to transport demand. As one of the Western Parkland City’s new city-shaping corridors, the North South Rail Line has the potential to change where people choose to live, work and play, and where businesses choose to locate, ultimately influencing the urban form and enabling the broader land use and economic vision of three cities to be realised.

6.2.3 Potential effects on related infrastructure projects

The protection of the final recommended North South Rail Line corridor for potential future public transport infrastructure is expected to directly and indirectly affect related infrastructure projects in western Sydney. In the northern study area, the location of the final recommended North South Rail Line corridor has the potential to complement the proposed Outer Sydney Orbital corridor and Western Sydney Airport.

6.2.3.1 Outer Sydney Orbital

Planning for the final recommended North South Rail Line and proposed Outer Sydney Orbital corridors has occurred in tandem, which has enabled opportunities for co-locating infrastructure to be identified and investigated. Co-location of transport infrastructure can deliver land efficiency benefits by minimising land take and severance. It can also provide environmental benefits by limiting the number of sensitive receivers affected by noise, air quality and visual impacts.

6.2.3.2 Western Sydney Airport

The *Western Sydney Rail Needs Scoping Study – Discussion Paper* includes potential options for rail servicing of the airport that could rely on the final recommended North South Rail Line corridor if required, these options include a connection to Leppington, a connection of the north-south link to Macarthur, connection to the T1 Main Western Rail Line at St Marys and connection to the T1 Main Western Rail Line at Parramatta. To this effect, the final recommended North South Rail Line corridor has the potential to facilitate rail servicing of the Western Sydney Airport in the future if one of these options is progressed in either the short or longer term. In addition to this, the final recommended North South Rail Line corridor has the potential to support additional housing and employment growth within the region that is stimulated by the delivery and operation of the Western Sydney Airport.

6.3 Traffic and transport

This section assesses the traffic and transport impact of future infrastructure in the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport.

The final recommended North South Rail Line corridor overlaying the key existing and future transport infrastructure in the northern study area is shown in Figure 6-3.

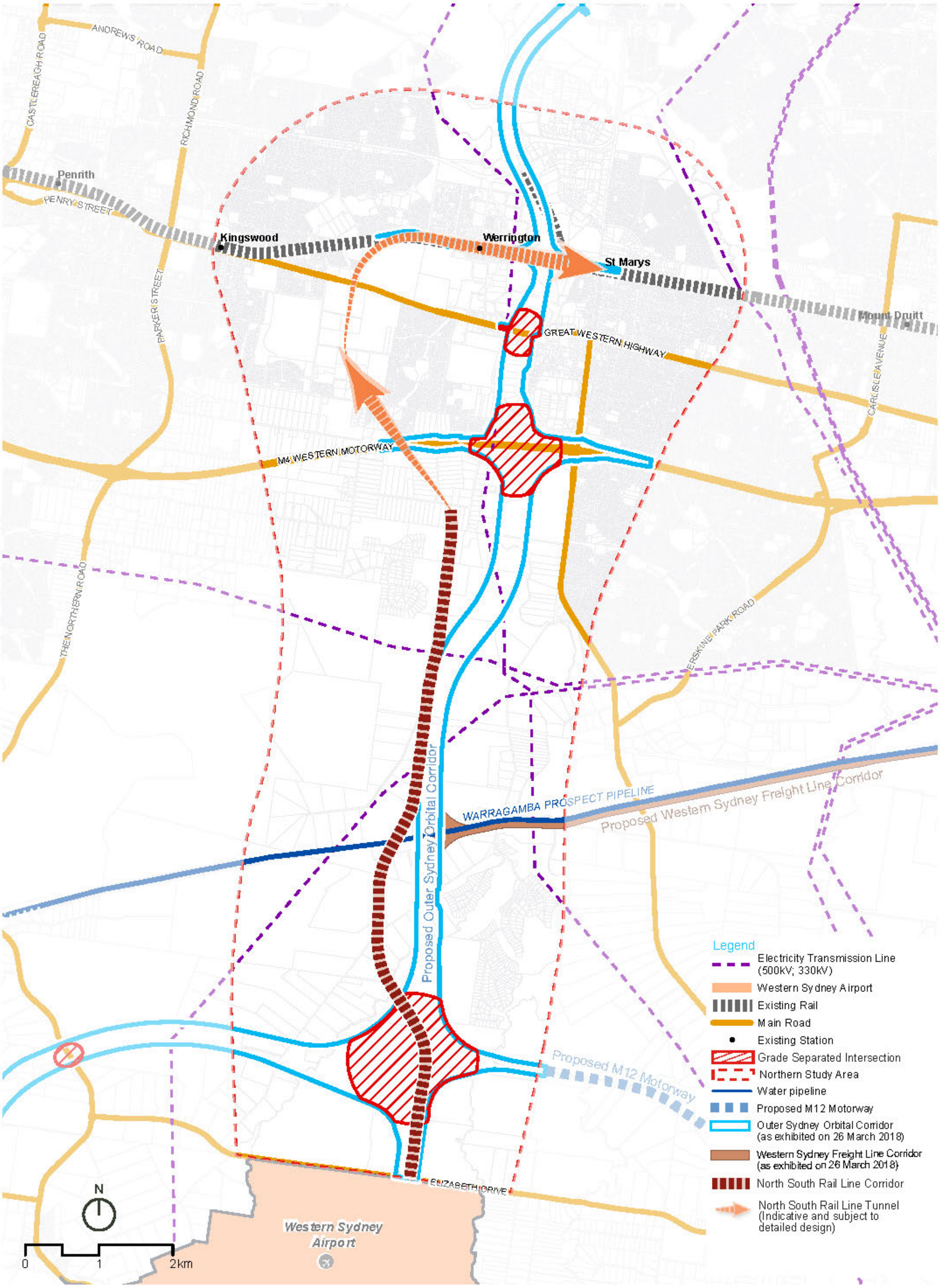

Figure 6-3 Final recommended North South Rail Line corridor overlaying infrastructure in the northern study area

6.3.1 How impacts have been avoided

The potential traffic and transport impacts of a future north-south rail link have been minimised by co-locating parts of the final recommended North South Rail Line corridor within the corridor being investigated for the Outer Sydney Orbital, as shown in Figure 6-3.

6.3.2 Assessment of road infrastructure impacts

Protection of the final recommended North South Rail Line corridor would not have an impact on existing traffic and transport conditions. Once the corridor is protected, however, it is expected that subsequent traffic and transport planning near the final recommended North South Rail Line corridor would take the corridor into account. Key principles for future road crossings include:

- No rail/road level crossings
- Crossings of all roads should be grade-separated, or roads diverted/truncated
- Crossings should be perpendicular where possible, to reduce the length of the structure
- Crossings should be positioned away from road intersections to minimise impact to pedestrians, access and traffic operations.

Table 6-1 identifies roads that the final recommended North South Rail Line corridor would cross between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport, including the proposed M12 Motorway and proposed Outer Sydney Orbital corridor, and discusses how planning for these crossings will be considered in the future.

Table 6-1 Road crossings in the northern study area

Affected road	Future function	Future consideration
Outer Sydney Orbital, Orchard Hills to Luddenham	Transport for NSW is investigating a corridor through western Sydney for a future motorway and freight rail line. The proposed corridor is known as the Outer Sydney Orbital and would connect Richmond Road in the north to the Hume Highway near Menangle in the south, with potential future links to the Illawarra and Central Coast (Roads and Maritime Services, 2017c). Within the northern study area, the Outer Sydney Orbital would provide links to the Great Western Highway, M4 Western Motorway and the Western Sydney Airport.	Planning for the North South Rail Line is occurring in tandem with the proposed Outer Sydney Orbital. Co-location of the North South Rail Line and Outer Sydney Orbital is proposed where possible to minimise land use impacts and the number of sensitive receivers affected by noise, air quality and visual impacts. The final recommended North South Rail Line corridor is located east of and parallel to the proposed Outer Sydney Orbital through Badgerys Creek and Orchard Hills. The final recommended North South Rail Line corridor intersects with the proposed Outer Sydney Orbital and Lansdowne Road, Orchard Hills.
M12 Motorway, Kemps Creek to Luddenham	The M12 Motorway would be about 16 kilometres long and connect the M7 Motorway, near Cecil Hills, to The Northern Road, near Luddenham. The M12 Motorway and proposed Outer Sydney Orbital would coincide between Badgerys Creek and The Northern Road. A grade-separated interchange is proposed north of Western Sydney Airport with the Outer Sydney Orbital proceeding northward towards St Marys and the M12 proceeding to the east and the previously mentioned link to the airport heading south from the interchange.	Planning for the North South Rail Line is occurring in tandem with the proposed Outer Sydney Orbital and M12 Motorway. Co-location of future road and rail infrastructure is proposed where possible in the northern study area to minimise land use impacts and the number of sensitive receivers affected by noise, air quality and visual impacts. The final recommended North South Rail Line corridor crosses the M12 Motorway to the east of the proposed M12 – Outer Sydney Orbital interchange.

Affected road	Future function	Future consideration
Elizabeth Drive, Badgerys Creek	Elizabeth Drive, at Badgerys Creek, is located in the southern section of the northern study area, along the boundary of the Western Sydney Airport. Elizabeth Drive is predominately a single lane in each direction with slip lanes for safe turning movements at some intersections.	The final layout of the Western Sydney Airport will be determined by the Australian Government. The airport layout will inform the design of the North South Rail Line at Elizabeth Drive. The North South Rail Line could remain at the surface or be in tunnel at the airport. Regardless of the design outcome, a crossing above or tunnelling below Elizabeth Drive would be required for the North South Rail Line to continue to the airport and further south.
Luddenham Road, Luddenham	Luddenham Road is an unclassified regional road (Roads and Maritime Services, 2017a). It connects Mamre Road in St Clair to Elizabeth Drive in Luddenham. The final recommended North South Rail Line corridor cross Luddenham Road in a north-south direction just south of Sydney Science Park. No future function for Luddenham Road has been identified.	Transport for NSW would liaise closely with the Department of Planning, Industry and Environment, councils and landowners during any future precinct planning and rezoning processes in Luddenham to ensure the final recommended North South Rail Line corridor is well understood and properly accommodated in land use structure and access plans.
Lansdowne Road, Orchard Hills	Lansdowne Road currently provides access to residential properties along Lansdowne Road and Samuel Marsden Road, as well as the Vines Holiday Cottages, Samuel Marsden Reserve, Riding for the Disabled Association (NSW) - Nepean Centre and Colyton St Clair Chiefs Baseball Club. No future function for Lansdowne Road has been identified.	Transport for NSW would liaise closely with the Department of Planning, Industry and Environment, councils and landowners during any future precinct planning and rezoning processes in Orchard Hills to ensure the final recommended North South Rail Line corridor is well understood and properly accommodated in land use structure and access plans.
Other roads	The final recommended North South Rail Line corridor crosses some internal access roads on agricultural properties in Luddenham and Badgerys Creek. It is likely that these roads are predominantly utilised by residents for rural property access. No future functions have been identified for these roads.	Transport for NSW would liaise closely with the Department of Planning, Industry and Environment, councils and landowners during any future precinct planning and rezoning processes in Luddenham and Badgerys Creek to ensure the final recommended North South Rail Line corridor is well understood and properly accommodated in land use structure and access plans.

6.3.3 Mitigation measures

Protection of the final recommended North South Rail Line corridor would allow road planning for the M12 Motorway, Outer Sydney Orbital, Western Sydney Aerotropolis and development of Sydney Science Park to continue with confidence about the location of future rail infrastructure.

Transport for NSW would liaise closely with the Department of Planning, Industry and Environment, councils and landowners during precinct planning and rezoning processes to ensure the final recommended North South Rail Line corridor is well understood and properly accommodated in land use structure and access plans. This would ensure that local transport arrangements can be designed to accommodate the future rail corridor without the need for costly local road diversions and realignments in the future.

A full traffic and transport impact assessment of the North South Rail Line would be prepared in the future, when the need to build and operate the new rail line is identified. This would allow for the assessment to incorporate the traffic environment at the time of development more accurately and to appropriately identify solutions to interactions between the local road network and railway stations.

It is highlighted that from the mid-2020s the Western Sydney Airport would also be a significant contributor to traffic in the northern study area.

Key factors to be considered in the planning and design of stations would be the intended role of the station, car parking arrangements, and their integration with other public transport modes, particularly buses. The design of future infrastructure would also account for the strategies for walking and cycling outlined in *Sydney's Cycling Future* (Transport for NSW, 2013a) and *Sydney's Walking Future* (Transport for NSW, 2013b), or the equivalent strategic policy at the time. This work may need to progress well before the detailed design and construction of future potential rail infrastructure.

6.4 Noise and vibration

This section assesses the potential noise and vibration impacts of future infrastructure in the final recommended North South Rail Line corridor between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport. Sensitive land uses surrounding the corridor are identified as well as how the corridor has avoided, minimised or offsets impacts.

6.4.1 How impacts have been avoided

Future infrastructure from Orchard Hills to Badgerys Creek would be located through a mostly greenfield area. Sensitive receivers near the corridor include dwellings on rural properties and are widely dispersed in Luddenham, Badgerys Creek and Orchard Hills. The future development of Western Sydney Aerotropolis including Sydney Science Park is likely to result in more sensitive receivers in proximity to the final recommended North South Rail Line corridor.

It is highlighted that from the mid-2020s the Western Sydney Airport would also be a significant contributor to the emission of noise in the northern study area.

6.4.2 Strategic environmental assessment

There would be no noise impact associated with the protection of the rail corridor. However, the future construction and operation of the North South Rail Line would result in noise impacts to surrounding areas. Early protection of the corridor provides the opportunity for the surrounding areas to be planned and designed in the full knowledge that a rail line would ultimately be built within the corridor. A conceptual analysis of the likely noise impacts of the future infrastructure has been carried out to determine if the future impacts of the final recommended North South Rail Line corridor can be adequately mitigated as part of the future design and environmental impact assessment, and to inform strategic planning for the areas around the corridor in the intervening period.

6.4.2.1 Noise assessment criteria

Once a project is identified for construction, operational noise trigger levels for the project would be based on the *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013). There is no rail line currently in operation within this area; as such, the new rail line development criteria for airborne noise would be applicable to a future railway infrastructure project.

The *Rail Infrastructure Noise Guideline* provides air-borne noise trigger levels relating to the overall noise levels (L_{Amax} and L_{Aeq}), as well as the increase in noise levels due to heavy rail infrastructure projects. To initiate an assessment of rail noise impacts and to investigate mitigation measures, both the increase in rail noise levels due to a project and the overall level of rail noise must exceed the trigger levels. For residential and other sensitive receivers, the applicable noise trigger levels are provided in Table 6-2 and Table 6-3 respectively.

The noise trigger levels apply both immediately after operations commence and for projected traffic volumes at an indicative period into the future to represent the expected typical level of rail traffic usage, for example, 10 years or similar period into the future after the commencement of operation of train services.

Ground-borne noise (or regenerated noise) occurs during a train pass-by when vibration energy is transmitted through the track support system (including in tunnels), which in turns excites the surrounding ground and creates vibration waves that can propagate through the ground to the foundations of nearby buildings causing the walls and floors to faintly vibrate and radiate noise.

The *Rail Infrastructure Noise Guideline* provides ground-borne trigger levels for heavy rail infrastructure projects. Where the assessed ground-borne noise levels are above the trigger levels, the project is to identify feasible and reasonable mitigation measures to control ground-borne noise levels with the objective of meeting the trigger levels. Rail Infrastructure Noise Guideline ground-borne noise trigger levels are provided in Table 6-4.

Table 6-2 Trigger levels for noise impact assessment for residential receivers

Type of development	Residential noise trigger levels	
	Day (7am – 10pm)	**Night (10pm – 7am)**
New rail line	Resulting rail noise levels exceed:	
	60 $L_{Aeq(15hour)}$ 80 L_{Amax}	55 $L_{Aeq(9hour)}$ 80 L_{Amax}
Redevelopment of existing rail line	Development increases existing rail noise levels AND Resulting rail noise levels exceed:	
	65 $L_{Aeq(15hour)}$ 85 L_{Amax}	60 $L_{Aeq(9hour)}$ 85 L_{Amax}

Source: *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013)

Table 6-3 Trigger levels for noise impact assessment for other sensitive receivers

Sensitive land use	Noise trigger levels for new rail line	Noise trigger levels for redevelopment of existing rail line
	Resulting in rail noise levels exceed:	**Development increases existing rail noise levels by 2.0 dB or more in L_{Aeq} in any hour AND Resulting rail noise levels exceed:**
Schools, educational institutions - internal	40 $L_{Aeq(1hour)}$	45 $L_{Aeq(1hour)}$
Places of worship – internal 1	40 $L_{Aeq(1hour)}$	45 $L_{Aeq(1hour)}$
Hospitals – internal	35 $L_{Aeq(1hour)}$	40 $L_{Aeq(1hour)}$
Hospitals – external	60 $L_{Aeq(1hour)}$	65 $L_{Aeq(1hour)}$
Passive recreation areas	60 $L_{Aeq(15hour)}$	65 $L_{Aeq(15hour)}$

Sensitive land use	Noise trigger levels for new rail line	Noise trigger levels for redevelopment of existing rail line
	Resulting in rail noise levels exceed:	**Development increases existing rail noise levels by 2.0 dB or more in L_{Aeq} in any hour AND Resulting rail noise levels exceed:**
Active recreation areas	65 $L_{Aeq(15hour)}$	65 $L_{Aeq(15hour)}$

Source: *Rail Infrastructure Noise Guideline* (Environment Protection Authority 2013)

Table 6-4 Trigger levels for ground-borne noise impact assessment

Sensitive land use	Time of day	Internal noise trigger level
Residential	Day (7am – 10pm)	Development increases existing rail noise levels by 3.0 dB or more in L_{Aeq} in any hour AND 40 dBA
	Night (10pm – 7am)	Development increases existing rail noise levels by 3.0 dB or more in L_{Aeq} in any hour AND 35 dBA
Schools, educational institutions, places of worship	When in use	Development increases existing rail noise levels by 3.0 dB or more in L_{Aeq} in any hour AND 40 – 45 dBA

Source: *Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013)

6.4.2.2 Vibration assessment criteria

Operational vibration trigger levels for the project would be based on *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006). This guideline provides acceptable vibration criteria relating to the comfort of building occupants. These criteria are significantly more stringent than the guideline's criteria for structural damage.

For intermittent vibration at residential receivers, vibration trigger levels are expressed in terms of the vibration dose value during the daytime and night-time periods. The vibration dose value is a measure that considers the overall magnitude of the vibration levels during a train pass-by, as well as the total number of train pass-bys during the daytime and night-time periods. For residential receiver locations, the guideline nominates 'preferred' vibration dose values of <0.2 $m/s^{1.75}$ (daytime) and < 0.13 $m/s^{1.75}$ (night-time) and 'maximum' vibration dose values of 0.4 $m/s^{1.75}$ (daytime) and 0.26 $m/s^{1.75}$ (night-time). For offices, schools, educational institutions and places of worship, the guideline nominates vibration dose values twice the residential daytime levels, for example 0.4 $m/ s^{1.75}$ during the daytime and night-time periods.

6.4.2.3 Assessment of impacts of surface corridor sections

Depending on the surrounding terrain, future dwellings next to the future North South Rail Line could have predicted noise levels that may exceed the planning L_{Aeq} daytime noise levels for a new rail line.

Potential vibration impacts can be managed at the time of detailed design.

6.4.3 Mitigation measures

6.4.3.1 Land use integration

As part of the land release and rezoning process, planning authorities and landowners should establish land use structure plans that minimise the location of sensitive buildings near to the likely noisiest parts of the final recommended North South Rail Line corridor. Transport for NSW should be involved in land release and rezoning processes to ensure that new land uses are compatible with potential future rail infrastructure and that appropriate noise mitigations are incorporated into subdivision patterns, development layout and design.

6.4.3.2 Design mitigation

If the final recommended North South Rail Line corridor is zoned Infrastructure (SP2), clause 102 of the *State Environmental Planning Policy (Infrastructure) 2007* or similar controls would apply, defining internal noise goals for residential buildings. In addition, development controls should be introduced as part of any future precinct plans to ensure that new residential areas contain appropriate noise mitigations, and that buildings located near the final recommended North South Rail Line corridor are constructed in a way that attenuates future adverse rail noise impacts for building users. The *Interim Guideline for Development Near Rail Corridors and Busy Roads* (Department of Planning, 2008) should be used to inform these development controls. Design approaches to mitigate future noise impacts could include:

- Establishing the external noise levels to determine appropriate building designs. This could be done individually for each dwelling as part of individual building applications or pre-defined noise levels could be mapped and provided as an overlay as part of a project master plan, allowing, for example, a future home owner to understand the building design requirements for a sensitive building across all parcels of land for sale.
- Design within sensitive buildings may also place non-habitable rooms such as a laundry, bathroom or garage, at facades that directly face the rail corridor, negating the need for higher construction noise treatments that may be required for bedrooms and living spaces.

Transport for NSW would work with the Department of Planning, Industry and Environment and the relevant council to ensure future railway noise impacts are properly understood and are made available to landowners, developers and council to inform the design and development of new precincts.

6.4.3.3 Rail noise source mitigation

A full noise and vibration impact assessment would be prepared in the future, when the need to build and operate the North South Rail Line is identified. This would allow for the assessment to incorporate the noise source mitigation at the time of development more accurately and to appropriately identify solutions to noise impacts on existing or expected sensitive receivers.

The provision of noise barriers may be considered following land use planning processes and after consideration of alternative mitigation options.

6.5 Visual amenity, built form and urban design

This section assesses the visual impact of the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport and particularly considers visual amenity, built form and urban design of the area surrounding the corridor. This section details how the corridor has avoided, minimised or offset visual impacts and outlines mitigation strategies to further reduce potential impacts.

6.5.1 How impacts have been avoided

The potential visual impact of a future north-south rail link has been minimised by co-locating parts of the final recommended North South Rail Line corridor within the proposed Outer Sydney Orbital corridor.

The potential co-location of future road and rail infrastructure should minimise the visual impact of the construction and operation of future transport infrastructure by reducing the number of potentially impacted sensitive receivers compared to this infrastructure being developed in separate corridors.

6.5.2 Strategic environmental assessment

Corridor protection would not have any impact on the landscape as it would not involve any physical work. However, protection of the final recommended North South Rail Line corridor could result in retention of certain landscape values while urban development takes place around the corridor within the Western Sydney Aerotropolis.

The visual, built and urban form impacts of potential future infrastructure have been assessed with reference to the physical parameters of infrastructure required for a future rail line, the extent of visual modification that would be required to accommodate a future rail line and the visual sensitivity of surrounding land uses.

From Orchard Hills to Badgerys Creek, the northern study area is currently open and rural, comprising cleared pastureland and large agricultural properties. Vegetation density differs throughout the landscape, with some scattered vegetation on agricultural properties and denser vegetation along creek lines. Although the study area is undulating, the future development of a rail line would introduce a new dominant feature to the landscape. If the future design of the final recommended North South Rail Line corridor includes viaducts and other elevated structures (particularly near flood prone land such as at the crossings of Cosgroves Creeks and other smaller tributaries of South Creek), visual impacts would potentially be high.

6.5.3 Mitigation measures

A future north-south rail link between Lansdowne Road, Orchard Hills, and Western Sydney Airport would have visual impacts for sensitive receivers within the surrounding area. The area around the final recommended North South Rail Line corridor is likely to experience growth and development in the future as part of the Western Sydney Aerotropolis and establishment of the Sydney Science Park. This would reduce visual impacts of the future rail line as land use changes would result in more residential and commercial development within the surrounding area, resulting in the corridor being less of a dominant feature in the landscape.

Future rezoning and precinct planning processes should consider locating industrial and commercial uses adjacent to those parts of the corridor likely to have the greatest future visual impact.

Neighbourhood and town centres comprising a mix of commercial, retail and residential uses can also be compatible with the potential impact of a future rail line. For example, activities that take place within a local centre are limited to business hours and are not generally activities that would be sensitive to a visual impact.

Where more visually sensitive land uses are proposed adjacent to the corridor, the following mitigation measures should be considered as part of the rezoning and precinct planning processes:

- Setback of visually sensitive land uses – by locating roads or public open spaces in between
- Landscaped buffers
- Streets adjoining future stations should be landscaped to include public open space to provide for future station precinct amenity.

A detailed visual impact assessment would be undertaken with the detailed design of a future rail line. This would ensure that an accurate visual impact assessment is undertaken that considers both proposed rail infrastructure and the adjoining uses for each part of the corridor. Where the visual modification of the landscape is high, the future railway infrastructure should be suitably and proportionately screened with landscaping.

6.6 Soil and water

This section assesses the soil and water impact of future infrastructure in the northern study area of the final recommended North South Rail Line corridor between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport, with a key focus on geology, hydrology, water supply, acid sulphate soils and contaminated land. Based on these conditions, this section discusses how the corridor has avoided, minimised or offset impacts on soil and water and mitigation measures to further reduce any potential impacts.

6.6.1 How impacts have been avoided

The final recommended North South Rail Line corridor has been aligned to generally avoid flood prone land and is mostly located above the 1 in 100 year flood levels. However, it is necessary for the alignment to traverse watercourses and parts of the South Creek flood plain.

The surface section of the final recommended North South Rail Line corridor is aligned to avoid many of the existing small dams and water storage areas in Orchard Hills, Luddenham and Badgerys Creek. The corridor travels through some small dams located on agricultural land as well as Cosgroves Creek and South Creek. The soil landscape of South Creek is known to include moderate to highly erodible soils and suitable erosion and sediment control measures would be implemented during construction.

6.6.2 Strategic environmental assessment

Corridor protection would have no immediate impact on geology, soil or water resources. However, construction and operation of the railway would result in soil and water impacts that would need to be taken into account as part of rail design, construction, and planning.

The final recommended North South Rail Line corridor has been selected to avoid disturbance to existing dams, drainage channels and other water courses/water bodies as much as possible, to minimise possible future soil and water impacts during construction.

6.6.2.1 Geology

The preliminary geological assessment indicates there are geological aspects that would require further geotechnical investigation to adequately inform the detailed project design. These aspects include, but are not necessarily limited to, extensive shale bedrock deposits, presence of anticlines and synclines and clays with high shrink/swell capacities.

