

A blurred landscape photograph featuring a large, white, bold number '4' centered in the middle. The background consists of a flat, open field with a mix of green and yellowish-brown grass, and a cloudy sky in the upper portion. The image has a motion blur or soft-focus effect, giving it a dreamy or abstract appearance.

4

The background features several diagonal stripes in various shades of teal and light blue, creating a sense of movement. A large, bold, teal-colored number '4' is positioned in the lower right quadrant of the image.

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Alignment and station locations

4.1 Introduction

This chapter describes the development of the preferred HSR alignment between Brisbane and Melbourne. It includes an explanation of how the corridors, which encompass the broad range of potential alignments previously identified in phase 1 of the study, have been developed and assessed to arrive at a preferred alignment and station locations for the capital cities and regional areas. The objective of the alignment options evaluation process was to select the most sustainable alignment based on the assessment criteria which included potential user benefits, engineering, cost and social and environmental values.

The chapter is structured as follows:

- **Section 4.2** outlines the methodology for selecting the preferred alignments and station locations.
- **Section 4.3** introduces the preferred alignments and station locations.
- **Sections 4.4 to 4.11** present the options along the route from north (Brisbane) to south (Melbourne) and explain the choice of the preferred alignments and stations.

The chapter is supported by several technical appendices:

- **Appendix 3A** details the evaluation criteria and methodology applied to a range of options.
- **Appendix 3B** describes the preferred alignment.
- **Appendix 3C** discusses the land requirements for implementing the preferred alignment.
- **Appendix 3D** contains detailed maps of the preferred alignment.

In determining the preferred alignment and station locations, the study considered the following questions:

- How could the value of each option be maximised to meet the travel demand?
- To what extent did each option avoid significant adverse environmental impacts?
- How successfully did each option minimise the need to acquire private property?
- How well did each option support land use planning strategies where feasible?
- To what extent did each option contribute to the aim of limiting construction risks, including impacts on existing railway operations and major roads?

4.2 Methodology for selecting the preferred HSR alignment and station locations

Alternative alignments and station locations were analysed and compared to select the preferred HSR alignment.

The analysis considered the costs, user benefits, accessibility, environmental and social impacts of each alternative, as well as the associated risks during construction. These criteria are briefly explained below. Full details can be found in **Appendix 3A**.

User benefits were calculated based on travel time, convenience and fares, all expressed in monetary terms over the appraisal period. In evaluating station locations, user benefits are measured as the relative costs of travel in accessing different stations. In selecting alignment alternatives, the benefits are measured as the relative value of travel time and cost savings or penalties using one alignment or another.

Accessibility in the capital cities, and particularly the relative proximity of each station option to other interconnecting transport modes (for example metropolitan rail, bus and tram services), were assessed qualitatively, using a range from

low to high. In regional areas, station locations were selected with regard to ease of access from motorways or major roads.

Environmental and social impacts of HSR alignment and station location options were considered through a strategic environmental assessment framework, based on the Australian Government's indicative strategic endorsement criteria¹. These criteria were derived from the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and included:

- Protection of the environment, in particular, matters of national environmental significance (MNES).
- Promotion of ecologically sustainable development.
- Promotion of the conservation of biodiversity.
- Demonstrated adaptation to reasonable climate change scenarios.
- Protection and conservation of heritage.

The strategic environmental assessment focused on identifying preliminary strategic considerations rather than project-level impacts. For instance, the maps in **Appendix 3D** illustrate the preferred alignment, but at this strategic stage, elements such as corridor boundaries are not exact and it is therefore not possible to estimate the precise impacts on specific properties. Should a decision be made to proceed with HSR, more detailed site surveys and specific geotechnical, environmental and engineering investigations will form part of the detailed design phase, in consultation with property owners.

Comparative cost estimates for the alignments were developed by applying unit prices to estimated quantities and distances for each of the cost components (e.g. tunnels, bridges and other civil works):

- Unit costs for the stations and for each of the major civil infrastructure elements of the alignments were built up from preliminary design specifications and benchmarked against recent domestic and international

1 Department of Sustainability, Environment, Water, Population and Communities, *Guide to Undertaking Strategic Assessments*, 2011.

examples. Unit prices for many of the non-civil infrastructure elements were based on recent HSR projects and similarly benchmarked.

- Operating costs were captured in the appraisal either through the proxy of train transit time/route length comparisons, or as a specific item where they provided material differentiation between route options (e.g. in Canberra, the through option would add 13 minutes to the non-stop travel time between Sydney and Melbourne compared to the direct route between Sydney and Melbourne which is possible with a spur option to Canberra).

Experience has shown that certain issues regularly lead to problems in meeting cost or time targets in major infrastructure works.

Construction risk (or constructability) was assessed on a scale from ‘very easy’ to very difficult’, taking into account not only variability in construction complexity, but also the likely interfaces with, and impacts on, third parties such as the need to provide noise barriers in some areas and fauna and stock crossings. Although the estimated ease of construction has a bearing on the construction cost estimate, it should be noted that additional issues may emerge during detailed design or implementation phases, which can affect the constructability assessment.

4.2.1 Generation of options for urban alignments and station sites

The location of city centre stations is one of the key influences on the demand for HSR services. In turn, the preferred location of city centre stations is a key determinant in the location of the urban alignment, since the preferred alignment is typically that which best serves the preferred station location, taking into consideration the cost of constructing each alignment. Shortlists of potential city centre station sites were identified using the following guidelines:

- Stations to be located close to existing railway stations or transit interchanges.
- Stations at surface level were preferred over subsurface or elevated stations.

- Station sites to avoid areas of environmental or heritage significance, and be sensitive to community and residential areas and current local land use.
- To make use of existing transport infrastructure wherever possible.

The following factors were considered in generating potential urban alignments:

- Existing and planned future rail and road corridors were examined for their suitability to allow a design speed of 250 kilometres per hour from the urban periphery to the city stations. This is considerably faster than conventional train speeds, which typically have design speeds of 80 kilometres per hour (or less) in inner urban areas and 115 kilometres per hour in outer suburbs.
- The horizontal curves required to accommodate these higher speeds mean that even the use of existing transport corridors for viaducts would require significant property acquisition to straighten them to accommodate the wide curves necessary for the HSR design speed. The additional cost of this land, and the complexity of the associated grade-separated junctions at existing overbridges, makes a viaduct more expensive than tunnelling in urban areas, but with none of the environmental shielding that tunnels ultimately provide. Tunnels have been proposed in most urban areas because of the lack of suitable rail corridors that could meet the HSR alignment and of suitable land to establish a new surface (or viaduct) corridor for HSR. New surface level corridors in urban areas are generally limited to undeveloped land, large areas of parkland or recreational reserves, or government-owned land, as the additional cost of procurement of developed land tends to make surface alignments even more expensive than tunnelling, but with the added environmental impacts.
- Where surface alignments and viaducts are not viable, the impact of geology, flooding, natural features (water body crossings, high ground), existing tunnels and suitable portal locations on tunnelling options was considered.

Demand analysis showed that having peripheral, as well as city centre, stations can increase the benefits of HSR by allowing capital city residents, in particular, to access the HSR without having to travel to the central city station. These benefits are maximised at locations which are well connected to the urban transport network. Potential peripheral station sites were identified using the following criteria:

- Fit with the preferred urban alignments.
- Sustainability impacts and land use planning constraints.
- Connectivity with the current and future planned urban transport networks.

Figure 4-1 shows the required geometry for an HSR alignment superimposed on the existing Bankstown line rail corridor. This HSR alignment through an urban area is designed to meet a design speed of 250 kilometres per hour. The tighter curves used on existing conventional inner suburban railways allow for travel at up to 80 kilometres per hour.

The disparity in the curves means that for HSR, either at surface or on viaduct, simply widening the existing rail corridor is not feasible. Any tightening of the curve on the HSR alignment would result in a lower operating speed, longer journey time and reduced user benefits. The new HSR corridor would require property acquisition, and would cut through existing communities and developments.

Figure 4-1 shows the minimum corridor width (30 metres), not including the additional width required for embankments or cuttings necessary to maintain the smooth vertical alignment required for HSR. Where the existing rail corridor is straight enough to accommodate the HSR alignment, it would still need to be widened, by procuring and clearing adjacent land, to create the 30 metres required for two dedicated HSR tracks. The rail corridors approaching Melbourne are one exception; in some cases the corridor is wide enough to accommodate HSR tracks, although the existing tracks would most likely need to be shifted within the corridor to accommodate the new HSR tracks. Where this is feasible, the preferred alignment utilises these existing corridors.

A surface alignment would still require every road or rail crossing to be grade separated, resulting in the additional impacts of overbridges or underpasses. Overbridges would need to pass at least seven metres above the HSR tracks. Even if the new surface alignment were constructed on viaduct, communities along the alignment would be bisected, with consequent social dislocation. There would also be challenges where a viaduct crossed motorways, rail corridors or any highly-skewed crossings. This height separation would have a significant visual impact in a metropolitan environment.

Comparative costs for in tunnel, on viaduct or at surface, between the two points of the alignment shown on **Figure 4-1**, are shown in **Table 4-1**.

Appendix 4B contains detail on the source of the costs used.

Table 4-1 shows that tunnelling can have a significant cost advantage (\$171 million per kilometre against \$230 million per kilometre for viaduct and \$252 million per kilometre for surface) in densely populated cities. In these areas, a surface alignment would require extensive property acquisition (at significant cost), and would result in community severance and dislocation of businesses and suburbs.

An additional advantage of tunnelling is that the tunnels could be more direct to the station, resulting in a shorter route than alignments on viaduct or at surface, further increasing user benefits of HSR over conventional rail. Combined with the reduction in environmental and community impacts, tunnelling was the preferred alignment solution in the urban areas.

Figure 4-1 Required geometry of HSR alignment, superimposed on the Bankstown line rail corridor

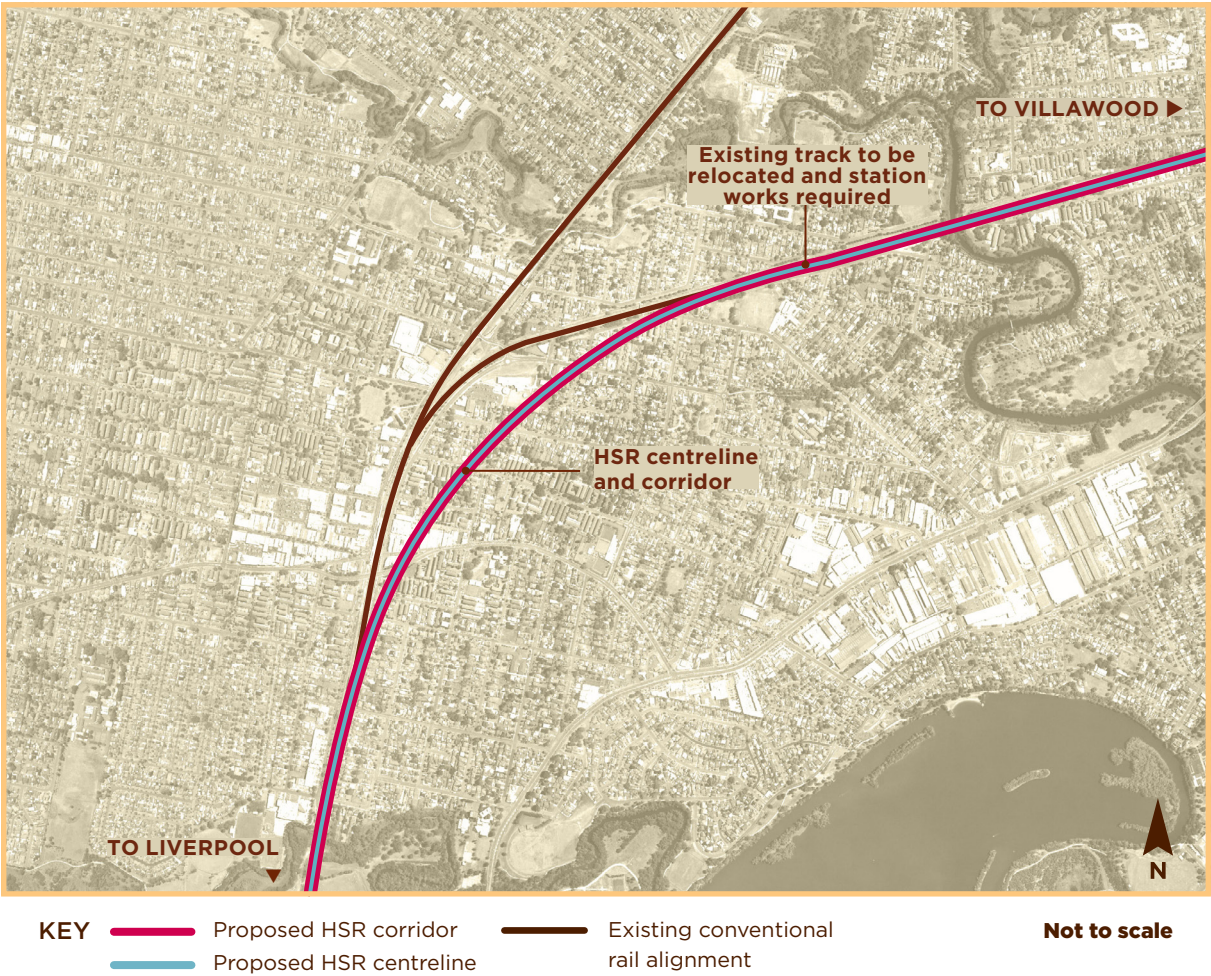


Table 4-1 Cost comparison for tunnel, on viaduct or at surface, between the two points shown on **Figure 4-1** (\$2012, \$million per km)

	Tunnel	Viaduct	Surface
Tunnels	170	-	-
Structures	-	105	80
Earthworks	-	13	13
General civil works	-	14	24
Permanent way	*	10	10
Signals and communications	*	5	5
Power	*	8	8
Land	1	75	112
Total	171	230	252

* These three items are included in the tunnels cost of \$170 million per km

4.2.2 Selection of the preferred urban alignments and station locations

The shortlists of alignments and stations were compared to identify those that best met the criteria. Alignments and stations were assessed using 'pair-wise' comparisons, in which two options were compared and the lesser performing option excluded from further assessment. This process was repeated until it yielded a single preferred option. The criteria for selecting the preferred city centre stations, alignments (both urban and regional) and peripheral station locations were:

- Access time and user benefits.
- Capital cost and relative construction complexity.
- Sustainability impacts and land use planning constraints.

Further discussion of these criteria and a constructability matrix are provided in **Appendix 3A**.

4.2.3 Generation of regional alignments and station locations

The demand modelling found that patronage on HSR was relatively unaffected by the precise siting of regional station locations. A prime consideration for determining how best to approach and serve regional towns was to avoid the impact of a high speed line through their centres. The frequency of trains passing (as many as 20 per hour in 2065), with the majority travelling at maximum speed (as only a proportion would actually be stopping), would create significant visual and environmental impacts on adjacent properties.

The creation of a suitable corridor to permit trains to travel through regional towns at speed would result in the demolition of a significant number of properties and realignment of any transecting roads, unless the route was tunnelled (at considerable additional cost). Even a viaduct crossing a town would have considerable negative impacts in terms of community severance, noise and visual amenity.

Alignments were therefore chosen to avoid the regional town centres but, where possible, to approach the outskirts of the towns, where property development is less dense and there is good accessibility by road. Regional stations were then identified on the preferred regional alignment and evaluated to balance local user benefit and environmental and social impacts.

4.2.4 Selection of the preferred regional alignments and station locations

Regional alignments

The study area was divided into seven sections for the purposes of appraisal:

- Brisbane-Grafton.
- Grafton-Port Macquarie.
- Port Macquarie-Twelve Mile Creek².
- Twelve Mile Creek-Sydney.
- Sydney-Goulburn.
- Goulburn-Albury-Wodonga.
- Albury-Wodonga-Melbourne.

Alignment planning software³ was used to generate up to 50 potential alignments of approximately 50 to 100 kilometres in length within each section that met particular topographical, environmental, geological, hydrological and cost constraints. These were then subject to progressive pair-wise comparison, with the two best performing and lowest cost alignments in each section being compared against the assessment criteria. This process continued in each section until only one alignment along the corridor remained – the preferred alignment.

Regional stations

HSR stations need to be located where the alignment is flat and straight. Given this constraint, the following guidelines were used to identify potential regional station sites:

- Good access from the regional road network.
- Proximity to population centres and growth areas.
- Proximity to other regional transport infrastructure, i.e. regional airports or rail stations.
- Avoidance of significant geographical constraints, such as flood plains or steep topography.
- Avoidance of other areas of significance, such as environmental or heritage areas or large infrastructure features.

The preferred regional station sites were selected on the basis of the following criteria:

- Accessibility.
- Sustainability and consistency with land use planning and regional planning strategies.
- Capital cost.
- Constructability.

More detail on the development and evaluation of alignments is provided in **Appendix 3A**.

Regional centres to be served

The market demand analysis indicated that there was significant demand from regional centres, both now and in future, based on population forecasts. Approximately 55 per cent of HSR trips are forecast to start or end their journey at a peripheral or regional station. Station locations were chosen along the preferred alignment on the basis of being able to serve the largest possible regional population.

² North of Newcastle.

³ Quantm, provided by Trimble Planning Solutions.

Figure 4-2 presents regional centres within the study area and their population forecasts at 2036, with potential station locations highlighted in red⁴.

While demand may exist in the regional centres, it does not necessarily follow that each regional centre should have its own HSR station, for the reasons outlined below.

The demand forecasts indicated that generally a regional centre with a population greater than 50,000 in 2036 could support a station⁵. While stations have been generally proposed at these centres, in some cases, a single regional centre with insufficient population for a station may draw on a larger population from surrounding districts and therefore also be identified as a preferred station location. Similarly, others with a population greater than 50,000 may be able to access a nearby station in the surrounding area, for example:

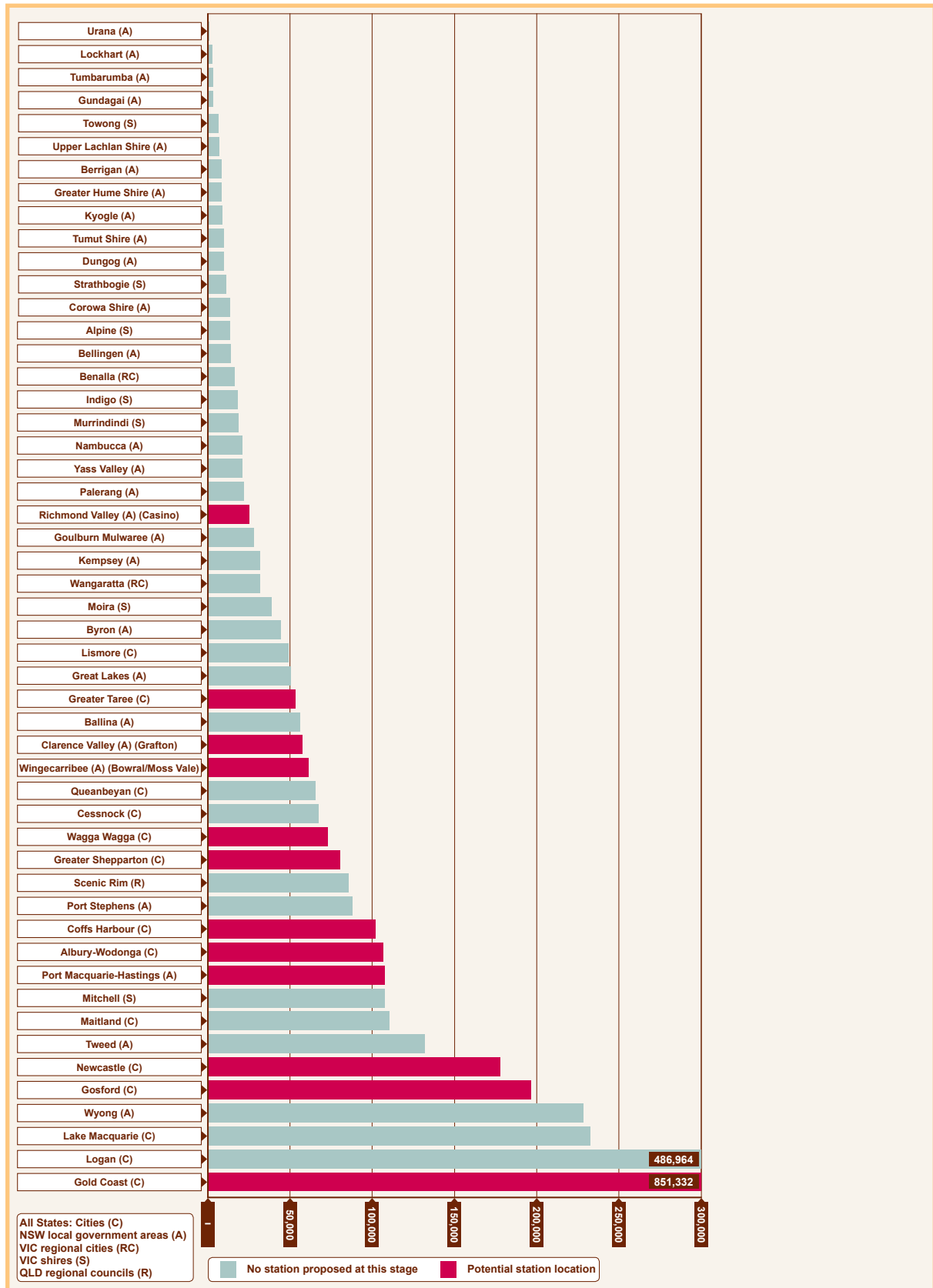
- Fringe metropolitan areas, such as Logan (Brisbane) and Mitchell Shire (Melbourne) would be served by the peripheral station or by the city centre station in each city.
- An HSR station located at Newcastle could serve the population centres of Maitland, Cessnock and Port Stephens. Lake Macquarie, with a forecast population of approximately 230,000 in 2036, could support an HSR station of its own; however, with the dispersed nature of the population and an HSR station at Newcastle, the population of Lake Macquarie could be served by the Newcastle and Central Coast stations.
- A Central Coast HSR station could serve both Gosford and Wyong, and also meet some of the travel demand from Lake Macquarie.
- The Far North Coast area of Lismore, Ballina, Byron and Casino could be served by one regional station, as the forecast combined population for the area in 2036 is 175,000⁶. The station location was also influenced by the preferred alignment south from Brisbane.
- The Great Lakes area could be served by a station at Taree, but could also be served by a Newcastle regional station.
- Queanbeyan could be served by the Canberra terminal station and the Gold Coast Terminal station could serve the nearby areas of the hinterland and Tweed.

4 ABS, loc. cit.

5 Towns served by regional stations on international HSR networks vary in size, but are generally above 50,000. The number of regional centres would mean an average distance between stations for the Brisbane-Sydney-Canberra-Melbourne sectors of approximately 100 km. This is greater than the average distance between stations on the Taiwan HSR (50 km), the Seoul-Busan line (65 km) and the Beijing-Shanghai line (60 km), but less than on the Madrid-Barcelona line (125 km).

6 ABS, loc. cit.

Figure 4-2 Forecast regional populations along the preferred alignment (2036)



Source: ABS, Census Data by LGA, 2010

4.3 Overview of the preferred HSR alignment and station locations

The alternative corridors, alignments and station locations described in this chapter were analysed and compared to select a preferred east coast HSR alignment that would be environmentally and economically sustainable. This section summarises the preferred alignment, which is illustrated in **Figure 4-3**.

Further details of the alignment selection for each sector are discussed in **sections 4.4 to 4.11**.

4.3.1 Brisbane-Sydney

From a new HSR station in the footprint of the existing Transit Centre adjacent to Brisbane's Roma Street station, the HSR alignment would run south in a tunnel beneath the existing Ipswich Line and emerge at St Lucia before crossing the Brisbane River and running on a viaduct along the Oxley Creek floodplain to Greenbank. A Brisbane peripheral station would be located just south of the M2 Motorway, west of Paradise Road.

From Greenbank, the alignment would follow an inland corridor via Beaudesert, including a series of tunnels beneath the Border Ranges at the Queensland/NSW border. The Gold Coast would be served by a spur line from near Beaudesert, including a four kilometre tunnel beneath Mount Tamborine to an HSR station adjacent to the existing conventional rail station at Robina. The route would continue south of Beaudesert in tunnel underneath the World Heritage Gondwana Rainforest in the Border Ranges National Park, pass Casino to the west, and stay east of the Great Dividing Range passing Grafton, Coffs Harbour, Port Macquarie and Taree to Newcastle.

The section from Beaudesert to Newcastle has a number of major structures including a seven kilometre viaduct across the Clarence River floodplain to the east of Grafton, a 2.5 kilometre tunnel beneath the Boambee State Forest to the southwest of Coffs Harbour, a five kilometre viaduct across the Wilson River floodplain to the northwest of Port Macquarie, a 15 kilometre viaduct across the Manning River floodplain to the east of Taree and a two kilometre tunnel beneath the Myall Lakes Ramsar Wetlands between Taree and Newcastle.

Avoiding built-up areas, including Wyee, Wyong and Ourimbah to the east and steeper topography to the west, the alignment would broadly follow the F3 Freeway corridor south of Newcastle into Sydney. This would include long lengths of tunnel (including a 6.5 kilometre tunnel north and a series of smaller tunnels south of the Hawkesbury River) and a high level crossing of the Hawkesbury River, on a bridge adjacent to the F3 Freeway crossing at Mooney Mooney.

Regional stations would be located west of Casino (along the Bruxner Highway), southeast of Grafton (adjacent to Grafton Airport), southwest of Coffs Harbour (west of the Pacific Highway), west of Port Macquarie (west of the Oxley Highway/Pacific Highway interchange), southeast of Taree (along Old Bar Road), west of Newcastle (east of the F3 Freeway) and at the Central Coast (north of the F3 Freeway/Pacific Highway interchange at Ourimbah).

The alignment into Sydney from the north would be in tunnel, generally following the Northern Line towards Homebush, then eastwards generally following the Western Line before terminating at Central station. A Sydney North peripheral station would be located adjacent to the conventional rail station at Hornsby.

Figure 4-3 Preferred HSR alignment and station locations



Note: The map shows 16 of the 20 proposed stations but omits the peripheral stations which would not be discernible at the scale shown.

4.3.2 Sydney-Melbourne

Exiting Sydney to the south, the route would be in tunnel from Central station to around Holsworthy and then predominantly at surface level to the east of Glenfield, Minto and Campbelltown. A Sydney South peripheral station would be located at the northern end of the Department of Defence land at Holsworthy, accessed via the M5 Motorway and Moorebank Avenue.

The preferred alignment would then broadly follow the Hume Highway corridor, passing through the Southern Highlands and heading inland toward Yass. The alignment would deviate from the Hume Highway corridor in places to minimise adverse impacts on residential areas, such as Mittagong, Bowral and Moss Vale, as well as environmentally sensitive areas and water supply catchment areas.

Canberra would be served via a spur line to an HSR station on Ainslie Avenue near Civic. The spur alignment would connect to the HSR alignment near Gunning. On the approach to Canberra it would run parallel to the Majura Parkway and then deviate to the west, in a 3.6 kilometre tunnel under Mount Ainslie towards Civic.

From Goulburn the main route would continue west through Yass, skirt the Brindabella Ranges and deviate north and west from the Hume Highway corridor to serve Wagga Wagga and then on to Albury-Wodonga. West of Albury-Wodonga, the alignment would also deviate from the Hume Highway corridor to avoid the hills northwest of Albury and to minimise noise and severance impacts on the community. From here, the preferred alignment would head towards Shepparton, past Seymour and broadly follow the Hume Freeway corridor toward Craigieburn.

The alignment into Melbourne would be at surface level via Craigieburn to Roxburgh Park, then via the Upfield Line corridor in tunnel from Gowrie to Southern Cross station. A Melbourne peripheral station would be located just north of the M80 Western Ring Road, west of the Hume Highway at Campbellfield.

The Sydney-Melbourne route has comparatively few major structures, the longest being a three kilometre viaduct across the Murrumbidgee River floodplain to the east of Wagga Wagga and a two kilometre viaduct across the Murray River floodplain to the west of Albury-Wodonga. Aside from the 3.6 kilometre tunnel under Mount Ainslie, there would be three other tunnels, each less than two kilometres in length.