6.6.2.2 Soils

The majority of the final recommended North South Rail Line corridor is within areas considered to have ‘no known occurrence’ of acid sulfate soils materials. Acid sulfate soil assessments would still be conducted and an acid sulfate soils management plan prepared at the time of project construction.

The alignment is within areas of high and moderate salinity risk and the soil landscape of South Creek is known to include moderate to highly erodible soils. This is relevant to the selection of suitable erosion and sediment controls during the construction phase.

6.6.2.3 Contamination

Sites with soil contamination impacts can present a localised risk to human health and the environment, as well as risks to downstream receptors if contaminants are migrating off-site, for example, via contaminated groundwater, surface water/runoff, or vapour migration. If not managed appropriately, construction activities which disturb soils and/or groundwater on contaminated sites have the potential to spread (or exacerbate the spread) of contamination impacts, increase the likelihood and severity of risks posed by contaminated materials and increase the extents and costs of remediation.

A desktop analysis of aerial photography has identified potential areas of environmental concern resulting from current or historical land uses. These areas include:

- Erskine Park Quarry, Orchard Hills
- SUEZ Kemps Creek Resource Recovery Park – Recycling Centre and Waste Management Service, Luddenham
- SUEZ Elizabeth Drive Landfill, Kemps Creek.

It is likely that other areas of contamination may be present within the northern study area however due to the level of assessment (desktop based) further investigations would need to be conducted.

6.6.2.4 Hydrology and aquifers

The impact of future surface rail infrastructure on groundwater level is likely to be low, as cut and fill would be engineered with perimeter drainage which would act to preserve the regional groundwater levels near the existing levels. These existing hydrogeological conditions would be subject to future investigation and impact mitigation subject of future project design.

Minimal change to local groundwater recharge would be expected as the existing shale derived clay soils have low permeability resulting in most rainfall falling along the final recommended North South Rail Line corridor being released as stormwater run-off rather than infiltrating to groundwater. It is not expected that existing farm dams in the northern study area contribute a large amount to groundwater.

Changes in groundwater levels from re-profiling the landscape and from reduced recharge beneath paved areas may result in a small reduction in discharge to surface water features. The impacts to these systems are expected to be minor because:

- Historical water quality and hydrogeological data suggest overall groundwater inputs to surface water are small, so reductions in recharge are not expected to create adverse impacts. Further, groundwater in this area is highly saline and a small reduction in flows may reduce salt loads to surface water features, improving overall water quality.
- Rainfall recharge to the alluvial aquifer is not affected. Further, groundwater in the alluvial aquifer systems appears to have limited contact with groundwater in the shale aquifers intersected by the final recommended North South Rail Line corridor, and do not rely on the shale aquifer for water supply.
- While recharge to groundwater might change, it is unlikely that groundwater elevations at discharge points would fall significantly (as they would still be a point of discharge). As such, it is not expected that stagnant pools present in surface waters during dry periods would be prone to drying up due to the proposed development.
- There would be localised impacts around excavations for the rail cuttings. This is not however expected to result in significant dewatering of riparian areas.

6.6.2.5 Groundwater quality

As the underlying aquifer system is of low beneficial use, adverse impacts may only potentially emerge when impacted groundwater migrates beneath areas of groundwater reliant vegetation (located in creek riparian areas) and/or discharges into creeks.

Groundwater flow velocities are expected to be slow and as such the emergence of any impacts would be slow. A groundwater monitoring approach is considered to be suitable to manage the identification of groundwater quality impacts.

Groundwater seepage would be either transported away from active construction areas and discharged back to the environment, and/or removed/discharged offsite to an appropriately licensed treatment facility. While seepage volumes to the subsurface rail corridor, caverns, and at cuttings are expected to be small, seepage minimisation methods may also be adopted to either eliminate or minimise the amount of groundwater seepage generated.

6.6.2.6 Impact on groundwater receptors

Impacts to surrounding registered water bores would be negligible as they are expected to be hydraulically separated from a construction site by the saline, low hydraulic conductivity shale aquifer.

The impact of the rail corridor on groundwater-dependent ecosystems is likely to be low. No creeks within or immediately adjoining the final recommended North South Rail Line corridor are listed as being reliant on groundwater inflow. This information is supported by the electrical conductivity data, which suggests that groundwater inflow is a minor component of creek flow.

The water sharing plan for the greater metropolitan groundwater resources lists two high priority groundwater-dependent ecosystem types (being wetlands and vegetation communities) within the Sydney central basin porous rock groundwater source. Other than Cumberland Plain Woodland, these features are located outside the catchments intersected by the final recommended North South Rail Line corridor.

6.6.2.7 Hydrology and flooding

The final recommended North South Rail Line corridor has been aligned to generally avoid flood prone land, and is mostly located above the 1 in 100-year flood level. However, it is necessary for the alignment to traverse watercourses and parts of the South Creek flood plain.

A future infrastructure assessment would need to consider flooding and hydrology conditions at the time, as ongoing urban development may impact on current flooding and hydrology conditions. Key considerations to be addressed through the design of the surface water management system are:

- Amendment of existing surface levels along the corridor may result in minor modifications to site flow paths and sub-catchment boundaries, which could increase discharges onto adjacent land.
- Capture of site runoff to implement water quality controls may result in a potential minor decrease in discharges onto adjacent land, however this is subject to further design to mitigate downstream impacts.
- Increase in the quantity and peak flows of rainfall runoff resulting from impervious surfaces might cause higher flood levels, reduce stream stability, and increase flooding risk to people.
- Concentration of discharges and higher velocities at culvert outlets may cause localised scouring of stream beds downstream of discharge points, particularly since the South Creek landscape is known to contain moderately to highly erodible soils.

6.6.2.8 Surface water quality

Water quality impacts during construction would be typical of large linear infrastructure projects and can be mitigated by the implementation of standard stormwater practices and adherence to industry standards for the storage and handling of chemicals.

Endorsed environmental values for the Hawkesbury-Nepean catchment include aquatic ecosystem protection, recreational water use, raw drinking water, irrigation and general use. The cumulative impact from urbanisation and other land-uses within the upper catchments of the Hawkesbury and Nepean Rivers is a recognised issue, and the *Lower Hawkesbury-Nepean River Nutrient Management Strategy* (Department of Environment, Climate Change and Water, 2010) provides a catchment-wide policy framework to coordinate and guide actions aimed at reducing nutrient loads and preserving the environmental values of this river system.

The receiving waters are 'NSW lowland rivers' and should be classified as 'slightly modified fresh water systems', with a 95 per cent protection level for freshwater ecosystems, as recommended in the ANZECC Guidelines. The guideline's default water quality trigger values for Lowland Rivers should be considered when selecting required water quality treatments for project discharges.

Information on the groundwater quality should be assessed during the design phase of the project to ascertain any requirements for treatment prior to release to surface water receiving environments.

Recreational water uses are only likely well downstream in the Hawkesbury River and are unlikely to be affected.

Drinking water catchments are unlikely to be affected as the surface sections of the corridor are downstream of any drinking water catchments and Sydney Water's Upper Canal.

6.6.3 Mitigation measures

6.6.3.1 Geology and soils

The final recommended North South Rail Line infrastructure would include a number of embankments and cuttings. Alluvial deposits are likely to exist around the creeks along the corridor. These have intrinsic geotechnical problems related to their shrink-swell properties and dispersiveness. Removal or improvement and strengthening of the track foundation may be required and should be considered as part of future project design.

6.6.3.2 Acid sulfate soils

It is recommended that where the final recommended North South Rail Line corridor intersects existing dams, drainage channels and other water courses/water bodies, detailed acid sulfate soil assessments should be undertaken on the affected properties and, if required, an acid sulfate soils management plan(s) be prepared, as part of future project design.

6.6.3.3 Contamination

It is expected that land contamination issues identified along the final recommended North South Rail Line corridor would be remediated, or addressed, to the extent required to render the land suitable for use as a rail corridor. Remedial action plans will be prepared (if required) to detail the actions required to address identified contamination issues.

6.6.3.4 Groundwater

Overall, drawdown impacts are expected to be minor and any mitigation measures would be linked to groundwater monitoring at key sites during the operation of the North South Rail Line. Baseline monitoring is recommended for determining existing conditions on which the emergence of impacts could be identified.

The proposed locations for groundwater monitoring would focus on the early detection of impacts and the protection of sensitive environmental receptors. As such monitoring, should occur:

- Around and down-gradient of major infrastructure and at depths equivalent to the depth of construction and operation impacts. It is noted that the key sources of groundwater quality impacts would be different during construction and during operation and as such, the monitoring network would also need to change
- Within areas of identified sensitive vegetation in creek riparian areas and around creeks.

Groundwater monitoring of both the alluvial aquifer and shale aquifers should be undertaken. Some monitoring of fill material should also be undertaken to assess the potential generation of a separate water table within the fill and intensified movement of salt.

Future project design would aim to minimise infiltration of contaminants to groundwater by redirecting any rainfall and run-off from the corridor through a surface water system that would prevent connection to the underlying groundwater systems. The design should include drainage systems and storage systems that are impermeable or that minimise leakage.

6.6.3.5 Hydrology and flooding

Detailed hydrological modelling of the North South Rail Line project within the new landforms (and changed flood conditions) for each precinct would be required during the detailed design of the infrastructure to:

- Ensure suitable flood immunity can be achieved
- Assess upstream and downstream flooding impacts
- Determine the size of detention basins.

Provision of water treatment controls and basins, including access to them for maintenance should be accounted for in the detailed hydrological modelling that would need to be carried out.

6.6.3.6 Surface water quality

A future north-south rail link would need to incorporate water sensitive urban design principles and measures to meet water quality objectives. These principles and measures are outlined in the publication *Water Sensitive Urban Design Technical Guidelines for Western Sydney* (URS, 2003).

6.7 Biodiversity

This section assesses the current ecological values within the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport and identifies potential impacts on these values because of future infrastructure within the corridor. It also identifies how the need to provide biodiversity offsets would be addressed through the process of corridor protection and other mitigation measures to reduce potential biodiversity impacts.

6.7.1 How impacts have been avoided

The final recommended North South Rail Line corridor bypasses the key vegetated area at the Defence establishment in the western section of the northern study area in Orchard Hills and, therefore, avoids significant impacts to vegetation at that site.

Most of the final recommended North South Rail Line corridor within the northern study area is on cleared land that is currently used for rural activities. This would avoid the removal of large amounts of vegetation.

6.7.2 Strategic environmental assessment

Protection of the final recommended North South Rail Line corridor within the northern study area would have no immediate impact on biodiversity. Corridor protection would not result in any land use change and it is not expected to result in any adverse biodiversity impacts prior to potential future infrastructure construction within the corridor. Construction and operation of the railway would result in potential future biodiversity impacts that would need to be considered as part of rail design and planning.

The final recommended North South Rail Line corridor crosses a few watercourses within the northern study area, including Cosgroves Creek, Blaxland Creek and other smaller tributaries of South Creek. These watercourses are key fish habitat and provide fish and regional riparian habitat which support various aquatic and terrestrial species within the study area. The Office of Environment and Heritage has identified riparian corridors to be major regional habitat connectivity linkages across the landscape and key areas for investment in habitat enhancement in western Sydney. Bridges and viaduct structures can reduce the physical impacts that built structures have on riparian and terrestrial environments. Shading from structures has the potential to impact these environments and the function of ecosystems within them. Form and height of structures can mitigate these impacts, as well as the strategic location of them within areas of dense vegetation and critical habitat.

The future construction of the North South Rail Line would result in some vegetation removal within the northern study area. The area of vegetation requiring removal and the vegetation communities affected are identified in Table 6-5. The removal of up to hectares of mapped native vegetation would be required within the final recommended North South Rail Line corridor in the northern study area for the construction of the North South Rail Line.

Table 6-5 Impacted vegetation communities

Vegetation community	BC Act status	Area (square metres)	Area (hectares)
10 – Shale Plains Woodland	Critically endangered	48,567	4.86
11 – Alluvial Woodland	Endangered (River-flat Eucalypt Forest on Coastal Floodplain Forest)	34,971	3.50
9 – Shale Hills Woodland	Critically endangered (Cumberland Plain Woodland)	351	0.04
Total		**83,889**	**8.4**

The *Biodiversity Conservation Act 2016* mandates the use of biodiversity offsets for most projects across NSW. The Act also identifies and protects threatened species, ecological communities and key threatening processes. The final recommended North South Rail Line corridor has been selected to avoid and minimise impacts on threatened species identified under the Act. In addition, the NSW *Biodiversity Offsets Policy for Major Project*s sets standards for biodiversity impact assessment and offsetting for major projects approvals in NSW until the Biodiversity Offset Scheme under the *Biodiversity Conservation Act 2016* is established. Future environmental assessment for an infrastructure project may be required to consider the *Biodiversity Offsets Policy for Major Projects*. The corridor identification process has sought to avoid and minimise impacts, consistent with the principles of the policy.

Potential ecological impacts that are likely to arise because of the construction and operation of the North South Rail Line include:

- Removal of native vegetation could result in loss of habitat for existing biota, including some threatened species; however, existing records of biota activity in the area as well as the potential design of the corridor indicates a minimal impact from any vegetation or habitat clearing
- Limitations on the connectivity through the area could occur; however, the foraging behaviour and movement of species in the area is unlikely to be significantly altered
- Edge effects may include increased spread of weeds in areas of adjoining vegetation, localise changes to surface hydrology and reduction in habitat quality because of construction impacts; however, the existing fragmented nature of the vegetation and habitats within the study area increase the likelihood that existing vegetation is already subject to substantial edge effects and the proposal is not likely to impose any significant additional edge effects
- Future construction work has the potential to increase erosion of banks and sedimentation in waterways and ongoing operational impacts could cause runoff from a future railway line; however, appropriate mitigation measures can be implemented to minimise these impacts.

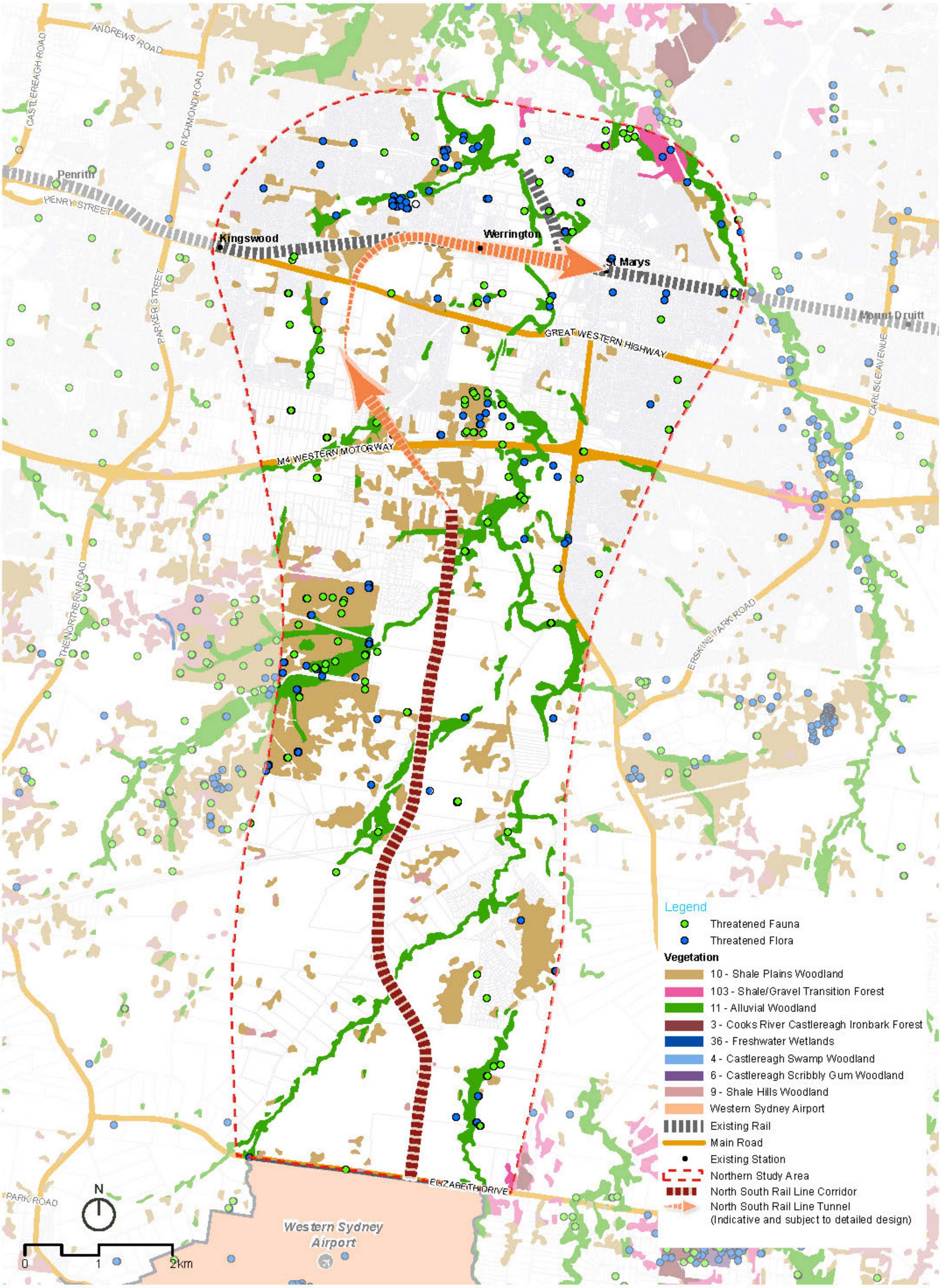

Figure 6-4 **Final recommended North South Rail Line corridor overlaying biodiversity in the northern study area**

6.7.3 Mitigation strategies

There is further potential to avoid impacts to native and endangered vegetation through detailed design of the North South Rail Line. Further detailed biodiversity assessment that would be required at the future environmental impact assessment stage includes field work, credit calculations, mapping and recording as well as further development of potential impact avoidance measures, impact mitigation measures and requirements for biodiversity offsets. Future biodiversity assessment of the project would also need to consider the recommendations of the *Cumberland Plain Strategic Sustainability Plan* that is currently being prepared by the Department of Planning, Industry and Environment.

In addition to this, a future application for infrastructure development would be referred to the Australian Government in accordance with the provisions of the *Environment Protection and Biodiversity Conservation Act 1999*, if required.

6.7.3.1 Mitigation measures

The following mitigation measures are likely to be required during the delivery of the potential future infrastructure to minimise the impacts on ecological values:

- Offset planting as part of a future biodiversity offsetting scheme
- Retention of existing hollow-bearing trees
- Retention or relocation of any ground habitat features
- Installation of temporary exclusion fencing prior to vegetation clearing
- Pre-clearance survey for threatened flora and fauna species prior to proposed clearing
- Vegetation clearing to be conducted under the supervision of a qualified ecologist
- Asset protection zone clearing to be conducted by hand to minimise disturbance to groundcover and soils
- Erosion and sedimentation controls to be installed prior to any earthworks or vegetation clearing
- Retention of a vegetation buffer around water bodies and riparian vegetation where possible
- Minimal the disturbance to the ground layer and topsoil during clearing activity.

6.7.3.2 Biodiversity offsets

Offsets are required for threatened species, populations, ecological communities and their habitat; however, they are not required for vegetation below a certain condition level or vegetation that is not an endangered ecological community, critically endangered community or habitat for a threatened species or population. While the protection of the final recommended North South Rail Line corridor does not require offsets, any future application for infrastructure development would need to undertake detailed flora and fauna surveys to determine offsets in accordance with the relevant biodiversity legislation. In accordance with the principles for corridor protection developed by Transport for NSW, biodiversity offsets would be secured to minimise future costs and provide biodiversity benefits prior to any impacts on habitat.

Transport for NSW is working with the Department of Planning, Industry and Environment to secure offsets as part of a Cumberland Plain Conservation Plan.

The biodiversity values to be offset and the nature and quantity of offsets required are to be set out in a Biodiversity Offset Strategy to accompany a future environmental assessment. Potential biodiversity values that would require offsetting are likely to include:

- Native vegetation above the nominated condition threshold level within surface rail sections on non-certified lands
- Threatened ecological communities within surface rail sections on non-certified lands
- Threatened species and their habitats, where the species generate species credits

- Aquatic habitats within creek lines, where marine vegetation and or/fish habitat are to be removed within surface rail sections on non-certified lands.

The proponent of a future rail infrastructure proposal would generally have to secure offsets prior to development commencing, or enter into a voluntary planning agreement should the offset be secured after development commences.

6.8 Heritage

This section assesses the impact on Aboriginal and European heritage of future infrastructure in the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport and outlines how the corridor has avoided, minimised or offset potential impacts.

6.8.1 How impacts have been avoided

The northern study area, between Orchard Hills and Badgerys Creek, has few heritage items, which limits the potential of the future construction of the North South Rail Line to have heritage impacts.

6.8.2 Strategic environmental assessment

6.8.2.1 Aboriginal heritage

There are no items recorded in the Aboriginal Heritage Information Management System within the final recommended North South Rail Line corridor between Orchard Hills and the future Western Sydney Airport site, however there are several items adjacent to the corridor. It is possible there are unrecorded sites or items present within the corridor as Aboriginal archaeological sensitivity is greater in certain landscapes, such as along watercourses. As such further assessment would be required (see 6.8.3.1). There are no known native title claims associated with the land in the final recommended North South Rail Line corridor.

There is potential for there to be direct and indirect impacts on Aboriginal heritage as a result of future North South Rail Line infrastructure; however, no specific or significant impacts have been identified as no Aboriginal heritage items have been discovered within the corridor. It is considered that impacts would most likely occur during the construction phase, with future operation unlikely to result in more than negligible impacts to any surrounding Aboriginal heritage. Through the application of appropriate mitigation measures, impacts on Aboriginal heritage would be minimised or avoided completely.

Protecting the final recommended North South Rail Line corridor would rezone large tracts of land, remnant vegetation, Aboriginal objects and cultural landscapes. Some Aboriginal sites, such as artefact sites, are currently considered to be common throughout the Cumberland Plain. However, as development of the Cumberland Plain increases, the number of intact Aboriginal sites decreases. Because of this, all Aboriginal archaeological sites are likely to be rarer and, therefore, more valuable in the future, including those that may eventually be discovered within the final recommended corridor.

6.8.2.2 European heritage

Future construction of the North South Rail Line would impact two local heritage items located within the southern portion of the northern study area (Figure 6-5). The Luddenham Road Alignment (local heritage number 843) is located across the study area from Elizabeth Drive, in the south-west, to Mamre Road, in the north-east. The final recommended North South Rail Line corridor would traverse the Luddenham Road Alignment in Luddenham.

The final recommended North South Rail Line corridor also travels through the McGarvie-Smith Farm (local heritage number 857) located on Elizabeth Drive, Badgerys Creek. McGarvie-Smith Farm was the first farm to be acquired by the University of Sydney in 1936 to support the teaching and research of veterinary science and agriculture (Jeffs & Rose, 1995). The corridor travels through the property in a north-south direction.

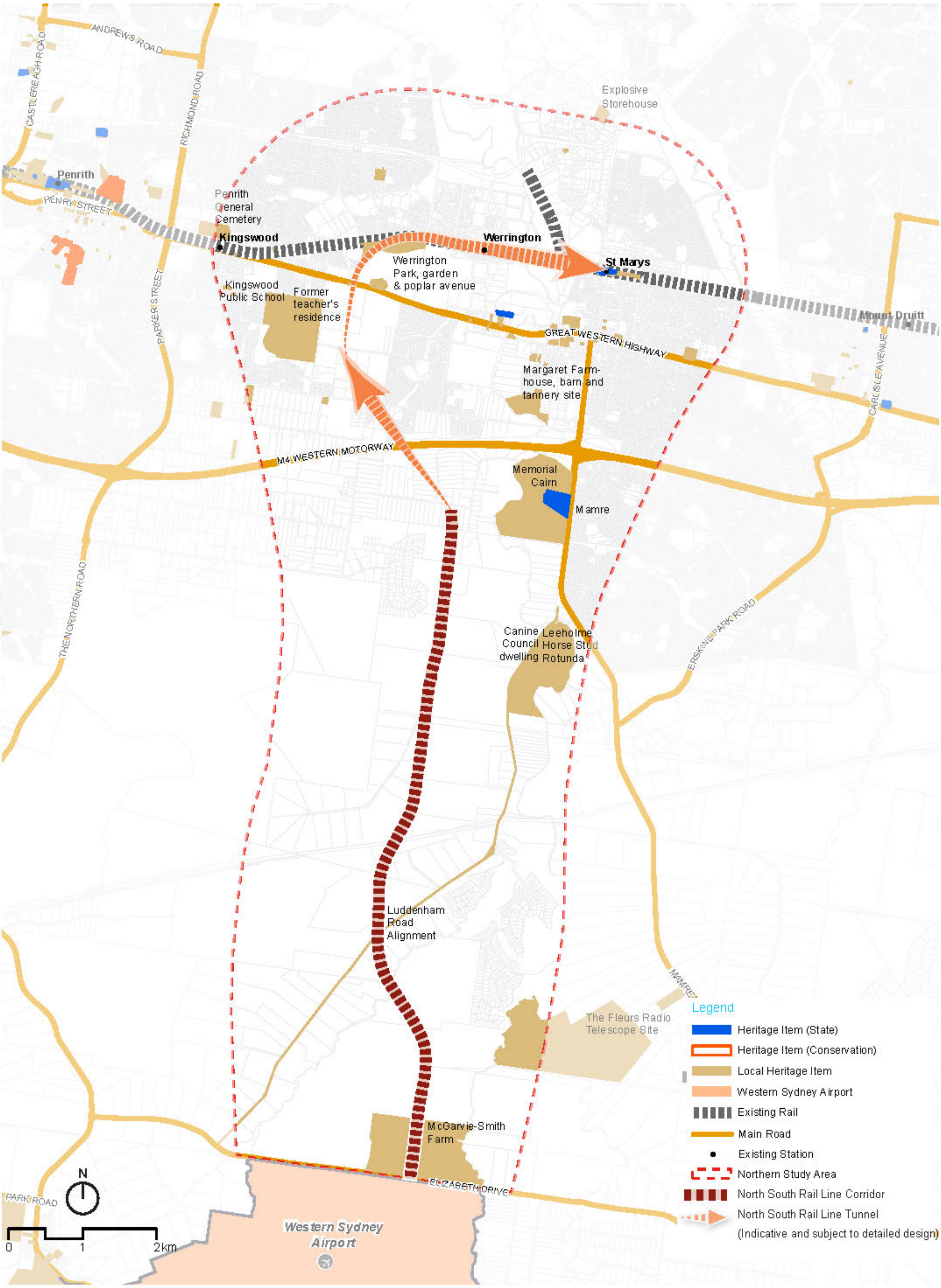

Figure 6-5 **Final recommended North South Rail Line corridor overlaying European heritage items in the northern study area**

Although not directly assessed as it is within the North South Rail Line Tunnel area (see Figure 6-5), it should be noted that St Marys Railway Station Group is listed on the State Heritage Register. Future design development of the deferred area would consider potential impacts to the heritage item.