Regional stations would be located in the Southern Highlands (adjacent to Mittagong Airport), east of Wagga Wagga (adjacent to Wagga Wagga Airport), west of Albury-Wodonga (north of the Hume Freeway/Murray Valley Highway interchange), and east of Shepparton (along the Midland Highway).

Twenty stations are proposed, with the capital city stations located in the central business districts (CBDs). The locations of the other stations vary and are explained in sections 4.4 to 4.11.

The proposed stations are:

- | | |
|------------------|----------------------|
| • Brisbane CBD | • Sydney North |
| • Brisbane South | • Sydney CBD |
| • Gold Coast | • Sydney South |
| • Casino | • Southern Highlands |
| • Grafton | • Canberra CBD |
| • Coffs Harbour | • Wagga Wagga |
| • Port Macquarie | • Albury-Wodonga |
| • Taree | • Shepparton |
| • Newcastle | • Melbourne North |
| • Central Coast | • Melbourne CBD |

4.4 Brisbane-Grafton (including the Gold Coast)

4.4.1 Brisbane

Overview

Brisbane is Australia's third largest capital city with a population of approximately two million people and employment at over one million, generating nine per cent of Australia's gross domestic product. Population and employment forecasts indicate a population for metropolitan Brisbane of almost three million by 2031, with employment of around 1.5 million⁷. By 2056, the population is predicted to reach around four million people⁸. The surrounding region is also expected to grow rapidly. The Brisbane local government area (LGA) and ten other surrounding LGAs together constitute the South East Queensland (SEQ) region, which is expected to have a population of six million by 2056, with strong growth on the Sunshine Coast to the north, in Toowoomba to the west and on the Gold Coast to the south⁹.

The long-term infrastructure policy for the city is set out in Brisbane City Council's *Brisbane Long Term Infrastructure Plan 2012-2031*¹⁰. This identifies a series of actions to deliver infrastructure strategies for transport and other services for the metropolitan area and key employment and commercial districts, including the Brisbane CBD. The *South East Queensland Regional Plan 2009-2031* and *Connecting SEQ 2031* outline the Queensland Government's land use and transport plans to support the growth in the SEQ region¹¹.

In Brisbane, congestion and insufficient capacity already affect the performance of the rail network.

The *Connecting SEQ 2031* plan foreshadows a number of new rail lines, including Cross River Rail and extensions to northwest Brisbane, light rail on the Gold Coast, an inner Brisbane subway and further expansion of the bus rapid transit (BRT) network¹². However, to date the planning strategies for Brisbane have not taken into account the possibility of HSR.

Strategic planning context and issues

The planned growth of Brisbane and the SEQ region will continue along existing developed corridors along the coast, as well as inland corridors towards and beyond Ipswich to the west and towards Beaudesert to the south. The *South East Queensland Regional Plan 2009-2031* maintains the existing urban footprint but identifies sufficient land to accommodate a projected population of 4.4 million people and their employment and economic development needs up to 2031, albeit in a more compact urban form¹³. The plan sets out specific growth management policies aimed at achieving urban consolidation and encouraging infill and redevelopment in established urban areas¹⁴.

The area between Brisbane and the Gold Coast includes continuous residential development from Coomera to the Gold Coast, as well as many natural and constructed waterways.

Environmental planning context and issues

The entry points into Brisbane feature a mix of well-vegetated tablelands (including Mount Tamborine) in the hinterland to the Gold Coast, and undulating land predominantly used for agriculture and rural small holdings within a valley that includes Beaudesert, south of Brisbane.

7 Brisbane City Council, *Brisbane Economic Development Plan 2012-2031*, 2012.

8 ABS, Census Data by LGA, 2011.

9 *ibid.*

10 Brisbane City Council, *op. cit.*

11 Department of Infrastructure and Planning, *South East Queensland Regional Plan 2009-2031*, 2009.

Department of Transport and Main Roads, *Connecting SEQ 2031 – An Integrated Regional Transport Plan for South East Queensland*, 2011.

12 *ibid.*

13 Department of Infrastructure and Planning, *op. cit.*, p. 8.

14 *ibid.*, p. 9.

The Greenbank Military Training Area occupies a key location south of Brisbane. This Defence site has environmental and heritage values in addition to being an important training base, which Defence has advised will be required for long-term military use.

The coastal urban areas from Brisbane to the Gold Coast are framed to the west by the upland hinterland of Mount Tamborine and Tamborine National Park and State Forest. Additional natural areas between Brisbane and Beaudesert include Buccan Conservation Reserve, Plunkett Conservation Park and the Burnam Range. To avoid direct impact on these areas of high conservation value, a tunnel under Tamborine National Park would be constructed.

The Brisbane region includes a number of major rivers and creeks (including the Brisbane, Logan, Bremer and Albert Rivers and Oxley Creek) that meander through wide valleys and floodplains as they travel to the coast. These waterways and their floodplains contain areas of ecological and heritage significance, including a number of key vegetated areas that are mapped as essential habitat under Queensland's *Vegetation Management Act 1999*, in addition to the nationally-listed Threatened Ecological Community Swamp Tea-tree (*Melaleuca irbyana*)¹⁵. At the strategic level of this study, detailed assessment of each of these areas was not possible; however, their presence was considered in the choice of alignment to minimise potential impacts on them. Specific mitigation measures would be designed at the concept design phase when the detailed assessment of each area would be undertaken, should a decision be made to proceed with HSR.

Assessment of potential station locations

Along with the necessity to provide a new crossing of the Brisbane River, ground level access to the CBD is difficult. Phase 1 of the study identified two potential precincts for HSR stations in the centre of Brisbane:

1. At, or near, the existing station at Roma Street.
2. At South Bank.

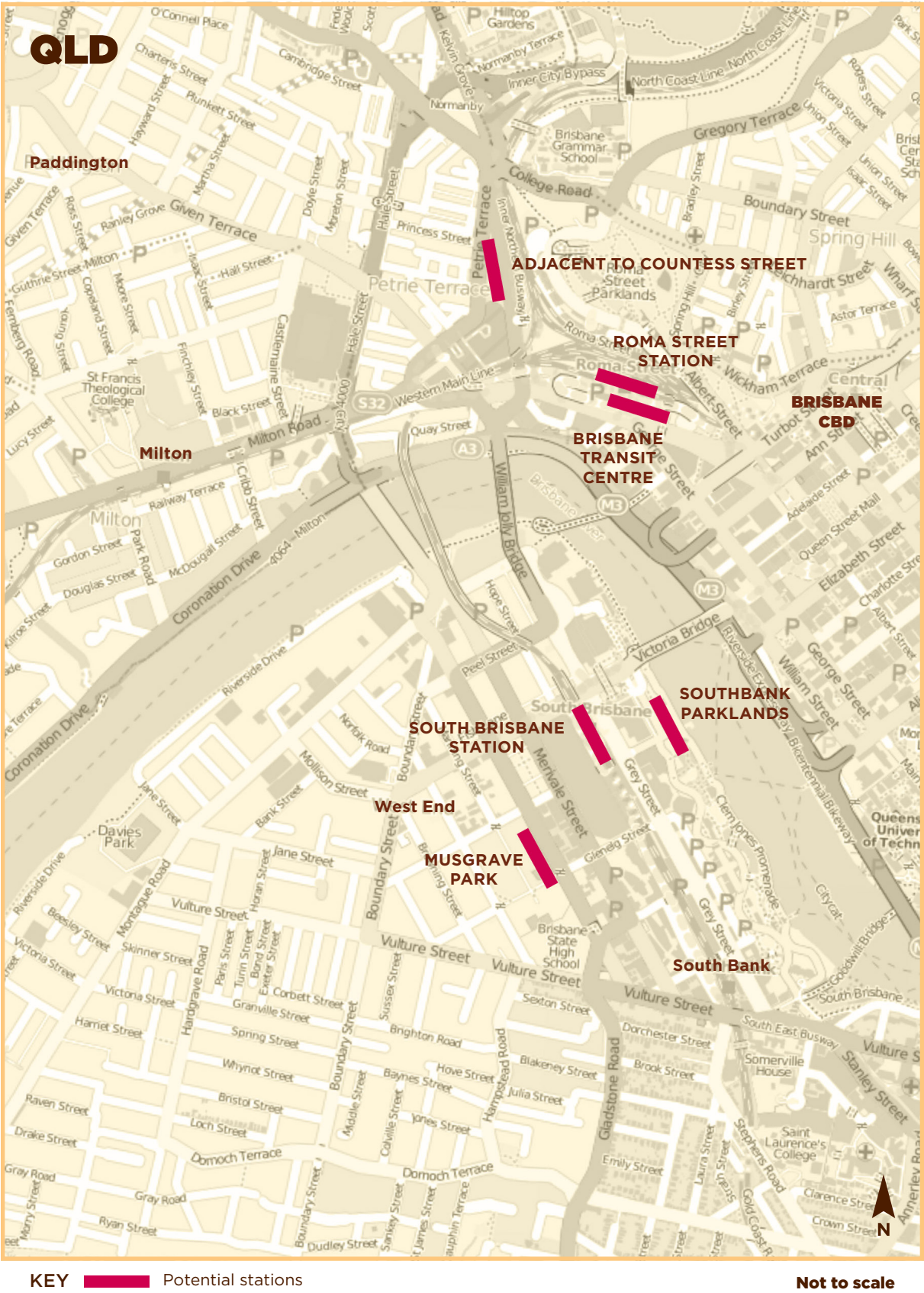
Other locations considered in phase 1 - including Bowen Hills, Fortitude Valley, Central station, Albert Street and Woolloongabba - were all ruled out due to poor accessibility or constructability. Further analysis, supported by consultation with the Queensland Government, identified three station sites at each of the two preferred precincts, namely:

- Roma Street precinct:
 - At Roma Street station.
 - A site adjacent to Countess Street.
 - At the site of the Brisbane Transit Centre.
- South Bank precinct:
 - At South Brisbane station.
 - In the South Bank Parklands.
 - In Musgrave Park.

These station sites are shown in **Figure 4-4**.

¹⁵ Essential habitat is vegetation in which a species that is endangered, vulnerable, rare or threatened has been known to occur.

Figure 4-4 Potential city centre station sites, Brisbane



Roma Street precinct

Three station sites were considered in the Roma Street precinct: at the existing Roma Street station, adjacent to Countess Street and at the Brisbane Transit Centre. All three sites provide similar user benefits but there are significant differences in cost, access and constructability.

Because the Roma Street precinct is north of the Brisbane River, a river crossing would be required for any corridor coming from the south, regardless of which site was chosen.

Roma Street station

Although the existing station at Roma Street appears to be ideal, it is on the Queensland Heritage Register, making it difficult to reconfigure for HSR operations. However, its proximity to the CBD gives it moderate to high accessibility, and it is located at a major transport interchange. This accessibility will be improved further with the proposed Cross River Rail.

Converting part of Roma Street station for use by HSR services would cost an estimated \$4.3–4.6 billion (\$4.1 billion for the urban access corridor and \$0.2–0.5 billion for the station structure). There would be additional costs associated with having to reconfigure and rebuild the existing operational railway tracks and platforms. Construction would cause significant disruption to existing rail operations, particularly given the constraints of the existing heritage station buildings, and would have an adverse impact on commuters.

Countess Street

An HSR station at the Countess Street site would have adverse impacts on existing buildings on the approach, heritage buildings associated with Victoria Barracks, and the parkland on Petrie Terrace. It would yield limited urban renewal opportunities. Further discussion of urban renewal in relation to strategically located transport infrastructure is provided in **Chapter 7** and **Appendix 3A**. It also has reduced accessibility for HSR passengers, particularly to the CBD, compared with other Roma Street station alternatives. Construction at the Countess Street site would cost an estimated \$4.35 billion (\$4.1 billion for the urban access corridor and \$0.25 billion for the station structure). HSR access to the site requires a north–south alignment, crossing the existing rail lines approaching Roma Street station from the west. Even with careful planning this would disrupt Queensland Rail services while the construction occurred.

Brisbane Transit Centre

Using the Brisbane Transit Centre site for an HSR station would provide new opportunities for urban renewal, with minimal adverse environmental and land use impacts. It would provide the opportunity to redevelop the site with an HSR station underneath, and is consistent with current and planned development in the area, such as the creation of the Justice Precinct for Civic Plaza and the improvements to public space at the western end of George Street. An HSR station at the Brisbane Transit Centre would cost an estimated \$4.47 billion (\$4.1 billion for the urban access corridor and \$0.37 billion for the station structure, excluding purchase of existing property, if required). It would also provide excellent connectivity with the proposed Cross River Rail, and largely avoid disrupting existing train services at Roma Street during construction.

South Bank precinct

Three station sites were considered at South Bank: at South Brisbane station, in the South Bank Parklands and in Musgrave Park. Despite being connected to the urban rail and BRT networks, the user benefits of sites in South Bank are lower than those in Roma Street because of the lower direct accessibility to the CBD.

South Brisbane station

South Brisbane station is on the Queensland Heritage Register. Consequently, the construction of an HSR station on this site would need to be carefully managed to avoid any negative impacts on the existing station. The site is moderately accessible, with direct connections to the urban rail and BRT network. An HSR station at this site would cost an estimated \$3.75 billion (of which \$3.5 billion is the cost of the urban access corridor and \$0.25 billion is the cost of the station structure). However, construction on this site would cause significant disruption to existing rail operations and would be severely constrained by the surrounding infrastructure environment.

South Bank Parklands

The South Bank Parklands site would require the HSR station and approaches to be elevated above flood level. This would maintain the existing road network connections, but would have major adverse impacts on the existing riverfront parkland and environment. With a pedestrian bridge over the river linking to the CBD, this site has moderate to high accessibility for pedestrians, but overall lower accessibility than the South Brisbane station site, due to its relative distance from the BRT and rail network. An HSR station at the South Bank Parklands site would cost an estimated \$3.7-3.8 billion (\$3.5 billion for the urban access corridor and \$0.2-0.3 billion for the station structure).

Musgrave Park

An HSR station at Musgrave Park would cost an estimated \$3.7 billion (\$3.5 billion for the urban access corridor and \$0.2 billion for the station structure). While developing an HSR station at Musgrave Park would be relatively simple from a constructability perspective, it is not easily accessible from the CBD, is not well served by public transport and has lower user benefits than the other options. The area is also of cultural importance for the Aboriginal people of Brisbane.

Preferred city centre station site

All of the sites in the South Bank precinct perform less favourably against the assessment criteria than those in the Roma Street precinct. The Roma Street sites have the potential to act as a catalyst for greater economic development, and are better aligned with Queensland Government planning policies than the South Bank sites. They also provide much better access and connectivity, and construction on these sites would have less impact on the environment and land use plans.

Of the options in the Roma Street precinct, the Brisbane Transit Centre is the preferred site for an HSR station. It is better aligned with local planning policies, offers the potential for redevelopment initiatives, and is likely to have fewer adverse impacts on heritage, operational and planned transport infrastructure, and on existing urban development.

The Brisbane Transit Centre is the preferred site for an HSR station in Brisbane.

Table 4-2 presents a summary of the assessment.

Table 4-2 Assessment of potential city centre station sites, Brisbane

Objective	Criteria	Roma Street precinct			South Bank precinct		
		Roma Street station	Adjacent to Countess Street	Brisbane Transit Centre	South Brisbane station	South Bank Parklands	Musgrave Park
Economics and connectivity	Difference in user benefits from Roma Street station (\$b)	-	-	-	-1	-2	-2
	Pedestrian access to CBD	High	Low	High	Moderate	Moderate - high	Low
	Public transport access (existing)	High	Moderate	High	Moderate	Low-moderate	Low
	Parking availability (existing)	Low	Low	Low	Low	Low	Low
	Proximity to residential centre	Moderate	Moderate - high	Moderate	Low-moderate	Low-moderate	Moderate
	Connectivity to arterial roads	Low - moderate	High	Low - moderate	Low	Low	Low - moderate
	Overall accessibility	Moderate - high	Moderate	Moderate - high	Low - moderate	Low - moderate	Low
Infrastructure	Capital cost (\$b) (station basic structure)	0.2-0.5	0.25	0.37	0.25	0.2-0.3	0.2
	Capital cost (\$b) (access corridor)	4.1	4.1	4.1	3.5	3.5	3.5
	Capital cost (\$b) (total)*	4.3-4.6	4.35	4.47	3.75	3.7-3.8	3.7
	Constructability**	5	4	4	5	4	1
Sustainability, land use planning & policy fit	Maintain existing land use***	4.0	3.8	4.0	4.0	4.0	3.8
	Maintain community function***	3.5	1.5	4.0	1.5	2.0	2.0
	Promote economic development***	6.0	6.0	6.0	6.0	6.0	6.0
	Summary	Slightly beneficial	Neutral	Slightly beneficial	Slightly detrimental	Slightly detrimental	Slightly detrimental
Conclusions		-	-	Preferred	-	-	-
Principal reasons for non-selection		Very difficult station constructability	Lower accessibility		Lower user benefits, low accessibility and impact on community function	Lower user benefits, low accessibility and impact on community function	Lower user benefits, low accessibility and impact on community function

*Highest cost preferred urban access corridor used for consistent comparison.

**Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

***Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Further detail is provided in **Appendix 5C**.

Potential urban access alignments

In determining the preferred HSR urban access alignment for Brisbane, the proposed Cross River Rail infrastructure scheme was examined for opportunities to share infrastructure and potential peripheral station sites. Existing rail corridors are anticipated to be fully utilised by conventional rail expansion. Any HSR alignments within, adjacent to or below existing rail and road corridor could reduce the impacts on existing inner urban development, but generally the existing geometry of these alignments is unsuitable for the speed of HSR trains.

Nine potential alignments through metropolitan Brisbane were identified to access an HSR station at the site of the Brisbane Transit Centre. Details and comparative evaluation of these can be found in **Appendix 3A**.

Preferred urban access alignment

All of the Brisbane urban access corridors are relatively similar in terms of length, travel time, sustainability merits and impacts on land use planning policy, and the user benefits of each are relatively equal. The main differentiator is the significant capital cost saving of the option via Oxley compared with the other options (between \$1.5 and \$3.7 billion).

Once an inland route via Beaudesert with a spur to the Gold Coast was selected, a number of urban access options were no longer feasible.

The appraisal confirmed that the alignment via Greenbank, and in particular the option via Oxley, is preferred. As this alignment includes a surface crossing of the Department of Defence land at Greenbank, two variations (presented fully in **Appendix 3A**) were also examined to determine whether a surface crossing of Defence land is the best option. These variations were:

- A tunnel under the Department of Defence land on the preferred alignment.
- A surface deviation to the east, avoiding the Department of Defence land.

The tunnel option has an increased cost of \$0.6 billion and its presence could limit Department of Defence land use. The eastern surface deviation represents a construction cost saving of \$0.2 billion (excluding land costs), but is one kilometre longer and would have significant impacts on existing residential and commercial developments. Both these options are rated more difficult to construct than the preferred option, in one case due to tunnelling through soft soils and in the second because of the interfaces between the HSR and existing rail corridor and the residential/commercial areas.

In summary, the preferred urban access in Brisbane is an alignment via Greenbank and Oxley (**Figure 4-5**).

Figure 4-5 Preferred urban access alignment, Brisbane



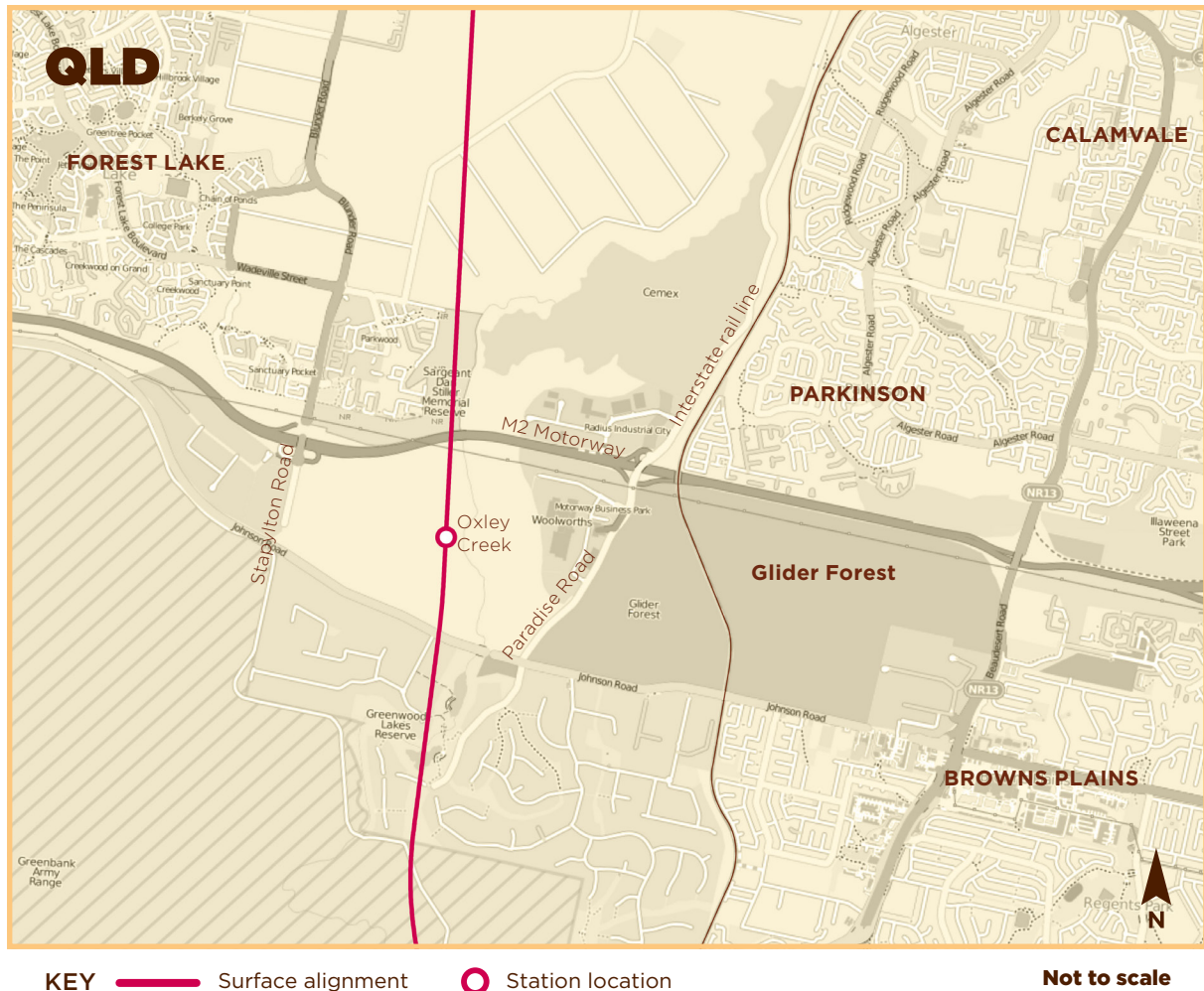
Peripheral station assessment - Brisbane

A peripheral station in Brisbane should have good connections to the regional road network as well as the regional growth areas. Two potential peripheral locations were identified, one near the M7 near Oxley and one west of Browns Plains near the M2. The selection process is described in **Appendix 3A**.

The preferred peripheral station site in Brisbane is adjacent to the M2/MR6 Logan Motorway, west of Browns Plains.

The station is located south of the motorway, west of Paradise Road, as shown in **Figure 4-6**. The site is woodland, forming part of the Glider Forest, adjacent to Oxley Creek. Road access would be provided from the motorway, via the Stapylton Road interchange. There is no urban rail access to the site (however, refer to **Chapter 5** for a discussion of a possible dedicated bus link service). The interstate rail line is located approximately two kilometres to the east but is not used for regular urban rail services at present. A peripheral station at this site would increase user benefits by \$0.9 billion.

Figure 4-6 Location of Brisbane South peripheral station site



Brisbane – preferred station sites and urban access alignment

The Brisbane Transit Centre is the preferred site for the city centre HSR station in Brisbane. This site aligns well with local planning policies and has fewer adverse impacts on heritage, operational and planned transport infrastructure and existing urban development than other sites considered. It also provides new opportunities for urban renewal and development, including above the HSR station.

The preferred access alignment to the Brisbane Transit Centre site is from Greenbank via Oxley. The cost of this alignment is approximately \$1.5 billion lower than other potential alignments, with no significant adverse impacts in terms of travel time and environmental and land use impacts.

The preferred peripheral station site in Brisbane is adjacent to the M2/MR6 Logan Motorway, west of Browns Plains.

4.4.2 Coastal vs inland corridor via Gold Coast or Beaudesert

Before the Brisbane urban alignment comparisons could be made, a decision was required to pursue either a coastal corridor via the Gold Coast or an inland corridor via Beaudesert.

The analysis showed strong demand for access to the Gold Coast, and that an alignment via the Gold Coast would generate in the order of \$10 billion more user benefits compared to an alternate alignment via Beaudesert, which would not serve the Gold Coast at all. However, an alignment through the Gold Coast would be more difficult to construct, would have a negative impact on populated and environmentally sensitive areas, and would cost \$2.7 billion more to construct

than the Beaudesert alignment. An alternative proposal of an inland alignment with a spur from Beaudesert out to the Gold Coast (without requiring a change of trains at Beaudesert) was therefore investigated.

Potential alignments within each corridor were assessed between Greenbank, a common point for the corridor alternatives to the north, and Whiporie, a common point to the south. The best performing alignments via the Gold Coast (shown in blue in **Figure 4-7**) and via Beaudesert with a spur to the Gold Coast (shown in red) were then selected for comparison.

A summary of the comparison is provided in **Table 4-3**, while the detailed appraisal of the alignments is provided in **Appendix 3A**.

Table 4-3 Comparison of alignments in the Brisbane-Whiporie corridor

Criteria	Brisbane-Grafton	
	Coastal alignment	Inland alignment, with a spur to the Gold Coast
Length (km) (Greenbank to Whiporie)	215	178
Estimated transit time (min) (Greenbank to Whiporie)	40.5	31.5
Relative net user benefits (\$b)	+0.4	0.0
Capital cost (\$b)	9.0	8.7
Constructability*	4	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

Figure 4-7 Potential alignments in the Brisbane-Whiporie corridor



An inland alignment with a spur from Beaudesert to the Gold Coast would achieve most of the benefits at no additional cost when compared to the coastal route, while minimising the environmental and social impacts.

The inland alignment via Beaudesert with a spur from Beaudesert to the Gold Coast is the preferred alignment.

4.4.3 Regional alignment and station assessments

Overview

South of Brisbane, potential HSR alignments traverse the South East Queensland and NSW Far North Coast regions. Due to the proximity of the Great Dividing Range to the coast, this area typically contains several types of terrain, ranging from very hilly to the mountainous Lamington and Border Ranges National Parks to relatively flat coastal areas.

The population is concentrated in the larger towns and the Gold Coast. The inland towns include Beaudesert, Kyogle, Casino and Lismore, while the coastal centres include the Gold Coast, Coolangatta-Tweed Heads, Murwillumbah, Byron Bay and Ballina. The Gold Coast is densely populated, accommodating approximately 500,000 residents and a large number of tourists. It has a wide range of residential environments, including extensive low-density residential communities, canal estates and high-rise developments.

Land use away from built up areas is largely forest, rainforest and agriculture, reflecting the subtropical climate and fertile soil. The diverse agriculture includes wine, fruit and various staple crops. The area has many large waterways including the Tweed, Brunswick, Wilsons and Richmond Rivers.

South of the Border Ranges National Park the alignment passes through patchy eucalypt forest in an otherwise cleared and disturbed landscape.

Transport infrastructure includes the M1 Motorway from Brisbane to the Queensland border at Coolangatta, the Pacific Highway which runs close to the coast, and the North Coast rail line. There are several regional airports, with Gold Coast (Coolangatta) Airport being the busiest as it serves the tourist demand to the Gold Coast.

Once the inland alignment via Beaudesert, with a spur from Beaudesert to the Gold Coast, was selected as the preferred corridor, alignment options were considered for the Brisbane-Grafton section.