While the impacts of construction of the North South Rail Line on surrounding heritage items would need to be investigated prior to a future detailed infrastructure application, it is considered that design and construction measures can be implemented to mitigate any impacts on the curtilage, fabric or setting of all affected heritage items. Upon completion of the North South Rail Line it is considered that there would be minimal impacts to the heritage values of the area if mitigation measures are implemented during design and construction.

In addition to the presence of the known heritage items, further investigation would need to be undertaken to determine the significance of any archaeological sites. It is considered that future design and construction methods may be implemented to minimise any impacts to the heritage value of the area.

6.8.3 Mitigation strategies

6.8.3.1 Aboriginal heritage

The following mitigation measures would be considered as part of a future infrastructure design phase:

- Consultation with the Office of Environment and Heritage and landowners regarding the Aboriginal sites affected by the final recommended North South Rail Line
- Consultation with Aboriginal stakeholders in accordance with the relevant Office of Environment and Heritage guidelines
- Investigation and assessment of Aboriginal heritage impacts in accordance with the relevant guidelines, including, but not be limited to, site visits, confirmation of registered Aboriginal sites, identification of unrecorded sites, areas which have been subject to little background research and an assessment of Aboriginal archaeological potential
- Construction phase mitigation measures may include test excavation, salvage excavation, detailed recording, reporting and artefact analysis, and heritage interpretation.

Future investigations present a unique opportunity to conduct a large-scale comparative study of Aboriginal archaeology in differing local contexts. As a result of this, there would be an opportunity for interpretation of Aboriginal heritage values to be incorporated into future design or to be included in a future Heritage Interpretation Strategy.

6.8.3.2 European heritage

The following mitigation measures would be considered as part of a future infrastructure design phase:

- Prepare a statement of heritage impact for the McGarvie-Smith Farm as part of a future infrastructure application.
- The heritage significance of the Luddenham Road Alignment would need to be assessed in future heritage assessments and take into consideration during the urban development in the area.
- A detailed archaeological impact assessment should be prepared as part of a future infrastructure application to investigate the potential archaeological sites, including a site survey and documentary analysis.

6.9 Air quality

This section assesses the possible air quality impact of future infrastructure in the northern study area of the final recommended North South Rail Line corridor between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport, with a focus on local and regional air quality.

6.9.1 How impacts have been avoided

Future infrastructure from Orchard Hills to Badgerys Creek would be located through a mostly greenfield area. Sensitive receivers near the corridor include dwellings on rural properties and are widely dispersed in Luddenham, Badgerys Creek and Orchard Hills. The future development of Western Sydney Aerotropolis including Sydney Science Park is likely to result in more sensitive receivers in proximity to the final recommended North South Rail Line corridor.

6.9.2 Strategic environmental assessment

Protection of the final recommended North South Rail Line corridor would have a negligible impact on air quality and greenhouse gases within the air shed as there would be no direct changes to emission sources.

Construction of the railway would generate air quality and greenhouse gas impacts, from construction activities such as vegetation clearance, earthworks, fuel combustion for construction vehicles (including for spoil storage and transport), and concrete batch plants and precast manufacturing facility activities.

Indirectly-related energy consumption would also generate greenhouse gas emissions. However, as any future construction phase would be relatively short-term and localised in nature, greenhouse gas emissions are not expected to significantly impact climate change.

Particulate matter emissions produced from increased soil exposure and earthworks is expected to have the most potential to create air quality impacts within the air shed during any future construction phase due to the magnitude of emissions and high existing background concentrations of both PM_{10} and $PM_{2.5}$. However, the following factors mean any impacts due to construction would be localised and short-term:

- The potential rail infrastructure in the final recommended North South Rail Line corridor is small in the context of the entire Sydney air shed
- Any elevation of pollutant concentrations would be experienced in the near vicinity of the source, but would reduce in magnitude with distance from the source
- Construction would only occur over a short time-frame.

There are a range of mitigation measures that can be adopted as part of the detailed environmental impact assessment and implemented during construction to minimise and manage emissions.

Operation of the potential future rail infrastructure is not expected to generate significant quantities of air emissions, as rolling stock would be electrically powered. The following aspects of railway operation would produce greenhouse gas emissions:

- Use of electricity for powering rolling stock and operational electrical systems including rail corridor lighting, communications, controls and electronic signage
- Combustion of fuel for operation of maintenance equipment and use of materials for railway maintenance.

It is highlighted that one of the principal objectives of the future railway infrastructure is to provide efficient and effective public transport to the new development precincts of the Western Sydney Aerotropolis. The provision of public transport is expected to result in substantial trip diversion resulting in reduced passenger vehicle trips on the local and regional road network, resulting in lower air pollutant and greenhouse gas emissions than would otherwise have been the case.

6.9.3 Mitigation strategies

The scope of air quality impact assessment would be determined as part of the future infrastructure application process, including whether air pollutant modelling is warranted in terms of identifying suitable mitigation and management measures to be implemented during construction.

Management of greenhouse gas emissions for the construction and operation of any future railway in the final recommended North South Rail Line corridor would be an important consideration in minimising any future contribution towards climate change, acknowledging that climate change science, technology and management approaches are likely to progress and improve in the future. Any future project-level environmental impact assessments should include calculations of predicted greenhouse gas emissions for construction, operation and maintenance of the railway.

6.10 Social

This section assesses the social impact of the final recommended North South Rail Line corridor in the northern study area between Lansdowne Road, Orchard Hills, and the northern boundary of the Western Sydney Airport. It considers the social impact of future infrastructure within the corridor on directly affected communities, community facilities and services. Through an assessment of the social impact of the corridor and future infrastructure, opportunities to avoid, minimise or offset impacts are discussed.

6.10.1 How impacts have been avoided

Potential social impacts would be assessed at the time of infrastructure delivery, accounting for the current land uses surrounding the corridor and the impact on the community at the time a project is proposed. A future environmental impact statement would need to be accompanied by a social impact assessment.

6.10.2 Strategic environmental assessment

The location of the final recommended North South Rail Line corridor has been carefully selected to ensure that social benefits are maximised. The corridor between Orchard Hills and Badgerys Creek is expected to be the subject of substantial urban transformation in the coming years. By protecting a corridor, the community can be given confidence about the location of future transport infrastructure and would be able to appropriately plan for this.

There is a clear opportunity for the final recommended North South Rail Line corridor protection process to ensure that future land use in the area can be distributed according to what land uses would be sensitive to a future rail line. It is considered that in areas that are yet to be developed, future integrated transport and land use planning can centre commercial and industrial development around segments of a future rail line that are likely to result in the most significant visual and noise amenity impacts. Future residential development may also be located so that any visual impact arising from a future rail line is minimised.

In particular, Sydney Science Park and Western Sydney Aerotropolis will be key drivers of growth surrounding the final recommended North South Rail Line corridor. The corridor travels through the western portion of the Western Sydney Employment Area, which has been identified as the largest new employment space in Sydney. The location of the corridor within this precinct could provide benefits to businesses and industries that are yet to be developed.

Protection of the final recommended North South Rail Line corridor would not have an impact on the existing community facilities or services. Once protected, however, it is expected that subsequent planning undertaken near the final recommended North South Rail Line corridor would take it into account.

In particular, corridor protection would maximise the opportunity to integrate the final recommended North South Rail Line corridor into future urban and employment areas and minimise impact to existing and future communities. The identification and protection of the final recommended North South Rail Line corridor would enable continued development of the rapidly growing and changing land use areas in the Western Sydney Aerotropolis, protect the corridor from development encroachment and facilitate forward planning to accommodate the potential impacts of a future railway.

The final recommended North South Rail Line corridor would facilitate future potential mass public transport infrastructure connecting to key existing and planned housing and employment centres, as well as facilitate potential further expansion/connection of public transport to other areas outside of the final recommended North South Rail Line corridor. This is consistent with the *Western City District Plan* and other strategic planning policies for the area. The potential future provision of public transport infrastructure to these centres would have several benefits for employment capacity, as well as reduce pressure on the existing transport network. Overall, these benefits would support the future growth of western Sydney and the Western Sydney Airport.

6.10.3 Mitigation strategies

Transport for NSW should be involved in land release and rezoning processes to ensure that new land uses that would be compatible with a future railway. Potential land use controls for inclusion in the relevant environmental planning instrument are discussed in Section 9, and would be subject to consultation with the relevant councils and the Department of Planning, Industry and Environment.

7 Environmental assessment of the southern study area

This section provides a strategic assessment of each of the potential environmental impacts associated with protection of the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area. An assessment is provided for the following environmental factors:

- Land use and property impacts
- Economic impacts
- Traffic and transport
- Noise and vibration
- Visual amenity, built form and urban design
- Soil and water
- Biodiversity
- Heritage
- Air quality
- Social impacts.

7.1 Land use and property impacts

This section identifies the existing land uses and potential property impacts within and next to the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area. It describes how potential impacts have been avoided, minimised or offset to reduce any impact associated with the protection of the final recommended North South Rail Line and South West Rail Link Extension corridors. This section also considers possible future land use changes or opportunities due to potential future infrastructure within the final recommended North South Rail Line and South West Rail Link Extension corridors and measures to minimise any future impacts.

The final recommended North South Rail Line and South West Rail Link Extension corridors overlaying land use in the southern study area are shown in Figure 7-1.

7.1.1 How impacts have been avoided

To minimise land use and property impacts on existing urban areas, future rail infrastructure between Oran Park and Macarthur would be in tunnel which would avoid impacts for hundreds of properties, including residential properties, schools and surface heritage items, along the final recommended North South Rail Line corridor.

The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to maximise flexibility in the design and function of future precincts within the growth areas. The final recommended North South Rail Line corridor is generally located at least 400 metres from major roads where possible, enabling the future local road network to be designed to support future residential and commercial precincts.

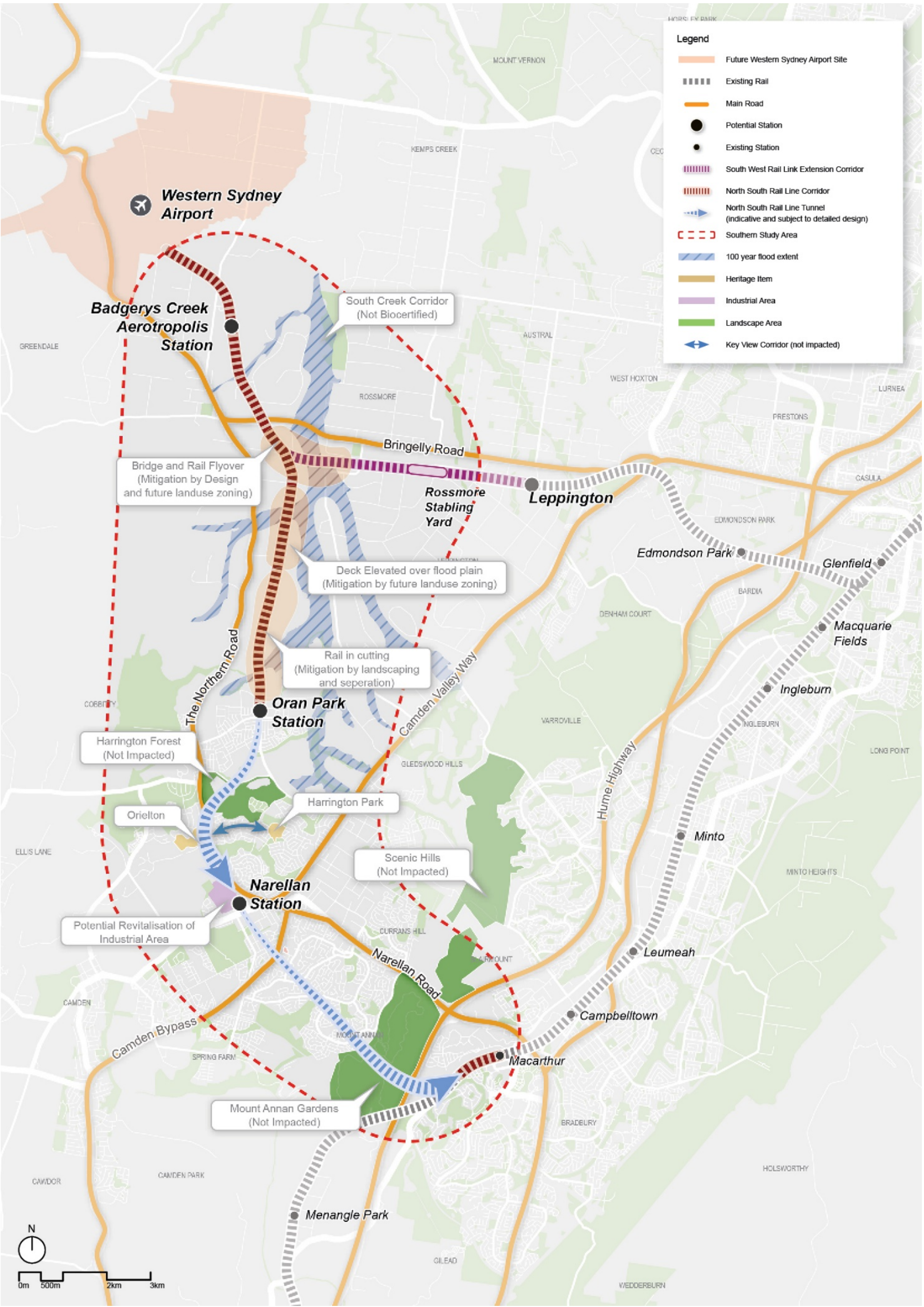

Figure 7-1 Final recommended North South Rail Line corridor overlaying land use in the southern study area

7.1.2 Property impact assessment

Where the final recommended North South Rail Line corridor is in tunnel, the future tunnelled infrastructure would be designed to avoid direct impacts to existing buildings and structures.

Land use and property impacts are limited to above ground sections of the final recommended North South Rail Line and South West Rail Link Extension corridors – located between Leppington, Western Sydney Airport and Oran Park, as well as the station precinct and construction staging compounds at Narellan, Oran Park and Macarthur.

7.1.2.1 Existing property impacts north of Oran Park

The surface section of the final recommended North South Rail Line corridor between Oran Park and the Western Sydney Airport would impact 68 properties. The final recommended South West Rail Link Extension corridor would impact an additional 35 properties between Leppington and Bringelly; most of these properties are rural-residential properties, but also including the following rural industries:

- Australia Koi Farm (83 Jersey Road)
- Sydney Watergardens Nursery (909 Bringelly Road)
- Market gardens (around Robinson Road, Mersey Road, Derwent Road and Badgerys Creek Road).

Given the major land use change that will occur in these areas, a viability assessment on the residual land parcels has not been carried out. It is expected that residual parcels would be amalgamated as part of the precinct planning and development process.

While direct impacts with existing utilities infrastructure have largely been avoided, the final recommended North South Rail Line corridor would cross under the existing 330kV transmission line immediately to the north of Oran Park Town Centre.

7.1.2.2 Land use integration north of Oran Park

While these properties are currently used for rural residential or agricultural land uses, they are located within the South West Growth Area and Western Sydney Aerotropolis and are expected to undergo significant land use change in the near future to provide for new residential suburbs, with associated business, retail and employment areas.

The loss of developable land due to protection of infrastructure corridors may be addressed as part of the land release and rezoning processes of future precincts by allowing higher land use densities on land within 800 metres walking distance of the new stations.

As described in Section 4.13.3, recent analysis commissioned by the Department of Planning, Industry and Environment identifies that there continues to be strong demand for new residential products in the South West Growth Area including higher proportions of small lot housing in the overall residential mix. Structural change in market preference and demand already supports a case for increased residential density levels, with precincts benefiting from train stations being logical priorities for denser residential product. Therefore, it is reasonable to conclude that future population densities in the South West Growth Area will exceed the initial population targets, offsetting the land set aside for future infrastructure and ultimately contributing to demand for the future delivery of the North South Rail Line and South West Rail Link Extension.

Early planning will therefore maximise the opportunity to integrate the final recommended North South Rail Line and South West Rail Link Extension corridors into future urban areas and minimise impact to existing and future communities. The protection of the final recommended North South Rail Line and South West Rail Link Extension corridors would enable continued development of these rapidly growing areas in western Sydney while facilitating forward avoidance or minimising the potential impacts of a future railway.

The railway infrastructure would need to be elevated on embankments or structures (such as bridges) over South Creek and over the Lowes Creek flood plain. The future infrastructure may also include an elevated rail flyover at Bringelly between these two elevated sections. From a land use compatibility perspective, it may be appropriate to locate employment, industrial and regional open space uses in these areas to minimise possible future land use conflicts. Transport for NSW would work with Camden Council and Liverpool City Council, and the Department of Planning, Industry and Environment towards achieving appropriate land use outcomes as part of the South West Growth Area precinct planning process.

The final recommended North South Rail Line and South West Rail Link Extension corridors have also sought to minimise 'land locking', which can occur where roads are elevated above or sunk below surrounding land parcels, hindering property access and constraining development opportunities.

7.1.2.3 Land use integration at proposed Oran Park Station

Consultation with Greenfields Development Company has identified a development site that can be protected for the future development of the Oran Park Station, adjacent to the town centre.

This location offers a direct connection to the existing and future Oran Park Shopping Centre and is centrally located in the context of the Oran Park town centre precinct. The proximity to Oran Park Drive also provides good walking access from residential areas to the north and west and supports the function of the station as a bus/rail interchange with good access to The Northern Road via Peter Brock Drive.

A tunnel staging and temporary construction site would be required at Oran Park. The Oran Park construction site would be located predominantly within the potential future station site, also comprising land within the block immediately to the south. The extent of the Oran Park construction site is shown in Figure 7-2. It is anticipated that Transport for NSW and Greenfields Development Company would agree on an interim land use for this site ensuring that it could be made available for station construction, and as a temporary tunnel construction site, when it is required.

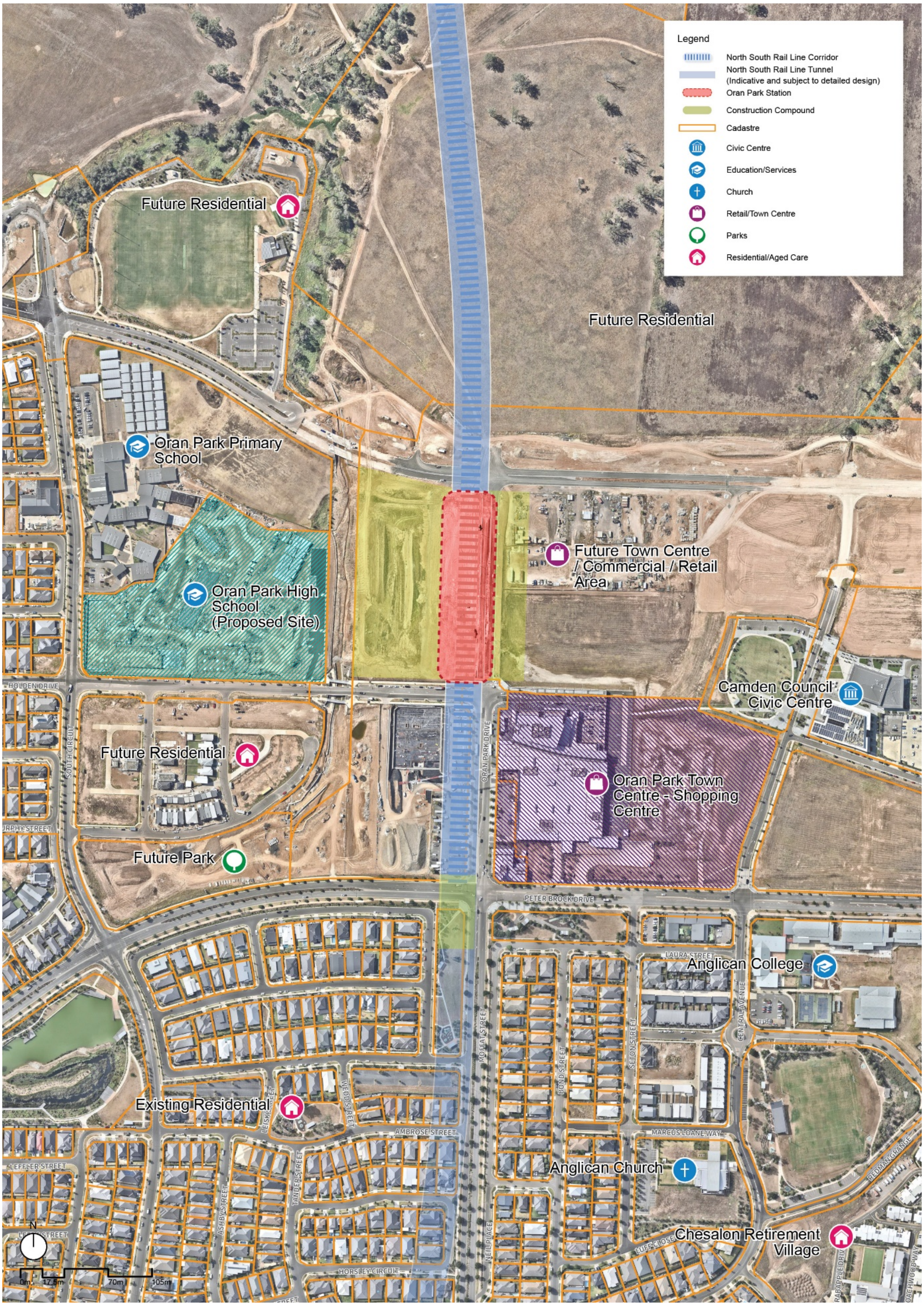

Figure 7-2 Proposed Oran Park Station and temporary construction site

7.1.2.4 Land use integration at proposed Narellan Station

In Narellan, 19 industrial and commercial properties would be directly impacted by the future Narellan Station or as part of the temporary tunnel construction site.

The selection of the station location at Narellan was determined by several factors, but particularly because it is within walking distance of a thriving town centre, with both a walk-up catchment and with good access to two major roads servicing a wider potential catchment requiring bus and park and ride transport interchange facilities.

A major tunnel staging and construction site would also be required at Narellan. The extent of the Narellan construction site is shown in Figure 7-3. Existing uses would be able to continue to operate but future applications for development will need to have regard for the future expected uses of the land in support of a new station.

The future development of a railway station within the Narellan industrial area is also expected to provide an opportunity to reconsider the longer-term planning objectives of this area, particularly the area located closest to the Narellan shopping centre.

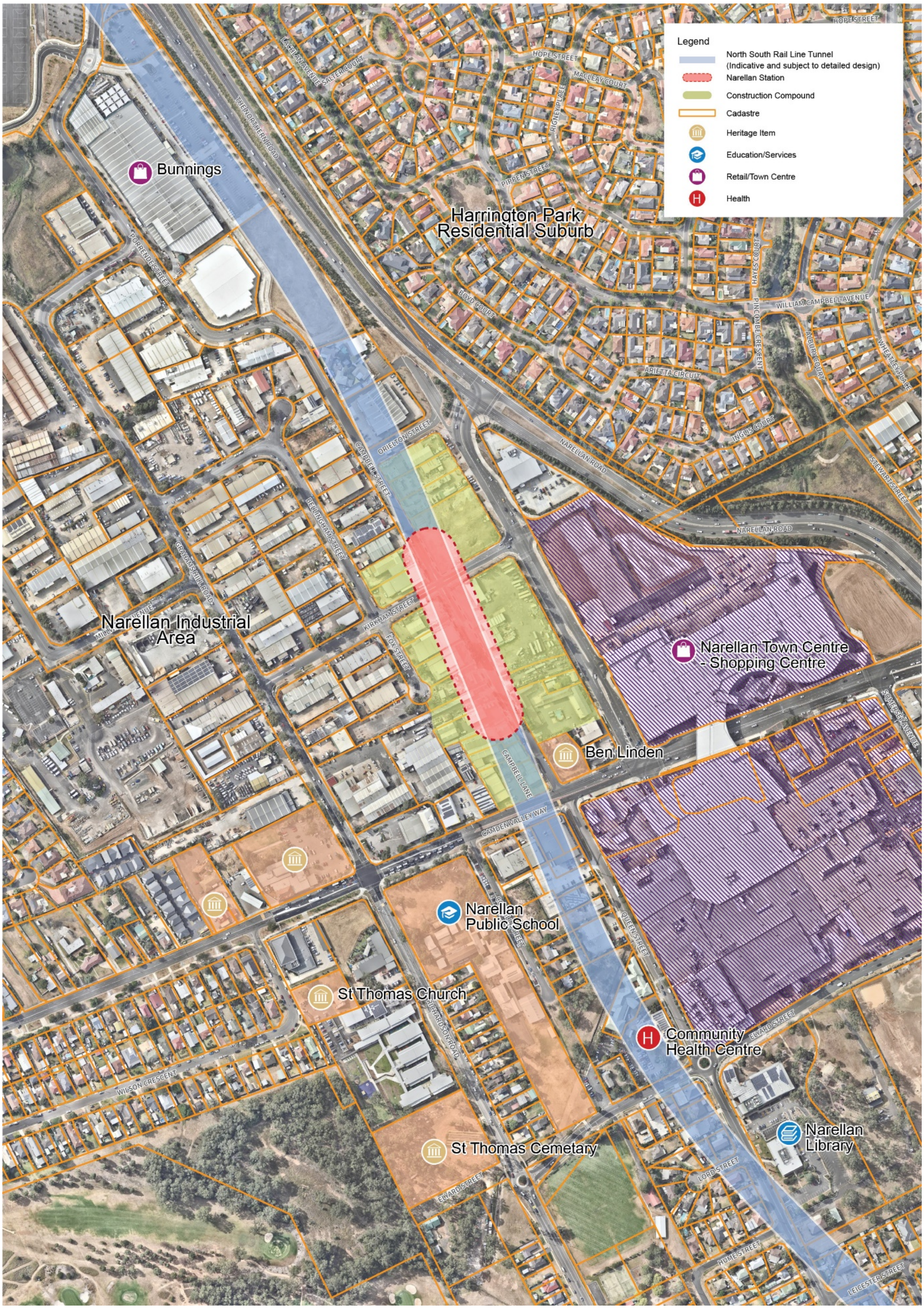

Figure 7-3 Proposed Narellan Station and temporary construction site

7.1.2.5 Land use integration at Macarthur

In Macarthur, land use impacts would be limited to land within the existing rail corridor and already owned by Transport for NSW or associated Government transport entities, except for a parcel of land described as Lot 1211 DP1136122. This lot is privately owned and is located between the existing T8 Main South Rail Line corridor and Menangle Road (see Figure 7-4). This portion of land may be required to accommodate future construction and/or rail corridor widening associated with the North South Rail Line approach to Macarthur Station. Acquisition of this parcel of land is unlikely to result in any significant adverse impacts as it is a small and irregularly shaped lot that is not of regional significance. Additionally, the lot also does not permit development of dwellings as it is zoned Business Development (B5). Campbelltown City Council's DA tracker shows that a Development Application for storage premises on the site was lodged on 27 April 2018 and this use does not preclude protection of the corridor in this location.

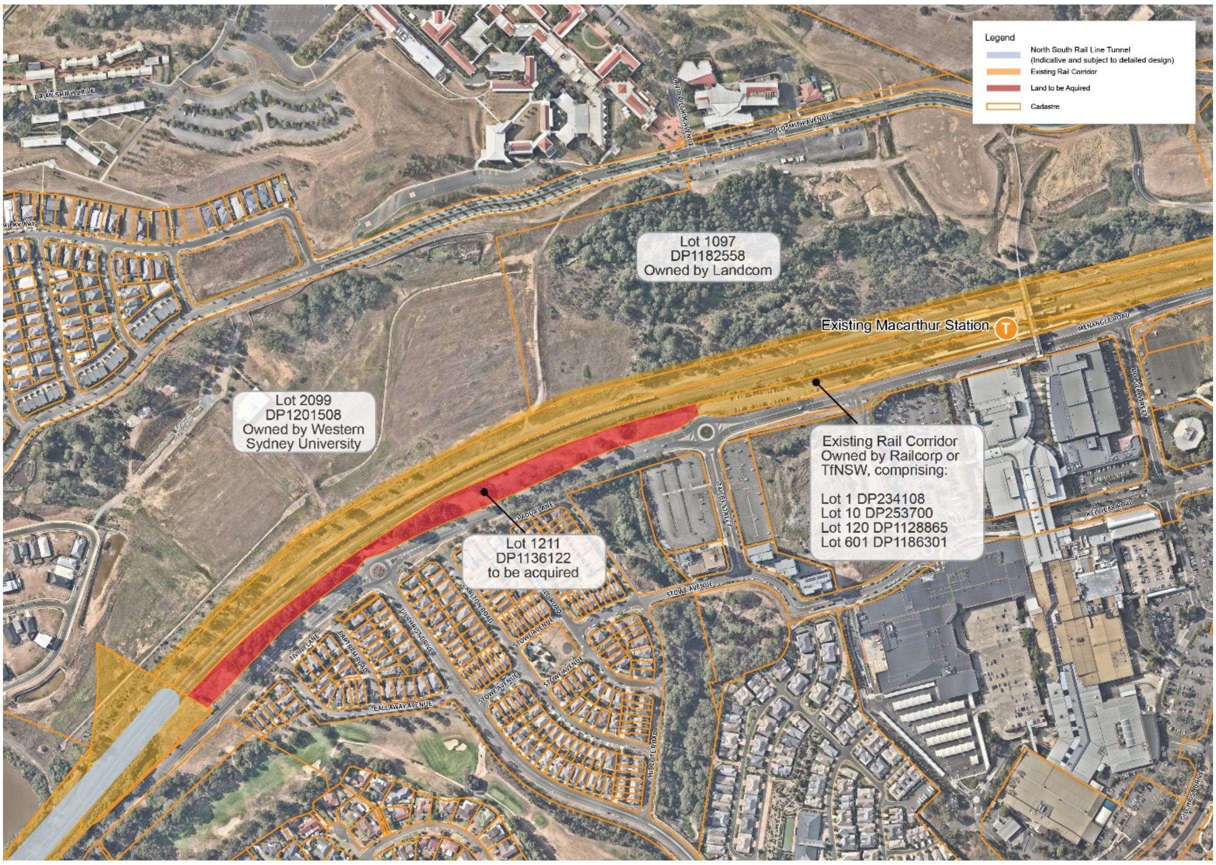

Figure 7-4 **Macarthur rail corridor widening**

7.1.2.6 Crown land

No Crown land is impacted by the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area.

7.1.3 Mitigation measures

The most significant land use impact mitigation is the decision to underground the final recommended North South Rail Line corridor in tunnel between Oran Park and Macarthur.

Protecting the final recommended corridors now would enable planning authorities to consider the future rail infrastructure when undertaking precinct planning processes and when assessing development applications. This would help to ensure that new development surrounding the final recommended corridors is compatible with the future rail infrastructure and is appropriate for being serviced by rail. Protecting the corridor would also assist planning authorities to ensure that conflicts between new sensitive land uses and the future rail infrastructure can be avoided, or mitigation measures incorporated where appropriate.

To minimise the potential land use conflicts associated with amenity impacts of future train operations, planning authorities would consider locating employment, industrial and regional open space uses adjacent to the final recommended North South Rail Line and South West Rail Link Extension corridors. These areas could be strategically located as it is likely that the future railway would be elevated on embankments or structures, including at the crossings of South Creek and the Lowes Creek flood plain and a potential flyover structure at Bringelly.

Once the corridor is protected, Transport for NSW would work with councils, landowners/developers and relevant agencies across the NSW Government to ensure that land use planning and transport planning processes around the protected corridors are integrated and coordinated. In particular, Transport for NSW would work with Liverpool City Council, Campbelltown City Council and Camden Council in relation to future planning around potential station precincts to ensure that future land use opportunities are fully explored.

Prior to construction of the future rail infrastructure, an environmental impact statement would assess impacts of the proposed infrastructure in the final recommended corridors on adjoining and surrounding land uses and would detail measures to avoid or mitigate potential impacts.

Interim land uses would also need to be established in consultation with the Department of Planning, Industry and Environment and the relevant councils and landowners for the short to medium term.

7.2 Economic impacts

This section provides an overview of the potential economic impacts and opportunities that may be created by future infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area. This section also considers economic impacts of future North South Rail Line and South West Rail Link Extension infrastructure on the wider region, with a view to short, medium and long-term impacts.

7.2.1 Expected economic benefits

The addition of 300,000 new residents within the South West Growth Area, as well as additional population growth in established centres such as Narellan and Macarthur, will generate demand for additional transport capacity if additional congestion costs are to be avoided.

The *Western Sydney Rail Needs Scoping Study* indicated that extending the South West Rail Link from Leppington to an interchange located to the south of the airport, within the Western Sydney Aerotropolis, will be important for supporting the growth of Greater Sydney's south-west, acting as the principal rail link between Western Sydney Airport and development in the region through to Liverpool.

The *Western Sydney Rail Needs Scoping Study* specifically discusses the options for a rail public transport connection to the future Western Sydney Airport. Western Sydney Airport will be a catalyst for economic growth in the region and an effective public transport connection is seen to be a key to the success of the airport, as well as to support the forecast growth of western Sydney. However, in the early years of airport operations, road transport links will play the most important role in providing connectivity for Western Sydney Airport customers and workers. These road links, including those delivered under the Australian and NSW Governments' $3.6 billion *Western Sydney Infrastructure Plan*, will also be important in fostering economic growth in the region.

7.2.2 Potential economic impacts of 'no corridor'

The potential negative impacts of failing to protect a corridor are set out in Section 6.2.2 and would equally apply to the southern section of the final recommended North South Rail Line corridor and the final recommended South West Rail Link Extension corridor, in particular through the Western Sydney Aerotropolis and South West Growth Area where precinct planning is yet to commence.

7.2.3 Potential effects on related infrastructure projects

South of Western Sydney Airport, the protection of the final recommended North South Rail Line and South West Rail Link Extension corridors for potential future public transport infrastructure is expected to directly and indirectly interface with related infrastructure projects in western Sydney, including The Northern Road and Bringelly Road upgrades.

The potential effects of the final recommended North South Rail Line and South West Rail Link corridors on these related infrastructure projects is discussed in the following sections.

7.2.3.1 The Northern Road and Bringelly Road

The *Western Sydney Infrastructure Plan* provides for upgrades to Bringelly Road and The Northern Road, among a range of projects, in the immediate vicinity of the final recommended North South Rail Line and South West Rail Link Extension corridors. Construction of both projects has commenced, and it is expected that the work in the immediate vicinity of the final recommended North South Rail Line corridor will be completed prior to any North South Rail Line work. The protection of the final recommended North South Rail Line corridor will not directly affect these roads or the upgrade process; however, future road work may be required to facilitate a grade-separated crossing of Bringelly Road at the time that the North South Rail Line infrastructure is delivered.

7.3 Traffic and transport

This section assesses the traffic and transport impact of future infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area.

The final recommended North South Rail Line and South West Rail Link Extension corridors overlaying the key existing and future transport infrastructure in the southern study area are shown in Figure 7-5. The final recommended North South Rail Line corridor connects to the T8 Main South Rail Line near Macarthur. However, detail of works required to integrate the future North South Rail Line with existing T8 Main South Rail Line infrastructure is subject to project definition and detailed design processes and is not addressed in this Strategic Environmental Assessment.

7.3.1 How impacts have been avoided

The location of the crossing of Bringelly Road was carefully selected to avoid impacts on key future intersections, including the grade-separated intersection between Bringelly Road and The Northern Road.

The final recommended North South Rail Line and South West Rail Link Extension corridors are located to minimise impacts on the likely future local road network, including by maximising the potential for future rail infrastructure to be in cut to reduce any impact on the existing or likely future road network. The Bringelly Road crossing is in a location where future rail infrastructure could be designed to be in a cutting to travel underneath the road surface.

The final recommended North South Rail Line and South West Rail Link Extension corridors are generally at least 400 metres from major roads, enabling the future local road network to be designed to support future residential and commercial precincts.

Locating the corridor in tunnel between Oran Park and Macarthur would further reduce any impacts on the road network.

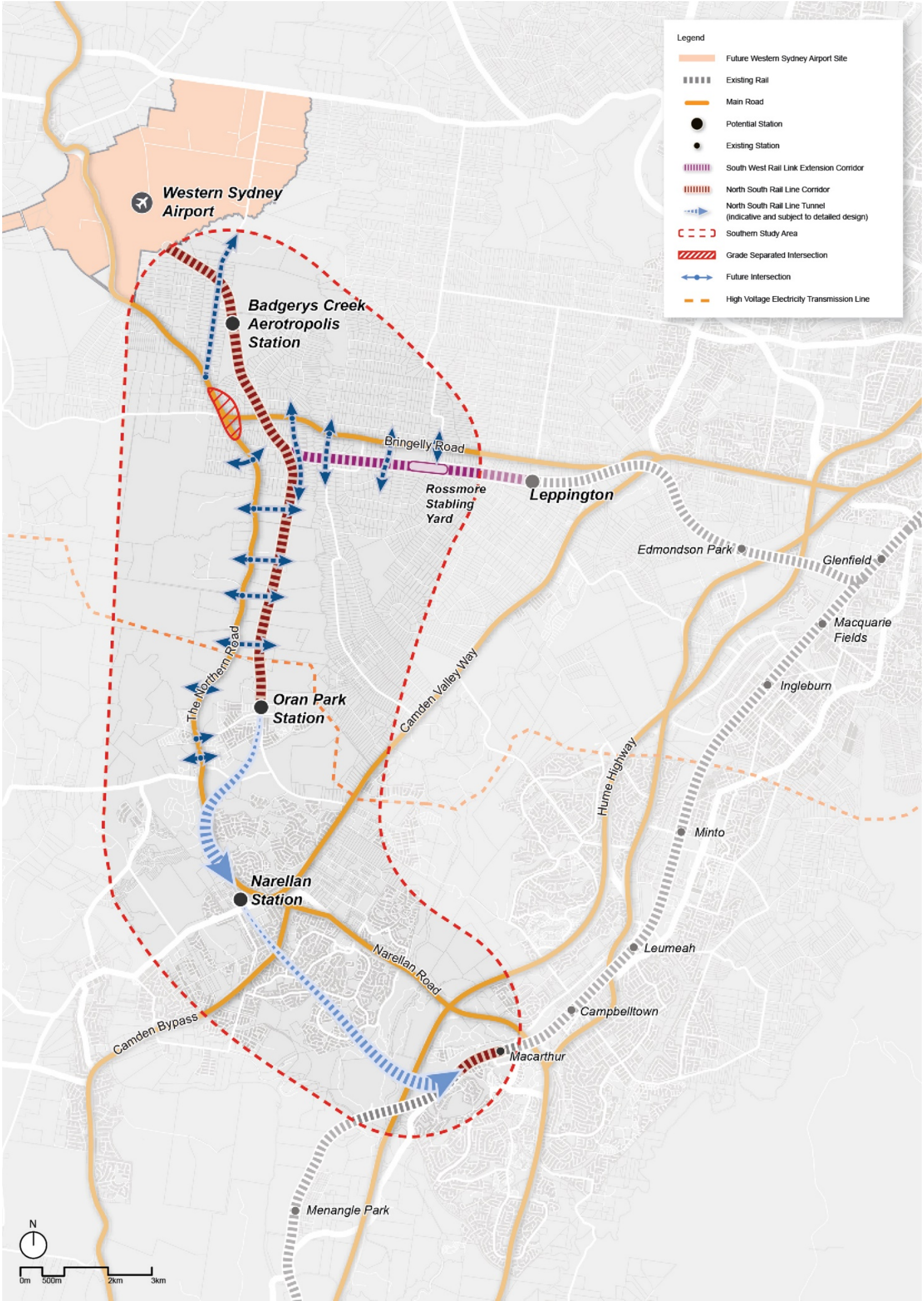

Figure 7-5 Final recommended North South Rail Line and South West Rail Link Extension corridors overlaying infrastructure in the southern study area

7.3.2 Assessment of road infrastructure impacts

In the southern study area, the final recommended North South Rail Line and South West Rail Link Extension corridors have been located to maximise the potential for future railway infrastructure to be in cut, providing the opportunity for the roads to cross over the rail corridor without needing to ramp up or down.

The location of the stations would minimise impacts on the State road network, with a general principle to try and locate stations at least 400 to 800 metres from a State road, to enable local accessibility to the station, and to ensure the land around the station can be suitably developed for servicing by rail.

7.3.2.1 State roads

In the southern study area, rail crossings of State roads have been a major factor in the location of the final recommended North South Rail Line and South West Rail Link Extension corridors. In particular, the new grade separated intersection between Bringelly Road and The Northern Road was considered to be a major constraint. Further, the need to cross The Northern Road, Camden Valley Way, Camden Bypass, and the Hume Highway were key reasons in supporting a decision to tunnel the final recommended North South Rail Line corridor south of Oran Park.

The only State road crossing of the final recommended corridors is at Bringelly Road, near the intersection with Kelvin Park Drive. Based on the indicative vertical alignment it is likely that the potential railway infrastructure may be in a cutting where it crosses Bringelly Road and would therefore be below the current pavement of the road. The crossing of Bringelly Road would need to be built without significant traffic congestion impacts. To achieve this, pre-fabrication of structures or trenchless excavation methods may be required including manufacture of precast concrete units adjacent to road crossings. However, this design work is not required at this stage of the corridor protection process and would be addressed as part of a potential future application for rail infrastructure.

7.3.2.2 Local roads

While local roads within the South West Growth Area are likely to be retained, their role and function are likely to change, and they may be realigned or extended as part of the development of each precinct. Existing local road crossings by the final recommended North South Rail Line and South Rail Link Extension corridors are described in Table 7-1 and shown in Figure 7-6.

Table 7-1 Future crossings of local roads in the southern study area

Affected road	Future function	Future consideration
Allenby Road, Rossmore	Allenby Road is likely to become one of many north-south connections, as other roads in the precinct are upgraded. These include Polo Road, North Avenue, Barry Avenue and Masterfield Street.	While it will be possible to design the future railway to ensure Allenby Road can cross the rail corridor, it is likely that Allenby Road will not be required to perform this function and may not ultimately be reconstructed to cross the rail corridor.
Masterfield Street, Rossmore	It is expected that Barry Avenue will be extended to connect to Masterfield Street, and the upgraded Masterfield Street / Bringelly Road intersection. This will involve a crossing of the final recommended South West Rail Link Extension corridor across the flood plain.	The vertical alignment of the road will need to be designed with consideration of the final recommended South West Rail Link Extension corridor, in consultation Transport for NSW.
Jersey Road, Bringelly	Jersey Road is expected to perform a key north-south link between Bringelly and Oran Park.	The railway would be elevated over South Creek and would remain elevated over Jersey Road to permit it to perform this north-south traffic function.

Affected road	Future function	Future consideration
Robinson Road, Bringelly	The final recommended North South Rail Line corridor crosses Robinson Road where the future rail infrastructure may include a grade separated rail flyover. Given that one leg of the rail flyover may be above the level of Robinson Road and the other leg may be below the level of Robinson Road, it is unlikely that Robinson Road would be able to remain in its current form. This would also mean that the Robinson Road / Jersey Road intersection would likely need to be removed.	There are no major east-west links across South Creek in this part of the South West Growth Area, so the future transport role of Robinson Road is likely to be limited to local access.
Carrington Road, Bringelly	The final recommended North South Rail Line corridor crosses Carrington Road in cut, so Carrington Road would be able to continue over the future railway.	There are no major east-west links across South Creek in this part of the South West Growth Area, so the future transport role of Carrington Road is likely to be limited to local access.
Kelvin Park Drive, Bringelly	The final recommended South West Rail Link Extension corridor will cross underneath Kelvin Park Drive in a cutting, meaning that accessibility to Kelvin Park Drive would remain if necessary.	It is highlighted that the intersection improvements as part of the Bringelly Road upgrade indicate that a continuation of Jersey Road is likely to be the main access road into the Kelvin Park area in the longer-term future. The longer term need for continued access via Kelvin Park Drive / Bringelly Road intersection is not clear.
Badgerys Creek Road, North Bringelly	Badgerys Creek Road is expected to continue to perform a key north-south link between Elizabeth Drive and The Northern Road.	The final recommended North South Rail Line corridor would likely cross under Badgerys Creek Road in a cut, ensuring it can continue to perform this role.
McCann Road, Rossmore	East of Rossmore Station the final recommended South West Rail Link Extension corridor sits over the eastern part of McCann Road, affecting existing access arrangements for two rural residential properties.	McCann Road is a no through road east of Polo Road, and while it may partially be retained for town-centre / station access upon redevelopment, it is unlikely to play a significant transport role.
Kirkham Street and Campbell Street, Narellan	These streets would provide access to the future Narellan Station, which could potentially result in temporary diversion of eastbound and northbound traffic via Porrende Street or Grahams Hill Road / Camden Valley Way.	The two eastern blocks of Kirkham Street and the southern block of Campbell Street may need to be closed in the long term to provide for the station / tunnel construction compound and to accommodate the future Narellan Station. The development of the station would likely trigger land use investigations into the overall precinct of the future station, which may lead to significant changes in land use immediately around the station. Access and traffic would be a major consideration in the planning for a future station precinct irrespective of whether substantial land use change takes place. Key factors to be considered in the planning and design of Narellan Station will be its integration with other public transport modes, particularly buses.

Proposed stations along the final recommended North South Rail Line and South West Rail Link Extension corridors would be located within existing or known future town centres to attract active trips (walking and cycling) and will provide an alternative to driving for all trips, including those work trips in the morning peak period. As such, the future railway infrastructure would contribute to reducing pressure on local and State roads.

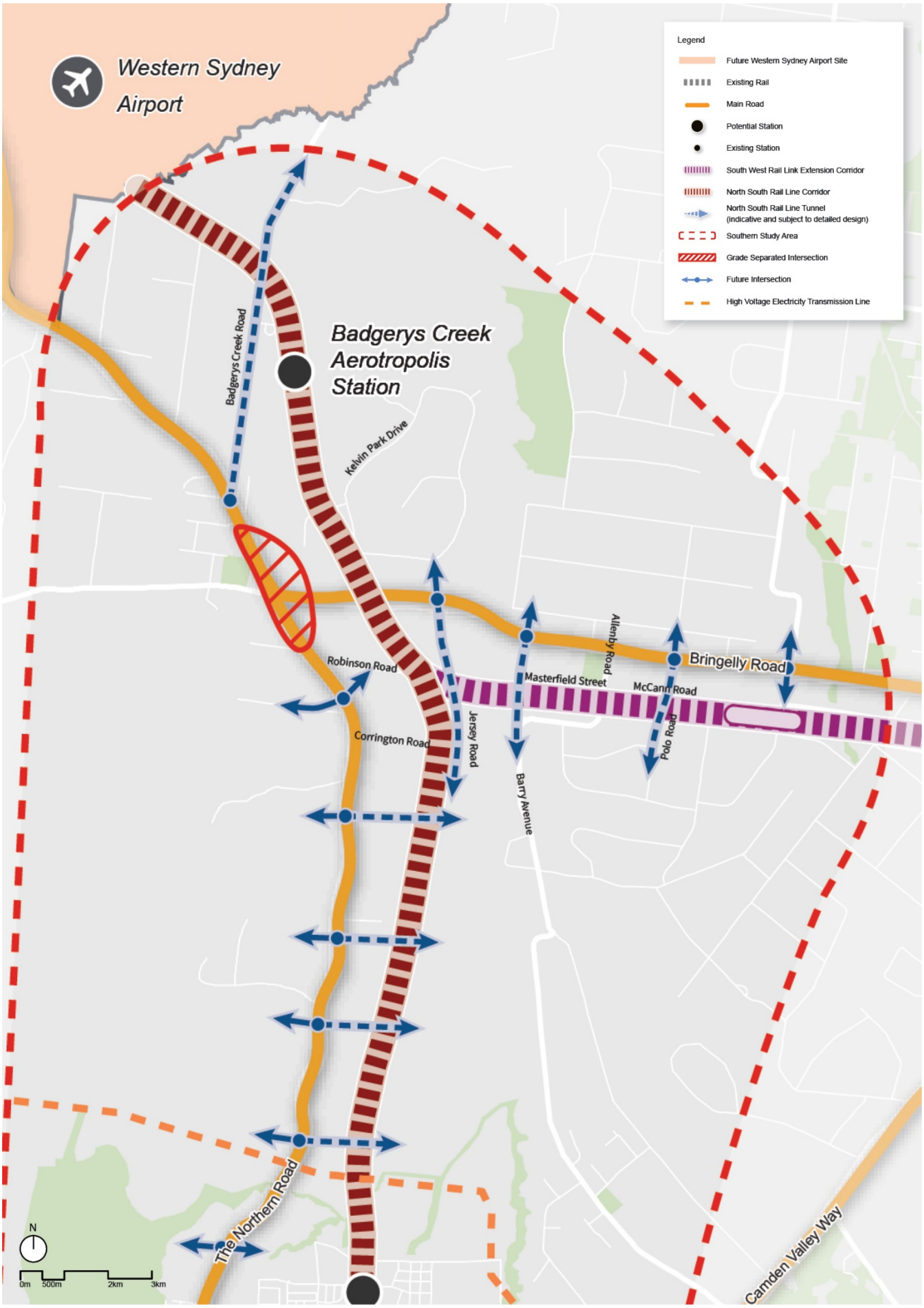

Figure 7-6 Future local road intersections and crossings in the southern study area

7.3.3 Mitigation strategies

The most significant traffic impact mitigation is the decision to underground the final recommended North South Rail Line corridor in tunnel between Oran Park and Macarthur. This decision avoids impacts to a number of State and local roads.

Mitigation strategies for the final recommended North South Rail Line and South West Rail Link Extension corridor in the southern study area are generally the same as described in Section 6.3.3, and would ensure that local transport arrangements can be designed to accommodate the future rail corridor without the need for costly local road diversions and realignments in the future, and also that the planning for station precincts is suitably integrated with other public transport and active transport modes.

7.4 Noise and vibration

7.4.1 How impacts have been avoided

The final recommended North South Rail Line and South West Rail Link Extension corridors are located to maximise the potential for future rail infrastructure to be in cut. This would minimise impacts on existing and possible future sensitive receivers.

South of Oran Park, any future infrastructure would be in tunnel, which would avoid airborne noise impacts to sensitive receivers at Narellan and its surrounding areas.

Between Rossmore, Western Sydney Airport and Oran Park, the North South Rail Line and South West Rail Link Extension would run at surface through what is currently a generally greenfield area. Rural-residential dwellings currently dot these areas, with road traffic noise likely to be dominated by the State roads of Bringelly Road and The Northern Road. Existing or known future sensitive receivers at Oran Park are shown in Figure 7-2.

Planned development of the growth areas is predicted to substantially alter the surrounding landscape, likely resulting in future dwellings and other sensitive buildings being located near and/or adjacent the final recommended North South Rail Line and South West Rail Link Extension corridors.

No sensitive receivers other than residential dwellings are currently located with 300 metres of the final recommended North South Rail Line and South West Rail Link Extension corridors, with the Oran Park Public School (about 360 metres), the Rossmore Public School / Preschool (about 420 metres) and the Bringelly Public School (about 800 metres) being the nearest existing educational, community or health/medical buildings.

South of Oran Park, the area is more suburban with low to medium density housing located within existing and new residential developments. South of Oran Park Station the final recommended North South Rail Line corridor is in tunnel, with a below ground station at Narellan. The proposed tunnel south of Oran Park would have no airborne noise impacts and would avoid the following sensitive receivers:

- United Cinemas Narellan
- Narellan Community Health Centre
- Mount Annan Public School
- Narellan X-Ray Centre
- Western Sydney University
- Harrington Park Medical Practice.