The Brisbane-Grafton section was divided into two sectors, the first from Greenbank to Whiporie (where the two alignment options converge) and the second in a common alignment from Whiporie to Grafton. The alignments considered are shown in **Figure 4-8**.

Figure 4-8 Brisbane-Grafton alignment options



Greenbank-Whiporie

Options were investigated to deviate the alignment to increase user benefits from a regional station location either east of Casino or east of Lismore. However, the existing rail or road corridors to access the urban areas of Casino and/or Lismore would not be suitable for an HSR alignment due to their abrupt and multiple changes in direction. The capital cost of deviating the alignment to the east of Casino exceeded the increase in user benefits. A deviation to the east of Lismore would have a significant increase in capital cost and a net user disbenefit due to the additional transit time for through passengers. Details of this comparison can be found in **Appendix 3A**.

The inland alignment via Beaudesert with a spur to the Gold Coast (shown in red in **Figure 4-8**) was identified as the preferred alignment.

Two alignments, a northern option (in blue on **Figure 4-8**) and a southern option (in red), were shortlisted for comparison. Other spur options between Beaudesert and the Gold Coast, while potentially more direct, would create more adverse sustainability and land use planning impacts, including on the Tamborine National Park, Nerang River reservoir (Advancetown Lake) and/or on the Department of Defence Canungra base between Mount Tamborine and Beechmont. Other options would also traverse longer lengths of steep terrain which would add to the capital cost.

While slightly longer than the northern option, the southern alignment option is preferred as it has fewer environmental impacts and is consistent with strategic planning objectives. The northern alignment would terminate at a station in Carrara and was discounted from further consideration on both cost and environmental grounds (see Gold Coast station assessment below, and **Appendix 3A**, for further detail).

The southern alignment (in red in Figure 4-8), terminating adjacent to the existing Robina station, is the preferred option for accessing the Gold Coast via a spur.

Whiporie-Grafton

The two shortlisted alignments for pair-wise comparison generally shared a common route between Whiporie and Grafton.

The decision to generally consider both options arose from the findings of the sustainability and land use planning appraisal, which included passing through the Banyabba State Forest and ‘high conservation value old growth forest’ listed on the National Heritage Register. Further assessment of potential impacts on these areas, and appropriate mitigation and offset measures, would be developed in the detailed assessment and design phase, should a decision be made to proceed with HSR.

The preferred alignment is an optimisation of the two alignments between Whiporie and Grafton.

Gold Coast station

The Gold Coast region is located approximately 70 kilometres southeast of Brisbane with an urban area stretching approximately 50 kilometres along the coast. It has grown significantly in recent years, and has become an important Australian tourism destination. The population of the Gold Coast was 494,500 in 2011 and is forecast to reach 850,000 in 2036 and 1.5 million by 2056¹⁶.

The biggest constraint in locating a suitable station on the Gold Coast was the potential impact on developed urban areas and planned future development, while any remaining undeveloped land would be subject to topographical constraints. Potential station locations at Carrara and Robina were assessed, with the objective of minimising impact on the urban areas while providing access to the regional road network. The location at Robina was the least constrained site, with the additional benefit of linkages with local public transport.

The alignment to the station would also have fewer adverse land use impacts than the alignment to station sites at Carrara. Options in the vicinity of

the station site were assessed, with the preferred location adjacent to the existing conventional rail station at Robina, as shown in **Figure 4-9**. The conventional rail and HSR stations would be adjacent to each other, with a walking distance of less than 40 metres between platforms.

The location at Robina has good access to the regional road network, and is close to the Pacific Highway/Robina Town Centre Drive interchange, approximately two kilometres away. Surfers Paradise would be 13 kilometres by road, Southport 18 kilometres by road and Coolangatta/Tweed Heads 25 kilometres by road.

From a land use planning and policy perspective, the *Gold Coast Planning Scheme 2003* (as amended) identifies Robina as a Key Regional Centre and a major public transport interchange¹⁷. It is strategically located to serve emerging residential communities on the western fringe of the Gold Coast. A station in this location would have synergies with the current strategic planning intent for this area.

Robina was selected as the preferred location for the HSR regional station on the Gold Coast.

Figure 4-9 Preferred Gold Coast station location



¹⁷ Gold Coast City Council, *Gold Coast Planning Scheme 2003*, version 1.2 amended November 2011.

NSW Far North Coast station

The Far North Coast region extends south from the Queensland border and incorporates the major regional centres of Tweed Heads and Lismore, coastal communities around Ballina and Byron Bay and the major towns of Casino and Murwillumbah. The region is the most biologically diverse in NSW and contains more than 20 National Parks¹⁸. The population of the Far North Coast region was 220,000 in 2011, with projections estimating the population will be 315,000 in 2036 and 328,000 by 2056¹⁹.

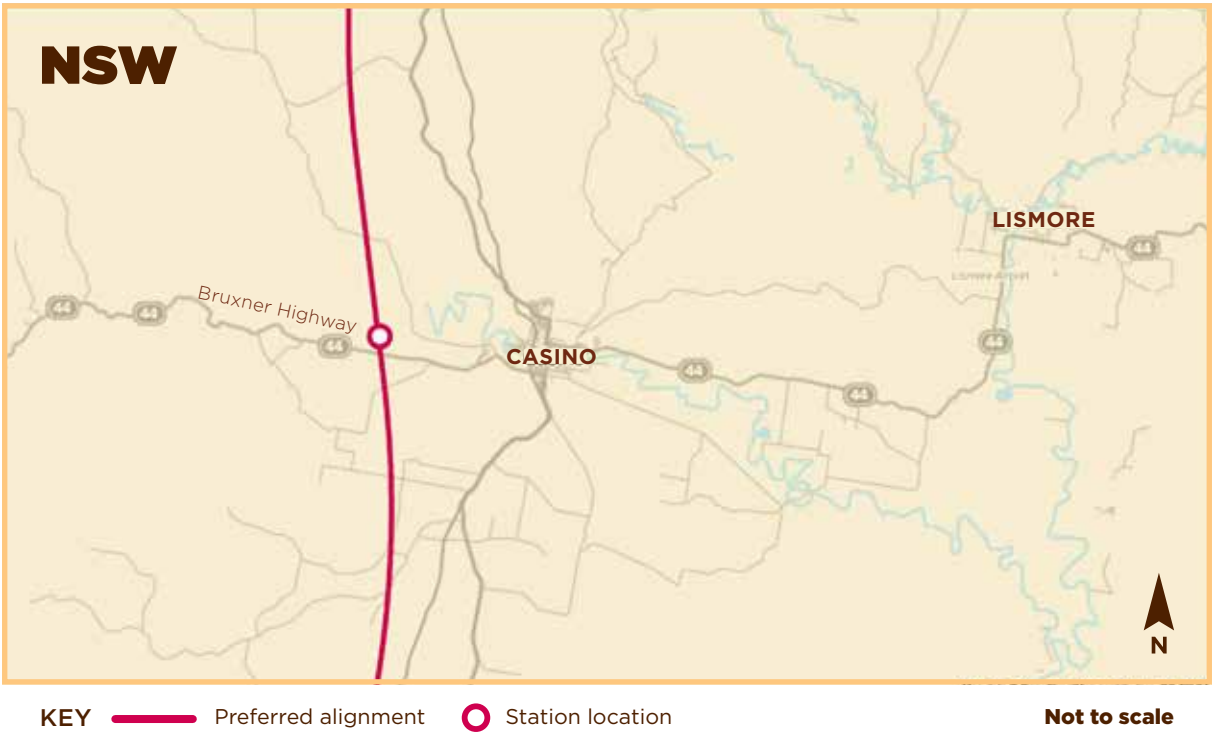
As discussed above in the context of the alignment between Greenbank and Whiporie, the preferred alignment shown in **Figure 4-10** passes to the west of Casino. Alignments that allow station options to the north and south of Casino would affect the town and require several crossings of the meandering Richmond River. Alternatives

passing to the east of Casino, allowing a station between Casino and Lismore, would attract more user benefits from Lismore and the coastal centres. However, the increased capital cost of this option relative to the preferred alignment (\$1.2 billion) was greater than the increase in user benefits (\$0.5 billion). A second option to the east of Lismore not only had larger increased capital costs compared to the preferred alignment (\$3.5 billion), but also reduced user benefits (-\$1.0 billion) due to the additional train transit time.

The preferred site for Casino station lies to the west of Casino along the Bruxner Highway.

As shown in **Figure 4-10**, this site provides good access from the regional road network. Casino, which has a regional airport and a conventional rail station, is approximately nine kilometres by road from the proposed HSR station location. Lismore is approximately 40 kilometres away by road.

Figure 4-10 Preferred Casino station location



18 NSW Department of Planning, *Far North Coast Regional Strategy*, 2006.

19 ABS, loc. cit.

4.5 Grafton-Port Macquarie

4.5.1 Overview

This section of the Mid North Coast is bounded by the Great Dividing Range to the west and the Pacific Ocean to the east. The most favourable corridors avoid the higher slopes of the range and traverse the foothills of the range down to the coastal floodplains. Acid sulphate soils are present on the floodplains and the region experiences significant flooding due to its large catchment areas. The main rivers in the area are the Clarence, Bellinger, Kalang, Nambucca, Macleay and Hastings Rivers.

The Nambucca and Macleay floodplains have been largely cleared, although small areas of Lowland Rainforest Threatened Ecological Community remain, particularly in the Bellinger and Kalang River catchments. Koala populations live in the forested areas of this section and provision would be made for koala and other fauna crossings under the alignment, including appropriate koala fencing in place of the standard fencing that would enclose the surface alignment.

Land use is generally mixed, with significant agriculture including timber and farm industries. Populations are concentrated in towns currently connected by the Pacific Highway including Grafton, Coffs Harbour, Nambucca Heads, Macksville, Kempsey and Port Macquarie. There are three potential station locations – at Grafton, Coffs Harbour and Port Macquarie.

The Grafton-Port Macquarie section was divided into four sectors: Grafton-Coramba (north of Coffs Harbour), Coramba-Charlmont (south of Coffs Harbour), Charlmont-Warrell Creek (north of Kempsey) and Warrell Creek-Port Macquarie.

The alignments assessed in this section are shown in **Figure 4-11**.

Figure 4-11 Grafton-Port Macquarie alignment options



4.5.2 Regional alignment and station assessments

Grafton-Coramba

The two shortlisted alignments generally share a common route between Grafton and Coramba. Other alignment options were less direct and/or would have increased sustainability and land use planning impacts. The use of existing rail or road corridors to access the town of Grafton would not be suitable for HSR because their alignment is not suitable for the speed of HSR.

The blue alignment would have adverse impacts on housing at Ulmarra, Glenreagh and Nana Glen, and on agricultural land, state nature reserves and high conservation value old growth forests. However, it is likely to have less severe impacts than the red alignment, which would affect the existing built-up areas of Boambee and Bonville as well as potential future development, including a planned industrial expansion area in the North Boambee Valley. The blue alignment was further optimised to minimise impacts and was preferred.

In the Grafton-Coramba sector, the western alignment (shown in blue in Figure 4-11) is the preferred option.

Grafton station

Grafton is identified as a major regional centre in the Mid North Coast region of NSW. The Mid North Coast encompasses eight LGAs (Clarence Valley, Coffs Harbour, Bellingen, Nambucca, Kempsey, Port Macquarie-Hastings, Greater Taree and Great Lakes) and is a popular retirement and holiday destination. It has a variety of beaches, scenic areas, national parks and forests.

The Grafton area had a population of 49,665 in 2011, and projections indicate it will have a population of 57,284 in 2036 and 59,517 in 2056²⁰. Station options around Grafton are constrained by the Clarence River and its floodplain to the east of the town. Station zones to the north of Grafton, along Lawrence Road, and ten kilometres south of Grafton, adjacent to Grafton Airport, were identified as potential options. Any options to the north of the southern location would adversely affect creeks, while options further south or east would increase the station distance from Grafton. Options further west would increase impacts on property and the Bom Bom State Forest, as the alignment would need to be shifted to the west.

While the southern airport option is slightly further away from Grafton than the northern option, it has better access from the Pacific Highway and arterial roads and would provide better connectivity to other areas, such as Woolgoolga and Maclean (both major towns in the *Mid North Coast Regional Strategy*)²¹.

The northern zone also has potential flooding issues and soft soil, which would require extensive ground treatment to allow construction of an HSR station, and would be more costly as a result. Therefore, the southern zone near Grafton Airport as shown in **Figure 4-12** is preferred.

Land south of Grafton Airport is the preferred location for Grafton station.

20 ABS, loc. cit.

21 NSW Department of Planning, *Mid North Coast Regional Strategy*, 2009.

Figure 4-12 Preferred Grafton station location



Coramba-Charlmont

The blue and red alignments shown in **Figure 4-11** seek to avoid the hilly terrain surrounding Coffs Harbour, resulting in alignments that are approximately ten kilometres from the city centre. Other more direct alignment options between Coramba and Charlmont would be significantly more costly to construct due to the long series of tunnels required to pass through the hilly terrain.

Following the existing rail corridor through and approaching the built-up areas of Coffs Harbour and Sawtell would add approximately 13 kilometres to the overall length of the HSR alignment. This longer length, as well as the lower design speeds necessary in the built-up areas, would increase train transit time by approximately six minutes for non-stopping services compared to the blue alignment. In addition to the adverse impact on existing built-up urban areas through Coffs Harbour and Sawtell, the alignment would be close to the coastline and at risk of potential shoreline recession, coastal inundation and rising sea levels²². The use of the existing rail corridor was therefore not pursued.

Overall, the blue alignment was preferred, despite having a capital cost of approximately \$0.3 billion more than the red alignment. However, the capital cost savings on the red alignment would be largely offset by the loss in user benefits from the longer train transit time (approximately 30 seconds).

The blue alignment would have significantly less detrimental impacts than the red alignment. Both alignments would intersect several state forests and existing urban areas and villages. The blue alignment would have some adverse impacts on housing in and around the village of Upper Orara, would pass within 100 metres of Upper Orara Public School. It would also impact housing and pass within 50 metres of a school at Coramba. The red alignment would have adverse impacts on the existing built-up areas of Boambee and Bonville and impact potential future development, including a planned industrial expansion area in the North Boambee Valley²³.

The blue alignment is the preferred option from Coramba to Charlmont.

²² ABS, loc. cit.

²³ NSW Department of Planning, 2009, loc. cit.

Figure 4-13 Preferred Coffs Harbour station location



Coffs Harbour station

Coffs Harbour is identified in the Regional Strategy²⁴ as a major regional centre in the Mid North Coast region of NSW. The region had a population of 68,413 in 2011, and projections indicate this will grow to 101,800 in 2036 and 105,700 in 2056²⁵. The urban area of Coffs Harbour is constrained by the surrounding terrain. Much of the proposed growth will occur in the areas immediately adjacent to the existing urban area, into the adjacent foothills, to the south in North Boambee and Bonville.

Options northwest of Coffs Harbour around Karangi, along the coast near Coffs Harbour CBD and southwest around Boambee and Bonville were assessed, with the southwest options being preferred due to their better road access and proximity to future development. Because of the vertical gradients of the HSR alignment passing Coffs Harbour, Bonville is the closest location to Coffs Harbour with sufficient level land area to accommodate a station.

Bonville has good transport links, with bus services linking to Coffs Harbour and Sawtell centres and conventional rail stations. There is direct access to the Pacific Highway and the future urban land proposed for release in the Bonville area in the Regional Strategy²⁶. The alignment is constrained to the south by the floodplain of the Bellinger River and there is minimal scope to move the alignment east, closer to the Pacific Highway. The preferred location is approximately 15 kilometres by road from both the centre of Coffs Harbour and Coffs Harbour Airport.

The preferred station location is to the west of the Pacific Highway/Archville Station Road interchange, south of Valery-Gleniffer Road, as shown in Figure 4-13.

Charlmont-Warrell Creek

The two alignments through this sector generally share a common route. Other alignment options were either less direct or had greater sustainability and/or land use planning impacts.

24 NSW Department of Planning, 2009, loc.cit.

25 ABS, loc. cit.

26 NSW Department of Planning, 2009, loc. cit.

The preferred alignment was selected taking into consideration the findings of the sustainability and land use planning appraisal, and designed to minimise adverse impacts on Ingalba State Forest, Viewmont State Forest, Newry State Forest and Tarkeeth State Forest.

The preferred alignment is an optimisation of the two alignments generally following the same route from Charlmont to Warrell Creek.

Warrell Creek-Port Macquarie

The principal difference in the two shortlisted alignments was the deviation around the township of Kempsey, with the blue alignment passing to the east of Kempsey and the red alignment to the west. Other options to the east have a higher capital cost and are generally less direct and/or have more adverse impacts on sustainability and land use planning, principally due to their proximity to built-up areas. The blue alignment has a higher capital cost (approximately \$0.2 billion more than the red alignment). While the red alignment could adversely impact on a planned future urban area at Greenhill, the impact could be mitigated by development around the HSR alignment and offset by the capital cost saving.

The red alignment is the preferred option between Warrell Creek and Port Macquarie.

Port Macquarie station

Port Macquarie is located within the Mid North Coast region of NSW and is identified as a major regional centre in the *Mid North Coast Regional Strategy*, together with the surrounding communities of Wauchope, Lake Cathie and Bonny Hills²⁷. Port Macquarie Airport is located approximately five kilometres west of the city centre, while the conventional rail station is located at Wauchope, 20 kilometres west of Port Macquarie.

The Port Macquarie area had a population of 72,696 in 2011. This is estimated to grow to an estimated 107,600 in 2036 and 111,800 in 2056²⁸. Much of the growth will occur in the area around the Oxley Highway/Pacific Highway interchange

at Thrumster. Other growth areas are identified at Wauchope, to the south in the Lake Cathie/Bonny Hills area, and in the Kew to Laurieton corridor.

The two major constraints near Port Macquarie are the Hastings River and large areas of planned residential growth around Thrumster. These constraints make it difficult to locate a station within ten kilometres of the city centre. Potential HSR station options were identified in the Oxley Highway corridor, east and west of the Pacific Highway, to facilitate access from Port Macquarie and Wauchope, the two main population centres in the area.

The preferred station location would be to the west of the Oxley Highway/Pacific Highway interchange.

This location is approximately 15 minutes by car (ten kilometres) from the centre of Port Macquarie. The preferred location shown in **Figure 4-14** would provide good access from the regional road network, as it is adjacent to the Pacific Highway/Oxley Highway interchange. The location would also provide access from the coastal communities at Lake Cathie/Bonny Hills and Kew/Laurieton, along the Pacific Highway. Access to Port Macquarie Airport would be via the Pacific Highway and to Wauchope conventional rail station via the Oxley Highway. Bus services currently run between Wauchope and Port Macquarie and could provide access to and from the HSR station. An indication of planned future development to the west of the Pacific Highway interchange is provided in the *Mid North Coast Regional Strategy*²⁹.

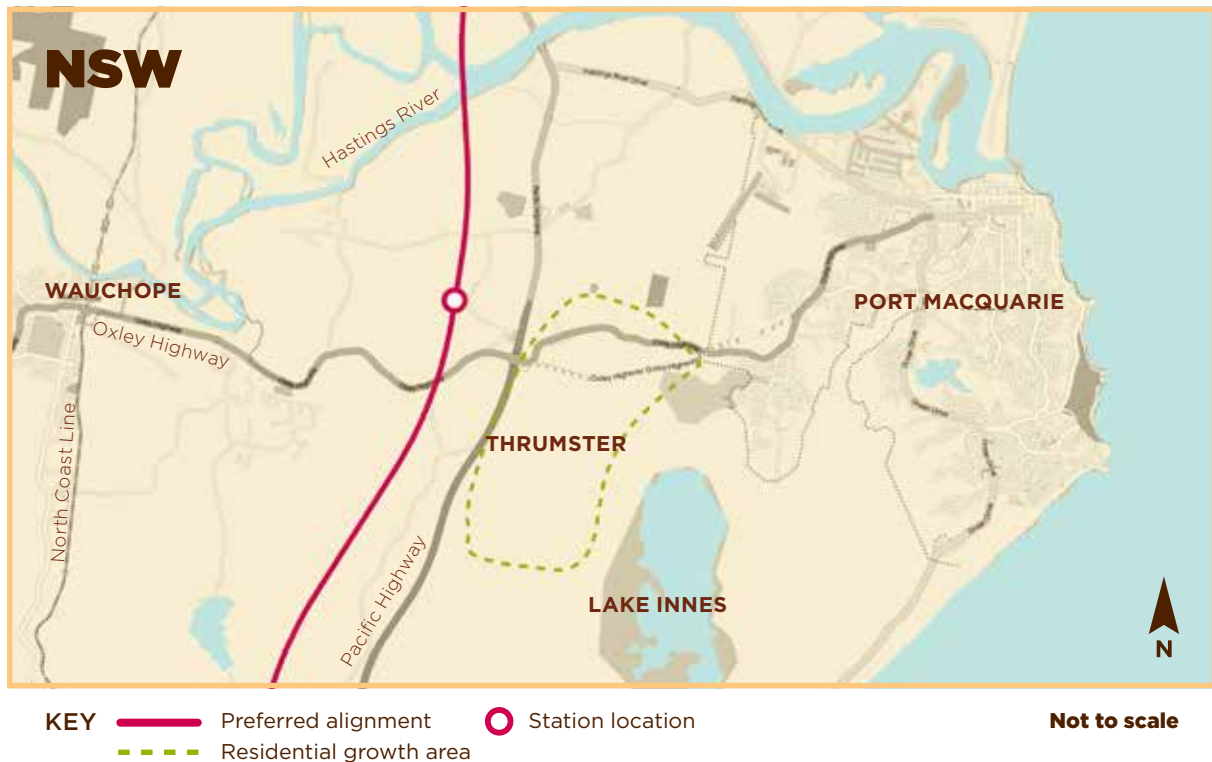
From a sustainability and land use planning perspective, this location avoids any significant environmental or heritage impacts. The location is close to Port Macquarie and Wauchope, as well as the future growth area at Thrumster - which would not be adversely impacted, but could be supported, by the station. There would be opportunities to integrate the developed area to the east of the Pacific Highway with a station to the west of the Pacific Highway.

²⁷ ibid.

²⁸ ABS, loc. cit.

²⁹ NSW Department of Planning, 2009, loc. cit.

Figure 4-14 Preferred Port Macquarie station location



4.6 Port Macquarie-Twelve Mile Creek

4.6.1 Overview

This section has similar characteristics to the area between Grafton and Port Macquarie, influenced by the steep topography of the Great Dividing Range and its foothills and coastal lakes and floodplains. The Cotton-Bimbang and Barrington Tops National Parks are located on the range in this section, while Myall Lakes National Park on the coast is a Ramsar Wetland³⁰.

Towns in the area include Taree, Nabadah, Bulahdelah, Forster and Karuah. Transport infrastructure includes the Pacific Highway and the North Coast Railway. Most air travel to and from the area is via the airports at Port Macquarie and Newcastle. This section contains one potential station location at Taree.

The Port Macquarie-Twelve Mile Creek section is divided into three sectors: Port Macquarie-Johns River (north of Taree), Johns River-Rainbow Flat (south of Taree), Rainbow Flat-Twelve Mile Creek (north of Newcastle)

The alignments assessed in this section are shown in **Figure 4-15**.

³⁰ The original intent of the Ramsar Convention was to protect waterbird habitats. The convention has broadened its scope to include the protection of all wetland biodiversity and the 'wise use' of all wetlands.

Figure 4-15 Port Macquarie-Twelve Mile Creek alignment options



4.6.2 Regional alignment and station assessments

Port Macquarie-Johns River

Between Port Macquarie and Kew, both shortlisted alignments pass to the east of Herons Creek. South of Kew, the alignments share a common corridor with both routes generally skirting the mountains of North Brother and Middle Brother. A more direct alignment would increase capital costs and would have adverse sustainability and land use planning impacts.

While both alignments are equal in terms of operational and infrastructure considerations, the blue alignment is preferable in terms of sustainability and land use planning outcomes, because it has less impact on existing communities and planned urban release areas than the red alignment. While both alignments impact on state forests and national parks, the blue alignment avoids a direct impact on Middle Brother State Forest (albeit by traversing part of Watson Taylor Lake). Two privately owned airfields would be affected by either alignment.

The blue alignment is preferred from Port Macquarie to Johns River.

Johns River-Rainbow Flat

The red alignment takes a direct route along this sector, whereas the blue alignment deviates to the west towards Taree town centre. Other alignment options were less direct and/or had greater sustainability and/or land use planning impacts.

The reduced train transit time (approximately 45 seconds) and the resulting additional user benefits for the red alignment effectively offset the additional capital cost (approximately \$0.3 billion) when compared to the blue alignment. The red alignment includes a very long viaduct across the Manning River Floodplain, due to the soft soil ground conditions in the lower floodplain area.

The red alignment would have less impact on Taree and settled areas in general. By comparison, the blue alignment would impact on the planned urban release area and employment area at Kundle Kundle (identified in the *Mid North Coast Regional Strategy*).

The red alignment is preferred for the section of route from Johns River to Rainbow Flat.

Taree station

Taree is located at the southern extent of the Mid North Coast region. It is nominated as a major regional centre in the Regional Strategy³¹. Taree is located to the west of the Pacific Highway, and Taree Airport is located approximately six kilometres east of the city centre. In 2011, Greater Taree had a population of 46,541. This is estimated to grow to 53,200 in 2036 and 55,300 in 2056³². A growth area is proposed north of Taree at Brimbin, and urban growth is also planned for the coastal communities at Old Bar, Diamond Beach and Hallidays Point.

The Manning River provides the greatest constraint to locating an HSR station around Taree, and its branches would necessitate multiple crossings. As a result, the alignment was moved about five kilometres to the east of Taree and the Pacific Highway. The floodplain of the Manning River would require a 15 kilometre long viaduct from just north of Old Bar Road to around Coopernook to provide flood immunity and avoid the risks of settlement due to the soft soils. A ground level station north of the viaduct would be approximately 20 kilometres by road from Taree, compared with ten kilometres for a station south of the viaduct, close to Old Bar Road. An HSR station south of Taree would also provide better access to the coastal communities of Old Bar, Diamond Beach, Forster and Tuncurry.

³¹ NSW Department of Planning, 2009, loc. cit.

³² ABS, loc. cit.

Figure 4-16 Preferred Taree station location



As shown in **Figure 4-16**, a station south of the proposed viaduct would provide good access from the regional road network, as it would be approximately five kilometres east of the Pacific Highway/Old Bar Road interchange. Taree has a regional airport and a conventional rail station, both of which would be approximately ten kilometres by road from the proposed HSR station. From a sustainability and land use perspective, this location avoids any significant impacts on environmental or heritage areas.

The preferred site for Taree station is south of the proposed viaduct, close to the Pacific Highway/Old Bar Road interchange.

Rainbow Flat-Twelve Mile Creek

The Ramsar Wetlands within Myall Lakes National Park are a prominent feature in this sector. Both alignments avoid major impacts on the Ramsar Wetlands. The blue alignment would pass beneath the narrowest part of the catchment of Ramsar Wetlands in a tunnel and provide a fairly direct route. The red alignment avoids the Ramsar

Wetlands and their catchment altogether, as shown in **Figure 4-15**.

Other alignment options are limited by the extent of the Ramsar Wetlands. Diverting around the Ramsar Wetlands with a route further to the west of the red alignment would add to the length of the route, train transit time and capital cost.

The capital cost of the red alignment is approximately \$1.3 billion more than the capital cost of the blue alignment, due to the greater number and additional length of tunnels required. The red alignment would also have substantially greater impacts upon state forests and rural housing than the blue alignment.

The blue alignment is preferred between Rainbow Flat and Twelve Mile Creek.

4.7 Twelve Mile Creek-Sydney

4.7.1 Overview

This section contains a large variety of landscape types. The Great Dividing Range continues southwest with the broad Hunter River floodplain and estuary to the west and north of Newcastle. Towards Sydney, the sandstone landform is dissected by the valleys and gorges formed by the Hawkesbury River and its tributaries. A chain of large coastal lakes extends from Grahamstown Lake to Pittwater, including Lake Macquarie, Lake Budgewoi and Brisbane Water with many smaller lakes and estuaries along the coastline.