At the Macarthur portal(s), the final recommended North South Rail Line corridor surfaces within the existing rail corridor. The nearest existing dwellings are located east of the existing rail corridor within the existing residential suburb of Glen Alpine. West of the identified tunnel portal, the new residential suburb of Macarthur Heights is under development. Airborne noise from the identified rail line as it returns to the ground surface would be assessed against the redevelopment of an existing rail line criterion.

7.4.2 Strategic environmental assessment

7.4.2.1 Assessment of impacts of above ground corridor sections

Operational noise and vibration assessment of the above ground corridor are set out in Section 6.4. Depending on the surrounding terrain, future dwellings next to the future North South Rail Line would be expected to have predicted noise levels that may exceed the planning L_{Aeq} daytime noise levels for a new rail line. A range of mitigation strategies are available to minimise these impacts including the cutting in of the final recommended North South Rail Line corridor north of Oran Park Station, wherever possible. Other mitigation strategies are discussed in Section 6.4.3.

7.4.2.2 Assessment of impacts of tunnel sections

Tunnel sections have not yet been designed and further detailed investigation is needed to inform the ground-borne noise impacts. Tunnelling design would need to include identification and adoption of appropriate mitigation strategies to avoid surface ground borne noise and vibration impacts. This may involve consideration of the horizontal and vertical location of tunnel combined with track attenuation.

In the case of railway tunnels, the ground-borne noise trigger levels almost always dictate lower vibration levels than the vibration objectives. As such, compliance with the ground-borne noise trigger levels should ensure that the above vibration design objectives would also be achieved.

7.4.3 Mitigation strategies

The most significant noise impact mitigation is the decision to underground the final recommended North South Rail Line corridor in tunnel between Oran Park and Macarthur. This decision avoids airborne noise impacts for hundreds of properties, including residential properties, schools and heritage items, along the final recommended North South Rail Line corridor. Ground borne noise and vibration from trains operating in tunnels can be managed by the installation of attenuating tracks sufficient to meet the design objectives. Standard attenuation is likely to be sufficient where the distance between the track and the sensitive receiver is more than 25 metres. Higher attenuation tracks would only be required in sensitive areas where the depth to tunnel is particularly shallow.

As part of the land release and rezoning process, planning authorities and land developers should establish land use structure plans that minimise the location of sensitive buildings in proximity to the noisiest parts of the final recommended North South Rail Line and South West Rail Link Extension corridors. In particular, planning authorities should consider locating employment, industrial and regional open space uses adjacent to the final recommended North South Rail Line and South West Rail Link Extension corridors. These areas should be strategically placed as it is likely that the future railway will be elevated on embankments or structures. This is expected to be limited to the crossing of the South Creek flood plain and around a potential grade-separated rail flyover at Bringelly.

Alternatively, mixed use and/or higher density residential buildings with suitable design and noise treatment can be located adjacent to the rail corridor to provide shielding of noise levels to lower density residential areas beyond, particularly at station locations.

Design and rail source noise mitigation strategies are described in Sections 6.4.3.2 and 6.4.3.3 respectively.

7.5 Visual amenity, built form and urban design

7.5.1 How impacts have been avoided

The final recommended North South Rail Line and South West Rail Link Extension corridors are located to maximise the potential for future rail infrastructure to be in cut, and so minimise visual impacts on existing and possible future sensitive receivers.

As shown in Figure 7-7, the final recommended South West Rail Link Extension corridor crosses the South Creek flood plain at a perpendicular angle to minimise the length of the bridge structure over the flood plain and reduce visual impacts associated with elevated bridges and fly-over structures. Further, the future rail fly-over structure at Bringelly would be located outside of the expected future town centre locations for Bringelly and Rossmore.

South of Oran Park, the future infrastructure would be in tunnel. This would avoid visual impacts to sensitive receivers at Narellan and its surrounding areas, including significant landscapes at Harrington Forest, the Scenic Hills, Australian Botanic Garden Mount Annan and William Howe Regional Park.

The tunnel portal(s) at Oran Park would be integrated with the Oran Park Station, minimising the visual prominence of the portal(s). At Macarthur, the tunnel portal(s) would be located within the existing rail corridor to minimise impacts.

7.5.2 Strategic environmental assessment

Key locations where visual impacts have been assessed in the southern study area are:

- Rossmore
- South Creek crossing and the potential rail flyover at Bringelly
- Narellan Station.

The final recommended corridors have been selected to maximise the potential for future railway infrastructure to be in cut, providing the opportunity for the roads to cross over the rail corridor without needing to ramp up or down as well as minimising noise and visual amenity issues. This proposed design would have the benefit of reducing visual impact to the surrounding area, and is most appropriate in visually sensitive locations, such as existing or future residential areas. In these visually sensitive areas additional mitigation measures may also be warranted, such as increased setbacks or a landscaped buffer.

7.5.2.1 Rossmore

The Rossmore precinct will be comprised of new dwellings, as well as local retail and service centres.

The future railway through Rossmore would likely be mainly within a cutting. It is noted that a neighbourhood centre or similar is likely to be located adjacent to the final recommended South West Rail Link Extension corridor at Rossmore, which reduce the visual impact as it is a less visually sensitive land use.

7.5.2.2 South Creek crossing and potential Bringelly flyover

It is likely that the future railway infrastructure would need to be elevated on embankments or structures (such as bridges) over South Creek and over the Lowes Creek flood plain. The future railway infrastructure may include elevated structures for a rail flyover at Bringelly that is located between these two elevated sections.

Areas adjacent to South Creek are likely to stay in their current form as riparian areas associated with a natural water course. As such, the visual modification to the surrounding landscape as a result of the future work would be high.

The visual sensitivity of the area around the potential Bringelly flyover would be lower if employment or industrial development was located in close proximity to the corridor. It would therefore be appropriate to consider locating employment and industrial uses in these areas to minimise land use conflicts associated with amenity impacts of the future infrastructure components and railway operations. This is generally consistent with the South West Growth Centre Structure Plan that envisages industrial / employment areas around the flood affected areas near South Creek and the Lowes Creek confluence.

7.5.2.3 Narellan Station

Narellan Station would be an underground station immediately adjacent to the established town centre. Visual impacts would be limited to urban design and built form of station access structures and associated ancillary development (such as car parking and bus interchanges). The visual sensitivity of the location is considered to be low, and the proposed development would not result in a significant change to the nature of the existing landscape. As such, the visual impact would be low.

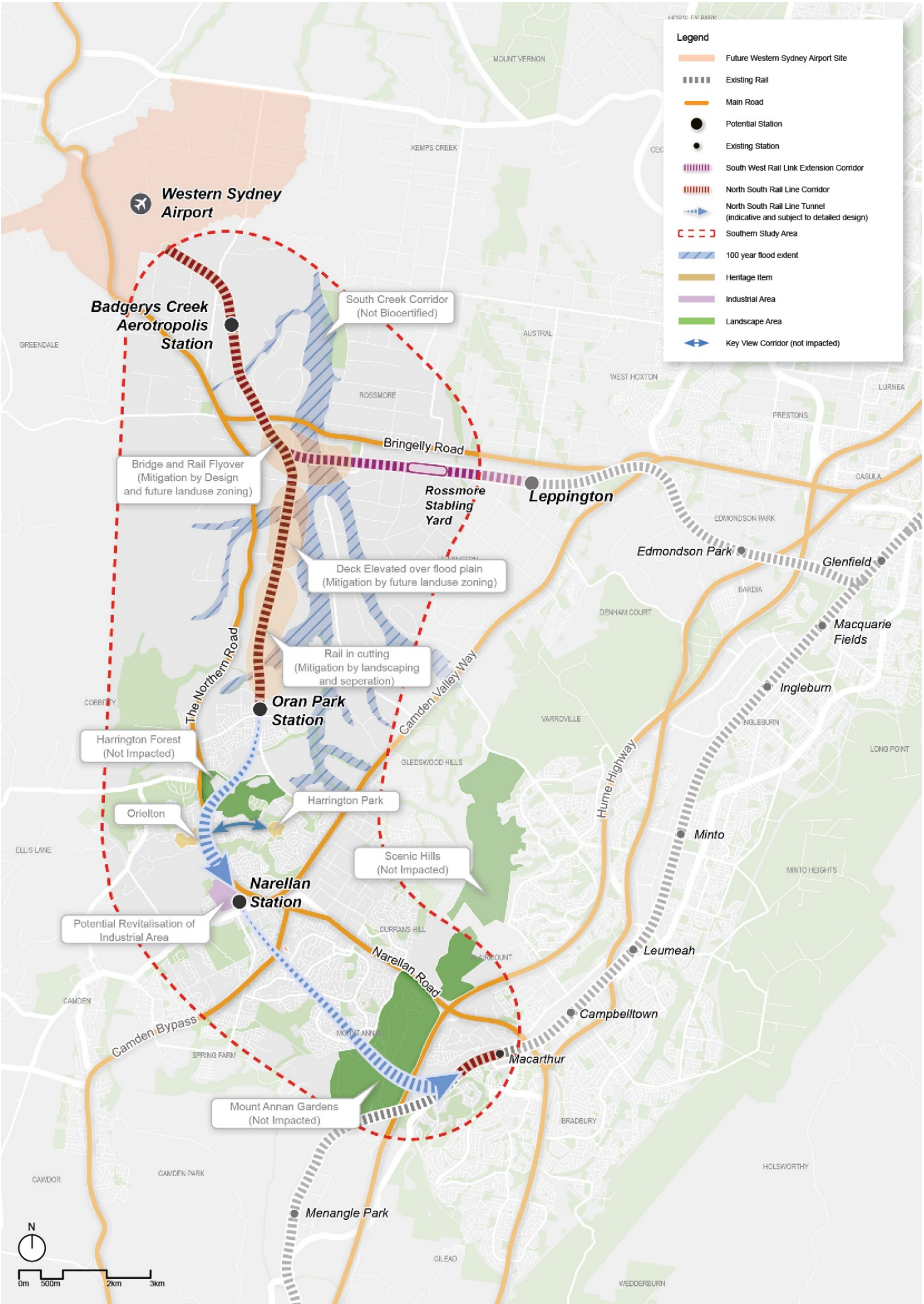

Figure 7-7 **Final recommended North South Rail Line and South West Rail Link Extension corridors overlaying landscape and visual features of the southern study area**

7.5.3 Mitigation measures

The most significant visual and landscape impact mitigation is the decision to underground the final recommended North South Rail Line corridor in tunnel between Oran Park and Macarthur. This decision avoids impacts to significant landscape elements at Harrington Forest, Scenic Hills, Australian Botanic Garden Mount Annan and William Howe Regional Park.

The area around the surface parts of the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area is undergoing significant change form new urban development, with further development likely to follow as the South West Growth Area expands. This presents the opportunity to design future development along the final recommended corridors to be compatible with a future rail line. For example, new development with low visual sensitivity can be located adjacent to segments of a future rail line likely to have the highest visual impact, while land uses with high visual sensitivity can be located adjacent to segments of a future rail line likely to have a lower visual impact.

7.6 Soil and water

7.6.1 How impacts have been avoided

West of Rossmore, the final recommended South West Rail Link Extension corridor crosses the main channel of the South Creek flood plain at a perpendicular angle to minimise the length of the bridge structure over the flood plain, as shown at Figure 7-8.

North of Oran Park, the surface section of the final recommended North South Rail Line corridor adopts an alignment generally following a natural localised ridgeline and avoiding existing flood storage dams and creeks.

South of Oran Park, the future North South Rail Line infrastructure would be in tunnel and avoid impacts to surface waters associated with Narellan Creek and Harrington Park Lake.

The final recommended North South Rail Line and South West Rail Link Extension corridors are separated from the Nepean River and are not expected to result in any detrimental impacts to the river.

The soil landscape of South Creek is known to include moderate to highly erodible soils and suitable erosion and sediment control measures will need to be implemented during construction.

7.6.2 Strategic environmental assessment

7.6.2.1 Geology

The preliminary geological assessment indicates that the following geological aspects will require further geotechnical investigation to adequately inform the detailed project design:

- Camden Syncline
- Rossmore Anticline
- Luddenham Dyke
- Woronora Anticline.

7.6.2.2 Soils

The Bringelly to Oran Park section of the final recommended North South Rail Line corridor passes through, or near, several dams and drainage channels which have a ‘high probability’ for acid sulfate soil materials to occur in bottom sediments and adjacent soils. As such, there is the potential for localised environmental risks from acid sulfate soils, including localised acidic runoff. Acid sulfate soil assessments would be conducted and an acid sulfate soils management plan prepared at the time of project construction.

The tunnel section of the North South Rail Line would require significant earthworks to construct and passes through an area (near Narellan Creek) considered to have a “low probability” of acid sulfate soil materials occurring within the soil profile. However, given that construction activities would involve substantial earthworks associated with tunnelling, further acid sulfate soil assessments would need to be conducted near Narellan to assess the presence and extent of acid sulfate soil materials and inform the need for an acid sulfate soils management plan to be prepared at the time of project construction.

The soil landscape of South Creek is known to include moderate to highly erodible soils. This is relevant to the selection of suitable erosion and sediment controls during the construction phase.

7.6.2.3 Contamination

Analysis has identified areas of environmental concern resulting from current or historical land uses. These areas include:

- Two larger scale agricultural and/or horticultural operations near where the final recommended North South Rail Line and South West Rail Line Extension corridors diverge at Bringelly
- Scrapyard near where the final recommended North South Rail Line and South West Rail Line Extension corridors diverge at Bringelly
- Recycling/composting facility between Oran Park and Bringelly Road
- Composting area between Oran Park and Bringelly Road
- Recycling and composting facility, around 800 metres north of Oran Park Town Centre
- Narellan industrial area containing numerous factories, warehouses, materials processing facilities and service centres
- Service station and car wash at Narellan
- Vacant land on the former brickworks site in Narellan, which appears discoloured and contains numerous stockpiles of likely soil/fill material.

Further contamination investigations are required to be carried out as part of the detailed design for the infrastructure.

7.6.2.4 Hydrogeology and hydrology

Assessment of hydrogeology, hydrology and water quality for the surface sections of the final recommended North South Rail Line and South West Rail Link Extension corridors has the same outcomes in the southern study area as documented in Section 6.6.2.4 for the northern study area.

The impact of a tunnelled section on groundwater is more complex. Based on previous experience within the Sydney Basin, the permeability of the intact shale and sandstone is expected to be low, with some areas of higher permeability associated with isolated defects in the rock. Groundwater inflows would primarily occur via geological features, such as highly fractured rock, joint swarms and residual soil interfaces. In these areas, the expectation is that ground treatment would be conducted such that the overall groundwater inflow would be limited to less than one litre /second/km (which has become an accepted criteria for transport infrastructure tunnels in Sydney).

If a drained tunnel concept is adopted, a tunnel groundwater management strategy is required that involves the collection of groundwater inflow at low point sumps within the tunnel(s). This water can then be pumped to a water treatment plant located near a portal. The long-term cost for groundwater treatment and pumping needs to be assessed when doing the cost estimation of the project.

The rate of inflow is a function of the ground conditions and influences the type of tunnel support that can be adopted. The groundwater table measurements derived from geotechnical boreholes indicate that the stable ground water table is relatively low and the anticipated ground water inflow during tunnel excavation would be low, and below the criteria of one litres/sec/km.

As part of a future infrastructure design phase, detailed groundwater assessment would be required to estimate accurate groundwater inflow and drawdown for the proposed tunnel.

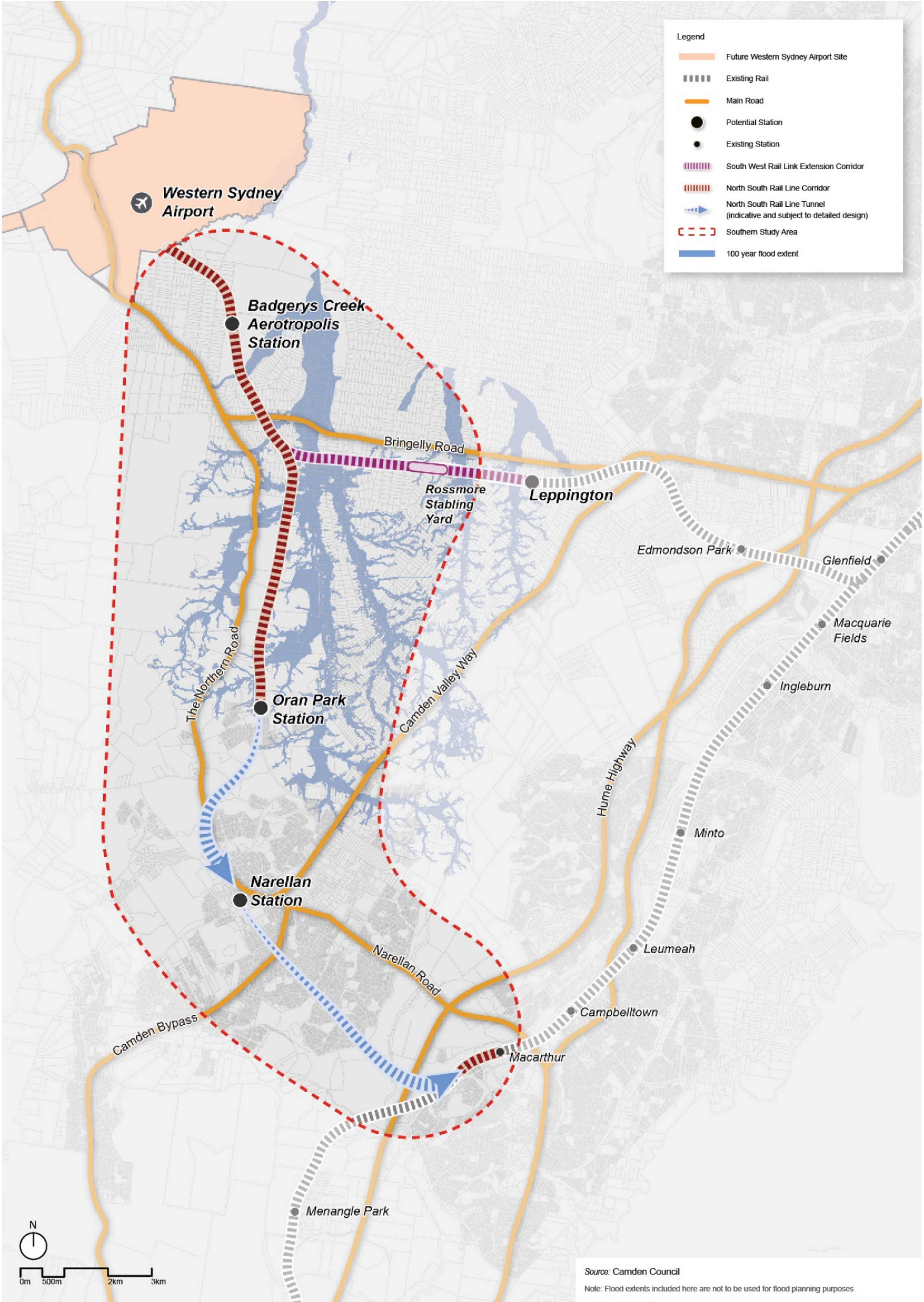

Figure 7-8 **Final recommended North South Rail Line and South West Rail Link Extension corridors overlaying flood impacts and watercourses in the southern study area**

7.6.3 Mitigation strategies

At the Oran Park Station, and through the Maryland, Lowes Creek, North Bringelly, Bringelly and Rossmore precincts the rail levels would need to be closely integrated with the civil engineering design of the future land use development. Detailed hydrological modelling within the new landforms (and changed flood conditions) for each precinct would need to:

- Ensure suitable flood immunity can be achieved
- Assess upstream and downstream flooding impacts
- Determine the size of detention basins.

Locations where the final recommended North South Rail Line and South West Rail Link Extension corridors cross the floodplain would require detailed consideration of design features with regard to how floods can affect the railway, and how creek crossings might alter flood behaviour. At creek crossings, the waterway opening would need to be designed with consideration to adverse flood afflux caused by hydraulic constriction of the bridge opening and piers, the potential for structural damage to piers or deck of the bridge from impact loads of flood debris, and inundation of bridge deck interrupting rail service or damaging rail infrastructure. This is relevant to all creek crossings, and particularly at South Creek, Lowes Creek and Bow Bowing Creek.

At tunnel portals, the railway formation levels would be elevated above the predicted probable maximum flood levels or flood walls would be constructed to prevent flooding of tunnels to minimise risk to human life and project infrastructure. This includes flood levels backing up from creeks, as well as more localised overland flow paths within urbanised areas. If this is not practical, then the portal levels must at least be elevated above the 1 in 100-year flood level. In these instances, the project should include flood evacuation planning including safe egress routes for workers and passengers.

The tunnel section between Oran Park and Narellan passes underneath several watercourses and the Sydney Water Supply Canal. The vertical alignment of the railway, geotechnical investigation and tunnel design would need to consider the risk of ground subsidence under watercourses and storages, and the potential impacts of water leakage from the surface and ingress into the tunnel(s).

Assessment of surface soils may not be required where the final recommended North South Rail Line corridor is in tunnel. However, the quality of local groundwater should be reviewed to identify potential groundwater and/or deep soil impacts over tunnel sections.

Overall, the types of measures and design features required to mitigate flooding risk would need to be tailored to each specific part of the future rail infrastructure, but are likely to be typical of linear infrastructure projects.

7.7 Biodiversity

7.7.1 How impacts have been avoided

The final recommended North South Rail Line and South West Rail Link Extension corridors are located within the South West Growth Area and Western Sydney Aerotropolis. Clearing of most native vegetation in the growth areas has been ‘Bio-certified’, meaning that the clearing is already approved and does not require detailed assessment or biodiversity offsetting as it has already been assessed and offset as part of the bio-certification process.

The final recommended South West Rail Link Extension corridor crosses the South Creek flood plain at a perpendicular angle to minimise the length of the bridge structure through the riparian corridor and to minimise any impacts on riparian and aquatic habitat.

South of Oran Park the future infrastructure would be in tunnel, which would avoid ecological impacts to the Endangered Ecological Community at Harrington Forest and within the Australian Botanic Garden Mount Annan. Land at Narellan Station and within the rail corridor south of Macarthur Station does not contain significant native vegetation.

7.7.2 Strategic environmental assessment

It is important to note that the native vegetation in the final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area is predominately within bio-certified lands where the clearing is already approved and does not require detailed assessment or biodiversity off-setting (see Figure 7-9). Land that has not been bio-certified is generally restricted to the riparian corridor along South Creek. The area within the final recommended corridors is considered to provide only limited habitat opportunities for native fauna, threatened or otherwise, and is unlikely to be utilised by any fauna groups other than highly mobile species or species typical of urban and semi-urban environments. Land at Narellan Station and within the rail corridor south of Macarthur Station does not contain significant native vegetation.

The total amount of vegetation clearing required in bio-certified and non-bio-certified lands is provided in Table 7-2. A future North South Rail Line and South West Rail Link Extension would require the removal of about 5.77 hectares of mapped native vegetation in the southern study area that is not bio-certified. Clearing of non-bio-certified native vegetation is estimated to include:

- About 4.04 hectares of River-flat Eucalypt Forest on Coastal Floodplain Forest within the South Creek corridor near Bringelly and along a tributary of South Creek, located just north of Oran Park
- About 1.73 hectares of Cumberland Plain Woodland within the South Creek corridor near Bringelly.

Table 7-2 Impacted vegetation communities in the southern study area

Vegetation community	BC Act status	Area (hectares)		
		Certified	Non-certified	Total
Alluvial Woodland	Endangered (River-flat Eucalypt Forest on Coastal Floodplain Forest)	3.90	4.04	7.94
Shale Plains Woodland	Critically endangered	17.36	1.73	19.09
Shale Hills Woodland	Critically endangered (Cumberland Plain Woodland)	15.77	0	15.77
Total		**37.03**	**5.77**	**42.8**

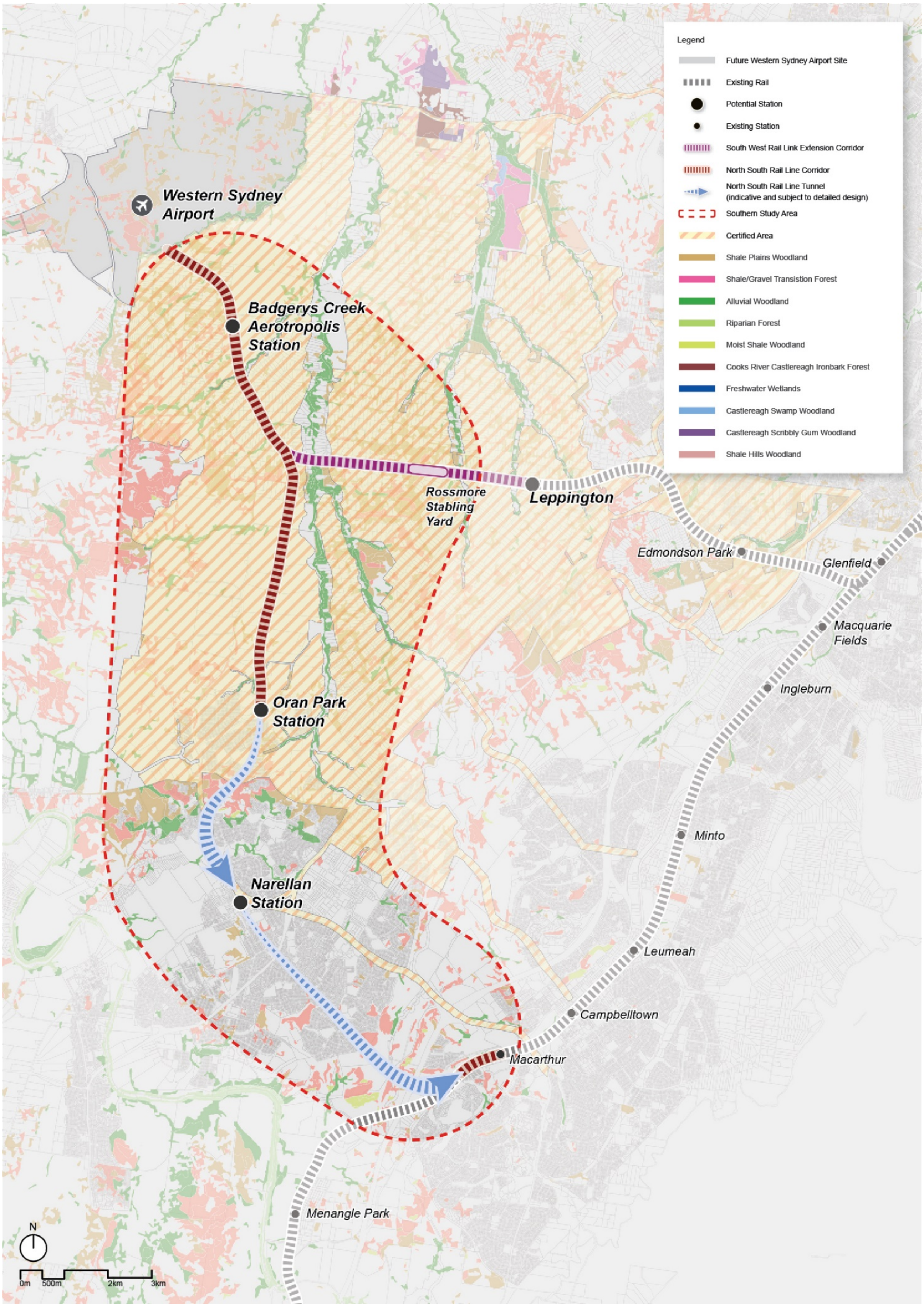

Figure 7-9 **Final recommended North South Rail Line and South West Rail Link Extension corridors overlaying biodiversity in the southern study area**

7.7.3 Mitigation strategies

The final recommended North South Rail Line corridor now includes a substantial future section of tunnel that avoids impacting biodiversity. In particular, the potential impacts to the ecological values within Harrington Forest was a major contributor to selection of tunnel south of Oran Park.

General ecological mitigation measures likely to be required during the delivery of the potential future infrastructure are set out in Section 6. Biodiversity off-set considerations are set our below.

7.7.3.1 Terrestrial biodiversity offsets

The terrestrial biodiversity values that may potentially require offsetting as part of the establishment of the rail corridor and future construction and operation of the rail line include the clearing of about 5.77 hectares of non-biocertified native vegetation. The ecosystem credits that will be required for future biodiversity offsets will be determined following field surveys. However, the likely credit types required to offset the non-biocertified Cumberland Plain Woodland vegetation types are as follows:

- ME19 Grey Box – Forest Red Gum grassy woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT850)
- ME17 Forest Red Gum – Grey Box shrubby woodland on shale of the southern Cumberland Plain, Sydney Basin Bioregion (PCT830)
- ME79 Swamp Oak open forest on river flats of the Cumberland Plain and Hunter Valley (PCT 1800).

Species credits would also be required to be offset if threatened species are potentially present within the non-biocertified parts of the final recommended North South Rail Line and South West Rail Link Extension corridors. The presence or absence of threatened flora species will require surveys conducted during the appropriate time of year according to the *NSW Guide to Surveying Threatened Plants* (Office of Environment and Heritage, 2016) prior to the construction of the projects. Potential species credits that may require offsetting, include:

- Threatened plant species recorded in the final recommended North South Rail Line corridor that are associated with grassy woodland habitats of western Sydney, such as *Pimelea spicata* and *Grevillea juniperina*
- Endangered populations of plants, including the *Marsdenia viridiflora* population
- Microchiropteran bats, including species that have previously been recorded within the locality, for example, Common Bent-wing Bat and Greater Broad-nosed bat, and for which suitable foraging and roosting habitat may be removed by any future clearing of the corridor.

7.7.3.2 National biodiversity offsets

The North South Rail Line and South West Rail Link Extension projects could have impacts on matters of national environmental significance listed under the *Environment Protection and Biodiversity Conservation Act 1999* including:

- Listed threatened species, as potential habitat for several threatened flora and fauna species occurring along the final recommended North South Rail Line corridor
- Listed threatened ecological communities, as several small patches of Cumberland Plain Woodland vegetation are located along the final recommended North South Rail Line and South West Rail Link Extension corridors.

However, due to the small area of impacted non-biocertified native vegetation, a preliminary conclusion is that the future infrastructure project is not likely to have a significant impact on any matters of national environmental significance. This conclusion is preliminary only and will need to be supported by data collected from field surveys and by detailed mapping and assessment of impacts, including addressing the relevant significance criteria presented in the Department of the Environment (2013) *Matters of National Environmental Significance – Significant Impact Guidelines 1.1*.

Should the detailed assessment of the future infrastructure conclude that a 'significant impact' is likely as a result of the project, then the project will need to be referred to the Department of the Environment and Energy for consideration as to whether the it constitutes a 'controlled action' within the meaning of the *Environment Protection and Biodiversity Conservation Act 1999*. Should the future infrastructure project be deemed a controlled action and residual impacts on the Matters of National Environmental Significance are deemed to be significant and unavoidable (after the application of avoidance and mitigation measures), then biodiversity offsets will be required by the Australian Government, in accordance with the *Environmental Offsets Policy* (Department of Sustainability, Environment, Water, Population and Communities, 2012).

According to the *Environmental Offsets Policy*, offsets can comprise a combination of 'direct offsets' and 'other compensatory measures'. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted to deliver a conservation gain. A minimum of 90 per cent of the offset requirements for any given impact should be met through direct offsets.

7.8 Heritage

7.8.1 How impacts have been avoided

The final recommended North South Rail Line and South West Rail Link Extension corridors in the southern study area avoid direct impacts on heritage items and conservation areas listed on the State Heritage Register and in local environmental plans. Heritage items in proximity to the final recommended North South Rail Line and South West Rail Link Extension corridors are shown in Figure 7-10.

While the landscape is acknowledged to be of cultural and social significance to Aboriginal people, there are no areas of particular cultural or social significance identified within the corridors.

The final recommended North South Rail Line corridor includes a substantial section of tunnel between Oran Park and Macarthur that would avoid impacts to heritage items. North of Oran Park there are a limited number of heritage items and future infrastructure is likely to be in a cutting to minimise any heritage landscape character impacts.

There are no known native title claims associated with the land in the final recommended North South Rail Line and South West Rail Link Extension corridors.

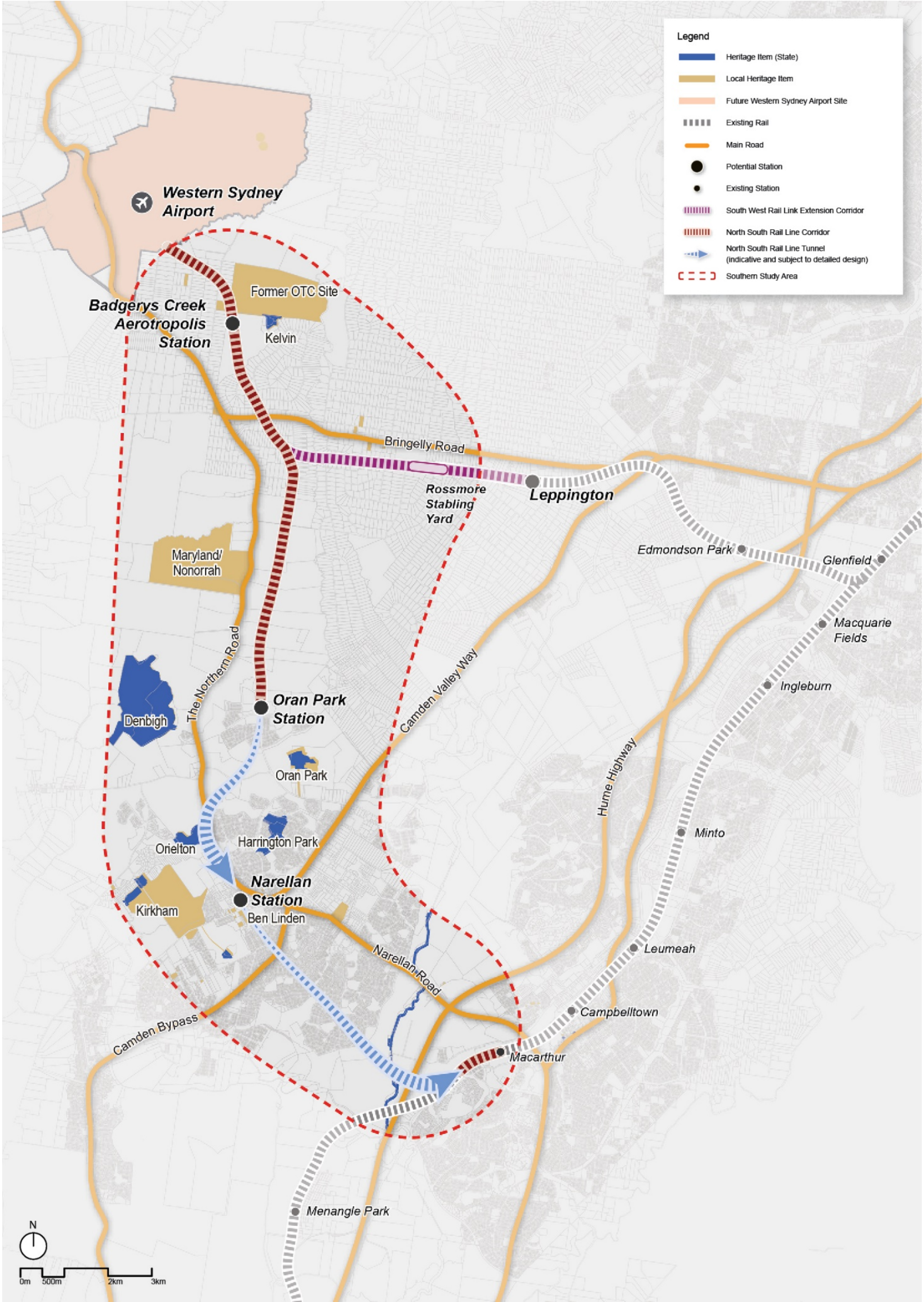

Figure 7-10 Final recommended North South Rail Line and South West Rail Link Extension corridors overlaying European heritage items in the southern study area

7.8.2 Strategic environmental assessment

7.8.2.1 Aboriginal heritage

There is potential for there to be direct and indirect impacts on Aboriginal heritage as a result of a future North South Rail Line and South West Rail Link Extension in the southern study area, however, no specific or significant impacts have been identified. It is considered that impacts would most likely occur during the construction phase, with future operation unlikely to result in significant impacts to any surrounding Aboriginal heritage. Through the application of appropriate mitigation measures, impacts on Aboriginal heritage should be able to be minimised or avoided completely.

Protecting the final recommended North South Rail Line and South West Rail Link Extension corridors would protect large tracts of land, remnant vegetation, Aboriginal objects and cultural landscapes. Certain Aboriginal sites, such as artefact sites, are currently considered to be common throughout the Cumberland Plain. However, as development of the Cumberland Plain increases, the number of intact Aboriginal sites decreases. As a result of this, all Aboriginal archaeological sites are likely to be rarer and therefore more valuable in the future, including those that may eventually be discovered within the final recommended North South Rail Line and South West Rail Link corridors.

7.8.2.2 European heritage

The long-term protection of the final recommended North South Rail Line and South West Rail Link Extension corridors could affect how heritage items are valued and maintained.

In relation to impacts on Orielton, the design of the final recommended North South Rail Line corridor would be in tunnel where Orielton is located and therefore any long-term impact would be minimised. Similarly, Ben Linden is unlikely to be directly impacted as a result of future rail infrastructure. Future construction of a station at Narellan would be within the visual curtilage of Ben Linden, however, due to its existing context within a light industrial and commercial area, the impact of this is considered to be minimal, and can be addressed through design.

Impacts on Bringelly Road will be negligible as the road is already undergoing significant upgrades. Similarly, any impact on the Bringelly/Greendale cultural landscape would be negligible as the area is already intended to undergo significant urban development removing the rural elements of the landscape.

At North Bringelly, the North South Rail Line would affect the access road and curtilage of the State Heritage Register listed ‘Kelvin’ group. In addition, the local heritage values associated with the former Overseas Telecommunications Commission site would be directly impacted.

While the impacts of construction of the North South Rail Line and South West Rail Link Extension on surrounding heritage items would need to be investigated prior to a future detailed infrastructure application, it is considered that design and construction measures can be implemented to avoid any significant impacts on the curtilage, fabric or setting of all affected heritage items. Upon completion of the North South Rail Line and South West Rail Link Extension it is considered that there would be minimal impacts to the heritage values of the area provided that mitigation measures are implemented during design and construction.

In addition to the presence of the known heritage items, further investigation would need to be undertaken to determine the significance of any archaeological sites. It is considered that future design and construction methods may be implemented to minimise any impacts to the heritage value of the area.

7.8.3 Mitigation strategies

The final recommended North South Rail Line corridor includes substantial future sections of tunnel that avoid impacts on heritage. The potential impacts to the State Heritage Register listed Orielton contributed to selection of the tunnel south of Oran Park. The commitment to tunnel also avoids impacts to areas of likely Aboriginal heritage value along Narellan Creek, along ridgelines and hill landforms in Harrington Forest, as well as around Gundungarra Reserve and William Howe Regional Park, Australian Botanic Garden Mount Annan, the Scenic Hills and the Western Sydney University Campbelltown campus.

7.8.3.1 Aboriginal heritage

The following mitigation measures will be considered as part of a future design phase:

- Consultation with Office of Environment and Heritage and landowners regarding the Aboriginal sites affected by the final recommended North South Rail Line and South West Rail Link Extension corridors
- Consultation with Aboriginal stakeholders in accordance with the relevant Office of Environment and Heritage guidelines. Consultation should be conducted at various stages during further planning
- Investigation and assessment of Aboriginal heritage impacts in accordance with the relevant guidelines, including, but not be limited to, site visits, confirmation of registered Aboriginal sites, identification of unrecorded sites, identification of areas which have been subject to little background research and an assessment of Aboriginal archaeological potential
- Construction phase mitigation measures may include test excavation, salvage excavation, detailed recording, reporting, artefact analysis, and heritage interpretation.

Future investigations present a unique opportunity to conduct a large-scale comparative study of Aboriginal archaeology in differing local contexts. As a result of this, there would be an opportunity for interpretation of Aboriginal heritage values to be incorporated into future design or to be included in a future heritage interpretation strategy.

7.8.3.2 European heritage

The following mitigation measures will be considered as part of a future design phase prior to the construction of the infrastructure:

- Prepare a statement of heritage impact for the former Overseas Telecommunications Commission Site, the ‘Kelvin’ group, Orielton and Ben Linden as part of a future infrastructure application
- The heritage significance of the Bringelly / Greendale cultural landscape and the Northern Road and Bringelly Road would need to be assessed in future heritage assessments and taken into consideration during the urban development in the area
- The design and construction of any future North South Rail Line work at Narellan should consider the heritage values of Ben Linden
- A detailed archaeological impact assessment should be prepared prior to a future infrastructure application to investigate the potential archaeological sites, including a site survey and documentary analysis
- Once construction methodology and the detailed design of the future rail line are known, impacts to potential archaeology should be avoided and mitigated by undertaking test excavation, salvage excavation, archaeological monitoring, detailed recording, reporting and artefact analysis as well as the preparation of a Heritage Interpretation Strategy.

7.9 Air quality

The assessment of air quality impacts in the southern study area is the same as that for the northern study area in Section 6.9.

7.10 Social

7.10.1 How impacts have been avoided

Potential social impacts would be assessed at the time of infrastructure delivery and reflect the then current land uses surrounding the final recommended North South Rail Line and South West Rail Link Extension corridor. A future environmental impact statement would be accompanied by a social impact assessment.

7.10.2 Strategic environmental assessment

The location of the corridor has been carefully selected to ensure that social benefits are maximised. To this extent, locating parts of the corridor in tunnel would minimise disruption to existing communities and ensure that the overall impact of corridor protection is beneficial. By protecting a corridor, the community can have a better awareness of the location of future transport infrastructure and would be able to appropriately plan for this.

The area around the surface section of the final recommended North South Rail Line and South West Rail Link Extension corridors between Rossmore, Western Sydney Airport and Oran Park is expected to be the subject of substantial urban transformation in the coming years, prior to the delivery of the North South Rail Line and South West Rail Link Extension infrastructure.

Protection of the final recommended North South Rail Line and South West Rail Link Extension corridors would maximise the opportunity to integrate future rail infrastructure into planned urban development and minimise impact to existing and future communities. Transport for NSW would continue to work with other relevant agencies across the NSW Government to ensure that land use planning and transport planning processes are integrated and coordinated, so that social disruption in the future can be avoided.

The location of the proposed Narellan Station presents an opportunity for renewal of the centre and will support the ongoing growth of the area.

The Oran Park Master Plan currently envisages a school and health/medical precinct to be located adjacent to Oran Park Station.

7.10.3 Mitigation strategies

Social mitigation strategies for the southern study area are the same as those for the northern study area described in Section 6.10.3.

8 Overall impact and environmental risk analysis

This section assesses the potential cumulative impacts of the final recommended North South Rail Line and South West Rail Link Extension corridors and the overall potential impact of future rail infrastructure in these corridors. An environmental risk analysis summary is also provided that identifies the potential environmental impacts associated with the protection of the final recommended North South Rail Line and South West Rail Link Extension corridors.

8.1 Cumulative environmental assessment

Cumulative impacts are the successive, incremental and combined impacts of one or more activities. Such impacts can be both positive and negative and can vary in intensity as well as in spatial and temporal extent. Cumulative impacts may be generated through the aggregation or interaction of impacts. The number of projects planned and underway across western Sydney and the potential cumulative impacts that may arise require collective consideration.

8.1.1 Related infrastructure and development

Major new development for residential, employment and recreation will occur in the growth areas and new transport infrastructure projects will be required to support them. Current and future road infrastructure projects in western Sydney are summarised in the *Western Sydney Infrastructure Plan* (Roads and Maritime Services, 2017b) and include:

- An upgrade of The Northern Road to a minimum of four lanes from Narellan to the M4 Western Motorway
- Construction of the proposed M12 Motorway between the M7 Motorway and The Northern Road
- Upgrade of Bringelly Road to a minimum of four lanes between The Northern Road and Camden Valley Way
- A $200 million package for local road upgrades.

Future infrastructure projects that are currently in various stages of planning include:

- Outer Sydney Orbital
- Western Sydney Freight Line
- Western Sydney Airport.

The outcomes of the *Western Sydney Rail Needs Scoping Study* will also likely shape future rail infrastructure development in western Sydney to 2056.

A review of the potential for cumulative impacts to arise is provided in Table 8-1, with further assessment provided in Sections 8.1.2 to 8.1.5 where a potential for cumulative impacts is identified.

Table 8-1 Cumulative impacts assessment

Matter	Assessment
Land use and property impacts	Progressive urbanisation of the landscape, shifting from largely rural to increasingly urban, with the corresponding loss of agricultural land uses and changes to economic activity. These changes in land use activity are likely to occur with or without the future rail infrastructure.
Economic impacts	Progressive urbanisation of the area is likely to result in positive cumulative economic impacts, as investment in infrastructure and land use programs increases opportunities for employment and housing.
Traffic and transport	Cumulative impacts on traffic and transport in the region are likely to be as a result of increased investment in transport infrastructure, as well as an increased residential population. Corridor protection is intended to address these traffic and transport impacts and be complementary to planned infrastructure investment in the region.
Noise and vibration	Progressive development of the region may result in cumulative noise and vibration impacts as a result of the intensification of land uses and construction.
Visual amenity, built form and urban design	Progressive development of western Sydney is likely to alter the existing visual amenity, built form and urban design character along the length of the final recommended North South Rail Line corridor between Orchard Hills and Oran Park and the final recommended South West Rail Link Extension corridor. There are also likely to be potential incremental changes in the visual character of established urban areas around Narellan, Campbelltown and Macarthur.
Soil and water	Progressive development of the area may result in potential cumulative soil and water impacts, altering flooding and soil quality conditions. Cumulative hydrological and water quality issues are considered in Section 8.1.5.
Biodiversity	Broader scale loss of ecological diversity, particularly of endangered ecological communities such as the Cumberland Plain Woodland, see Section 8.1.3.
Heritage	Cumulative impacts on heritage items are discussed in Section 8.1.4.
Air quality	Agglomeration of individual smaller scale impacts such as airshed changes, watershed alterations or climate change that collectively trigger regional sensitivity criteria. The future North South Rail Line and South West Rail Link Extension infrastructure would not contribute to a worsening of airshed or climate change issues.
Social	Progressive urbanisation of the area is likely to result in positive cumulative social impacts, as investment in infrastructure and land use programs increases opportunities for employment and housing.
Construction	Potential agglomeration of construction impacts, depending on the timing of construction, which may include air, noise and water quality impacts. These are construction impacts that are not related to corridor protection and would be addressed as part of the environmental impact assessment supporting a future infrastructure application.

8.1.2 Cumulative impact on land use

There is considerable discussion in this Strategic Environmental Assessment of current and future development within and along the final recommended North South Rail Line and South West Rail Link Extension corridors and changes in land use activity that are likely to occur, with or without the future infrastructure.

Cumulative impacts of corridor protection and ongoing urban development in the Western Economic Corridor and Greater Penrith to Eastern Creek Corridor will have a transformative effect on the character of western Sydney, particularly in relation to the visual character of the landscape, noise, stormwater, traffic and transport. As a result of this, cumulative impacts associated with development and infrastructure delivery would be assessed and mitigated through detailed land use planning. The objective of early corridor protection is to assist in the mitigation of cumulative impacts by ensuring land uses can be appropriately distributed.

In relation to cumulative impacts outside the Western Economic Corridor, corridor protection would not result in any additional impacts beyond what would ordinarily be expected through the course of incremental development. In this way, land use planning and future infrastructure applications would be able to adequately address any impacts that arise.

Future public transport infrastructure in the final recommended corridors is expected to strengthen the role of new and existing strategic centres at Western Sydney Aerotropolis, Oran Park, Narellan and Macarthur, particularly when considered alongside proposed road transport infrastructure upgrades and ongoing urban development.

Overall, most impacts discussed in this Strategic Environmental Assessment are not considered to result in any impact beyond what would ordinarily be expected as part of ongoing development, with the exception of the issues discussed in the following sections.

8.1.3 Cumulative impacts on ecological values

Impacts on flora and fauna associated with the future construction and operation of the North South Rail Line and South West Rail Link Extension are likely to be relatively restricted and limited in extent. However, clearing would be required in certain locations resulting in a loss of flora and fauna habitats and biodiversity values. In addition to this, there would also be several other large infrastructure works that would occur in western Sydney over the timeframe of the construction and operation of the North South Rail Line and South West Rail Link Extension. Key projects include major road upgrades as part of the *Western Sydney Infrastructure Plan* as well as service and infrastructure work to support future residential growth throughout the South West Growth Area.

On an individual basis, these developments may only have localised and limited impacts on biodiversity but each are likely to involve some loss of threatened species habitat and a reduction in the extent of threatened ecological communities. The collective impacts of the above developments in western Sydney could be significant at a regional scale in particular, as they would all occur within the same region and over similar timeframes.

It will be the responsibility of the NSW Government and relevant local councils to consider the significance of the cumulative impacts relating to infrastructure and development projects in western Sydney. It is recommended that a regional scale approach to avoidance of impacts on biodiversity should be considered, with appropriate mechanisms for setting aside land and funding for biodiversity offsets. Transport for NSW may either set aside land or funding for biodiversity offsets for the project at the strategic environmental assessment phase or may defer the need for offset until the project begins the delivery phase, which will be quantified in a future environmental impact statement.

8.1.4 Cumulative impacts on heritage items

The long-term protection of the corridor may affect how heritage items are valued and maintained, which may impact on the heritage significance of the item. Specifically:

- The final recommended North South Rail Line corridor would traverse the Luddenham Road alignment in Luddenham
- The final recommended North South Rail Line corridor travels through the McGarvie-Smith Farm in Badgerys Creek
- Orielton is located partly within the final recommended North South Rail Line corridor, but this portion of the corridor will be in tunnel and is unlikely to affect its heritage value
- Ben Linden is located in proximity to the tunnel portion of the final recommended North South Rail Line corridor and the future Narellan Station. Ben Linden is currently located within a light industrial area and any impacts as a result of the future station are unlikely to directly impact the heritage significance of this item
- The Northern Road and Bringelly Road potential local heritage items are currently undergoing upgrades that will likely result in an adverse effect on the heritage significance of the roads as the alignment and setting will be altered
- The Bringelly / Greendale cultural landscape is located within the South West Growth Area and the significance of this area is likely to be impacted as a result of planned urban development. It is noted that the protection of the corridor could temporarily protect a section of the cultural landscape, but the scale of urban development would likely diminish any heritage value over time

- Long term protection of the final recommended North South Rail Line and South West Rail Link Extension corridors could temporarily protect portions of potential historical archaeological sites, but future urban development in the northern and southern study areas is likely to impact on potential archaeological sites.

8.1.5 Cumulative impacts on water resources

Future development in the Western Economic Corridor would result in modified groundwater conditions and surface water conditions that are likely to affect flooding behaviour. For this reason, any future infrastructure application would need to be designed, planned and assessed based on the conditions at the time and stormwater arrangements should take into account the future infrastructure.

The cumulative impact from urbanisation and other land uses within the catchment is a recognised issue and the Lower Hawkesbury-Nepean River Nutrient Management Strategy prepared by Office of Environment and Heritage provides a catchment wide policy framework to coordinate and guide actions aimed at preserving the environmental values of the river system. The most sensitive environmental issue is likely to be the cumulative impact of development within the South Creek catchment on the water quality objectives for the Hawkesbury Nepean River.

8.2 Overall impact

The *Environmental Planning and Assessment Act 1979* specifies that justification of major projects must have regard to biophysical, economic and social considerations and the principles of ecologically sustainable development.

This means that the decision on whether a project can proceed or not needs to be made in the full knowledge of its effects, both positive and negative, whether those impacts can be quantified or not. An assessment must therefore focus on the identification and appraisal of the effects of the proposed change over the area's existing conditions.

Various components of the biophysical, social and economic environments have been examined in this Strategic Environmental Assessment and are summarised below.