This area includes Newcastle, the Hunter Valley, the Central Coast and their associated concentrations of populations, industry and tourism. Population is sparse outside these areas, reflecting the challenging terrain and extensive area of national parks, reserves and state forests.

Transport infrastructure includes the Pacific Highway, the F3 Sydney-Newcastle Freeway, and the Newcastle and Central Coast rail line between Sydney and Newcastle. The majority of air travel in the region is centred on Newcastle Airport at Williamtown. This sector contains two potential station locations – one at Newcastle and one on the Central Coast.

Twelve Mile Creek-Sydney is divided into three sectors: Twelve Mile Creek-Wyee, Wyee-Ourimbah and Ourimbah-Mount Kuring-gai.

The alignments assessed within this section are shown in **Figure 4-17**.

Figure 4-17 Twelve Mile Creek-Sydney alignment options



4.7.2 Regional alignment and station assessments

Twelve Mile Creek-Wyee

The red alignment passes to the east of Raymond Terrace and Grahamstown Lake, and avoids the RAAF Base Williamstown, Ramsar Wetlands to the east of Hexham (Hunter Estuary Wetlands) and the Tomago aluminium smelter. The blue alignment passes to the west of Raymond Terrace and generally between the built-up areas of Thornton and East Maitland. The two alignments share a common route south of Ryhope.

Other alignment options providing access closer to the town centre of Newcastle would require long lengths of tunnel or would significantly affect built-up areas, including through the acquisition of residential and commercial properties. While both alignments would impact on growth areas at the Wyong Employment Zone, which is a state significant area listed in NSW's *State Environmental Planning Policy (Major Development) 2005* and currently under development, the red alignment would have more adverse impacts on existing residential and industrial properties compared to the blue alignment. The blue alignment would impact on an existing urban area, an urban release area at Thornton North, and a planned freight hub to the east of Maitland.

Both alignments would traverse areas subject to potential mine subsidence over a similar length and would require special remedial works, such as grouting any voids left by mining.

The blue alignment has a \$0.4 billion lower capital cost. The red alignment extends for a further five kilometres adjacent to residential areas.

The blue alignment is the preferred option from Twelve Mile Creek to Wyee.

Newcastle station

Newcastle is the seventh largest city in Australia and the second largest urban area in NSW. The city has a population of approximately 148,535

in the LGA, and has experienced continued population growth over the past decade. The population of Newcastle is projected to grow to 177,700 in 2036 and 184,600 in 2056³³.

Newcastle is the world's largest coal export port and has major education and health care facilities. The regional airport, which is the major RAAF base, located to the north of the city, handles more than one million passengers every year. The Newcastle urban area extends from the city centre to the F3 corridor, including the major centres of Charlestown, Glendale, Hamilton and Mayfield, which provide services for the surrounding population and serve as employment centres. The Newcastle LGA adjoins the Lake Macquarie LGA, which encompasses the major centres of Warners Bay, Belmont and Toronto.

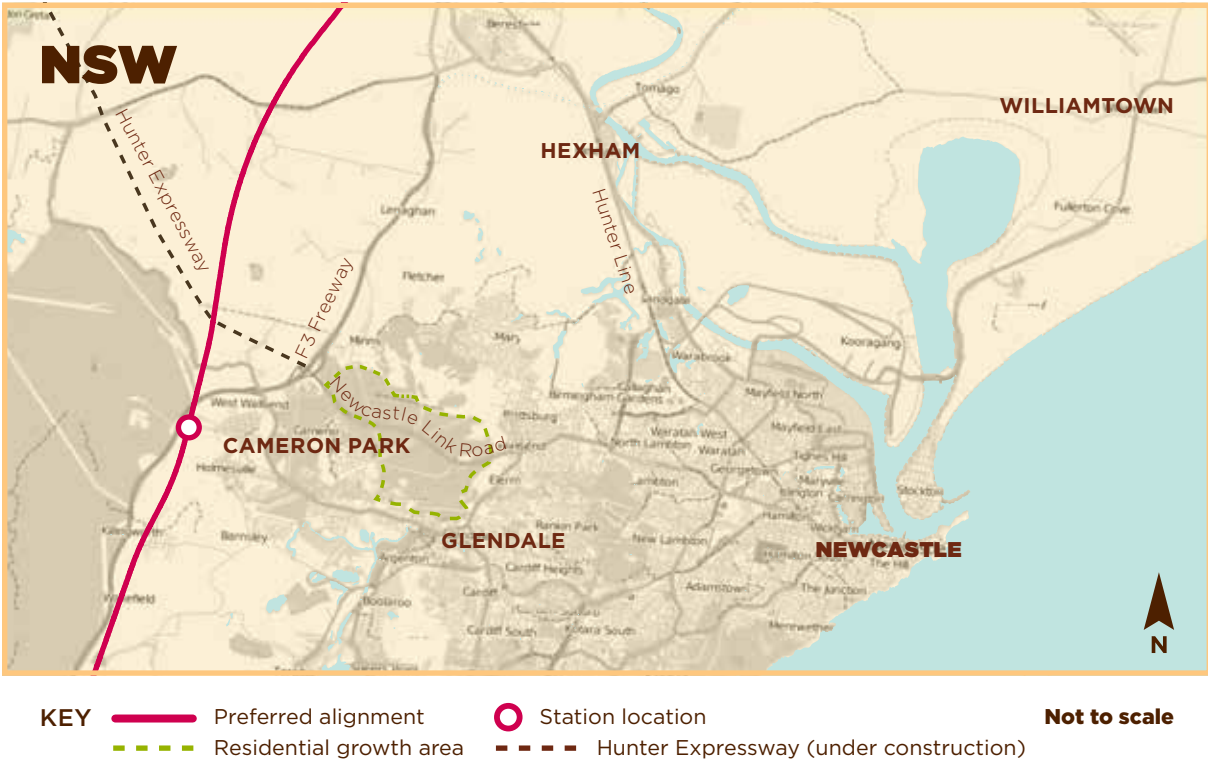
Potential station locations were identified close to the Pacific Highway (F3 Freeway) near Cameron Park and Hexham. Both locations offer good access to Newcastle and the Maitland region via the Newcastle Link Road and the Hunter Expressway (currently under construction) or the New England Highway respectively. Locations closer to Newcastle city centre were tested but any gain in user benefits was more than offset by the additional cost of moving the alignment.

A station near Cameron Park would better serve the population to the southwest of the Newcastle city centre and the Lower Hunter Valley via the Hunter Expressway, which is expected to open at the end of 2013. The station would also be accessible to residents in the Lake Macquarie area and northern parts of the Central Coast via the F3. Options for station locations in the vicinity of Cameron Park were investigated and a preferred location is proposed to the south of the F3 Freeway, as shown in **Figure 4-18**. It is close to the F3 Freeway/Newcastle Link Road/Hunter Expressway interchange. Newcastle city centre is approximately 20 kilometres away by road, as is Maitland.

The preferred station site for Newcastle is west of Cameron Park, adjacent to the F3 Freeway.

33 ibid.

Figure 4-18 Preferred Newcastle station location



Wyee-Ourimbah

The two alignments in **Figure 4-17** generally share a common route, avoiding built-up areas including Wyee, Wyong and Ourimbah to the east and steeper topography to the west. Other alignment options were found to increase sustainability and/or land use impacts, mainly due to urban impacts, and/or were found to increase capital costs as the options traversed steeper topography.

The capital costs of the red alignment were approximately \$0.1 billion higher than the blue alignment. The red alignment also entailed additional adverse sustainability and land use impacts, including on sections of the Wyong Employment Zone at Halloran and North Wyong, which are currently under development and intended to be completed in the short term.

The blue alignment is the preferred alignment option from Wyee to Ourimbah.

Central Coast

The Central Coast is a highly developed region located approximately 75 kilometres north of Sydney. It comprises the LGAs of Gosford and Wyong and covers the area from the Hawkesbury River in the south to the southern shore of Lake Macquarie in the north.

Major constraints in the Central Coast area include hills, national parks and significant residential development, with built-up areas often extending to the edge of the ranges. The current population of the Central Coast is 312,186. This is expected to grow to 424,700 in 2036 and 495,400 in 2056³⁴. The population is concentrated in a number of centres that have been linked in recent years by continued residential development. The larger centres include Gosford, Wyong, Tuggerah, Woy Woy and The Entrance. The dispersed and low density nature of settlement over a large area presents challenges for locating an HSR station on the Central Coast that is easily accessible to all the populated areas.

Figure 4-19 Preferred Central Coast station location



The most accessible Central Coast HSR station zone options are located along the F3 Freeway corridor at:

- Kariong, near the Central Coast Highway interchange.
- Ourimbah, near the Pacific Highway interchange.
- Tuggerah, near the Wyong Road interchange.

The Kariong option would cater for the commercial core of the Central Coast at Gosford, strengthening its role as the main regional centre, while the Tuggerah option would provide the growing Wyong Shire with an accessible HSR station. The Ourimbah option, located between the other potential station locations, could serve the entire Central Coast population more effectively than a station located at either Kariong or Tuggerah.

A station at Ourimbah would be within a 30 minute drive of 85 per cent of the Central Coast (the combined Gosford and Wyong LGAs) population; corresponding figures for the Kariong and Tuggerah zones are 82 per cent and 69 per cent respectively. Ourimbah may also offer potential staging opportunities and/or connectivity between the HSR and urban rail networks. This is discussed further in **Appendix 3B**.

The preferred station location is north of the F3 Freeway/Pacific Highway interchange, as shown in **Figure 4-19**. The location would provide good access from the regional road network, as it is adjacent to the Pacific Highway interchange at Ourimbah. Ourimbah has a conventional rail station approximately two kilometres away by road.

Ourimbah is the preferred station option servicing the Central Coast.

Ourimbah-Mount Kuring-gai

The blue alignment in **Figure 4-17** closely follows the existing F3 Freeway on its approach to the Hawkesbury River. It includes long lengths of tunnel and a high level crossing at the Hawkesbury River, with the rail level being 35 metres above mean water level.

The red alignment has short lengths of tunnel at the north end, a tunnel under residential areas around Gosford and a long (7.5 kilometres) tunnel north of the Hawkesbury River through Brisbane Water National Park. The red alignment is predominantly within the existing rail corridor immediately north of the Hawkesbury River but would be separate from the existing rail line.

Other options to cross the Hawkesbury River were considered but all involved greater length, poor geometry resulting in slower speeds, and greater impacts on existing residential areas and national parks. A tunnel crossing of the Hawkesbury River was also investigated but not shortlisted, due to the required tunnel depth – approximately 80 metres below the water surface level – because of the mud and poor quality geology associated with the river bed. Such a tunnel would also be more than 25 kilometres long in order to reach suitable foundation material at the river crossing and then return to the surface on either side of the river.

Although the red alignment is approximately 2.5 kilometres shorter and approximately 30 seconds faster than the blue alignment, it would have greater environmental impacts, additional capital costs, poor access and would be very difficult to construct.

The red alignment would have more detrimental impacts on Brooklyn itself, where it would impact existing residential areas. It would also have a greater impact on national parks, state forests and areas of cultural significance. Parts of the red alignment are very remote and pass through difficult terrain. The capital cost of this alignment would be further increased by poor construction access, the need for marine operations (the area around the Hawkesbury River would only be

accessible by water) and the extent of additional works necessary to establish permanent access. The red alignment is also likely to require additional approvals with implications for the project timeline as well as a longer construction program.

While the blue alignment would affect Sydney Water infrastructure to the west of Brooklyn, it takes better advantage of already disturbed areas, is much more accessible and therefore would be easier to construct.

The blue alignment is the preferred route from Ourimbah-Mount Kuring-gai.

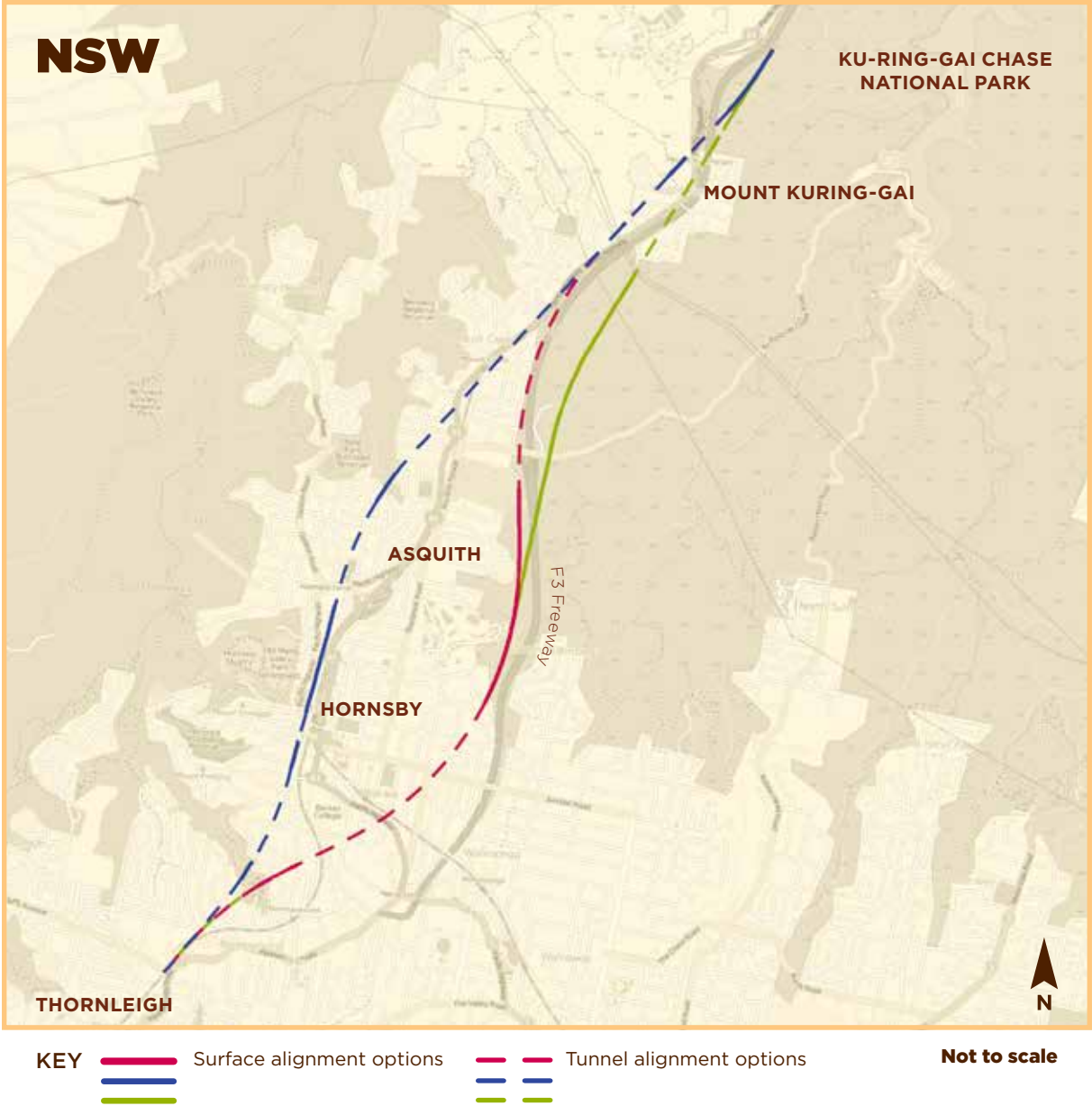
Mount Kuring-gai-Thornleigh

Further refinement was undertaken to extend the regional alignment into the urban area around Hornsby (shown as the green line in **Figure 4-20**). The green alignment has the shortest overall length of tunnel and the lowest capital cost option, but does not have a suitable station location and would also have adverse impacts on Ku-ring-gai Chase National Park. For these reasons, it was not taken forward to assessment against the red and blue options. The blue alignment passes to the west of Hornsby's commercial centre in tunnel and could include an HSR station adjoining the existing railway station at Hornsby. The red alignment is located to the immediate west of the Sydney-Newcastle Freeway and could include a station at a site currently occupied by Asquith Golf Course.

The blue alignment is favoured, largely due to the planning benefits and opportunity for urban renewal associated with a station at Hornsby. The red alignment, with a station at Asquith, would have excellent access off the Sydney-Newcastle F3 Freeway, but a station at Asquith would have less development potential than one at Hornsby. Under the *Metropolitan Plan for Sydney 2036*, Hornsby is the designated Major Centre and the primary focal point for public transport, high density housing and higher order civic, cultural, retail and economic activity for the northern part of Sydney, while Asquith is intended to remain a village³⁵. A station at Asquith would be inconsistent with this strategy.

35 NSW State Government, *Metropolitan Plan for Sydney 2036*, 2010.

Figure 4-20 Mount Kuring-gai-Thornleigh



The capital cost of the options is not a differentiator for this sector. The blue alignment is marginally shorter and would cost less than the red alignment. However, a station structure at Hornsby would require a deeper excavation, with associated costs. Access roads would also require upgrading.

The blue alignment is preferred from Mount Kuring-gai to Thornleigh.

Assessment of urban access alignments from the north

The assessment of city access alignments began by identifying existing or planned transport corridors, so that impacts on urban areas could be minimised by remaining within these corridors, and so that capital costs could be minimised by remaining at surface level. Current and planned projects relevant to potential HSR access routes in Sydney are listed in **Table 4-4**.

Table 4-4 Current and planned projects relevant to HSR access in Sydney

Project	Relevance to this study
North West Rail Link	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
Epping to Parramatta rail line	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
South West Rail Link (under construction)	New rail corridor and interface/connection with existing rail corridor(s), providing opportunity for shared use in new corridor and reducing potential use in existing corridors.
Southern Sydney Freight Line (completed)	New track within existing rail corridor reducing potential use by HSR.
Enfield Intermodal Terminal (under construction)	Interface/connection with existing rail corridor(s) reducing potential use by HSR.
M5 Motorway widening and corridor expansion	Road widening within an existing road corridor and new tunnel adjoining existing, reducing potential use by HSR.
M4 Motorway extension and widening	Road widening within an existing road corridor and new tunnel to extend motorway to the east towards the city, reducing potential use by HSR.
Revesby Quadruplication Project (Airport and East Hills Line) (under construction)	New track within existing rail corridor reducing potential use by HSR.
Moorebank Intermodal Terminal	Interface/connection with existing rail corridor(s) reducing potential use by HSR.
North Sydney Freight Corridor	New track within existing rail corridor reducing potential use by HSR.
CBD rail expansion and second harbour crossing	New rail corridors and interface/connection with existing rail corridor(s) providing opportunity for shared use in new corridor and reducing potential use in existing corridors.

Many of the corridors considered were unsuitable for high speed operation because of sharp curves and changes in gradient. In many where the geometry was suitable, any spare ground level capacity had already been designated for future expansion of existing facilities, including the following:

- M4 Motorway corridor to Granville – the planned widening of the M4 Motorway

included in the recent *Draft NSW Long Term Transport Master Plan* for Sydney's road network makes a ground level alignment unfeasible³⁶.

- M5 Motorway corridor – on completion of the current M5 Motorway widening, there would be minimal land available for an HSR alignment.
- East Hills Line – the East Hills Line to Glenfield will be at capacity on completion

of the Revesby Quadruplication Project (East Hills Line) currently under construction, with minimal land available for an HSR alignment, and was not carried forward.

As discussed in **section 4.2.1**, the geometry of the existing corridors limits the ability to use them for viaducts in urban areas, because they would require many deviations to smooth out the geometry to maintain design speed. This would require the acquisition of properties, with adverse social and environmental impacts and increased cost. In addition, preliminary analysis showed that bored tunnel in the Sydney urban area is often the most cost-effective construction method, due to the high cost of densely-developed land, the cost of elevated structures and the costs associated with the reduction of environmental and heritage impacts.

All the Sydney access alignments therefore include long lengths of tunnel.

Three potential alignments through metropolitan Sydney were identified to access Central station from the north: the North Shore line, the Northern line combined with the Carlingford line, and the Western line.

The three potential alignments are shown in **Figure 4-21**. The preferred alignment is shown in red and labelled 'Option 2' on the map. Those that were shortlisted, and later discarded, are shown in grey and are labelled 'Option 1' and 'Option 3' on the map and in the following discussion.

Details and comparative evaluation of these can be found in **Appendix 3A**.

Figure 4-21 Preferred urban access alignment to Sydney from the north



Preferred urban access alignment – Sydney from the north

While Option 1 (in tunnel, generally following the North Shore line) is the most direct route from the north and has the most user benefits, it would require a deep tunnel beneath the CBD and Sydney Harbour, adding significantly to the capital cost. The constructability risk of this option would be increased by potential interaction with the subsurface built infrastructure in the Sydney and North Sydney CBDs. This would mean remaining deep below the surface and approaching Central station in tunnel from the north. This in turn would result in the difficult construction of an underground five-platform station, as it would not be possible to use the existing surface platforms. The utilities infrastructure under Central station also increases the cost and/or the depth of this option.

An urban rail tunnel crossing Sydney Harbour is being considered by the NSW Government as part of the long-term transport master plan for Sydney's rail network³⁷. However, this tunnel crossing is primarily intended to be part of a Sydney mass transit network and could not be shared with HSR services without major additional cost and realignment to provide the required geometry.

Option 2 would provide the lowest cost route to Central station from the north. Both Option 2 and Option 3 (in tunnel, generally following the North Shore line to Pymble, then via a tunnel connection to the Northern line near Rhodes to Homebush, then eastwards in tunnel, generally following the Western line) would have longer travel times than Option 1 of approximately two to three minutes. These longer travel times would incur user disbenefits of between \$0.8 billion and \$1.0 billion relative to Option 1³⁸.

As the options are all in tunnel, there was no significant difference between the options from an overall sustainability, land use impact and policy perspective.

The preferred alignment to access Sydney from the north is a route travelling in tunnel, generally following the Northern line towards Homebush, then eastwards in tunnel generally following the Western line. This preferred option is shown as Option 2 in Figure 4-21.

Peripheral station assessment – Sydney North

As was identified in phase 1 of this study, the northern peripheral station zone extends from Hornsby to Epping near the M2 Motorway. The southern peripheral zone extends from Liverpool to Campbelltown, broadly along the M5 Motorway corridor. Easy interchange with the urban transport network (road and rail) is desirable to provide access between the HSR stations and urban centres within Sydney. A station at Hornsby was assessed as the main option. There are limited alternative options for a station to the north of Sydney. Much of the area surrounding the preferred alignment is residential, and a peripheral station would have significant environmental impact and would require the acquisition of properties. There are few defined centres that could accommodate an HSR station, and limited opportunities to interface with both the urban rail and road networks. Opportunities for peripheral station sites along Pennant Hills Road were reviewed, but no sites could be found that met the location criteria.

Hornsby provides access to the arterial road network via the Sydney-Newcastle F3 Freeway, which is planned to be connected to the Sydney orbital network via the M2 Motorway in the future. Road traffic access to the station site is limited by the capacity of the local road network; additional road infrastructure would be required to provide capacity for vehicles accessing the HSR car park. Good access to the urban rail network would be provided via an interchange at Hornsby station, which is served by the Northern line, North Shore line, Western line, and Newcastle and Central Coast line.

³⁷ *ibid.*

³⁸ User benefits are a direct function of the estimated train transit time. For the Sydney north corridor, the impact of variations in HSR running times on user benefits is estimated at about \$329 million per minute saved, for the period 2035 to 2065.

Implementing this station option would increase HSR user benefits by \$1 billion compared with not having a northern peripheral station. The preferred alignment would be in tunnel through Hornsby, requiring a below-ground HSR station. The station could be constructed using cut-and-cover techniques, and is potentially viable. However, the construction complexity means a station structure cost estimate of approximately \$150 million.

This site would be located within Hornsby town centre, immediately to the west of (and adjacent to) the existing Hornsby station, as shown in **Figure 4-22**. It would be located in an area currently used as a car park, between Jersey Street and Jersey Lane, adjacent to the Hornsby Council and NSW Police Local Area Command buildings. It would not require demolition of the Hornsby Council building or NSW Police Local Area Command buildings. The development of the station at this site could precipitate a major uplift and urban renewal opportunity in this area.

Figure 4-22 Location of Sydney North peripheral station



4.7.3 Sydney

Overview

Sydney has a population of approximately four million people, with a forecast of around seven million by 2056³⁹. Developed urban land in Sydney currently extends approximately 65 kilometres from the CBD to the southwest at Campbelltown, and around 30 kilometres to the north at Hornsby.

Parramatta, considered Sydney's second CBD, is 20 kilometres west of the Sydney CBD at the approximate geographic centre of the Sydney metropolitan area⁴⁰.

The *Metropolitan Plan for Sydney 2036* seeks to accommodate population growth to 2036 with an additional 770,000 dwellings and the creation of 760,000 new jobs⁴¹. Residential growth is planned through both infill development to higher densities within established urban areas, and expansion on Sydney's periphery, with growth areas designated on the urban fringe to the southwest and northwest of Sydney.

Employment growth is planned in existing city centres and new towns within the northwest and southwest growth areas. The Sydney CBD will remain Sydney's primary employment destination with approximately half a million jobs by 2036⁴². Parramatta is forecast to accommodate around 70,000 jobs by 2036⁴³.

The NSW Government has prepared a new transport master plan to support this growth. This master plan will seek to provide viable alternatives to car travel and build on current transport projects and studies, such as the South West and North West Rail Links, Southern Sydney Freight Line, expansion of the light rail system, and a Northern Beaches Bus Rapid Transit (BRT) system⁴⁴.

The draft master plan and the metropolitan strategy acknowledge the potential for an HSR connection through Sydney entering the city in the north and southwest. However, no HSR route is evident in Sydney metropolitan subregional strategies.

The deep valleys carved through the sandstone plateau to the north of Sydney Harbour present challenges for the alignment approaching the Sydney CBD, in addition to crossing the Parramatta River and/or Lane Cove River and Sydney Harbour.

In summary, the extent of existing development, topography and sensitive environmental attributes present major constraints in identifying suitable existing routes for HSR through the Sydney metropolitan area.

Strategic planning context and issues

The historical patterns of development in Sydney are reflected in the lower density development (predominantly single detached dwellings) within suburbs on Sydney's periphery (many of which emerged during the growth booms of the 1970s onwards) and middle ring (post World War II suburbs, also featuring detached dwellings), with denser suburbs of pre-war residential development and high street retail centres. The older inner areas have higher proportions of apartment buildings, terraces and semi-detached dwellings, and widespread heritage conservation areas. The heritage conservation areas within the inner suburbs (as well as the CBD areas of both Sydney and Parramatta), combined with the denser development, fragmented land ownerships and strata title buildings, present significant challenges for redevelopment in the inner areas of Sydney and Parramatta.

39 ABS, loc. cit.

40 NSW Department of Planning, *West Central Subregion: Draft Subregional Strategy*, 2007.

41 NSW State Government, loc. cit.

42 NSW Department of Planning, *Sydney City: Draft Subregional Strategy*, 2008.

43 NSW Department of Planning, 2007, loc. cit.

44 Transport for NSW, *NSW Long Term Transport Master Plan*, 2012.

The topography of Sydney features rolling hills to the southwest and plateau landforms in the northern parts of the metropolitan area with deep, steeply incised valleys. The existing road and rail networks reflect the topography with both road and rail corridors having many curves and changes in gradient that are unsuitable for HSR where the design speed for urban areas is 250 kilometres per hour. Sydney's undulating topography and drainage system has created a road pattern that is frequently circuitous, with few straight transport corridors in comparison with other Australian capital cities such as Perth or Melbourne. Furthermore, few new road or other transport corridors are being identified on statutory planning documents within the expanding areas of Sydney, with reliance instead on the expansion of existing corridors. Transport for NSW also has plans for upgrading and increasing the number of tracks within its existing rail corridors, which preclude their use for future HSR.

Sydney has historically been an expensive residential market, with desirable inner city and harbourside locations in particular commanding high land values, making the acquisition of property for transport corridors costly.

These characteristics present challenges for improving transport infrastructure within Sydney.

Environmental planning context and issues

The metropolitan area features five major rivers: the Nepean and Georges in the south and west, Lane Cove River and Parramatta River/Sydney Harbour in the central part of the metropolitan area, and the Hawkesbury in the north. The topography and waterways together with their associated ecological and Aboriginal heritage sites presented challenges to finding HSR alignments that would minimise environmental impacts on these natural features and landscapes.

The Sydney Basin is also framed by national parks to the south (Royal National Park, the oldest in Australia) and the north (Ku-ring-gai Chase National Park and Brisbane Water National Park). In addition, the Holsworthy military area to

the south extends over 30,000 hectares between Liverpool and Sutherland to the Royal National Park. Avoidance of ecological and heritage sites within the national parks was considered in the selection of a preferred HSR alignment.

Settlement and land use in Sydney has led to the majority of the native vegetation in the southwestern and western parts of the metropolitan area being cleared. Some of the remaining native vegetation, particularly the Cumberland Plain Woodland community, is endangered, and government environmental strategies and planning processes seek to retain as much of it as possible.

The topography and geology in the northern half of the metropolitan area has resulted in the retention of higher proportions of native vegetation in that area. Much of the northern extremity of metropolitan Sydney from the Hawkesbury River south to St Ives is dominated by native vegetation and the Ku-ring-gai Chase National Park. The extent of this park in the northern half of Sydney, and its dramatic plateau and incised valley topography, present environmental and construction challenges for locating road and rail infrastructure.

Assessment of potential station locations

Sydney would be the hub of HSR on the east coast. With HSR services planned to approach from both the north and south, a Sydney HSR station would need to accommodate nearly twice the volume of passenger flows compared to any other city HSR station. It would also be likely to have commuter services using the HSR infrastructure, which would add considerably to the peak hour passenger movements. As such, it would need efficient connections with the urban transport network, and in particular with the CBD as the primary destination for business users and tourists.

Phase 1 of the HSR study shortlisted four Sydney precincts:

- Central station precinct – a terminating station located within the current Central station footprint.

- Eveleigh precinct – a terminating station north of Eveleigh Yards, and two terminating station options oriented east–west in the vicinity of the Australian Technology Park.
- Homebush and surrounding precinct.
- Parramatta precinct.

Other areas considered in phase 1 but not pursued further included North Sydney, Strathfield and Sydney (Kingsford Smith) Airport⁴⁵. These areas were discounted for the following reasons:

- A suitable site at North Sydney could not be identified.
- An HSR station at Strathfield was not considered able to support existing or likely future metropolitan strategies. It would also be in a constrained location and likely to have major impacts on existing land uses.
- Analysis of patronage demand indicated that the primary demand for HSR services is to/from CBDs. The number of passengers transferring from HSR to air would not be sufficiently high to justify the city centre station being at Sydney Airport.

Although the Strathfield station site was not carried forward, it was included for completeness in assessing Homebush and its surrounds.

The assessment of station locations in Sydney was further complicated, when compared to other cities, by the cost of the urban access alignments, which forms a large proportion of the total infrastructure costs (approximately 23 per cent of the whole network). This cost varied significantly between the options.

The four shortlisted precincts are discussed below.

Central station precinct

Demand forecasts have confirmed that Sydney CBD is the primary destination for regional, domestic and overseas business travellers and tourists. This site (shown in **Figure 4-23**) would provide the most direct access for those passengers.

Central station would provide very high accessibility to transport networks because of the extensive pedestrian access and connectivity to the bus, rail and light rail networks. As Sydney's main suburban railway interchange, it would provide better connections to the metropolitan rail network than any other site. Potential extensions to the rail and light rail networks being investigated by the NSW Government would further improve the accessibility of Central station as a transport node. An HSR station at Central would therefore provide much greater user benefits than other potential station sites in Sydney.

Central station could be reconfigured to accommodate HSR services. This would require considerable planning and preliminary work to relocate current tracks and services from the Country Link platforms. As ten platforms would ultimately be required, it is proposed to provide these on two levels at the Lee Street side of the station, with a new street level concourse in between. The five platforms serving the southern line would be at the same level as the existing platforms, with those for the northern line beneath the new concourse. All HSR passengers travelling through Sydney would need to change trains at Central. Discussions with Transport for NSW confirmed that the proposed reconfiguration of Central station is compatible with long-term development plans for Central. Full details of the proposed station configuration can be found in **Chapter 5**.

45 AECOM, loc. cit.

Construction of facilities to serve HSR operations at Central station would involve both the conversion of existing platforms as well as construction of new platforms. The constructability of the station structure, while maintaining the ongoing operation of existing rail services, would be more complex than the alternatives at Eveleigh, Homebush and surrounds, or Parramatta.

The area surrounding Central station is currently undergoing urban renewal, with major developments occurring at Central Park (the former Carlton United Brewery) and the University of Technology City campus. While the areas around Central station and the southern CBD contain heritage buildings and recently constructed developments, there are likely to be further opportunities for urban regeneration, urban intensification, economic development and value capture created as the result of an HSR station and integrated land use/transport developments.

Eveleigh precinct

Three station sites were considered in the Eveleigh precinct: one at Eveleigh rail yards and two sites oriented east–west in the vicinity of the Australian Technology Park, as shown in Figure 423. Eveleigh is designated as a Specialised Centre within the *Metropolitan Plan for Sydney 2036*⁴⁶. Regeneration of Eveleigh is part of the renewal of Redfern, the suburb adjacent to the east, whose master plan includes improved transport facilities at Redfern station and the introduction of new retail and commercial buildings.

Eveleigh is located approximately two kilometres south of Central station, at the southern edge of the Sydney CBD. All sites at this location have lower accessibility than a site at Central station because there are fewer public transport connections and poorer access for pedestrians, cyclists and cars. User benefits are lower by an order of \$3 billion.

Eveleigh rail yards

Part of the Eveleigh site is used for rail maintenance purposes, with the remainder occupied by the Eveleigh Rail Yards building, a heritage asset used for regular markets that attract visitors from across Sydney. Construction of an HSR station in the Eveleigh rail yards would have significant impacts on heritage assets and the local community through the loss of community facilities and potential disturbance during construction. However, the reduction in user benefits (–\$3 billion) at Eveleigh when compared to Central was the deciding factor in this option not being taken forward.

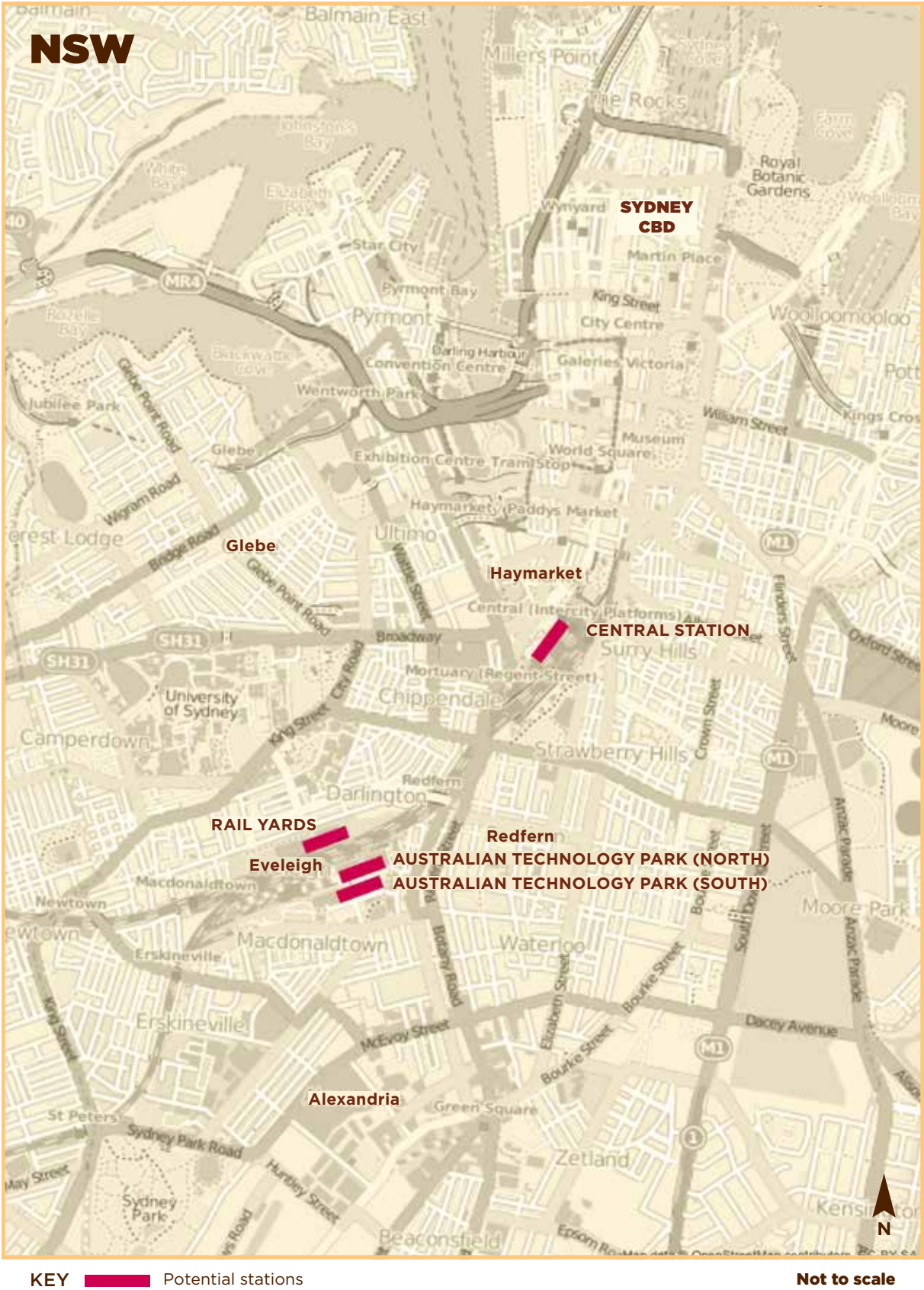
Australian Technology Park

The Australian Technology Park was established by the NSW Government on the southern side of the Eveleigh rail yards. The potential station sites are located on an east–west alignment within the Australian Technology Park, one slightly to the north using part of the rail yards and one to the south solely within the Australian Technology Park.

Construction of an HSR station on either site would have significant impacts on businesses operating in the Australian Technology Park. The northern option would also require the relocation of rail maintenance facilities. The constructability of either option on this site has been ranked as moderate, because of the challenges of undertaking construction adjacent to operating rail lines and the impacts on residential and commercial property.

Figure 4-23 shows the potential city centre station locations for Sydney.

Figure 4-23 Potential city centre station sites, Sydney



Homebush and surrounds precinct

Four station options (shown in **Figure 4-24**) were considered in Homebush and surrounds: at Olympic Park station, Olympic Park/Bicentennial Park, Homebush West (adjacent to Flemington station) and north of Strathfield station. However, a terminal station in Homebush (or surrounds) would comparatively reduce the user benefits of an HSR network with a station terminating at Central by about \$38 billion. The reduction in user benefits is due to the distance of Homebush from the CBD. A significant addition to current public transport capacity would be required between Homebush and the Sydney CBD, if HSR terminated in the Homebush precinct.

Olympic Park (Olympic Park station and Olympic Park/Bicentennial Park)

Olympic Park is a major events centre (with the former Olympic Stadium, Arena, and Showgrounds) and is emerging as a commercial and residential precinct in its own right. The Olympic Park-Rhodes precinct has been designated as a Specialised Centre⁴⁷. New high density commercial development has commenced immediately adjacent to the existing Olympic Park station. Plans for the precinct involve more than one million square metres of floor space, including restructuring of existing low density business park uses south of the existing Olympic Park station.

Two station options were evaluated within the Olympic Park precinct: one at the existing Olympic Park station, the other at Olympic Park/Bicentennial Park to the south of Sarah Durack Avenue. The existing railway station is not large enough to accommodate a Sydney HSR station and would need to be demolished, causing significant disruption to the precinct during construction and compromising access for patrons of major events.

Implementing an HSR station at Olympic Park would assist with the commercial and residential plans for the precinct, and would raise its capacity for delivering patrons to major sporting and entertainment events. In this respect, the location of a station at Olympic Park would support NSW

Government policy, and would enable urban development and economic activity, albeit from a very low base compared to Central station.

Homebush West

This station site would provide connectivity to the Western Line at Flemington. It is south of the M4 Motorway, and could be accessed via the Centenary Drive interchange.

The station would probably need to be subsurfaced to avoid impacts on existing transport systems (the M4 Motorway and Western line) and surrounding communities. This would require a high cost station structure, comparable with other station options in this precinct.

Constructing an HSR station in this location would significantly impact adjacent land uses, including Flemington Markets which is a large agricultural market place. It would also impact nearby residential areas.

Strathfield station

An HSR station close to Strathfield would provide the opportunity for interface with the urban rail network at a key interchange location. The Northern, South, North Shore, Western and Inner West lines all pass through Strathfield, providing a high level of rail accessibility within the metropolitan area.

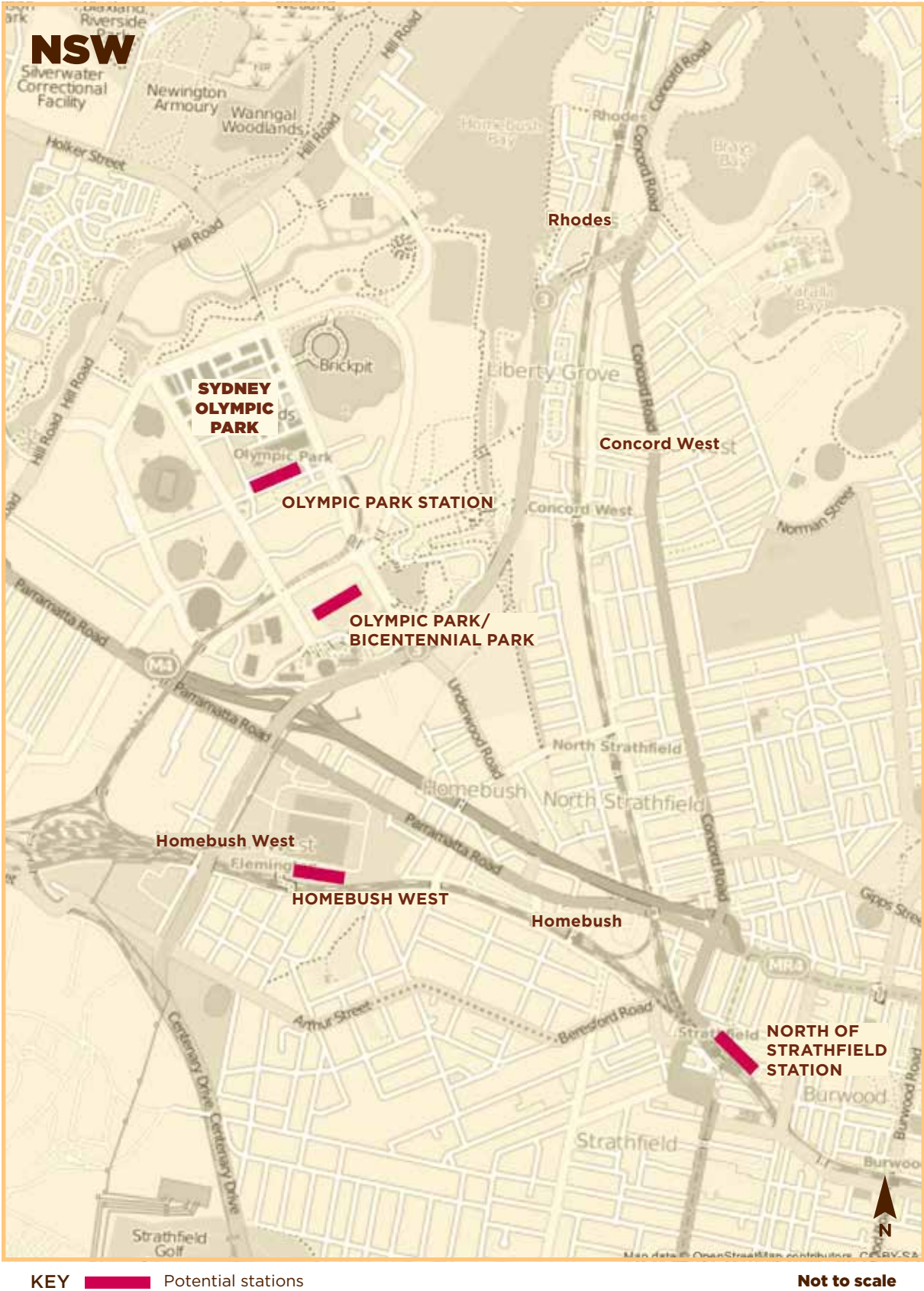
Access to the HSR station by road would be via the M4 Motorway and Leicester Avenue. The road network in this area is subject to congestion during peak periods, limiting access to the HSR station.

As the chief rationale for this location is to provide a good connection with the urban rail network, the HSR station would need to be located close to the existing station. However, an HSR station to the north of the existing Strathfield station, the only practicable site, would be located in a constrained urban environment and would have significant impacts on residential and retail properties.

Figure 4-24 shows the potential Sydney station sites at Homebush and surrounds.

47 NSW State Government, loc. cit.

Figure 4-24 Potential Sydney station sites at Homebush and surrounds



Parramatta City Centre precinct

NSW Government policy is to develop Parramatta as Sydney's second CBD⁴⁸. There are plans to increase the number of jobs in Parramatta from 43,200 in 2006 to 70,000 by 2036⁴⁹. Parramatta's growth over the past two decades has been underpinned by government relocation strategies. An HSR station at Parramatta would support objectives to promote Parramatta as Sydney's second CBD.

Parramatta is a key centre for regional retail, entertainment and recreation facilities for Western Sydney. In recent years, the Parramatta City Centre has also been the focus of a significant number of high-rise residential developments, providing more affordable residential accommodation.

The station site at Parramatta (south of Westfield Shopping Centre) would have moderate accessibility for passengers, lower than all the other station sites considered, with its accessibility affected by the distance from the Sydney CBD. A station at Parramatta would significantly reduce HSR patronage demand to/from Sydney CBD because of the need to transfer modes and travel a further 20 kilometres, as well as the potential lack of parking to cater for demand by car. These issues are estimated to reduce user benefits by \$45 billion relative to a station at Central.

While Parramatta is centrally located within the Sydney urban area, the location for a station site is constrained by the current layout of the CBD and the existing rail services, heritage buildings and the highway system. As a result, the station at Parramatta would have to be underground and involve demolition of major existing structures, with the site vacant for the construction period of at least three years while station development occurs. An HSR station could not be provided beneath the existing Parramatta interchange because it would need to be located 30 metres below ground, which is considered undesirable from a user perspective. There is also no international precedent for a main HSR station at this depth. Limited land is available for parking close to the station in Parramatta, and the provision of large car parks within the city centre would reduce redevelopment opportunities around the station.

The constructability of an HSR station at Parramatta would be moderately difficult. There would be no direct interfaces with operational lines, and construction would require the demolition of buildings within the station footprint and approaches, as well as considerable disruption to residents and businesses during the construction period.

Figure 4-25 shows the potential Parramatta station site in Sydney.

48 NSW State Government, loc. cit.

49 *ibid.*

Figure 4-25 Potential Parramatta station site, Sydney



Preferred city centre station site

Although Central station has the highest capital cost of the Sydney CBD station options, the net benefits far exceed all other options. It has the highest level of accessibility for sites in Sydney, is located closest to the Sydney CBD, which was confirmed to be the main centre of demand, and provides opportunities for significant urban regeneration in the surrounding areas.

Station options at Eveleigh have lower accessibility for travellers and would have significant impacts on heritage assets. A terminal station in the Homebush precinct would reduce user benefits by \$38 billion compared to Central, and would have a significant impact on the total benefits of an HSR system. In addition, potential HSR stations at Homebush West and Strathfield would significantly affect residential areas and would have high construction costs.

Further analysis has been undertaken to examine the potential for Olympic Park as a through station, i.e. as a second Sydney station in addition to Central, providing access for users travelling to and from areas west of the Sydney CBD. While an HSR station at Central has been shown to provide the greatest overall benefits for trips to and from Sydney, a second station in Sydney would provide improved access for trips originating from areas west of the Sydney CBD, and may or may not replace through stations on Sydney's northern and southwest periphery.

A second station was found to involve additional costs that exceeded the anticipated benefits and has not been taken forward. The detailed evaluation is shown in **Appendix 3A**.

Although an HSR station in Parramatta could support its development as Sydney's second CBD, its lower capital costs (due to the shorter urban access alignments) are significantly outweighed by the reduction in user benefits, the likely significant cost of fast mass transit link(s) to the Sydney CBD, and the anticipated social and environmental impacts of the station construction.

Central is the preferred location for a city centre station in Sydney.

A summary of the station site assessment is presented in **Table 4-5**.

Table 4-5 Assessment of potential station sites, Sydney

Objective	Criteria	Central station	Eveleigh		
		Existing station footprint	Rail yards	Australian Technology Park (north)	Australian Technology Park (south)
Economics and connectivity	Difference in relative user benefits from Central station(\$b)	0	-3		
	Pedestrian access to Sydney CBD	High	Low-moderate	Low	Low
	Public transport access	High	Low-moderate	Low	Low
	Proximity to residential centre	High	High	High	High
	Connectivity to arterial roads	Low-moderate	Moderate	Moderate	Moderate
	Overall accessibility	High	Moderate	Moderate	Moderate
Infrastructure	Capital cost (\$b) (station structure)*	0.25	0.38	0.38	0.4
	Capital cost (\$b) (access corridor)**	12.2	12.1	12.1	12.1
	Capital cost (\$b) (total)	12.5	12.5	12.5	12.5
	Constructability***	4	3	3	3
Sustainability, land use planning and policy fit****	Maintain existing land use	4.0	4.0	4.0	4.0
	Maintain community function	2.5	1.0	1.5	1.5
	Promote economic development	6.0	4.0	2.7	3.3
	Summary	Slightly detrimental	Slightly detrimental	Moderately detrimental	Slightly detrimental
Conclusions		Preferred	-	-	-
Principal reasons for non-selection			Lower accessibility and impact on community function	Lower accessibility and impact on community function	Lower accessibility and impact on community function

*Comparative capital cost estimates for the station structure were based on six platforms for a station in Sydney.

Finalisation of the demand has resulted in a requirement for ten platforms. While the capital cost of the station structure is therefore higher than that shown above, the relative difference between station options does not change. The higher station structure cost has been included in the overall system capital cost estimates.

**Highest capital cost access corridor used for comparison.

***Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

****Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Objective	Homebush and surrounds				Parramatta
	Olympic Park station	Olympic Park/ Bicentennial Park	North of Strathfield station	Homebush West (adjacent to Flemington station)	South of Westfield shopping centre
Economics and connectivity	-38				-45
	Low	Low	Low	Low	Low
	Moderate	Low	High	Moderate	Moderate
	Moderate-high	Moderate-high	High	High	High
	High	High	High	High	Moderate
	Moderate-high	Moderate-high	Moderate-high	Moderate-high	Moderate
Infrastructure	0.54	0.42	0.32	0.42	0.65
	7.0	7.0	7.0	7.0	6.5
	7.5	7.4	7.3	7.4	7.1
	4	3	5	3	3
Sustainability, land use planning and policy fit****	3.6	4.0	4.0	4.0	4.0
	3.0	2.5	2.5	3.0	1.5
	6.0	6.0	6.0	2.7	6.0
	Slightly detrimental	Slightly detrimental	Slightly detrimental	Slightly detrimental	Slightly detrimental
Conclusions	-	-	-	-	-
Principal reasons for non-selection	Lower user benefits and difficult constructability	Lower user benefits	Lower user benefits and very difficult constructability	Lower user benefits and few opportunities for renewal	Significantly lower user benefits

4.8 Sydney-Goulburn

4.8.1 Overview

South of Sydney, a decision to select either a coastal corridor via Wollongong or an inland corridor via the Southern Highlands was required before urban alignment comparisons to the south of Sydney could be made.

Although the cost of construction for a corridor via Wollongong would be significantly higher than via the Southern Highlands, the option via Wollongong would serve a significant passenger catchment area. Analysis was therefore undertaken to assess the overall benefits of a Wollongong alignment; this is presented in **section 4.8.1**.

Potential alignments within each corridor were assessed between Central station and Hanging Rock (north of Goulburn), a common point to the south. The alignments via Wollongong and the Southern Highlands that performed best at the time of assessment were then selected for comparison⁵⁰. Details of these alignments and the context in which they were assessed are provided in **Appendix 3A**.

4.8.2 Wollongong alignment

Wollongong is a regional city of 192,418 people⁵¹ located around 85 km south of Sydney. It is part of the Illawarra region, which in 2011 had a population of around 276,000 people⁵². It comprises suburban settlements along the coast to the north, and more widespread suburban areas to the west and south. The urban areas are framed by the steep Illawarra escarpment, water catchment areas and national park, which feature important remnant vegetation, contrasting with the cleared, generally flatter land on which the urban development has occurred. These areas also feature significant areas of underground coal mining.

The population of the Illawarra is forecast to increase by around 50,000 over the next 25 years⁵³. This growth is anticipated through urban expansion in the southern Illawarra around West Dapto and the Calderwood Valley, as well as through infill development to higher densities in the established suburbs of Wollongong.

Finding undeveloped or unconstrained routes for an HSR alignment into Wollongong is a significant challenge due to topography, natural environment, and existing and committed urban development areas.

The alignment would traverse the Royal National Park to the south of Sydney. South of Helensburgh it would comprise a long (>15 kilometres) tunnel to accommodate the change in elevation of approximately 300 metres from the top of the Illawarra escarpment to Wollongong. The alignment would use a combination of surface sections, within the existing rail corridor, and tunnel sections between Woonona and Dapto.

The route south of Dapto would require a long (>22 kilometres) tunnel to accommodate a change in elevation of approximately 700 metres to the top of the Illawarra escarpment near Burrawang, continuing at grade to Hanging Rock. Both the northern and southern tunnels through the Illawarra escarpment would be deeper than the existing conventional rail tunnels and would pass through coal seams. These coal seams present the risk of explosive methane gas during construction and operation of the railway. There is no current engineering control measure available that would completely seal the tunnels from methane, presenting the risk of closure of the tunnels should methane be detected, with implications for the operational reliability of the entire Sydney-Melbourne line. These tunnels, combined with the need to treat past mine workings, present a significant risk for HSR and a \$7.3 billion dollar increase in the capital cost alone.

50 It is noted that after the comparison was complete, the alignment via Southern Highlands was refined further (see section 4.8.2). The refinement improved the performance of the Southern Highlands alignment and reinforced the decision to prefer the alignment via the Southern Highlands.

51 ABS, *Census Data by LGA*, 2011.

52 NSW Department of Planning, *Illawarra Regional Strategy*, 2008.

53 *ibid*.

A more detailed analysis of the issues and risks associated with these tunnels is contained in **Appendix 3A**.

Southern Highlands alignment

The Southern Highlands alignment has fewer high and moderate detrimental impacts than the Wollongong alignment. These potential impacts could be further reduced during the design phase by introducing small deviations to avoid sensitive

land uses. Details of the Southern Highlands alignment are discussed in **section 4.8.3**.

There is no tangible difference in net user benefits between the Wollongong and Southern Highlands alignment options, with both producing user benefits of \$3.9 billion.

A summary of the comparison is provided in **Table 4-6**, while the detailed appraisal of the alignments is provided in **Appendix 3A**.

Table 4-6 Comparison of alignments in the Sydney-Goulburn corridor

Criteria	Sydney Central station-Hanging Rock	
	Via Wollongong	Via Southern Highlands
Length (km)	143	139
Estimated transit time (min)	37.2	31.6
Relative net user benefits (\$b)	0	0
Capital cost (\$b)	17.4	10.1
Constructability*	5	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

The Southern Highlands alignment is the preferred option between Sydney and Goulburn.

4.8.3 Sydney

Assessment of urban access alignments to the south

Heading south from Central station, a number of existing transport corridors were examined for use. As discussed, the geometry of many of the corridors considered was unsuitable for high speed operation and, in many of those which were suitable in terms of geometry, any spare capacity at surface level was designated for future expansion of existing facilities.

Corridors assessed included:

- Central to Casula/Moorebank.
- Casula/Moorebank to Douglas Park.