8.2.1 Social and economic

Corridor protection and potential future railway infrastructure has the potential to result in positive social and economic impacts as it would:

- Protect land now for future rail infrastructure to minimise future costs associated with rail infrastructure
- Protect corridors that link strategic centres as identified in the Greater *Sydney Region Plan*, *Western City District Plan* and *Future Transport Strategy 2056* to provide transport infrastructure close to places of employment
- Be located to avoid impacts on existing sensitive receivers
- Create an opportunity for future land uses to be established to respond to the potential for future rail infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors
- Deliver additional development capacity for employment-generating land uses
- Deliver additional dwellings in transit-oriented development around new transport nodes, increasing the demand for local employment-supporting services
- Increase the broader population catchment able to access the region for employment by public transport, increasing the ability of businesses to access potential employees and customers
- Promote/support the development of accessible and liveable town centres based around active transport and public transport, and not the sole reliance on private vehicles.

8.2.2 Biophysical

The assessment presented in Sections 6 and 7 of this Strategic Environmental Assessment has demonstrated that the final recommended corridors have minimised the potential for biophysical impacts and demonstrated that potential future rail infrastructure would not result in any unmanageable biophysical impacts following the implementation of the mitigation measures discussed above.

8.3 Ecologically sustainable development

The *Environmental Planning and Assessment Regulation 2000* lists four principles of ecologically sustainable development:

- The precautionary principle
- Intergenerational equity
- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing of environmental resources.

These principles and their application to the final recommended North South Rail Line and South West Rail Link Extension corridors are discussed in the following sections.

8.3.1 The precautionary principle

The precautionary principle is utilised when uncertainty exists about potential environmental impacts. It recommends that if there are threats of serious or irreversible environmental damage, a lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. The precautionary principle requires careful evaluation of potential environmental impacts to avoid, wherever practicable, serious or irreversible damage to the environment.

This Strategic Environmental Assessment has not identified any serious threat of irreversible damage to the environment associated with the protection of the final recommended North South Rail Line and South West Rail Link Extension corridors. Where appropriate, the precautionary principle would be adopted during assessment of potential future rail infrastructure to minimise any adverse environmental impacts in accordance with the mitigation measures outlined in Sections 6, 7 and 10.

8.3.2 Intergenerational equity

Intergenerational equity is concerned with ensuring that the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations. The proposal has been designed to benefit both the existing and future generations by identifying corridors that will minimise impacts on existing land uses and to ensure that future land uses can be appropriately distributed. Protecting the corridors will aim to ensure that future rail infrastructure can be delivered in a timely and cost-efficient manner. Potential future rail infrastructure will benefit future generations by providing a transport link between homes and places of employment and will support the ongoing growth of western Sydney.

8.3.3 Conservation of biological diversity and ecological integrity

The principle of biological diversity upholds that the conservation of biological diversity and ecological integrity should be a fundamental consideration in the assessment of projects. The final recommended North South Rail Line and South West Rail Link Extension corridors would not have any significant effect on the biological diversity and ecological integrity of the local area, with future potential rail infrastructure applications capable of applying appropriate mitigation strategies to ensure impacts on biological diversity and ecological integrity are minimised.

8.3.4 Improved valuation, pricing and incentive mechanisms

The principles of improved valuation and pricing of environmental resources requires consideration of all environmental resources which may be affected by a proposal, including air, water, land and living things. At the corridor protection stage of the process, it is considered that no environmental resources in the area will be adversely affected. Future potential rail infrastructure applications will consider valuation, pricing and incentive mechanisms and other mitigation measures to minimise any impacts on environmental resources required or impacted by future rail infrastructure.

8.4 Environmental risk analysis

An environmental risk analysis has been undertaken that establishes a residual risk for a range of environmental factors by reviewing the significance of environmental impacts and the ability to manage those impacts. The environmental risk analysis has been adapted from Australian Standard AS4369.1999 Risk Management and Environmental Risk Tools.

Figure 8-1 indicates the significance of environmental impact and assigns a value between one and 10 based on:

- The receiving environment
- The level of understanding of the type and extent of impacts
- The likely community response to the environmental consequence of protecting the corridors.

The manageability of environmental impact is assigned a value between one and five based on:

- The complexity of the mitigation measures
- The known level of performance of the safeguards proposed
- The opportunity for adaptive management.

The sum of the values assigned provides an indicative ranking of potential residual impacts after the mitigation measures are implemented. Table 8-2 presents the findings of the environmental risk analysis.

The environmental risk analysis identifies and addresses the impacts of corridor protection. Construction and operation of future transport infrastructure within the final recommended North South Rail Line and South West Rail Link Extension corridors would be the subject of a future environmental impact assessment to assess impacts and identify mitigation measures in accordance with the *Environmental Planning and Assessment Act 1979*.

Significance of impact	Manageability of impact				
	5 Complex	4 Substantial	3 Elementary	2 Standard	1 Simple
1 – Low	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)	3 (Low)	2 (Low)
2 – Minor	7 (High/Medium)	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)	3 (Low)
3 – Moderate	8 (High/Medium)	7 (High/Medium)	6 (Medium)	5 (Low/Medium)	4 (Low/Medium)
4 – High	9 (High)	8 (High/Medium)	7 (High/Medium)	6 (Medium)	5 (Low/Medium)
5 – Extreme	10 (High)	9 (High)	8 (High/Medium)	7 (High/Medium)	6 (Medium)

Figure 8-1 Significance of environmental impacts matrix

Table 8-2 Environmental risk analysis

Potential environmental impacts of corridor protection			Risk analysis		
Item	**Potential environmental impact**	**Proposed mitigation strategies**	**Significance of impact**	**Manageability of impact**	**Residual impact**
Land use and property	Affected properties subject to development restrictions until such time as the infrastructure is delivered.	▪ Implement statutory corridor protection measures within appropriate environmental planning instruments to identify and manage land use and property within and immediately adjoining corridor.	3	3	6
Economic	Corridor land is not economically used until the future infrastructure is delivered.	▪ In consultation with the Department of Planning, Industry and Environment, councils and landowners, an interim land use strategy will be prepared to set out the preferred land use outcomes sought by Transport for NSW when considering land use changes until such time that a transport project proceeds.	3	2	5
Traffic and transport	No traffic and transport impacts associated with corridor protection.	▪ Implement statutory corridor protection measures within appropriate environmental planning instruments to identify and manage land use and property within and immediately adjoining corridor to ensure that future road network is influenced by the final recommended North South Rail Line and South West Rail Link Extension corridors.	2	2	4
Noise and Vibration	No noise and vibration impacts associated with corridor protection.	▪ Implement statutory corridor protection measures within appropriate environmental planning instruments to identify and manage land use and property within land immediately adjoining corridor to ensure that future urban development is influenced by the final recommended North South Rail Line and South West Rail Link Extension corridors – including siting of sensitive land uses, and design of buildings.	2	2	4

Potential environmental impacts of corridor protection			Risk analysis		
Item	**Potential environmental impact**	**Proposed mitigation strategies**	**Significance of impact**	**Manageability of impact**	**Residual impact**
Visual amenity, built form and urban design	No visual and landscape impacts associated with corridor protection.	▪ Implement statutory corridor protection measures within appropriate environmental planning instruments to identify and manage land use and property within land immediately adjoining corridor to ensure that future urban development is influenced by the final recommended North South Rail Line and South West Rail Link Extension corridors – including siting of sensitive land uses.	2	2	4
Soil and Water	No geology, soil and water resource impacts associated with corridor protection.	▪ Implement statutory corridor protection measures within appropriate environmental planning instruments to identify and manage stormwater management systems within land next to the final recommended North South Rail Line and South West Rail Link Extension corridors.	2	2	4
Biodiversity	No biodiversity impacts associated with corridor protection.	▪ Future approvals and/or concurrence in accordance with the *Biodiversity Conservation Act 1979* and *Environment Protection and Biodiversity Conservation Act 1999* as required. ▪ Biodiversity offsets to be obtained.	2	2	4
European heritage	The protection of the corridor could affect how heritage items are valued and maintained.	▪ Design of future infrastructure to consider the heritage values of McGarvie-Smith Farm and Ben Linden. ▪ Future approvals and/or concurrence in accordance with *Heritage Act 1977*.	2	2	4
Aboriginal heritage	No Aboriginal heritage impacts associated with corridor protection.	▪ Future approvals and/or concurrence in accordance with the *National Parks and Wildlife Act 1974*.	2	2	4
Air quality	No air quality impacts associated with corridor protection.	▪ Design of future infrastructure to consider greenhouse gas emissions.	2	2	4

Potential environmental impacts of corridor protection			Risk analysis		
Item	**Potential environmental impact**	**Proposed mitigation strategies**	**Significance of impact**	**Manageability of impact**	**Residual impact**
Social	▪ No community facilities or services impacted by corridor protection. ▪ Landowners of affected properties may not be able to sell the property.	▪ A transparent and equitable process to manage and communicate the property acquisition process should be established as early as possible to assist in managing land owner concerns.	2	2	4

9 Corridor protection process

9.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979*, supported by the Environmental Planning and Assessment Regulation 2000, sets out mechanisms for the management, development and conservation of the environment as well as for the orderly and economic use and development of land. The *Environmental Planning and Assessment Act 1979* includes provisions relating to the following matters:

- Requirements for rezoning land including for the preparation of a local environmental study as part of the rezoning process
- Matters for consideration when determining a development application, infrastructure application or activity.

9.1.1 Rezoning of land

Part 3 of the *Environmental Planning and Assessment Act 1979* creates the authority for State Environmental Planning Policies and local environmental plans to be made. Local environmental plans are made by councils to guide planning decisions for local government areas through zoning and development controls to manage the ways in which land is used. Implementation of local environmental plans is facilitated through development control plans which provide detailed planning and design guidelines. A development control plan typically identifies additional development controls and standards for addressing development issues at a local level and can be applied more flexibly than a local environmental plan. State Environmental Planning Policies deal with matters of State or regional environmental planning significance.

Under the *Environmental Planning and Assessment Act 1979*, only the Governor may make a State Environmental Planning Policy, while authority to make a local environmental plan is delegated to the Minister for Planning or the Greater Sydney Commission.

When making or amending environmental planning instruments, the relevant planning authority, for example, a council or the Secretary of the Department of Planning, Industry and Environment, must take into account the Ministerial directions contained in Section 9.1 of the *Environmental Planning and Assessment Act 1979*. These directions require councils to address a range of matters when seeking to rezone land.

9.1.2 Infrastructure approvals

Division 5.2 of the *Environmental Planning and Assessment Act 1979* currently contains provisions relating to the environmental assessment and approval of State Significant Infrastructure, including the application process, which includes the issuing of environmental assessment requirements by the Secretary of the Department of Planning, Industry and Environment, the preparation of an environmental impact statement and the public exhibition of the project. It is likely that any future application for rail infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors would be required to comply with this legislative process.

Under Division 5.2 of the *Environmental Planning and Assessment Act 1979*, a range of approvals under other legislation do not apply to State Significant Infrastructure. Approvals under the following legislation, which might otherwise be required prior to the construction of the North South Rail Line and South West Rail Link Extension in the future, would not be required as a result of Division 5.2:

- *Fisheries Management Act 1994*
- *Heritage Act 1977*
- *National Parks and Wildlife Act 1974*
- *Native Vegetation Act 2003*
- *Water Management Act 2000* (except for an aquifer interference approval which remains).

When the Government commits to progressing with the construction and operation of an infrastructure project within the final recommended North South Rail Line and South West Rail Link Extension corridors, an environmental assessment of the proposed project under the *Environmental Planning and Assessment Act 1979*, or the relevant legislation at that time, would be prepared. This stage of the corridor delivery process may be decades away and would be subject to available funding and the regulatory context at the time.

9.2 Land proposed for protection

Land in the above ground sections of the final recommended North South Rail Line corridor and all the final recommended South West Rail Link Extension corridor is proposed to be protected. The vertical and horizontal alignment of the section of tunnel in the final recommended North South Rail Line corridor is still under investigation and no protection of this tunnel is proposed.

Protection of the above ground sections of the final recommended corridors now will enable the land release precinct planning processes to factor in the future location of the rail corridors and to provide for appropriate land uses around the corridors including near the future railway stations. This is particularly relevant for land within the Western Sydney Aerotropolis and South West Growth Area, where land has already been released for future urban development.

At Narellan and Oran Park, the final recommended North South Rail Line corridor to be protected includes temporary tunnel construction compound sites. At Macarthur, the final recommended North South Rail Line corridor for protection is limited to slivers of land on either side of the existing rail corridor. Detailed maps showing the properties impacted by the final recommended North South Rail Line corridor are available alongside this Strategic Environmental Assessment.

Corridor protection will be achieved through the planning system. It is intended that an environmental planning instrument will be prepared under Part 3 of the *Environmental Planning and Assessment Act 1979* that will rezone the final recommended North South Rail Line and South West Rail Link Extension corridors as Infrastructure (SP2).

The outcomes that protection of the final recommended corridors by rezoning are intended to achieve are to:

- Facilitate the future delivery of the North South Rail Line and South West Rail Link Extension for passenger train services by preventing development from occurring within the final recommended corridors that is incompatible with the future infrastructure, minimising future community disruption and minimising property acquisition costs
- Not affect existing uses which will be able to continue in the immediate term
- Enable the NSW Government to acquire the land and specify the relevant acquisition authority for owner-initiated land acquisition under the *Land Acquisition (Just Terms Compensation) Act 1991* until that time.

The Department of Planning, Industry and Environment is the relevant planning authority responsible for the preparation of the environmental planning instrument(s) that will protect the final recommended North South Rail Line and South West Rail Link Extension corridors.

9.3 Other statutory requirements

Table 9-1 identifies relevant Australian Government, NSW Government and local legislation that needs to be considered in the context of corridor protection and the potential future delivery of rail infrastructure. Table 9-1 also identifies what a future environmental impact assessment for potential mass transit would need to consider.

Table 9-1 Relevant legislation and guidelines

Legislation/guidelines	Relevance to the final recommended North South Rail Line and South West Rail Link Extension corridors	Future assessment considerations
Environment Protection and Biodiversity Conservation Act 1999	The requirements of the *Environment Protection and Biodiversity Conservation Act 1999* have been considered when selecting the final recommended corridors. The Australian Government's Department of Environment and Energy has been engaged during the preparation of this Strategic Environmental Assessment in accordance with the guidelines in Appendix 1.	Referral to the Australian Government's Department of Environment and Energy is potentially required when planning for the future infrastructure to assess the potential impact on Matters of National Environmental Significance.
Environmental Planning and Assessment Act 1979	The *Environmental Planning and Assessment Act 1979* controls development in NSW, including rezoning and development approvals (refer to Section 9.1).	A future environmental impact statement would need to be prepared in accordance with the requirements of the *Environmental Planning and Assessment Act 1979*.
Biodiversity Conservation Act 2016	The *Biodiversity Conservation Act 2016* mandates the use of biodiversity offsets for most projects across NSW as well as identifies and protects threatened species, ecological communities and key threatening processes. The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to avoid and minimise impacts on threatened species identified under the Act.	A future environmental impact statement would need to assess the impact of potential mass transit infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors on threatened and endangered species, populations and communities, as well as provide for offsets in accordance with the Biodiversity Offsets Scheme established under the Act.
Water Management Act 2000	The *Water Management Act 2000* regulates activities that impact on surface or groundwater systems. The need to obtain approvals for work in, on or under waterfront land has informed the selection of the final recommended North South Rail Line and South West Rail Link Extension corridors.	A future environmental impact statement would need to obtain approval under the *Water Management Act 2000* for any work undertaken in the final recommended corridors that are in, on or under waterfront land.
National Parks and Wildlife Act 1974	The *National Parks and Wildlife Act 1974* protects Aboriginal sites and relics in NSW and includes requirements for consultation and consent where development is likely to impact on Aboriginal relics and values. The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to minimise any impacts on Aboriginal relics.	A future environmental impact statement would need to assess the impact of potential mass transit infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors on Aboriginal sites or relics.
Heritage Act 1977	The *Heritage Act 1977* protects European heritage items and requires consent for any work that is likely to impact on listed heritage items. The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to minimise any impacts on heritage items as a result of corridor protection or future mass transit infrastructure in the corridors.	A future environmental impact statement would need to assess the impact of potential mass transit infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors on heritage items. A future application for development in the final recommended corridors may also be referred to the NSW Heritage Council.

Legislation/guidelines	Relevance to the final recommended North South Rail Line and South West Rail Link Extension corridors	Future assessment considerations
Land Acquisition (Just Terms Compensation) Act 1991	The *Land Acquisition (Just Terms Compensation) Act 1991* establishes a process for equitable compensation of landowners whose land is acquired. Any land acquisition undertaken subsequent to protection of the final recommended North South Rail Line and South West Rail Link Extension corridors would be undertaken in accordance with the provisions of this Act.	Any land acquisition undertaken prior to the delivery of potential mass transit infrastructure in the final recommended North South Rail Line and South West Rail Link Extension corridors needs to occur in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.
Crown Lands Act 1989	No Crown land is affected by the final recommended North South Rail Line and South West Rail Link Extension corridors.	No Crown land is affected by the final recommended North South Rail Line and South West Rail Link Extension corridors. It is unlikely a future environmental impact statement would need to address the *Crown Lands Act 1989*.
State Environmental Planning Policy (Sydney Region Growth Centres) 2006	The State Environmental Planning Policy (Sydney Region Growth Centres) 2006 regulates development of the former South West Growth Centre. The structure plan for the former South West Growth Centre established under the policy was considered in the selection of the final recommended North South Rail Line and South West Rail Link Extension corridors. It is likely that the protection of the final recommended corridors would require subsequent amendments to the policy.	A future environmental impact statement may need to demonstrate how potential future mass transit infrastructure in the final recommended corridors is consistent with the controls of the State Environmental Planning Policy (Sydney Region Growth Centres) 2006.
State Environmental Planning Policy (Infrastructure) 2007	The State Environmental Planning Policy (Infrastructure) 2007 contains a variety of regulations for the planning and delivery of infrastructure and services. The policy is not directly applicable to the protection of corridors, however, requirements for rail infrastructure and associated development that are established by the policy have been considered in the selection of the final recommended corridors.	A future environmental impact statement may need to establish that the works are consistent with the requirements of the State Environmental Planning Policy (Infrastructure) 2007
Penrith Local Environmental Plan 2010	The Penrith Local Environmental Plan 2010 establishes land use controls for the Penrith local government area. The selection of the final recommended North South Rail Line corridor has taken into account existing land use patterns facilitated by the Penrith Local Environmental Plan 2010.	A future environmental impact statement would need to consider the provisions of the Penrith Local Environmental Plan 2010.
Liverpool Local Environmental Plan 2008	The Liverpool Local Environmental Plan 2008 establishes land use controls for the Liverpool local government area. The selection of the final recommended North South Rail Line corridor has considered existing land use patterns facilitated by the plan.	A future environmental impact statement would need to consider the provisions of the Liverpool Local Environmental Plan 2008.
Camden Local Environmental Plan 2010	The Camden Local Environmental Plan 2010 establishes land use controls for the Camden local government area. The selection of the final recommended North South Rail Line corridor has considered existing land use patterns facilitated by the plan.	A future environmental impact statement would need to consider the provisions of the Camden Local Environmental Plan 2010.

Legislation/guidelines	Relevance to the final recommended North South Rail Line and South West Rail Link Extension corridors	Future assessment considerations
Campbelltown Local Environmental Plan 2015	The Campbelltown Local Environmental Plan 2015 establishes land use controls for the Campbelltown local government area. The selection of the final recommended North South Rail Line corridor has considered existing land use patterns facilitated by the plan.	A future environmental impact statement would need to consider the provisions of the Campbelltown Local Environmental Plan 2015.
***Planning Guideline for Major Infrastructure Corridors* (Department of Planning and Environment, 2016)**	The *Planning Guideline for Major Infrastructure Corridors* is for use by infrastructure agencies with a focus on achieving appropriate land use outcomes and ensuring a strong evidence base for decision making. The preparation of this Strategic Environmental Assessment has been guided by the 'heads of consideration' contained in the guideline.	A future environmental impact statement would demonstrate how potential mass transit infrastructure is consistent with the guideline.
***Rail Infrastructure Noise Guideline* (Environment Protection Authority, 2013)**	The *Rail Infrastructure Noise Guideline* contains trigger levels above which heavy rail infrastructure projects need to consider feasible and reasonable mitigation measures to address noise and vibration impacts (refer to Sections 6.4.2.1 and 6.4.2.2). The ability of future rail infrastructure to comply with the guideline was considered during selection of the final recommended North South Rail Line and South West Rail Link Extension corridors.	A future environmental impact statement would need to consider the criteria contained in the guideline.
***Interim Guideline for Development Near Rail Corridors and Busy Roads* (Department of Planning, 2008)**	The *Interim Guideline for Development Near Rail Corridors and Busy Roads* supports the operation of the State Environmental Planning Policy (Infrastructure) 2007 and provides guidelines for the management of development in and around rail corridors and busy roads.	A future environmental impact statement would demonstrate how potential mass transit infrastructure is consistent with the guideline.

10 Commitments and mitigation measures

This section discusses strategic measures to avoid, minimise and, if necessary, offset the predicted impacts of any significant risks to the environment posed by the final recommended corridors.

10.1 Infrastructure design

Future infrastructure development within the final recommended corridors will be the subject of a design process that recognises the need to 'right-size' future infrastructure to best match the demand profiles and customer needs across different areas to improve operational efficiency and financial sustainability. The following sections provide broad design principles for the new infrastructure.

10.1.1 Vertical alignment of above ground infrastructure

The corridors should be at-grade wherever possible; elevated track and tunnels should only be incorporated to avoid insuperable natural constraints, or to protect existing natural or built environments where no viable alternative can be found.

Earthworks and engineering structures should be minimised and optimised across the length of the corridors as far as possible.

10.1.2 Station precinct design

Station locations need to align with the overall project planning objectives, considering factors such as transfers between modes, as well as urban planning for any existing or new town centres, local transport access, current and likely property ownership boundaries and topography.

Further detailed understanding of the station catchments and passenger demand, as well as the broader network operational analysis, will allow further refinement of station characteristics, including platform size and numbers, as well as the scale and function of passenger transfer infrastructure.

10.2 Interim land use strategy

An interim land use strategy will be resolved with local councils, Greater Sydney Commission and the Department of Planning, Industry and Environment to set out the preferred land use outcomes sought by Transport for NSW when considering land use changes until such time that a transport project proceeds (or is approved under the *Environmental Planning and Assessment Act 1979*). Corridor protection outcomes that will influence the interim land use strategy include:

- Corridor protection must allow for, and facilitate, the eventual development of the final recommended North South Rail Line and South West Rail Link Extension corridors for passenger train services
- Corridor protection should look to minimise future community disruption and opposition to the eventual development of rail infrastructure in the final recommended corridors for passenger train services
- Corridor protection should minimise property acquisition costs. For example, temporary development of housing or commercial buildings within the final recommended corridors may be acceptable if these properties can be acquired when the transport project moves to the construction

phase without significant disruption to the structure of surrounding development patterns or unreasonable additional costs to the project

- Corridor protection should be undertaken in such a way as to inform and support the development of appropriate land uses and densities, particularly at future station locations
- The protected corridors should remain in active use to avoid short- and medium-term sterilisation of the land.

Any interim activity in the corridors is expected to be removed and replaced with transport infrastructure at some point in the future. The purpose of the interim land use strategy is to influence development patterns so that this process can occur without compromising the integrity of the land development structure and associated broader land use when the transport infrastructure is developed.

10.3 Future environmental assessment

Any future proposal to build and operate a rail line in the corridors will be required to be subject to a comprehensive environmental assessment in accordance with the provisions of the *Environmental Planning and Assessment Act 1979*. At this time, environmental impacts in relation to noise, air quality, impact on native flora and fauna and visual amenity would be subject to technical expert assessment in accordance with the procedure for State Significant Infrastructure. This process has been outlined at Section 9.1.2 and involves the preparation of a State Significant Infrastructure application informed by technical experts. A comprehensive and accurate assessment of environmental impacts would be undertaken at this time. A future environmental assessment would be required to assess the following matters:

- Legislative and policy context
- Consultation
- Biodiversity
- Flooding and hydrology
- Heritage
- Noise and vibration – amenity
- Noise and vibration – structural
- Socio-economic, land use and property
- Soils
- Sustainability
- Transport and traffic
- Place making and urban design
- Water quality
- Utilities.

11 Conclusion

The 30-minute city is one of the key goals for the Greater Sydney Region over the next 20 years and the protection of the final recommended corridors will assist in achieving integrated transport and land use outcomes where homes are located within a 30-minute journey of a strategic centre. The rapid urban growth in western Sydney and planning for the Western Sydney Airport by the Australian and NSW Governments has reinforced the need to protect a corridor for future public transport infrastructure so that infrastructure can be built efficiently and cost-effectively when it is needed.

The projected growth in population and employment in western Sydney highlights the importance of ensuring that appropriate provisions are made now to meet the future transport needs of not only western Sydney but also the wider Sydney Metropolitan region. Integrated transport planning decisions are required that consider the long-term requirements for both land use and transport.

The strategic need for corridor protection has been established at the Australian Government and NSW Government levels in the *Australian Infrastructure Plan*, the *Future Transport Strategy 2056* and the *Greater Sydney Region Plan.* The final recommended corridors would assist in enabling a north-south connection between the growing south-west, the Western Sydney Aerotropolis and the new growth area in the Greater Penrith to Eastern Creek Corridor.

Given the rapid expansion of development in western Sydney, early protection of corridors is vital to ensure that there is sufficient land available in the future when the construction of railway infrastructure is required. With the expected change in patterns of land use, early protection of future rail corridors will inform future land use planning, minimise acquisition costs and avoid redundant development.

Identifying and protecting corridors for the final recommended North South Rail Line and South West Rail Link Extension corridors is an important opportunity to undertake before development in the region reduces future opportunities for such a piece of infrastructure. It would also provide clarity for the Department of Planning, Industry and Environment, councils and developers, and provide greater certainty about land use plans for existing and future residents in the area.