Central to Casula/Moorebank

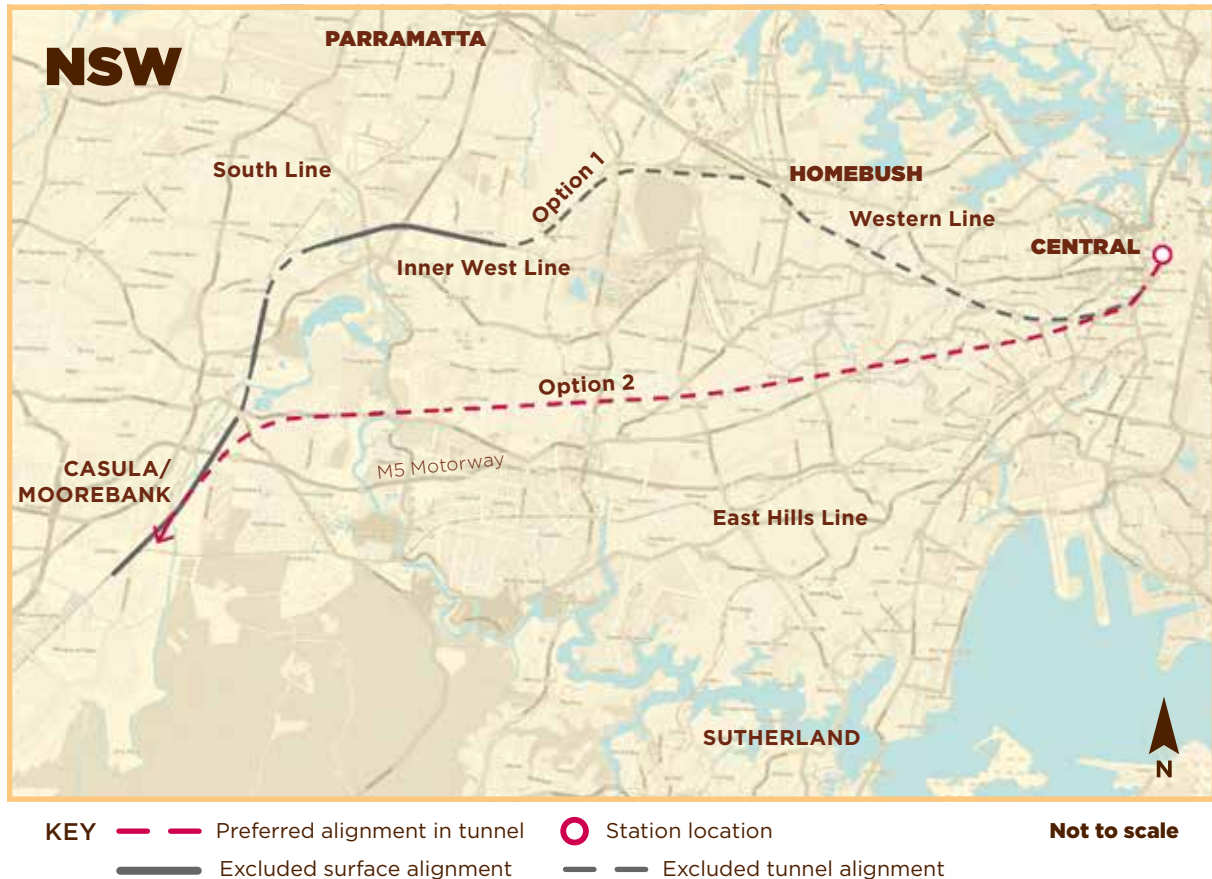
Two potential alignments through metropolitan Sydney were identified heading south from Central station:

- Tunnel and surface lengths within the Inner West line (Option 1).
- A tunnel from Central to Casula/Moorebank (Option 2).

These options are illustrated in **Figure 4-26**.

The preferred alignment is shown in red and labelled 'Option 2' on the map. The second option ('Option 1') is shown in grey.

Figure 4-26 Preferred urban access alignment to the south, Sydney



Details and comparative evaluation of these can be found in **Appendix 3A**.

The Option 1 route (in tunnel westward to Homebush and then following the Inner West line and the South line to Casula/Moorebank) would require longer transit times (because it would be longer and slower, to suit the alignment geometry) with consequent lower user benefits. It would be more difficult to construct due to interfaces with the existing rail corridor, and would have greater impact on existing urban areas.

There is also a risk that the cost of Option 1 would increase, as it may require a longer length of tunnel due to the uncertainty of the future surface capacity within the Inner West/Bankstown line corridor. The Southern Sydney freight line, a single

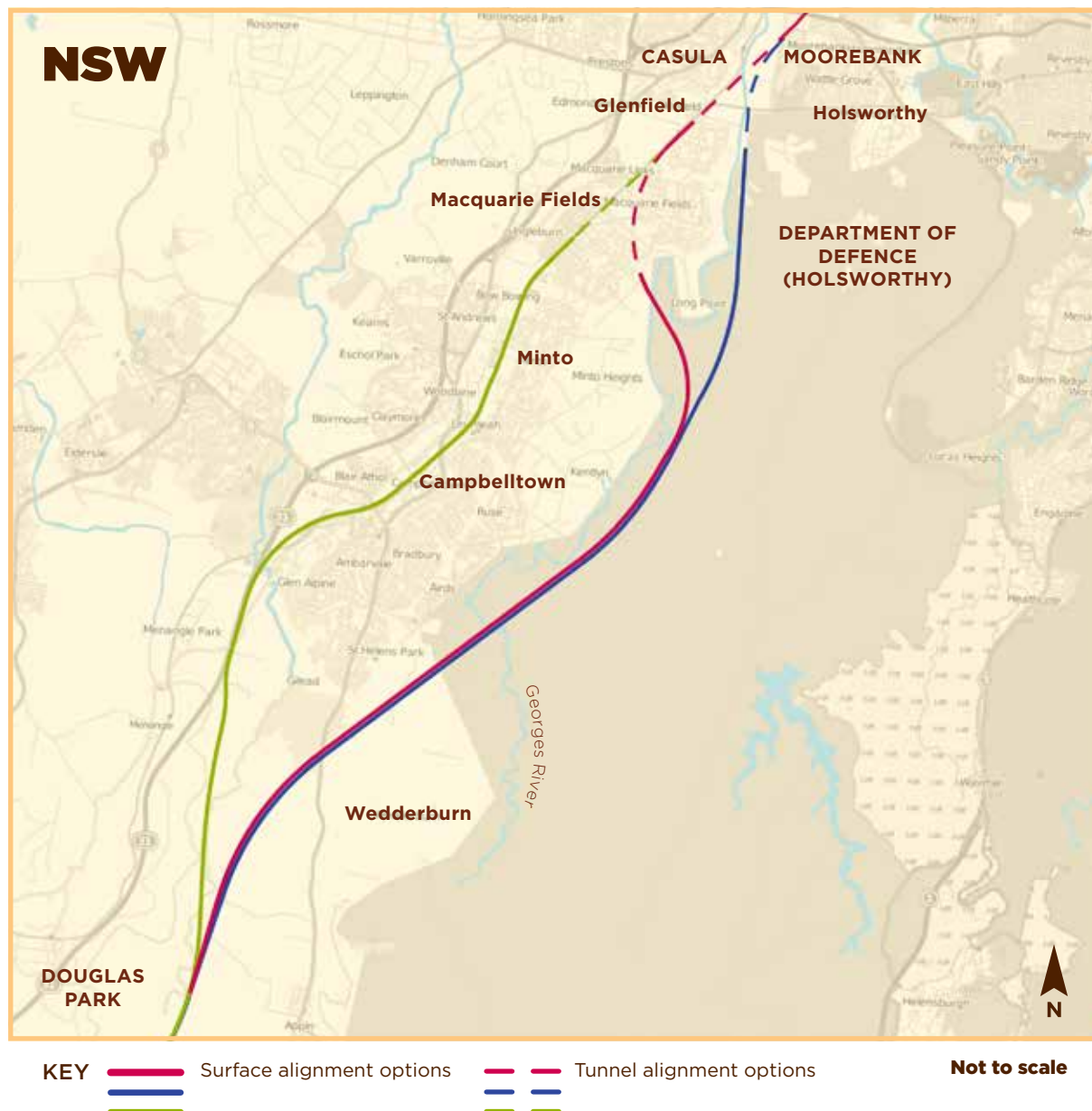
track bi-direction freight line in the rail corridor which commenced operations in January 2013, may be duplicated in the future and the planned second Sydney Harbour rail crossing may connect commuter services from the North West Rail Link to the Bankstown line, both requiring additional infrastructure in the corridor⁵⁴.

As Option 2 is all in tunnel, it would have less environment and land use impact than Option 1, which would have some adverse impacts in its surface sections.

A tunnel directly from Central to Casula/Moorebank (designated Option 2) is the preferred alignment option to the southwest.

54 *ibid.*

Figure 4-27 Casula/Moorebank-Douglas Park alignment options



Casula/Moorebank-Douglas Park

Further refinement south of Casula/Moorebank was undertaken to extend the alignment south beyond the urban edge to Douglas Park, to connect into the regional alignment. The potential to provide an interchange from HSR to the existing rail network at Glenfield, akin to the level of connectivity at Hornsby, was also assessed. Three options were identified as shown on **Figure 4-27**.

Preferred urban access alignment to the south

The blue alignment is nearly \$0.9 billion less expensive than the other options proposed. It is predominantly at surface level, generally following the Georges River to the east of Glenfield, Macquarie Fields, Minto and Campbelltown to Douglas Park. It would have minimal community impacts, but higher environmental impacts on native vegetation. It would not allow a peripheral

station to be co-located with Glenfield station. The peripheral station on this alignment would be located at the tunnel portal on the Department of Defence land at Holsworthy, and station access would be by road from the M5 Motorway and Moorebank Avenue. The blue alignment also traverses the Department of Defence land at Holsworthy.

While the green alignment uses the existing railway corridor, where practical, to minimise adverse impacts on built up areas, it is longer and has slower operating speeds due to geometric constraints. As a result, the green alignment has lower user benefits than the blue alignment, but it would permit connectivity between HSR and suburban rail via an HSR station at Glenfield. Although the green alignment would have minimal environmental impacts, it would have adverse impacts on community function, amenity and land use as it passed through more densely populated areas and would cause severance and noise impacts.

The green alignment would involve higher capital costs and would be more difficult to construct than the blue alignment, requiring significant staging and enabling works and multiple interfaces with external parties, including rail and road authorities. There is also a risk that the green alignment would require a longer length of tunnel to mitigate its adverse impacts on existing development, which would add to the capital cost estimate. The existing railway corridor is also likely to have limited capacity to accommodate additional infrastructure with the opening of the Southern Sydney Freight Line and the construction of the South West Rail Link.

The red alignment follows the green alignment in tunnel from Casula through to Glenfield, where an underground station could be constructed, before proceeding back into a tunnel under Macquarie Fields and joining the blue alignment at the surface. The red alignment would have minimal community impacts during construction (except at Glenfield), and similar environmental impact to the blue alignment. It would also traverse Department of Defence land at Holsworthy.

The three alignments were comparatively assessed using the pair-wise process. The green alignment performed worst and was therefore discarded on the basis of transit time (10.5 additional minutes) and user disbenefits (-\$1.9 billion) compared to the blue alignment, and the risk of an additional length of tunnel being required that would further increase the estimated capital cost of \$3.62 billion. The comparative assessment of the blue and red alignments is provided in **Appendix 3A**.

Both blue and red alignments impact Department of Defence land to varying extents, and the adoption of either alignment would be subject to resolving these impacts with the Department of Defence.

The preferred alignment for Casula/Moorebank-Douglas Park is the blue alignment.

Peripheral station assessment – Sydney South

Sites for peripheral stations south of Sydney are constrained by the Georges River (and its floodplain) and the location of the preferred HSR alignment in tunnel to the east of the Georges River, while Liverpool city centre and the urban rail network are to the west of the Georges River. Crossing the Georges River to access these areas would add significant cost. The Georges River creates a boundary between the developed areas to the west and the Defence land to the east, as shown in **Figure 4-28**. The alignment would pass through or beneath the developed areas, and only one site has been considered on the western side of the river.

Five potential sites were identified. Details and comparative evaluation of these can be found in **Appendix 3A**.

A peripheral station at Holsworthy would generate \$2.8 billion in relative user benefits at a reduced cost compared to other surrounding options at Moorebank and Glenfield. It would provide reasonable access to the regional road network via the M5 Motorway at the Moorebank Avenue interchange. A dedicated public transport link could be provided to nearby Glenfield station, which is on the urban rail network. This service would most likely be a shuttle bus service, subject to demand.

While the Glenfield site provides opportunities for urban renewal and creates excellent interchange opportunities with the urban rail system, it would require an additional \$0.91 billion in alignment

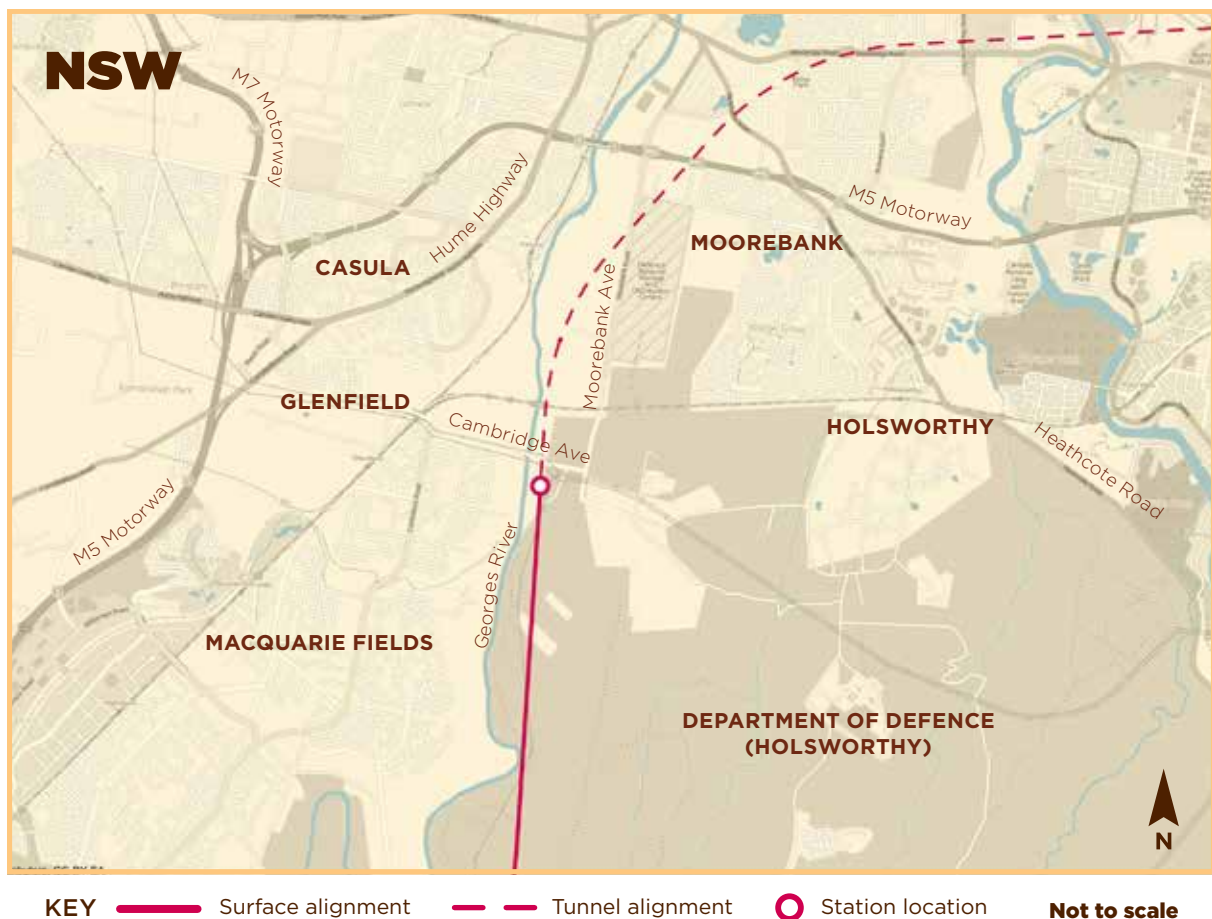
and station capital costs. Road access could be constrained, and additional road infrastructure may be required to provide capacity for vehicles accessing the HSR car park.

The Holsworthy site would accommodate a surface station just south of where the alignment emerges from the tunnel from Sydney Central. Locating a station any further north from this would mean that it would have to be sub-surface at considerable extra cost. However, no suitable location free of flooding was identified.

For HSR alone, the alignment via a peripheral station at the Holsworthy site provides the greatest user benefits at the least cost. Future opportunities to allow interchange with the urban rail network should be investigated if further phases of HSR development occur.

Holsworthy is the preferred Sydney South peripheral station site.

Figure 4-28 Location of Sydney South peripheral station site



Sydney – preferred station sites and urban access alignment

Sydney would be the hub of HSR on the east coast, with HSR services approaching both from the north and south. The Sydney station would therefore need to accommodate nearly twice the volume of passenger flows of any other city station. It would also have commuter services approaching from both directions, which would add considerably to the peak hour flows.

Urban development, topography and environmental issues present major challenges in identifying suitable routes for HSR through the Sydney metropolitan area. An appraisal of potential access alignments into Sydney has confirmed that direct tunnels from the periphery of Sydney to the CBD are the optimal arrangement.

The Central station option is preferred for HSR services in Sydney. Demand analysis shows that Central station provides large benefits for both business and leisure travellers, which far outweigh any difference in capital costs.

Peripheral stations would be located at Hornsby to the north of Sydney, and at Holsworthy to the south of Sydney, as these sites provide the highest net benefit.

4.8.4 Regional alignment and station assessments

Overview

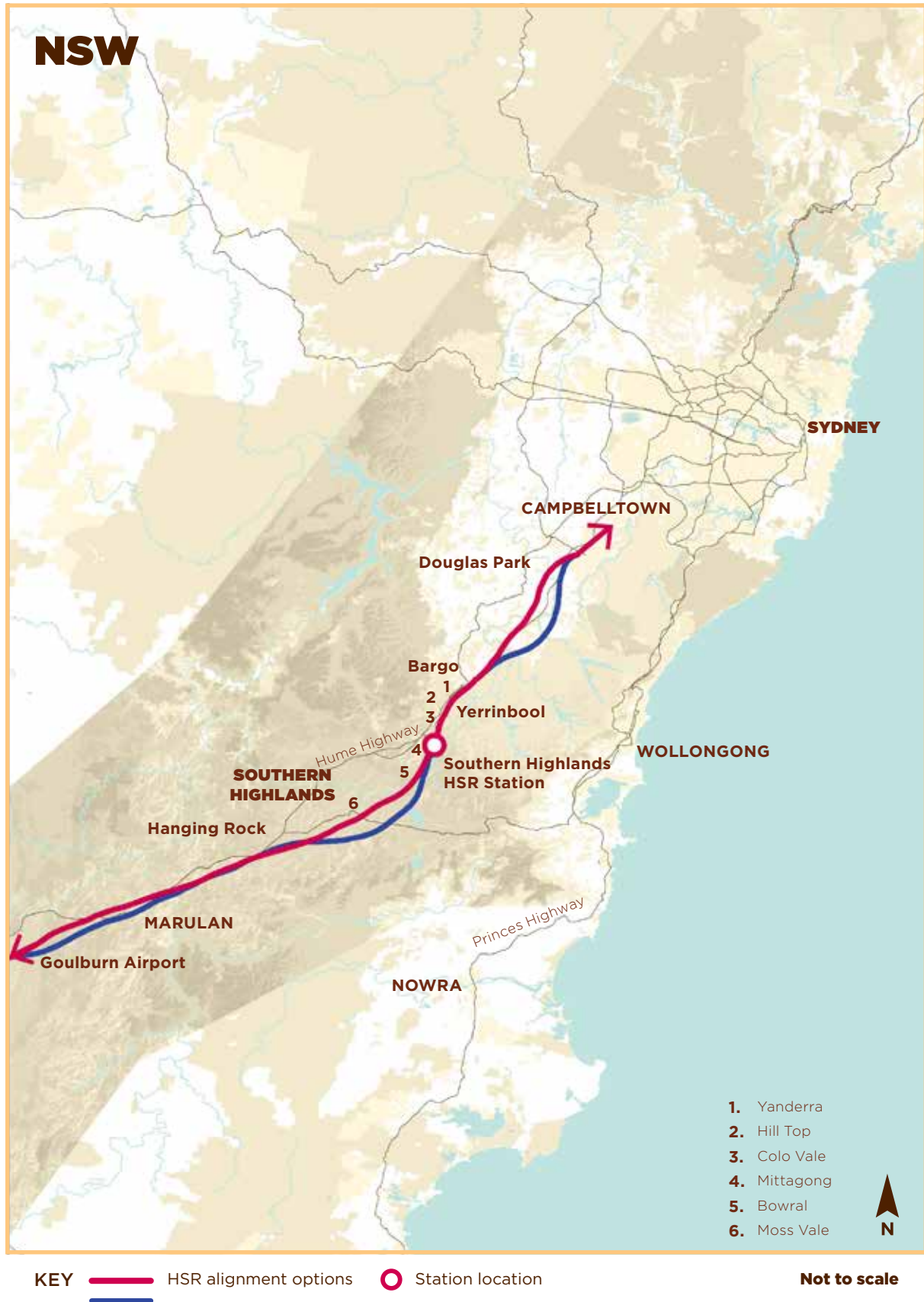
Beyond the urban limits of Sydney's southern suburbs, the landscape changes into an area of relatively undisturbed forests and national parks, from the Blue Mountains to the Illawarra escarpment and the Southern Highlands.

The Southern Highlands is an important tourist destination with European heritage interest. The Hume Highway is the main road from Sydney to Canberra and beyond, through Yass and southwards to Melbourne. Regional and interstate rail services are operated on the Main South line, which broadly parallels the Hume Highway. The Southern Highlands towns of Berrima, Mittagong, Bowral and Moss Vale are close to both the Hume Highway and the conventional rail line.

West of the Illawarra escarpment and the deeply dissected river valleys of the Hawkesbury-Nepean, Wingecarribee and Paddys Rivers, the terrain becomes less difficult on the approach to Goulburn as the land transforms to the Southern Tablelands. The Sydney-Goulburn section of the preferred HSR alignment was divided into four sectors (as shown in **Figure 4-29**): Douglas Park to Bargo, Bargo to Yerrinbool, Yerrinbool to Hanging Rock (near Marulan), and Hanging Rock to Goulburn Airport.

One regional station is proposed in the Southern Highlands, east of Mittagong, near Mittagong Airport.

Figure 4-29 Sydney to Goulburn alignment options



Douglas Park-Bargo

The blue alignment in **Figure 4-29** is generally to the east of the Hume Highway and the built-up areas of Menangle Park, Menangle, Douglas Park and Wilton, whereas the red alignment is generally to the west of the Highway. Other alignment options closer to the Hume Highway would have greater impacts on existing and proposed urban development. Options further east or west of the two shortlisted alignments are less direct, encounter steeper topography and would thus incur additional capital costs.

The red alignment would have slightly greater detrimental impacts on a planned urban release area at Menangle Park than the blue alignment, which would affect a smaller area on the eastern edge along with Broughton Anglican College. The red alignment would have an adverse impact on species listed as endangered under the EPBC Act and areas of cultural heritage significance. Both alignments would pass through the Sydney Catchment Authority water supply catchment south of Douglas Park. The blue alignment would be closer to any future potential airport at Wilton, and could therefore provide better opportunities for potential transport links.

The blue alignment is the preferred option between Douglas Park and Bargo.

Bargo-Yerrinbool

The alignment options for this short sector were reduced to a single alignment (shown in red in **Figure 4-29**) that follows the existing freeway, to minimise sustainability and land use impacts, primarily on the adjacent built-up areas and water supply catchments. Although the alignment passes through the western edge of the Avon Dam water supply catchment, it avoids impacts on the Bargo State Conservation Area and a succession of urban areas, including Mittagong, Colo Vale, Hill Top and Yerrinbool.

The alignment alongside the existing road corridor (shown in red in Figure 4-29) is preferred from Bargo to Yerrinbool.

Yerrinbool-Hanging Rock

The two shortlisted alignments selected for pair-wise comparison both run to the east of Mittagong, Bowral and Moss Vale.

Alignments to the west of these towns would have greater impacts on residential areas, including impacts on the towns of Berrima and Colo Vale, as well as Yanderra further to the north, and would require multiple crossings of the Hume Highway. Avoiding these towns would require alignments well west of the Hume Highway and would be less direct than other options.

While the blue alignment would have lesser environmental impacts along this route, the red alignment would impact upon existing and planned urban and semi-urban land east of Moss Vale. Although the blue alignment is located close to Wingecarribee Reservoir, the HSR footprint would be some 300 metres downstream of the dam structure. The capital cost of the red alignment would be approximately \$0.1 billion greater than the blue alignment.

The blue alignment is the preferred option between Yerrinbool and Hanging Rock.

Hanging Rock-Goulburn Airport

The red alignment would pass to the north of the township of Marulan, whereas the blue alignment would pass to the south. Other alignments options were less direct. The red alignment would affect the existing Marulan urban area and land to the south and west that is zoned for future residential and general industrial development.

The blue alignment would impact areas listed on the National Heritage Register at Old Marulan Town along the existing highway corridor, and a truck parking area within the Eastern Marulan Highway Service Centre. The potential impacts on Old Marulan Town could be mitigated by undertaking a detailed archaeological survey, excavation and thorough recording of the site, should a decision be made to proceed with HSR on this alignment.

The blue alignment to the south of Marulan is the preferred option between Hanging Rock and Goulburn Airport.

Figure 4-30 Preferred Southern Highlands station location



Southern Highlands station

The Southern Highlands encompasses the towns of Berrima, Bowral, Mittagong and Moss Vale in Wingecarribee LGA. The LGA had a population of 44,395 in 2011, with forecast growth to 61,085 in 2036 and 63,466 in 2056⁵⁵. Approximately 65 per cent of the population currently resides in the main towns, while the remaining 35 per cent is relatively evenly distributed between villages and regional districts.

As with the Central Coast, designation of an HSR station that is easily accessible to a dispersed population is challenging. The terrain is also a significant constraint in the area, influencing the choice of possible sites. Three potential station locations were identified along the preferred alignment:

- East of Mittagong near Mittagong Airport.
- Southeast of Bowral near the intersection of Kangaloon Road and Sheepwash Road.
- East of Moss Vale along the Illawarra Highway.

The track geometry at Bowral cannot provide the flat and straight alignment required for a station. Of the two remaining options, the site east of Mittagong would cater for the population of this large town. The option to the east of Moss Vale, located on the Illawarra Highway, would also provide good connectivity to the major town of Moss Vale and surrounding regional areas.

The Mittagong location is within a 30 minute drive for 75 per cent of the Southern Highlands (Wingecarribee LGA) population, compared to 72 per cent for the Moss Vale location.

Mittagong is the preferred location for a Southern Highlands station (Figure 4-30).

The site would provide good regional road access via both the new and old Hume Highways and Old South Road. Mittagong would be approximately five kilometres by road, Bowral approximately ten kilometres by road and Moss Vale approximately 20 kilometres by road from the proposed HSR station location. The site is well placed to serve

55 ABS, loc. cit.

future population growth, which is expected to mainly be centred in existing urban areas around Bowral, Mittagong and Moss Vale.

4.9 Goulburn-Yass (including Canberra)

4.9.1 Overview

This area comprises parts of the Southern Tablelands and part of the ACT. It is generally sparsely populated, apart from Canberra and the main towns such as Yass and Goulburn.

The area is characterised by generally flat country. Canberra is surrounded by mountainous terrain, with the Snowy Mountains to the south and the Brindabella Ranges to the west. Route options are further constrained by Lake George to the east.

The optimal alignment between Goulburn and Yass is dependent on how Canberra is accessed. The analysis of a ‘spur’ versus a ‘through’ alignment was followed by an assessment of the Canberra station location, and then the regional alignments between Goulburn and Yass and between Gunning and Sutton (linking into the spur line into Canberra).

4.9.2 Canberra

Canberra is Australia’s capital city and is located in the ACT approximately 290 kilometres southwest of Sydney by road and approximately 660 kilometres northeast of Melbourne by road.