Protection of the final recommended North South Rail Line and South West Rail Link Extension corridors represents an integrated transport solution that balances infrastructure benefits and opportunities with land use and environmental impacts and meets the stated objectives of Australian and NSW strategic policies. Protecting the final recommended North South Rail Line and South West Rail Link Extension corridors well in advance of their construction would:

- Protect land from development that might preclude future rail infrastructure, or make it more difficult and/or expensive to build when it is required
- Provide residents, employers, councils, landowners, developers and government agencies with greater confidence that transport infrastructure can and will be built
- Provide more certainty about where future transport infrastructure will be located, so that new development can be planned around it
- Assist in the long-term planning of transport services and train fleet investments
- Ensure that town centres and other employment centres are located and planned to optimise their access to public transport

- Allow appropriate land use restrictions and setbacks to be built into master plans and design codes to reduce potential noise and other environmental impacts on residences, schools, and other sensitive receptors
- Allow directly-affected landowners to factor transport corridors into their plans, and to dispose of land at their own volition
- Allow the NSW Government to develop cost-effective, measured approaches to corridor land acquisition and management.

The final recommended North South Rail Line and South West Rail Link Extension corridors have been selected following a comprehensive process that has involved community consultation, exploration of multiple alignments and the input of technical experts. Following investigations into existing natural and built constraints in the study area as well as public consultations, the final recommended North South Rail Line and South West Rail Link Extension corridors have been selected to avoid environmental, social and economic impacts.

One of the key features of the final recommended North South Rail Line corridor is the section that would be in tunnel between Oran Park and Macarthur. This feature has been incorporated into the final recommended North South Rail Line corridor to avoid potential impacts on existing landowners in these areas as well as to avoid any impact on Harrington Forest, Australian Botanic Garden Mount Annan, schools, heritage items and local/State roads. However, the whole of life cost of tunnel rail infrastructure is substantially higher than for surface rail infrastructure.

The proposed surface corridor has been deliberately located to respond to existing topographical constraints as well as the presence of native flora and fauna, flood conditions and the local/State road network.

As a result of the comprehensive corridor selection process that has been undertaken, it is considered that potential environmental impacts arising from corridor protection or future transport infrastructure have been minimised or avoided.

Western Sydney is set to grow dramatically over the next 30 years. The NSW Government has set targets for residential and employment growth and the land release program is already well underway.

The *Future Transport Strategy 2056* identifies the challenges that the transport system in NSW needs to address to support the state's economic and social performance. With the projected growth in population and employment in western Sydney, it is important to ensure that appropriate future provisions are made now to meet the future transport needs of not only western Sydney but also the wider Sydney Metropolitan region. Integrated transport planning decisions are required that consider the long-term requirements for both land use and transport.

References

Australian Bureau of Statistics (2015) Household and Family Projections, Australia, 2011 to 2036

Camden Council (2017) *Camden Community Strategic Plan*

Campbelltown City Council (2017) Campbelltown *2027, Community Strategic Plan*

Department of Environment, Climate Change and Water (2010) Lower Hawkesbury-Nepean River Nutrient Management Strategy

Department of Environment and Conservation (2006) *Assessing Vibration: A Technical Guideline*

Department of Infrastructure and Regional Development (2016) *Western Sydney Airport - Environmental Impact Statement – Volume 2a Stage 1 Development*

Department of Planning and Environment (2018), *Stage 1: Initial Precincts Draft Western Sydney Aerotropolis Land Use and Infrastructure Implementation Plan*

Department of Planning and Environment (2016) *Planning Guideline for Major Infrastructure Corridors*

Department of Planning and Environment (2015) *Priority Growth Areas Housing Market Needs Analysis Final Draft*, prepared by AEC for the Department of Planning and Environment

Department of Planning and Environment (2014) *A Plan for Growing Sydney*

Department of Planning and Environment (2013) *Broader Western Sydney Employment Area draft Structure Plan*

Department of the Environment (2013) *Matters of National Environmental Significance – Significant Impact Guidelines 1.1*

Department of Planning (2008) *Interim Guideline for Development Near Rail Corridors and Busy Roads*

Department of Planning and Infrastructure (2013) *Broader Western Sydney Employment Area – Draft Structure Plan*

Department of Sustainability, Environment, Water, Population and Communities (2012) *Environmental Offsets Policy*

Eco Logical (2013) *Broader Western Sydney Employment Area – Ecology Study*

Elton Consulting (2013) *Sydney Science Park, Luddenham – Social Planning Report*

Environment Protection Authority (2013) *Rail Infrastructure Noise Guideline*

Greater Sydney Commission (2018a) *Greater Sydney Region Plan*

Greater Sydney Commission (2018b) *Western City District Plan*

Infrastructure Australia (2017) *Corridor Protection: Planning and investing for the long term*

Infrastructure Australia (2016) *Australian Infrastructure Plan*

Infrastructure NSW (2018) *State Infrastructure Strategy 2018-2038*

Infrastructure NSW (2014) *State Infrastructure Strategy Update 2014*

Jeffs, R. & Rose, H. (1995) *Faculty of Agriculture Handbook 1995* - *The University of Sydney*

Liverpool City Council (2013) *Growing Liverpool 2023*

Office of Environment and Heritage (2016) *NSW Guide to Surveying Threatened Plants*

Office of Environment and Heritage (2015) Biodiversity Investment Opportunities Map, Mapping Priority Investment Areas for the Cumberland Subregion

Penrith Business Alliance (2011) *Penrith Health and Education Precinct – Strategic Vision*

Penrith City Council (2015a) *Planning Proposal – St Marys Town Centre, Reclassification of Certain Public Land*

Penrith City Council (2015b) *Planning Proposal – Sydney Science Park Volume 1*

Penrith City Council (2017) Penrith *Community Plan 2017*

Roads and Maritime Services (2017a) *Schedule of Classified Roads and Unclassified Regional Roads*

Roads and Maritime Services (2017b) *Western Sydney Infrastructure Plan*

SGS Economics and Planning (2013) *St Marys Village EIA*

Transport for NSW (2018a) *Future Transport Strategy 2056*

Transport for NSW (2018b) *Outer Sydney Orbital Transport Corridor –Strategic Environmental Assessment*

Transport for NSW (2016) *Western Sydney Rail Needs Scoping Study – Discussion paper*

Transport for NSW (2013a) *Sydney's Cycling Future*

Transport for NSW (2013b) *Sydney's Walking Future*

Transport for NSW (2012) *Long Term Transport Master Plan*

URS (2003) *Water Sensitive Urban Design Technical Guidelines for Western Sydney*

Worley Parsons (2015) *Updated South Creek Flood Study – Volume 1*

Appendix 1 Environmental assessment scope

Project:	North South Rail Line and South West Rail Link extension corridors
Location	North South Rail Line corridor: St Marys to Macarthur via Western Sydney Airport, North Bringelly, Oran Park and Narellan[1] South West Rail Link Extension corridor: Rossmore to North Bringelly
Lead agency	Transport for NSW
General – The scope	A strategic environmental assessment is to be prepared as the evidence base to inform the creation of statutory planning controls to secure land for the purpose of a long-term major infrastructure corridor. There may be a 'fit for purpose' of the Strategic Environmental Assessment against the scope presented in this document. The final strategic environmental assessment will be exhibited with the draft planning mechanism to reserve the final North South Rail Line corridor and South West Rail Link Extension corridor alignments. This is a strategic planning exercise therefore the assessment of impacts should be based on preliminary environmental assessments and indicative design requirements/standards that are currently applicable for the potential future infrastructure, rather than final design requirements. More detailed design should only be undertaken if it is required to confirm the identified corridor alignment affected by complex issues.

Item	Scope	Where addressed in the SEA
Content of the Strategic Environmental Assessment:	The strategic environmental assessment should address: 1. **The strategic justification**: This section should provide a description of the strategic need for the future infrastructure project, as well as provide the rationale for why reservation of a corridor is required at this time. This section should detail the overall objectives of the project as well as how the reservation fits within current government strategic plans and policies at all levels (local, State and federal). The scope for this section includes: ▪ An outline the long-term transport planning context of the western Sydney region and the project's broader application to the NSW transport network. ▪ Providing the strategic justification of the proposed future infrastructure, the overarching objectives of the project and the long-term outcomes they seek to achieve. Consideration should be given to: - The strategic transport need for the proposed future infrastructure - How the proposed future infrastructure will integrate with the broader transport network (existing and proposed) in the adjoining districts and region - How the corridor reservations and proposed infrastructure projects align with strategic plans or policies (local, State and federal) ▪ Analysis of alternative transport solutions that could be undertaken to address the strategic need identified above. This should include: - Other transport scenarios (such as a 'do-nothing' scenario or a 'build when required' [without reservation] scenario) - Assessment the strategic costs and benefits of reserving the corridor compared to the alternative transport solutions and consequence of these other solutions.	Section 2.1.4 Section 2.1.2 Sections 2.2 to 2.4 Section 2.1.4 Sections 2.1.1 and 2.2.4 Sections 6.3.2 and 7.3.2
	2. The infrastructure project and its components This section should provide an overview of the business requirements of the potential future infrastructure which will be used to inform the corridor alignments. The scope for this section includes: ▪ A high-level description of the business requirements of the future infrastructure and any related considerations that will form part of determining the corridor alignments. These include: - Identifying the strategic locations that the future infrastructure projects needs to connect, for	Section 5.1.1 Sections 2.1.1, 2.2.4 and 2.3.3

Item	Scope	Where addressed in the SEA
	example, servicing future growth areas and access to intermodal terminals	Sections 5.3.1 and 5.3.2
	- Width needed for the future corridors, for example, differing infrastructure needs/design over the extent of the corridor	Section 5.3.3
	- Strategic connections to other infrastructure networks, for example, rail, road and cycle modes or key interchanges	Section 5.1.1
	- Strategic design requirements, for example, slope or topography and design standards.	
	3. Corridor alignment constraints alignments This section should identify and provide a strategic assessment of the corridor investigation areas' constraints. The scope for this section includes:	
	▪ Strategic environmental opportunities and constraints within the corridor investigation areas	Sections 3 and 4
	▪ Existing land uses within the corridor investigation areas	Sections 3.5 and 4.5
	▪ Outline the process by which corridor alignments constraints were identified and corridor options assessed. This should include:	
	- Description of the process of how the corridor options were derived, for example, investigation area and constraints analysis	Section 5.1
	- Explanation of multi-criteria analysis used to assess the constraints within the corridor investigation areas	Section 5.1.3
	- A summary of the assessment of corridor alignment options	Sections 5.1.3 and 5.5
	- Relevant summary of how corridor options have considered the key issues in sections 5-15 of these requirements.	Section 5.1.3
Key issues	**4. Recommended corridor alignments** This section should provide a detailed description of the recommended corridor alignments and how they achieve the overarching objectives of the corridors and the potential future infrastructure, with reference to how the corridor alignments integrate and supports strategic plans. The scope for this section includes:	
	▪ A description of the recommended corridor alignments and potential construction methodology for the future infrastructure. This includes notation of above or below ground construction	Section 1.3
	▪ An overview which outlines how the recommended corridor alignments:	
	- Meets the overarching objectives of the projects	

Item	Scope	Where addressed in the SEA
	- Relates and interacts with existing and proposed infrastructure and transport networks - Integrates with strategic plans and supports broader objectives of the western Sydney region, for example, growth planning, land use and infrastructure strategies ▪ Identification of the sections of the recommended corridor alignments which require reservation, for example, sections at grade requiring rezoning or tunnel sections requiring design considerations to be applied ▪ Detail how the recommended corridor alignments have considered the key issues in sections 5-15 of these requirements.	Section 2.1 Section 2.3 Sections 2.2 to 2.4 Sections 9.2 and 9.3 Appendix 1
Key issues	The Strategic Environmental Assessment must also address the following specific matters for the identified corridor alignment. An assessment of all key issues is required for the sections of the identified corridor alignment requiring reservation. Sections of the identified alignment that are proposed to be in tunnel (and therefore will not be reserved) are only required to address the matters that are marked with an asterisk (*).	
	5. Land use and property impacts This section should identify the land use and property impacts within the recommended corridors and adjacent to the recommended corridor alignments. This section should also describe how land use and property impacts were avoided, minimised to reduce potential impacts of the recommended corridor alignments on surrounding land uses and properties. The scope for this section include: ▪ Identifying the current land uses within the recommended corridor alignments and describe the potential impacts of the recommended corridor alignments on: - Residential land uses - Industrial land uses - Open space/recreational/national parks - Agricultural land - Extractive/mineral/energy resources* - Utility infrastructure* - Major transport infrastructure* For each land use specify the number of existing lots and potential lots (based on draft environmental planning instruments and development proposals) affected by the recommended corridor alignments. ▪ Consideration of the potential implications of relevant legislation or protected land ownership, for example:	Sections 6.1.2 and 7.1.2 Sections 6.1.2 and 7.1.2 Sections 6.1.2.2, 6.8.2.1, 7.1.2.6 and 7.8.2.1

Item	Scope	Where addressed in the SEA
	- Crown Lands - *Native Title Act 1993* - *National Parks & Wildlife Act 1974*	
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts of the recommended corridor alignments on surrounding land uses and properties. *	Sections 6.1.1 and 7.1.1
	▪ A broad outline of the suite of possible mitigation options to address the remaining impacts of the potential future infrastructure on surrounding land uses and properties. *	Sections 6.1.3 and 7.1.3
	▪ Consideration of any potential cumulative impacts on the land within the recommended corridor alignments created by the potential future infrastructure and other existing and future infrastructure development.	Section 8.1.2
	▪ An outline of where future detailed assessments may be required as part of the Environmental Impact Assessment of the future infrastructure. *	Sections 6.7 and 10.3
	6. Future land use opportunities This section should identify possible future land use changes or opportunities that could be capitalised on as a result of the potential future infrastructure within the recommended corridor alignments. The scope of this section includes:	
	▪ An outline of potential future land use opportunities surrounding the corridors as a result of the potential future infrastructure, including commentary on potential: - Economic growth - Areas of change such as interchanges or major connections with other major infrastructure projects (current and future) - Housing growth.	Sections 6.1.2, 6.3.2, 7.1.2 and 7.3.2
	▪ Consideration of the potential future infrastructure in relation to the Regional and District Plans (current and proposed/draft).	Sections 2.3.1 and 2.3.2
	7. Economic impacts This section should provide an overview of potential future economic impacts and opportunities that may be created by the potential future infrastructure. Economic impacts to the wider region are also to be commented on, providing short-, medium- and long-term scenarios. The scope of this section includes:	
	▪ Commentary on the potential economic impacts of both reserving the corridors and the delivery of the potential future infrastructure. Including:	Sections 6.2 and 7.2

Item	Scope	Where addressed in the SEA
	- Expected economic (or productivity) change created by the potential future infrastructure. This includes:	
	▪ Consideration of the wider economic impact of the potential future infrastructure on the western Sydney region, Greater Sydney, Regional NSW, strategic and district centres and key employment locations	Sections 6.2.1 and 7.2.1
	▪ Consideration of whether the potential future infrastructure may generate opportunities for new employment locations or centres	Sections 6.2.1 and 7.2.1
	▪ The potential cumulative economic impacts of the corridors when considered together and alongside other infrastructure projects.	Sections 6.2.3 and 7.2.3
	8. Traffic and transport This section should provide an assessment of the potential impact of the recommended corridor alignments and potential future infrastructure on the surrounding area of the corridors. The scope for this section includes:	
	▪ A description of how the preferred corridor alignments will meet the transport-related objectives of the corridors and potential future infrastructure. Consideration to be given to: - Sensitive land uses - Future growth areas - Strategic plans (current and proposed/draft).	Sections 2.1.3 and 2.3
	▪ An assessment of the traffic and transport impacts on the local, regional, State and national road and rail network. This includes opportunities for potential extension of these networks or identifying where networks may need to be severed due to the potential future infrastructure project and corridor alignments.	Sections 6.3.2 and 7.3.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative traffic and transport impacts on the surrounding traffic flows and transport demand.	Sections 6.3.1 and 7.3.1
	▪ A broad outline of the suite of possible mitigation options to remaining impacts of the potential future infrastructure on surrounding traffic flows and transport demand, for example, future design considerations or operational requirements.	Sections 6.3.3 and 7.3.3
	▪ Consideration of the potential cumulative impacts on the transport infrastructure within the corridors created by the potential future infrastructure and other existing and future infrastructure development.	Sections 6.3.2, 7.3.2 and 8.1.1
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.3.3, 7.3.3 and 10.3

Item	Scope	Where addressed in the SEA
	9. Noise and vibration* This section should assess the potential noise and vibration impacts of the potential future infrastructure in the vicinity of the recommended corridor alignments. An indicative map of the potential noise and vibration impacts within the vicinity of the corridors should be provided.	Figure 6-1 and Figure 7-1
	The scope of this section includes: ▪ Identification of sensitive land uses (current and future) surrounding the corridors likely to be impacted by the potential noise and vibration of the potential future infrastructure.	Sections 3.11, 4.11, 6.4.2 and 7.4.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative noise and vibration impacts on the surrounding sensitive land uses.	Sections 6.4.1 and 7.4.1
	▪ A broad outline of the suite of possible mitigation options to address the remaining noise and vibration impacts of the potential future infrastructure on surrounding sensitive land uses, for example, future design considerations.	Sections 6.4.3 and 7.4.3
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.4.3, 7.4.3 and 10.3
	10. Visual amenity, built form and urban design The visual impact of the recommended corridor alignments and subsequent potential future infrastructure should be identified, with consideration given to visual amenity, built form and urban design of the areas surrounding the corridors. The scope of this section includes:	
	▪ Identification of strategic visual, built or urban form impacts of the potential future infrastructure on the surrounding area.	Sections 6.5.2 and 7.5.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts on the surrounding visual, built or urban form.	Sections 6.5.1 and 7.5.1
	▪ An outline of the urban design principles and objectives to guide further design and assist in addressing the impacts of the potential future infrastructure on surrounding visual, built or urban form.	Sections 6.5.3 and 7.5.3
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.5.3, 7.5.3 and 10.3

Item	Scope	Where addressed in the SEA
	11. Soils and water*	
	This section should identify soil and water issues related to the recommended corridor alignments.	
	The scope for this section includes:	
	▪ Identification and description of the geological and hydrological conditions within and surrounding the recommended corridor alignments. Consideration is to be given to: - Key hydrological features (e.g. watercourses, dams) - Water supply - Acid sulphate soils - Contaminated land	Sections 3.3, 3.4, 4.3 and 4.4
	▪ Description of the hydrological and geological impacts in relation to the recommended corridors and potential future infrastructure, including the strategic assessment of: - Location and nature of flood regimes affecting the corridors or to be affected by the potential future infrastructure - Potential impacts on surface water, groundwater, soils, flooding, riparian areas and potable water	Sections 6.6.2 and 7.6.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts on the surrounding hydrological and geological features.	Sections 6.6.1 and 7.6.1
	▪ A broad outline of the suit of possible mitigation options to address the remaining impacts of the potential future infrastructure on surrounding hydrological and geological conditions (e.g. future design considerations).	Sections 6.6.3 and 7.6.3
	▪ Consideration of the potential cumulative impacts on the hydrological and geological conditions surrounding the corridors created by the potential future infrastructure and other existing and future infrastructure development.	Section 8.1.5
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.6.3, 7.6.3 and 10.3

Item	Scope	Where addressed in the SEA
	12. Biodiversity This section should evaluate the current ecological values within the recommended corridor alignments and identify potential impacts on those ecological values as a result of the potential future infrastructure. This section should also identify how offset obligations will be addressed after the corridor is reserved. The scope for this section includes:	
	▪ A strategic assessment of the potential ecological impacts of the corridor reservations and potential future infrastructure both within the corridors and adjoining with specific reference to: - Wetlands - Vegetation and habitat clearing - Connectivity - Edge effects - Riparian/aquatic habitat and marine vegetation - Soil and water quality - Adjoining waterways - Salinity, erosion and sedimentation - Ongoing water management.	Sections 6.7.2 and 7.7.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided, minimised and/or offset its impacts on the ecological values of the corridor investigation areas. This may include: - Outlining the approach to offset strategies for ecological impacts and native vegetation clearing - Consideration of the *Biodiversity Conservation Act 2016* and *NSW Biodiversity Offsets Policy for Major Projects* (Office of Environment and Heritage, 2014).	Sections 6.7.1 and 7.7.1
	▪ A broad outline of the suite of potential mitigation options to address the remaining impacts of the potential future infrastructure on surrounding ecological values and within the corridors, for example, future design considerations or operational requirements.	Sections 6.7.3 and 7.7.3
	▪ Consideration of the potential cumulative impacts on the ecological values surrounding the corridors created by the potential future infrastructure and other existing and future infrastructure development.	Section 8.1.3
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.7.3, 7.7.3 and 10.3
	All biodiversity assessments should take into account: ▪ Impacts on features of High Environmental Value, as described in the relevant Regional and/or District Plan (current and proposed/draft)	

Item	Scope	Where addressed in the SEA
	▪ *Draft Guidelines for Threatened Species Assessment* (Department of Environment and Conservation/Department of Primary Industries, 2005) ▪ *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (Department of Environment and Conservation, 2004) ▪ *Draft Policy and Guidelines for Fish Habitat Conservation and Management – Update 2013* (Department of Primary Industries, 2013) ▪ *Guidelines for Aquatic Habitat Management and Fish Conservation* (Department of Primary Industries, 1999).	
	13. Heritage This section should identify the impact of the recommended corridor alignments and subsequent potential future infrastructure on aboriginal and non-aboriginal heritage. The scope for this section includes:	
	▪ Identification of the State and local aboriginal and non-aboriginal heritage affected by the recommended corridor alignments including: - Heritage items - Conservation areas - Areas of cultural and archaeological significance	Sections 6.8.2 and 7.8.2
	▪ Description of the potential impacts of the recommended corridor alignments and potential future infrastructure on the identified State and local aboriginal and non-aboriginal heritage in the corridors.	Sections 6.8.2 and 7.8.2
	▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts on the aboriginal and non-aboriginal heritage in or directly adjacent to the recommended corridor alignments.	Sections 6.8.1 and 7.8.1
	▪ A broad outline of the suite of potential mitigation options to address the remaining impacts of the potential future infrastructure on aboriginal and non-aboriginal heritage in the corridors.	Sections 6.8.3 and 7.8.3
	▪ Consideration of the potential cumulative impacts on the aboriginal and non-aboriginal heritage in the corridors created by the potential future infrastructure and other existing and future infrastructure development.	Section 8.1.4
	▪ An outline of where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.8.3, 7.8.3 and 10.3

Item	Scope	Where addressed in the SEA
	14. Air quality This section should identify possible air quality impacts of the potential future infrastructure with consideration of local and regional air quality. The scope for this section includes: ▪ Identification of possible air quality impacts of the potential future infrastructure and corridor reservations on the local and regional air quality with specific consideration given to sensitive receivers. ▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts on the local and regional air quality, for example, future design considerations or operational requirements. ▪ A broad outline of the suite of possible mitigation options to address the remaining impacts of the potential future infrastructure on local and regional air quality. ▪ Outline where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.9.2 and 7.9 Sections 6.9.1 and 7.9 Sections 6.9.3 and 7.9 Sections 6.9.3, 7.9 and 10.3
	15. Social This section should evaluate the impacts of the recommended corridor alignments and subsequent potential future infrastructure on the directly affected community and its facilities and/or services should be identified and discussed in this section. The scope of this section includes: ▪ A strategic assessment of the social impacts of the recommended corridor alignments and potential future infrastructure on the directly affected community and community facilities/services. ▪ Where applicable, an outline of how the recommended corridor alignments have avoided or minimised negative impacts on the community and its facilities/services. ▪ A broad outline of the suite of possible mitigation options to address the remaining impacts of the potential future infrastructure on the community and its facilities/services. ▪ Consideration of the potential cumulative impacts on the community and its facilities/services created by the potential future infrastructure and other existing and future infrastructure development. ▪ Outline where future detailed assessments would be required as part of the Environmental Impact Assessment of the future infrastructure.	Sections 6.10.2 and 7.10.2 Sections 6.10.1 and 7.10.1 Sections 6.10.3 and 7.10.3 Section 8.2.1 Sections 6.10.3, 7.10.3 and 10.3

Item	Scope	Where addressed in the SEA
	16. Environmental risk analysis* This section is to include an environmental risk analysis summary which should identify the potential environmental impacts associated with the recommended corridor alignments. The scope for this section includes: ▪ Provide a matrix assessment of the potential impacts associated with the recommended corridor alignments and the potential future infrastructure (as identified in sections 5-15) with specific attention given to: - Strategic mitigation measures and their staged application - Potentially significant residual environmental impacts after mitigation measures are applied.	Section 8.4
Consultation	During the preparation of the Strategic Environmental Assessment, there is an expectation that the agency will consult with the relevant local, State and/or Australian Government authorities, service providers, community groups and affected landowners. This may involve: ▪ Local, State and Australian government authorities, including engaging with Department of Planning, Industry and Environment and Greater Sydney Commission about the application of the future infrastructure projects to the relevant District Plans, Regional Plans and Land Use and Infrastructure Implementation Plans ▪ Specialist interest groups, including Local Aboriginal Land Councils, and others such as Aboriginal stakeholders ▪ Relevant utilities and environmental assessment service providers ▪ The public, including community groups and adjoining and affected landowners. The Strategic Environmental Assessment should describe the consultation process and the issues raised and identify where the design of the projects or the corridor alignments have been amended in response to these issues. Where amendments have not been made to address an issue, a short explanation should be provided.	Sections 5.4.1 and 5.5

Item	Scope	Where addressed in the SEA
Statutory planning considerations	**Statutory planning considerations: Current planning framework*** This section should identify the existing environmental planning instruments that apply to the recommended corridor alignments and relevant sections or clauses that will be affected by potential statutory planning controls in relation to the corridor reservations. The scope for this section includes: ▪ Identification of the existing environmental planning instruments that apply to the recommended corridors that will be affected by potential statutory planning controls in relation to the corridor reservations. This should include: - All existing relevant local environmental plans - All existing relevant State Environmental Planning Policies - All existing relevant structure plans and local action plans and development control plans - All existing relevant land use and infrastructure strategies - Other plans, polices and strategies relevant to the recommended corridors	Section 9.3
	Statutory planning considerations: Future planning framework* This section identifies the land use outcomes that the environmental planning instrument should achieve. This section should not propose zoning recommendations or development controls. The scope for this section includes: ▪ Identifying the sections of the recommended corridor alignments that need to be reserved. ▪ Identify the sections where reservation is not required, but design outcomes of permissible uses may need to be managed. For example, limitation on the depth of basement car parks.	Section 9.2 Not applicable

Bringing ideas to life

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