Strategic planning context and issues

The Australian Government established the National Capital Authority (NCA) to develop the National Capital Plan as the primary plan for the ACT. The NCA maintains Canberra’s unique heritage (especially symbolic corridors) and national public places through the National Capital Plan.

The ACT Government’s planning regime is managed by the Environment and Sustainable Development Directorate (ESDD), incorporating the ACT Planning and Land Authority (ACTPLA), the statutory agency responsible for planning, zoning, development control and future growth within the ACT. The ESDD is responsible for the Territory Plan, which must be consistent with the National Capital Plan.

Approximately 350,000 people currently live in Canberra, with this number projected to increase to 550,000 by 2056⁵⁶. Canberra’s planning policy continues the development of a city based on a polycentric pattern, with the city centre (Civic) as the hub surrounded by urban precincts and residential areas, each with its own centre. While urban intensification is noted for other town centres and transit corridors, Civic is the focal point for urban intensification, and the ‘city will remain the “first among equals” of the town centres’ as the ACT’s commercial and retail centre, with the Central National Area containing the prime administrative and cultural institutions⁵⁷.

The ACT’s current transport plans include a range of transport projects to support population growth, including a rapid transit network based on the ‘hub and spoke’ network form, connecting Civic to other town centres (but not Canberra Airport, as illustrated in **Figure 4-31**)⁵⁸. Current government commitments are to the first stage of a light rail network between Civic and Gungahlin to the north, along the Northbourne Avenue transport corridor. Later stages are proposed to connect Civic with the other satellite suburban centres.

The role of Canberra Airport in the national aviation market was recently considered by the Australian and NSW Governments. This study concluded Canberra Airport is too far from the Sydney market to serve as Sydney’s second major regular public transport airport, but that it will grow to serve the southern NSW region, and is the only airport in the region capable of serving as an aviation freight hub⁵⁹.

56 ABS, loc. cit.

57 ACT Government, *ACT Planning Strategy*, June 2012.

58 ACT Government, *Transport for Canberra: Transport for a sustainable city 2011–2031*, 2011.

59 Australian and NSW Governments, loc. cit.

Figure 4-31 ACT proposed rapid service public transport network (2031)



Source: ACT Government, 2012

Environmental planning context and issues

The HSR approaches into the ACT from NSW are primarily in open country and relatively free of known environmentally sensitive features. However, extensive areas of environmentally sensitive ecological and biological features exist in and around Canberra itself.

In some cases, these reserves act as open space buffers between growing urban areas and are being expanded. Examples include the Crace Grassland Reserve, Gungaharra Grasslands Reserve, Mulligan's Flat Nature Reserve and Gorooyarroo Nature Reserve in the vicinity of Gungahlin. The golden sun moth, listed as a critically endangered species under the EPBC Act, is found in several locations in and around Canberra. GIS datasets for these and other sensitive areas and features were used extensively in planning the urban access alignment for Canberra.

Access to Canberra

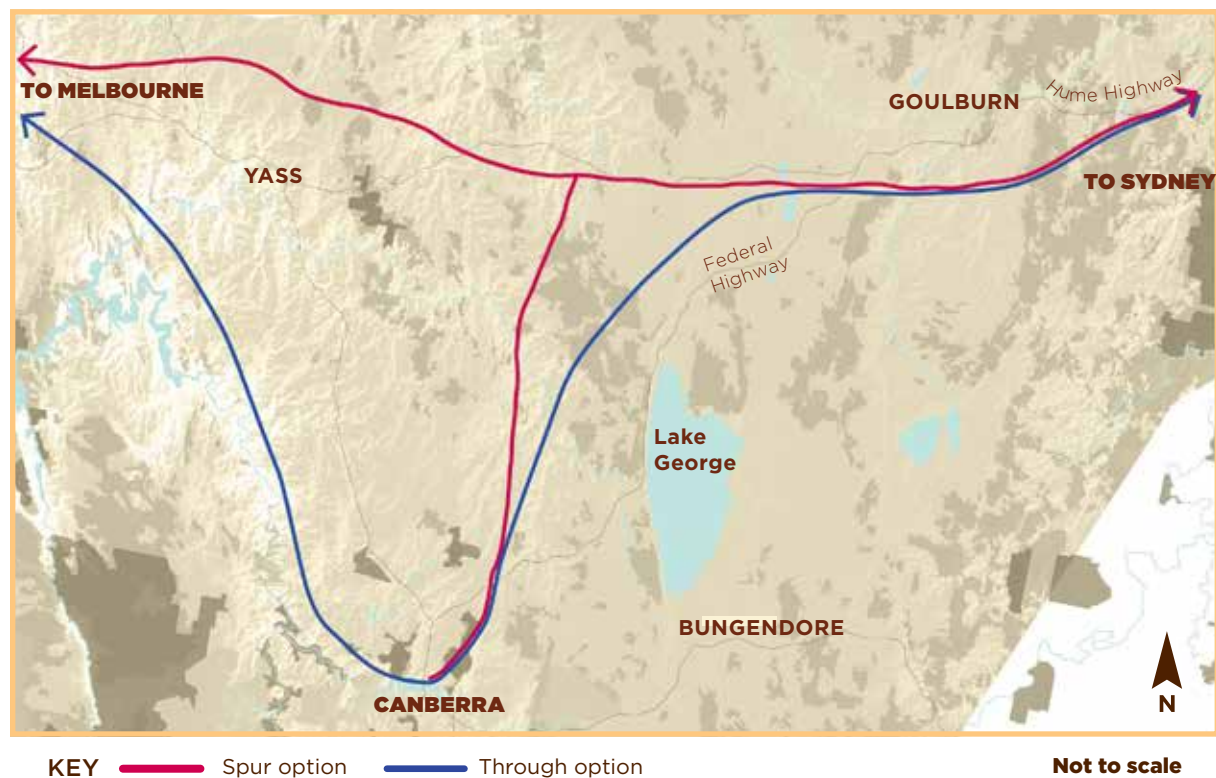
Canberra would be connected to the HSR network by a spur line (shown in red in **Figure 4-32**).

The preferred alignment would be parallel to the Majura Parkway, east of Mount Ainslie and then deviate to the west in a 3.6 kilometre tunnel under Mount Ainslie towards Civic.

This alignment performs best in terms of overall capital cost, user benefits and fewest adverse impacts on urban land and residents in and around Canberra.

A 'through' alignment (shown in blue in **Figure 4-32**) was also considered for Canberra. However, compared to a more direct route between Yass and Goulburn paralleling the Hume Highway, the through alignment increases the travel time for passengers not travelling to or from Canberra by 13 minutes for a non-stopping train (and by 19 minutes for a service that stops at Canberra), as well as potentially exposing existing and planned Canberra suburbs to severance and noise impacts, regardless of whether trains stop in Canberra.

Figure 4-32 'Through' and 'spur' alignments, Canberra



Spur vs. through alignment - sustainability and land use considerations

Stations on a ‘through’ alignment would require additional land for track junctions at each end of the station (the station throat). These stations would be a minimum of 800 metres long, inclusive of track junctions. The two through tracks would be located in the centre of the station, isolated by concrete walls from the stopping tracks and side platforms, to permit the passage of through fast trains.

Stations on the ‘spur’ alignment would terminate at Canberra, removing the need for one set of track junctions and reducing the overall station length to approximately 600 metres. Smaller station footprints on the ‘spur’ alignment would require less urban land in Canberra’s centre, and would have less impact on adjacent infrastructure such as roads, utilities and buildings. Any sub-surface station would have to be constructed by cut and cover requiring demolition of any buildings or loss of trees above its footprint. There would, however, be an opportunity for subsequent development above the station after completion, within the height limits imposed by the National Capital Plan to preserve views of Mount Ainslie.

Access into Canberra’s urban centre would require property acquisition, impact existing infrastructure (roads and utilities), and potentially create noise and vibration impacts. These impacts would be greater through urban areas for the ‘through’ alignments, because they are longer than the ‘spur’ alignments. Some of this impact could be mitigated through the use of tunnels.

Both alignments would affect rural areas beyond Canberra’s urban extents. Impacts in rural areas would be less intense than those in urban areas. The potential impact on rural land and infrastructure would be greater with the ‘through’ alignment due to its longer length. The spur alignment achieves shorter travel times for passengers travelling between Melbourne and Sydney (the largest market for HSR), and results in \$3.3 billion additional user benefits compared with the through alignment. It also has capital cost savings of \$1.3 billion (for the proposed station at Ainslie Avenue), fewer adverse impacts on urban land and residents, and little impact on the service frequency to or from Canberra. Canberra residents would also not be affected by noise emanating from 20 trains per hour (in 2065) travelling at speed through the suburbs and city, with only six stopping.

A spur link to Canberra is the preferred option.

A summary of the comparison is provided in **Table 4-7**, while the detailed appraisal of the alignment options is provided in **Appendix 3A**.

Table 4-7 Comparison of through and spur alignments into Canberra

Criteria	Corridor into Canberra	
	Through alignment	Spur alignment
Length (km) (regional and urban)	140	121
Relative transit time (min) (Sydney-Melbourne non-stop)	+13.0	0
Relative transit time (min) (to Canberra)	0	+3
Relative net user benefits (\$b)	0	+3.3
Capital cost (\$b)	3.1-4.6	2.4-3.5
Constructability*	4	3
Sustainability and land use**	Not preferred	Preferred
Conclusion	-	Preferred

*Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

**Sustainability and land use assessed on a pair-wise comparison against seven criteria.

Assessment of potential station locations

Canberra has a smaller CBD than Brisbane, Sydney or Melbourne and the origin/destination of trips is more dispersed, with a higher proportion of car use. Four potential HSR station precincts were identified, as shown in **Figure 4-33**:

1. Lyneham, with a potential station site at Canberra Racecourse.
2. Dickson, with sites at Northbourne Avenue and Antill Street.
3. Civic, with sites at Northbourne Avenue and Ainslie Avenue.
4. Canberra Airport, with sites at the airport terminal and out of the airport grounds adjoining Pialligo Avenue.

Figure 4-33 Potential HSR station locations in Canberra



Lyneham precinct

This station site is located within the area currently used as Canberra Racecourse. If it were to be developed as an HSR station, the racecourse would need to be relocated.

The racecourse is located toward the north of a transport corridor between Gungahlin and Civic, which includes Flemington Road, the Federal Highway and Northbourne Avenue. Few HSR passengers would access this station on foot, with most travelling to the station by car/taxi or public transport. The site is approximately six kilometres to the north of Civic, which takes approximately 15 minutes by car. Northbourne Avenue experiences congestion during peak periods and trips may take longer at these times, and HSR passengers travelling by public transport would need to interchange at Civic for onward trips. A major parking facility could be provided adjacent to the station and it could be possible to integrate this station with the proposed light rail network. The area around the site could be redeveloped to provide residential, retail or employment opportunities. However, any development at Lyneham that attracts retail and employment opportunities is likely to have a detrimental impact on nearby Dickson, and is therefore contradictory to current planning for the centre of Canberra.

Dickson precinct

Very few passengers would access an HSR station at Dickson on foot. As with other station options located outside the Civic precinct, most passengers would arrive by car/taxi or public transport. Dickson is located toward the middle of the Gungahlin to City (Civic) public transport corridor, with the 4.5 kilometre drive to Civic taking around ten minutes. As with other station options in Northbourne Avenue, access to other areas of Canberra may be affected by peak period congestion. A major parking facility would need to be provided near the station, potentially requiring the removal of existing buildings. The station would also need to be underground, requiring the restriction of traffic access to Northbourne Avenue/Antill Street during the two to three years

of construction, which would also impact on the proposed light rail alignment and station.

Dickson-Antill Street

The Dickson-Antill Street HSR option would be located within Antill Street in the vicinity of the Dickson Centre, currently used for commercial and retail purposes. Construction would require the removal of existing buildings (commercial/retail and residential both north and south of Antill Street) and would impact on adjacent properties during construction and operation. The site would provide the opportunity for redevelopment to provide residential, commercial and/or retail facilities.

Dickson-Northbourne Avenue

The Dickson-Northbourne Avenue option would be located within the median of Northbourne Avenue. Potential redevelopment opportunities exist in the vicinity, through redevelopment of properties acquired for station construction. This option would have significant impacts on Northbourne Avenue during construction within the median, and would require removal of the trees that are an essential feature of this avenue as a gateway to Canberra. The construction of the station would require the complete closure of Northbourne Avenue, between Morphett Street and Antill Street, for approximately two to three years. This is considered an unacceptable impact on this significant formal entry to the national capital.

Civic precinct

The station sites identified in the Civic precinct are well located within Canberra's public transport network, and close to the city (Civic) interchange where the five rapid transit lines converge, providing good access to most of Canberra. Civic is the planned centre of the future transport network and urban growth in Canberra, and is the hub for the planned light rail service, commencing with the Civic to Gungahlin line⁶⁰. A major parking facility would need to be provided nearby, requiring the removal of existing buildings. A station in Civic yields the best user benefits.

60 ACT Government, loc. cit.

Civic-Northbourne Avenue

The Civic-Northbourne Avenue station site would be located within the median of Northbourne Avenue. It would not require property acquisition for the station itself, although it would significantly impact Northbourne Avenue and the proposed light rail during construction for a period of two to three years. The construction of the HSR station would require the complete closure of Northbourne Avenue, between London Circuit and Barry Drive/Cooyong Street, for two to three years, causing major disruption to Civic and through traffic. Potential redevelopment opportunities exist in Civic, which could be stimulated by an HSR station.

Civic-Ainslie Avenue

The Civic-Ainslie Avenue station option would be located within the median of Ainslie Avenue, requiring closure of most of Ainslie Avenue for two to three years during construction, and would not require property acquisition for the station itself. However, it is proposed that the site on the corner of Cooyong Street and Ainslie Avenue, currently developed as social housing, be used for additional multi-storey car parking combined with mixed use redevelopment. The current proposal for redevelopment of the site proposes buildings up to 15 storeys along Cooyong Street⁶¹. Existing buildings on the corner of Currong St and Ainslie Avenue are eight storeys high. Ainslie Avenue is a link in Canberra's transport network, although not as important as Northbourne Avenue, which acts as an entry avenue to Canberra. Potential redevelopment opportunities exist along Ainslie Avenue and in surrounding precincts, extending into Braddon.

Canberra Airport precinct

A submission from the ACT Government to the *Preliminary Draft Master Plan for Canberra International Airport* in 2009 indicated policy concerns around the expansion of employment activity at the airport. The submission stated that 'development outlined in the Draft Master Plan could challenge the role of Civic and the town centres in Canberra's commercial and retail hierarchy'⁶².

Recognising that the airport plays an important employment role in Canberra, the submission went on to state:

However, the Spatial Plan states that Civic and the town centres will be the primary focus for future employment growth. The town centres provide a focus for the surrounding residential population and are well served by public transport, appropriate community infrastructure and the arterial road network. On the contrary, uncontrolled growth at the airport has the potential to lead to increased travel time and associated greenhouse gas emissions as a result of longer more car dependant trips, compared to development at Civic and the town centres. Furthermore, the list of planned uses of Airport land goes beyond the essentially industrial, broadacre and transport-related uses envisaged for the eastern area of the ACT in the Spatial Plan⁶³.

Canberra Airport is located on a 'frequent local service public transport corridor' (a category of public transport corridor defined by the ACT Government), which provides less public transport capacity than the core 'rapid service network'⁶⁴. Canberra's 'frequent local service public transport corridors' aim to provide a service every 15 minutes (or better), while the 'rapid service network' on Northbourne Avenue is intended to provide a service every two to ten minutes (or better)⁶⁵.

61 ACT Government Community Services Directorate, *Urban Renewal Project Sections 52 & 57 Braddon & Section 7 Reid*, Planning Report Volume One, September 2011.

62 Canberra International Airport Pty Ltd, *Preliminary Draft Canberra International Airport 2008 Master Plan*, 2008.

ACT Government, *Submission by the ACT Government on the Canberra International Airport 2009 Preliminary Draft Master Plan*, May 2009.

63 *ibid.*

64 ACT Government, 2012, *loc. cit.*

65 *ibid.*

Located eight kilometres from the city centre, all passengers would be required to access an HSR station at the airport by car/taxi or public transport. There may be some synergies to share transport facilities provided at Canberra Airport, although both the HSR system and airport would experience concurrent demands.

Canberra Airport-Terminal

The Canberra Airport-Terminal site would be located adjacent to the recently expanded airport terminal facilities. This site would affect existing airport infrastructure and operations, and would be moderately difficult to construct. Redevelopment opportunities may be created by the HSR station, although these are likely to be industrial or commercial land uses, given the potential impacts of airport operations. A proposal by Canberra Airport to fund an HSR station at Canberra Airport has been published and would introduce some private funding (suggested at \$140 million)⁶⁶.

Canberra Airport-Pialligo Avenue

The Canberra Airport-Pialligo Avenue site would be located adjacent to the airport, to avoid direct impacts on the airport precinct. It would be easier to construct than a site at the terminal, but the site is remote from the airport and would require connecting pedestrian bridges or underpasses to cross the road.

Preferred city centre station site

An HSR station in Civic would allow HSR passengers to walk to buildings within the CBD and provide better access to the primary tourist destinations in the Parliamentary Triangle than a station at Lyneham, Dickson or Canberra Airport.

Either Civic station site would benefit from the economic status of Civic as Canberra's CBD, planned employment and retail development, and good fit with territory government planning and growth policy, and would provide opportunities for urban renewal. The construction of a station

in Ainslie Avenue would not be as disruptive as a station built in Northbourne Avenue. However, a Civic station is dependent on vehicle access and parking arrangements in Civic being able to accommodate the volume of forecast HSR passengers, especially in peak periods.

Civic-Ainslie Avenue has been nominated as the preferred station site (see Figure 4-34).

Preferred urban access alignment

The alignment to Civic-Ainslie Avenue would cross over the planned Majura Parkway near its start at the intersection of Mount Majura Road and Majura Road⁶⁷, then run parallel to Majura Parkway east of Mount Majura and deviate to the west, with a tunnel under Mount Ainslie towards Civic. The railway would approach Ainslie Avenue in a cutting, passing beneath Limestone Avenue before surfacing for the station platforms.

This alignment would shield Canberra residents in the urban area to the west of Mount Ainslie from visual and noise impacts, and would minimise the visual and noise impacts of HSR in the immediate area. Ainslie Avenue would be reconfigured after construction to reinstate through traffic.

Further detail of the Ainslie Avenue station is provided in **Chapter 5**.

The Civic-Ainslie Avenue site provides significant net user benefits, and creates opportunities for urban renewal and consolidation in the centre of Canberra. The cost of the HSR station is estimated to be \$0.16 billion. An HSR station at Civic-Northbourne Avenue has the highest capital cost at \$0.28 billion, due to a longer and more complex access alignment and the deep cut-and-cover construction required in a constrained work site/environment. It would require complex staging and enabling works to accommodate general traffic and construction access on Northbourne Avenue. The cut-and-cover construction in the median of Northbourne Avenue for the Northbourne Avenue station option would significantly impact works

⁶⁶ Canberra Airport, *57 minutes Canberra to Sydney ... and less than a decade away*, media release, 12 June 2012.

⁶⁷ The HSR alignment does not fully take account of the recently published Majura Parkway alignment. The HSR alignment would be elevated to pass over the Parkway, which would be constructed before HSR is built. A bridge is currently allowed for in the capital cost with further provisions within the capital cost risk allowances.

on the Gungahlin to City light rail project, which is planned to run in Northbourne Avenue⁶⁸. This disruption is anticipated to last two to three years.

The Dickson-Northbourne Avenue option is estimated to have a comparable cost to Ainslie Avenue, but would generate \$2 billion less in user benefits. The estimated total capital cost of the Dickson Antill Street option is \$100 million more, and user benefits would be \$2 billion less, than a station at Ainslie Avenue. The reduction in user benefits for the Dickson station sites are due to the longer station access times compared to the Civic station sites. Neither HSR station site at Dickson performed as well against the criteria as other sites. Stations at these sites have higher than average costs and would require demolition of buildings or impact Northbourne Avenue.

The Canberra Racecourse site has the lowest capital cost of the Canberra options of \$0.11 billion (the station structure), has a shorter access alignment than other options, would be relatively easy to construct and would be at surface level, removing the need for tunnelling. However, the user benefits are estimated to be \$2 billion lower than a station at Civic. The Canberra Racecourse site is not preferred because user benefits would be lower than other options, and the site is contrary to current centre planning in Canberra, even though it would provide opportunity for major mixed-use development adjacent to a station.

While the Canberra Airport sites had lower capital costs than other options, they also had the lowest user benefits of potential HSR sites in Canberra, limited redevelopment opportunities, and lowest public transport access. The proposed private funding contribution of \$140 million did not outweigh these issues. The sites are also contrary to current centre planning in Canberra, and lack the ability to generate mixed use development (residential and commercial) adjacent to a station, due to aircraft noise impacts.

The proximity of the Civic-Ainslie Avenue station site to the hub of a rapid transit system would facilitate public transport access to the HSR. In addition, car access to the HSR station could be accommodated by the provision of with multi storey public car park development with a mixed use commercial component on the site. Should capacity be exceeded, additional parking could be located towards the eastern end of Ainslie Avenue, with a shuttle bus service connecting the station precinct and car park. Nonetheless, if adequate parking were considered not to be feasible at Civic-Ainslie Avenue, a station at Canberra Airport is an alternative that could be further explored.

Table 4-8 presents a summary of the station options assessment. No peripheral stations are proposed in Canberra, due to the small size of the urban area. The preferred alignment may require slight amendment to accommodate the new Majura Parkway.

68 ACT Government, Gungahlin to City Transit Project, Project Update 3, September 2012.

Table 4-8 Assessment of potential city station options, Canberra

Objective	Criteria	Lyneham	Dickson		Civic		Airport	
		Racecourse	Antill Street	Northbourne Avenue	Northbourne Avenue	Ainslie Avenue	At Airport terminal	Adjacent to Pialligo Avenue
Economics and connectivity	Difference in user benefits from Civic options (\$b)	-2	-2	-2	-	-	-3	-3
	Pedestrian access to CBD	Low	Low - moderate	Low-moderate	High	High	Low	Low
	Public transport access (existing)	Moderate	Moderate	Moderate	High	High	Low	Low
	Parking availability (existing)	Low	Low-moderate	Low-moderate	Low	Low	High	Low - moderate
	Proximity to residential centre	Moderate	Moderate	Moderate	Moderate-high	Moderate-high	Low-	Low-
	Connectivity to arterial roads	High	High	High	Moderate - high	Moderate - high	High	High
	Overall accessibility	Moderate	Moderate	Moderate	Moderate - high	Moderate - high	Low-moderate	Low-moderate
Infrastructure	Capital cost – station structure only (\$b)*	0.11	0.21	0.15	0.28	0.16	0.13	0.11
	Station constructability**	1	5	5	5	3	3	1
	Capital cost – urban corridor (\$b)	0.31	1.0	0.92	1.5	0.95	0.52	0.52
	Urban corridor constructability**	2	4	4	4	3	2	2
	Capital cost – total (\$b)	0.42	1.21	1.07	1.78	1.11	0.65	0.63

Table 4-8 Assessment of potential city station options, Canberra (continued)

Objective	Criteria	Lyneham	Dickson		Civic		Airport	
		Racecourse	Antill Street	Northbourne Avenue	Northbourne Avenue	Ainslie Avenue	At Airport terminal	Adjacent to Pialligo Avenue
Sustainability, land use planning and policy fit***	Maintain existing land use – station	4.0	3.6	3.8	3.8	4.0	3.8	4.0
	Maintain community function – station	3.0	1.0	1.5	3.5	3.5	3.5	4.0
	Promote economic development – station	4.7	4.7	4.7	4.7	4.7	2.3	2.3
	Summary – station	Neutral	Slightly detrimental	Neutral	Neutral	Neutral	Neutral	Neutral
	Summary – urban corridor	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral	Neutral
Conclusions		-	-	-	-	Preferred	-	-
Principal reasons for non-selection		Lower net user benefits	Very difficult station constructability	Very difficult station constructability	High capital cost and very difficult station constructability	-	Lowest user benefits and accessibility. Lower economic development potential.	Lower user benefits and accessibility. Lower economic development potential.

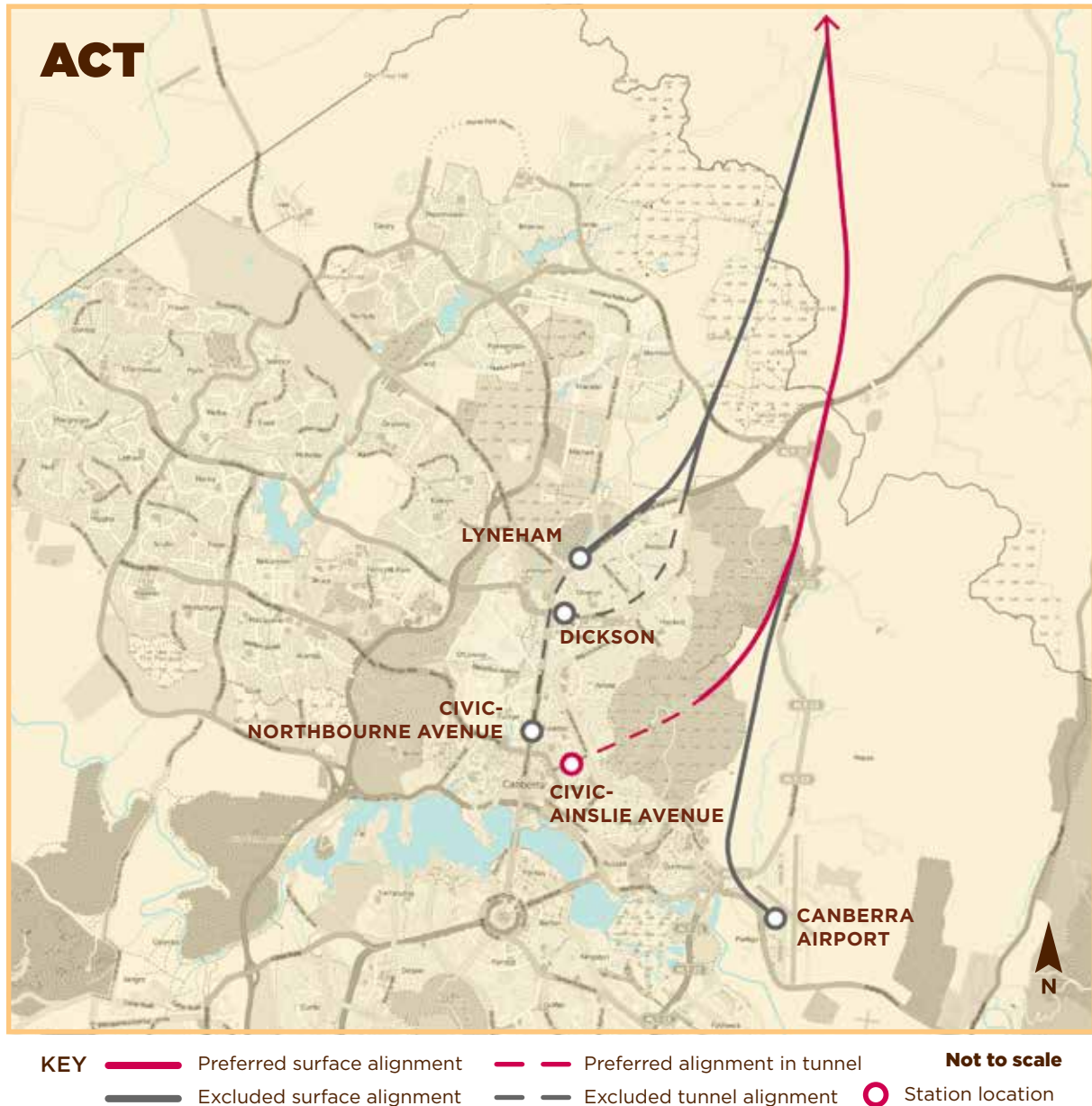
* Comparative capital cost estimates for the station structures were based on two platforms for a station in Canberra.

Finalisation of the demand has resulted in a requirement for three platforms. While the capital cost of the station structure is therefore higher than that shown above, the relative difference between station options does not change. The costs allowed in the capital cost estimate include all land, architectural finishes and car parking. The higher station structure cost has been included in the overall system capital cost estimates.

** Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

*** Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Figure 4-34 Preferred city centre station and alignment, Canberra



Canberra - preferred station site and urban access alignment

Civic-Ainslie Avenue is the preferred city centre station site in Canberra. This site provides more than \$2 billion additional user benefits over other options and an additional \$1 billion in net benefits when access and station construction costs are taken into account.

The preferred urban access alignment is broadly parallel to the Majura Parkway to the east of Mount Ainslie, with a tunnel section under Mount Ainslie to access Civic. This alignment would minimise the visual and noise impacts of HSR on the urban area to the west of Mount Ainslie. Ainslie Avenue would require reconfiguration to accommodate the station and its accesses, and to provide for through traffic.

4.9.3 Regional alignments (Goulburn-Yass connecting to Canberra spur)

Following the selection of the preferred station site and urban access alignment, the regional alignments between Goulburn and Yass, connecting to the Canberra spur at Gunning, were assessed (see **Figure 4-35**).

Goulburn Airport-Yass

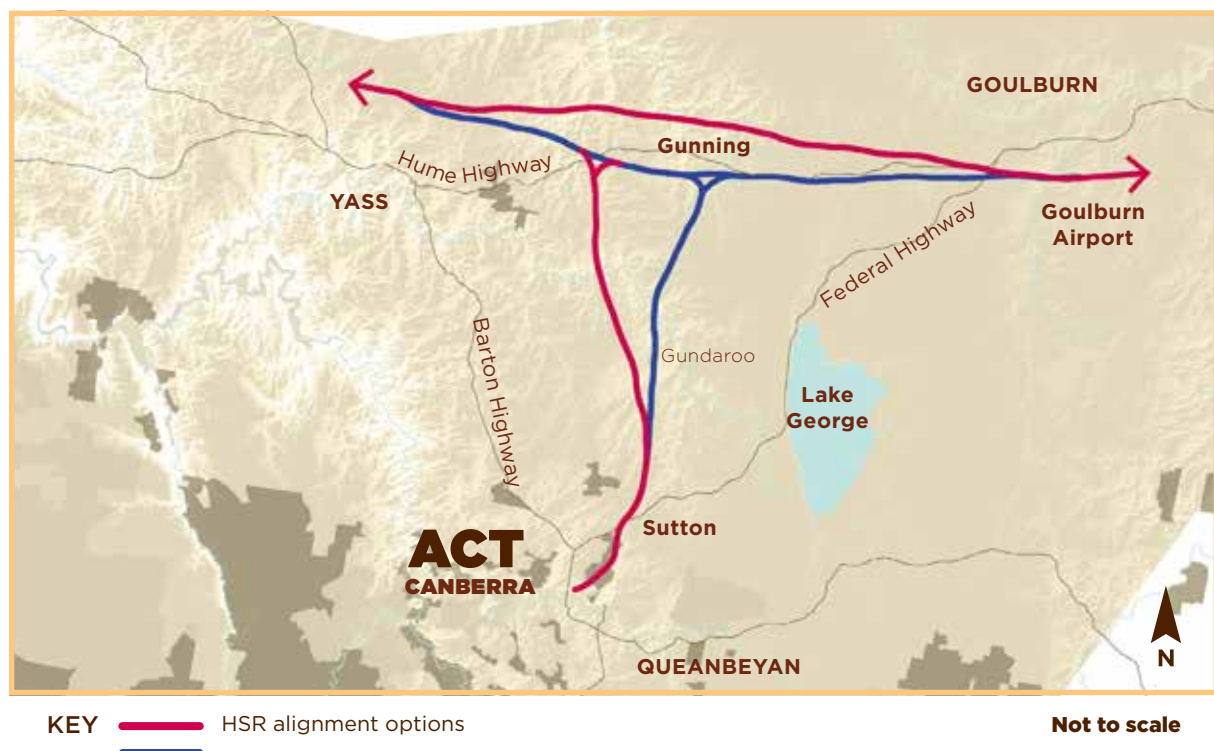
The red alignment passes to the north of the township of Gunning, whereas the blue alignment passes to the south. An alternative alignment located between the shortlisted red and blue alignments, while being slightly more direct, would have greater impact on the built-up area of Gunning and was not progressed.

While both alignments are close to Goulburn Airport, both options have adequate clearance between the HSR alignment and the runway.

The red alignment would have more adverse sustainability and land use planning impacts and higher capital costs (approximately \$0.3 billion higher, because of the additional length of spur line required to connect the line to Canberra) and would adversely affect part of the village of Breadalbane. The red alignment would also require a greater number and total length of bridge structures compared to the blue alignment, in part due to its multiple crossings of the existing Sydney-Melbourne rail corridor and Old Hume Highway.

The blue alignment to the south of Gunning (shown in Figure 4-35) is the preferred alignment between Goulburn Airport and Yass.

Figure 4-35 Goulburn to Yass alignment options



Canberra spur alignment options

Two alignments were shortlisted, which connected to the preferred blue alignment between Goulburn Airport and Yass. The main difference was the junction point with the through line, as shown in **Figure 4-35**. The blue alignment connected to the east of Gunning, while the red alignment connected to the west. Other alignments east of the blue alignment would encounter steeper terrain north of Gundaroo, and would therefore be more costly.

The red alignment would require an additional distance of 13 kilometres to be covered on the through line for Sydney-Canberra, incurring an additional train transit time of 2.5 minutes. Although this would be a benefit for Melbourne-Canberra passengers, the majority of boardings and alightings at Canberra would be for travel to and from Sydney. The blue alignment would have less impact on vegetated areas than the red alignment.

The blue alignment is the preferred alignment option between Gunning and Sutton.

4.10 Yass-Albury-Wodonga

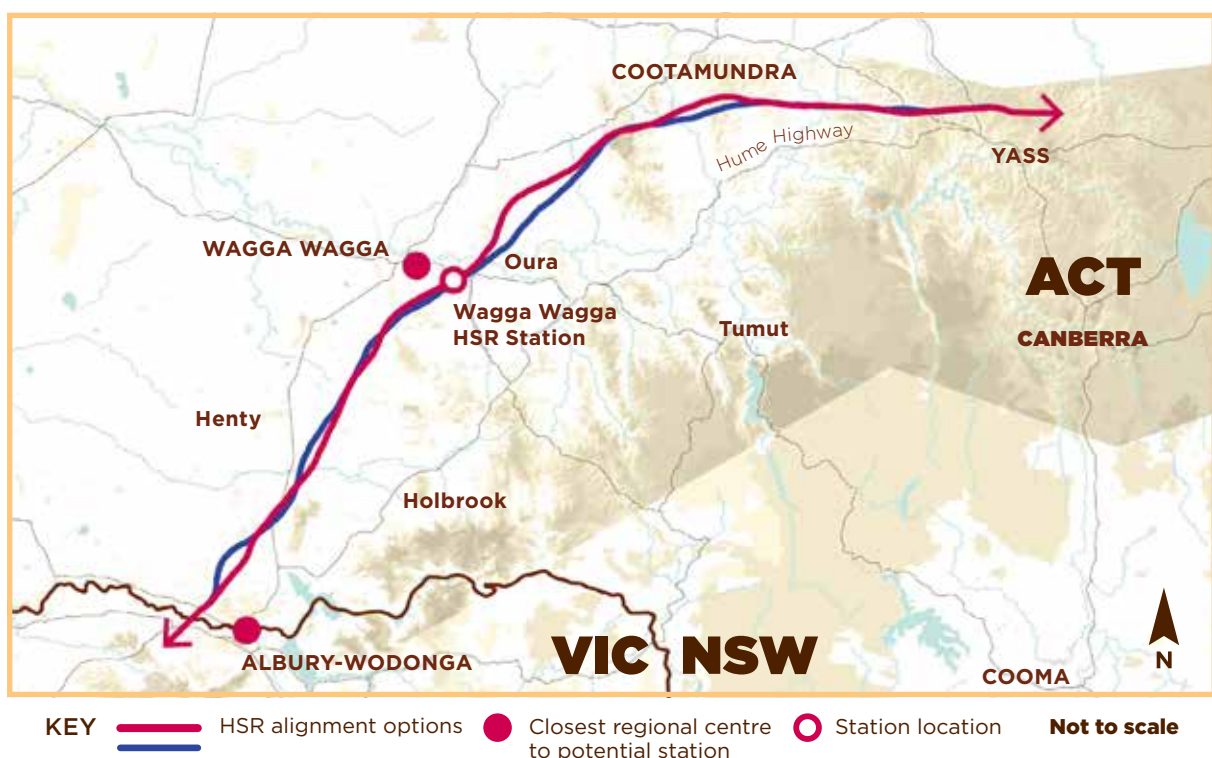
4.10.1 Overview

This area comprises parts of the South West Slopes and the Riverina. The terrain is hilly to the east but in the west towards Wagga Wagga the slopes ease to form the Riverina plain.

The region is generally sparsely populated, apart from the main towns such as Yass, Cootamundra, Gundagai, Tumut, Tarcutta, Wagga Wagga and Holbrook.

The higher altitude of much of this section means cooler temperatures, and some of the area is a recognised wine region. Away from the highlands, the area is characterised by flatter country which has generally been extensively cleared and is used for grazing purposes and modified wheat crops. Timber is a significant industry in the region, centred on Tumut. Major water courses include the Murray River and its main tributary, the Murrumbidgee River, with the associated wetlands of the Lowbidgee Floodplain. The Yass-Albury-Wodonga section is divided into two sectors: Yass-Wagga Wagga and Wagga Wagga-Albury-Wodonga, as shown in **Figure 4-36**.

Figure 4-36 Yass-Albury-Wodonga alignment options



4.10.2 Regional alignment and station assessments

Yass-Wagga Wagga

The two shortlisted alignments generally share a common route between Yass and Cootamundra, but between Cootamundra and Wagga Wagga are separated by up to six kilometres. Other options further south would involve significant additional capital costs due to the hillier terrain east of the Hume Highway.

The preferred option was selected taking into consideration the findings of the sustainability and land use planning appraisal, including minimising impacts at Oura and the Ulandra Nature Reserve. The blue alignment affects slightly more intensive agricultural land but the red alignment would have more significant impacts on urban areas, particularly Oura village.

The preferred alignment is an optimisation of the two shortlisted alignments.

Wagga Wagga station

Wagga Wagga is a major regional centre in the Riverina region. The Riverina is a major agricultural producer, with a large food and wine industry. Wagga Wagga City Airport is approximately ten kilometres east of the city centre on the Sturt Highway.

Wagga Wagga had a population of 59,458 in 2011, which is projected to grow to 72,800 in 2036 and 75,700 in 2056⁶⁹. A major growth area is proposed south of the city, around Lake Albert, which provides a constraint to potential station locations, as does the Murrumbidgee River, which runs east to west to the north of Wagga Wagga.

Options for station locations in the vicinity of Wagga Wagga City Airport were assessed.

The preferred location for a station at Wagga Wagga is to the south of the airport.

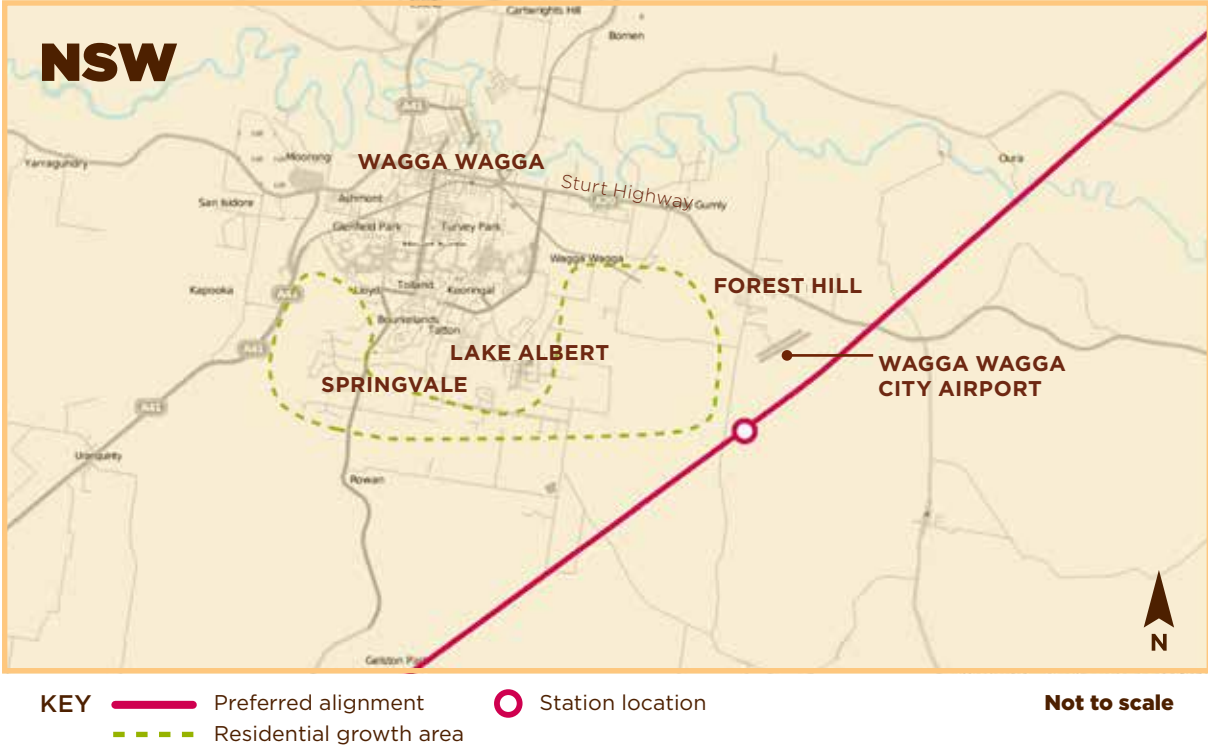
As shown in **Figure 4-37**, the location provides good access to the Sturt Highway via Elizabeth Avenue, with potential for synergy with the airport access off Elizabeth Avenue. Wagga Wagga, which has a conventional rail station, would be approximately 15 kilometres by road from the preferred station location.

Options to the north of the airport and Sturt Highway are constrained by the Kyeamba Creek floodplain and are likely to cost more, due to the added costs of construction in the floodplain. The urban development area planned to the south and east of Wagga Wagga would be supported by the station location, and there is a possible long-term option for a flood-free southern highway bypass on this land, which would improve accessibility to the station⁷⁰.

⁶⁹ ABS, loc. cit.

⁷⁰ ABS, loc. cit. Wagga Wagga City Council, Draft Spatial Plan, 2008.

Figure 4-37 Preferred Wagga Wagga station location



Wagga Wagga-Albury-Wodonga

The two alignments shown in **Figure 4-36** generally share a common route between Wagga Wagga and Henty. The alignments between Henty and Albury-Wodonga are separated by up to four kilometres. Alignment options to the east are less favourable because of the steeper terrain to the east and northwest of Albury-Wodonga. Alignments serving the Albury-Wodonga town centre along the route of the existing railway would have significant impacts on built-up areas, requiring acquisition of residential properties. Options further to the west are less direct and would have greater sustainability and land use planning impacts and/or higher capital costs.

There is no differentiation between the alignments on cost or travel time criteria.

The preferred alignment is therefore a further optimisation of the two shortlisted alignments to minimise potential impacts on agriculture and urban areas.

The blue alignment would have adverse impacts on a cluster of buildings at Maxwell and the edge of an intensive agriculture area, while the red alignment would have direct impacts on community infrastructure and the amenity of urban areas.

Albury-Wodonga station

Albury is located in the Murray region of NSW, while Wodonga is located in Victoria on the opposite bank of the Murray River. Together, Albury and Wodonga form a major regional centre, with a regional airport and the Charles Sturt University Campus. The population of Albury-Wodonga was 83,329 in 2011, which is projected to grow to 106,700 in 2036 and 113,500 in 2056⁷¹. A growth centre is proposed east of Albury around Thurgoona.

The area surrounding Albury-Wodonga has major natural features - including Lake Hume, the Murray River and hills northwest of Albury - as well as future residential growth areas. Potential HSR station zones were identified, taking these constraints into account while still seeking to provide good access.

Figure 4-38 Preferred Albury-Wodonga station location



Alignments and stations to the north and east of Albury would have significant adverse impacts on the existing built-up area.

As shown in **Figure 4-38**, options further north on the alignment would be constrained by the Murray River and its floodplain, while options further south would increase the station distance from Albury-Wodonga. The alignment would be constrained from moving closer to Albury-Wodonga by the topography north and west of Albury, Lake Hume to the north and east, and endangered species around Chiltern to the west.

The preferred station is located at Barnawartha North, southwest of Albury-Wodonga. The preferred location would provide good access to the Hume Freeway via the Murray Valley Highway. Albury would be approximately 25 kilometres by road and Wodonga approximately 20 kilometres by road from the proposed HSR station location,

between 15 and 20 minutes by vehicle via the Hume Freeway. A station in this area would also provide access to the Rutherglen and Murray Valley region to the west.

The preferred alignment could allow connections to be made between the HSR alignment and the existing rail line north and south of Albury-Wodonga in the future, if warranted, allowing regional services to access the existing stations. Options to the north of the Murray Valley Highway would be more costly, due to the additional costs of construction in the floodplain.

The preferred location for Albury-Wodonga station is northwest of the Hume Freeway/Murray Valley Highway interchange.

4.11 Albury-Wodonga-Melbourne

4.11.1 Overview

The landscape of the Albury-Wodonga-Melbourne area is dominated by the western edge of the Great Dividing Range, with the Hume Freeway tracing the path of least resistance as the range falls away from the High Country west to the Goulburn Valley region.

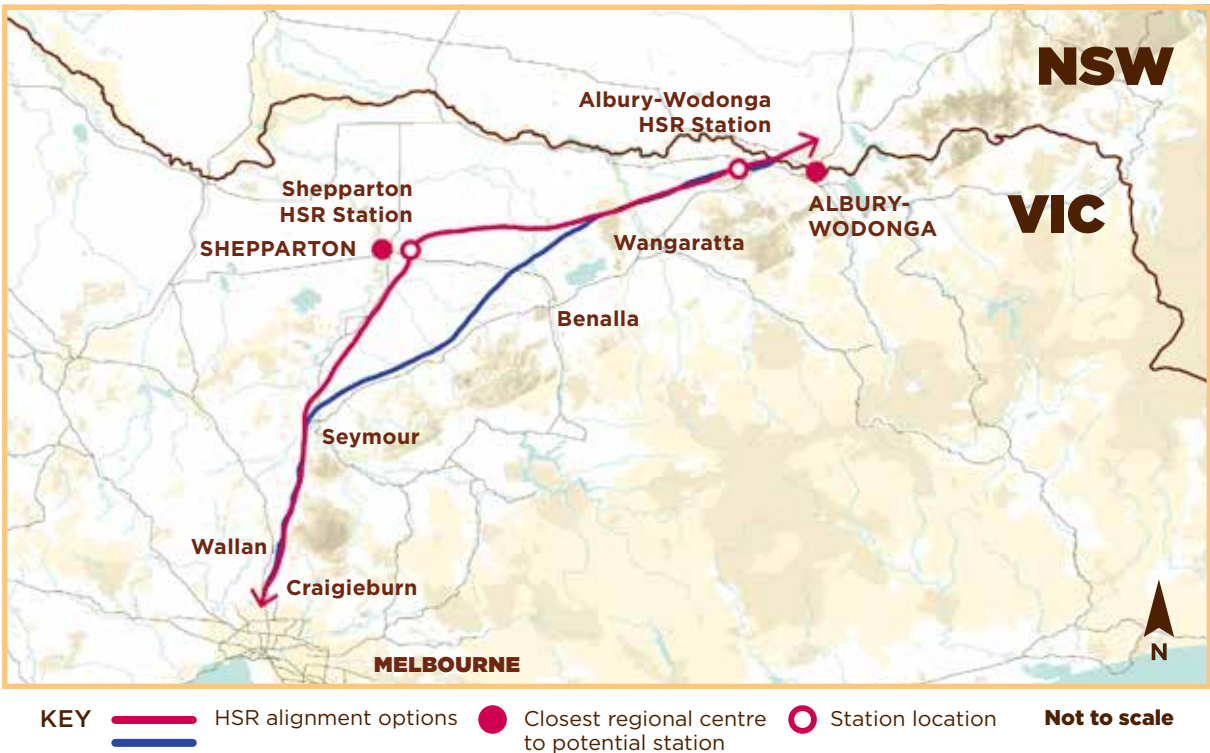
The main transport infrastructure is the Hume Freeway and the North East rail line. The main centres of population are the towns of Wangaratta, Benalla, Shepparton and Seymour. Agriculture in the region is diverse and includes fruit production and beef, dairy and sheep farms. The Goulburn

River flows west from the range and runs north through Seymour and Shepparton to join the Murray at Echuca. South of Seymour, the landscape gradually changes from regional to semi-regional to urban on the approach to Melbourne.

The Albury-Wodonga-Melbourne section is divided into three sectors: Albury-Wodonga-Wangaratta, Wangaratta-Seymour and Seymour-Craigieburn. Alternative sectors were subsequently established between Seymour and Wallan and Wallan to Craigieburn, to allow for the final assessment of the urban access corridors into Melbourne. This did not affect the preferred alignment between Seymour and Craigieburn.

The alignments assessed in this section are shown in **Figure 4-39**.

Figure 4-39 Albury-Wodonga-Melbourne alignment options



4.11.2 Regional alignment and station assessment

Albury-Wodonga-Wangaratta

Both the red and the blue alignments generally share a common route, with the greatest separation being less than two kilometres over relatively short lengths. Other alignment options were less direct and/or had increased sustainability and/or land use impacts.

The preferred alignment is an optimisation of the red and blue alignments.

This approach to options selection was based on the sustainability and land use planning impacts, particularly those on Boorhaman and the Chiltern Box-Ironbark National Park. The blue alignment would also have impacts on an industrial area adjacent to the Hume Highway.

Wangaratta-Seymour

The red alignment is a route via Shepparton while the blue alignment is a more direct route, generally following the Hume Highway as shown in **Figure 4-39**.

The red alignment is approximately 15 kilometres longer and would add 2.5 minutes to the train transit time, with a resulting disbenefit to through passengers of approximately \$0.8 billion. This would be broadly offset by the demand and user benefit (approximately \$0.7 billion) generated by an HSR alignment and a station close to Shepparton.

The red alignment via Shepparton would have a capital cost approximately \$0.1 billion higher than the more direct blue alignment. This relatively small difference, despite the considerable additional length, is because of the greater volume of earthworks that would be required on the more direct blue route due to its more undulating terrain.

Both alignments would have some impact on Plains Grassy Woodland, an endangered ecological vegetation class, that would need to be mitigated and/or offset during detailed design and construction should a decision be made to proceed

with HSR. The red alignment passes through the Rowan Swamp State Game Reserve. The blue alignment would impact on intensive agricultural land and would pass close to Longwood village, the Avenel Golf Course and the Avenel Aerodrome.

An alternative arrangement was also evaluated, which would serve Shepparton with a spur line from the blue alignment at Seymour, using either the existing rail line or a new dedicated HSR line between Shepparton and Seymour. However, neither option is justifiable on economic grounds (see **Appendix 3A** for details).

While the red alignment has a longer train transit time, the user disbenefit of the additional transit time would be broadly offset by the demand that would be generated by an HSR station close to Shepparton. The saving in capital cost for the blue alignment would be minimal and does not warrant bypassing Shepparton.

The red alignment is the preferred option between Wangaratta and Seymour.

Shepparton station

Shepparton is a regional city, located approximately 180 kilometres northeast of Melbourne. The City of Greater Shepparton had a population of approximately 60,449 people in 2011, which is projected to grow to 80,400 in 2036 and 88,200 in 2056⁷². The city has a regional airport and a conventional rail station with services to Melbourne.

Irrigation channels are a major constraint for any alignment close to Shepparton. Land east of Shepparton close to the Midland Highway would be the preferred area for a station. Options for station locations in this area were assessed and a preferred location was identified north of the Midland Highway, west of Pine Lodge Road, as shown in **Figure 4-40**.

This location would provide good road access on the Midland Highway from Shepparton, approximately ten kilometres by road from the proposed HSR station location. It would also avoid the fruit growing region and irrigation channels to the west.

72 *ibid.*

Figure 4-40 Preferred Shepparton station location



Seymour-Craigieburn

The two alignments generally share a common route between Seymour and Craigieburn and pass the built-up areas of Broadford, Kilmore and Wallan to the east. However, the alignment options do diverge in some sections to avoid various potential impacts.

Alignment options to the west of the built-up areas of Broadford, Kilmore and Wallan would have adverse impacts on proposed future land release areas as well as being a less direct route. Alignment options to the east of the shortlisted alignments would traverse increasingly steep terrain, which would add to the capital cost.

The red alignment would have more adverse sustainability and land use planning impacts compared to the blue alignment. While both

alignments would impact on urban growth precincts located between Craigieburn and Wallan and the Hidden Valley Golf Course community near Wallan, the red alignment would impact on an existing community between Wandong and Heathcote Junction. Due to being co-located with the existing rail line, the blue alignment would impact on endangered ecological communities that have survived relatively undisturbed in the rail reservation. A mitigation strategy for impacts on these vegetation communities, which could include offsets, would be developed during the concept design phase, should a decision be made to proceed with HSR.

The blue alignment is the preferred alignment option between Seymour and Craigieburn.

4.11.3 Melbourne

Overview

Melbourne has a population of approximately four million, which is projected to increase to over 6.6 million by 2056⁷³. Planning for Melbourne is managed through the Victorian Department of Planning and Community Development. The Department oversees the preparation of the Metropolitan Plan for Melbourne and urban growth strategies for cities and regions, and is preparing a new strategy for Melbourne, following the publication of *Melbourne 2030: a planning update – Melbourne @ 5 million* in 2008⁷⁴. Local government prepares local zoning and development plans consistent with the state growth strategies.

The Growth Areas Authority is an independent statutory body responsible for preparing and implementing urban expansion plans within Melbourne's growth areas. The current growth strategies call for about half of Melbourne's expansion to be accommodated in new suburbs within growth areas on the edge of Melbourne, in four corridors:

- Casey-Cardinia in the southeast.
- Melton-Caroline Springs in the northwest.
- Hume-Mitchell-Whittlesea in the north.
- Wyndham in the southwest⁷⁵.

This expansion is being supported by the construction and planning of new infrastructure such as:

- The newly constructed South Morang Rail extension.
- The Sunbury Electrification project, under construction.
- The Regional Rail Link project, under construction.
- The proposed Outer Metropolitan Ring Road.
- The Tullamarine Freeway extension to the Outer Metropolitan Ring Road.

- The planned Melbourne Metro.
- A proposed Melbourne Airport Rail Link.

A key principle of an HSR system is the grade separation of HSR and other road and rail assets. A significant challenge in Melbourne is the large number of road/rail level crossings on the existing conventional rail network. This alone makes the strategy of following existing rail corridors at surface level very difficult in most cases.

Strategic planning context and issues

The northern and northwestern approaches to the Melbourne metropolitan area generally present few topographic constraints due to the gentle undulating landform that characterises this part of the state.

The Melton-Caroline Springs and Hume-Mitchell-Whittlesea growth areas are relevant to the HSR alignment, as access to the city from the north would be through one of these areas. Urban development already extends approximately 30 kilometres northwest from the CBD to Caroline Springs/Calder Park and around 35 kilometres north of the CBD to Craigieburn.

To the northwest of Melbourne, in the Melton-Caroline Springs growth corridor, growth areas are proposed around Rockbank, located in the vicinity of the planned Outer Metropolitan Ring Road. As part of the Hume-Mitchell-Whittlesea growth corridor in the north, key growth areas are proposed north of Craigieburn and include Donnybrook, Kalkallo and Beveridge. These straddle the transport corridor containing the existing railway line to Sydney and the Hume Freeway to northern Victoria. Planning for a number of these areas to the north and northwest of Melbourne is already underway and further new urban development is expected over the medium to long term.

⁷³ ABS, loc. cit.

⁷⁴ Department of Planning and Community Development, *Melbourne 2030: a planning update – Melbourne @ 5 million*, December 2008.

⁷⁵ This excludes the announcement regarding further growth areas made by the Growth Areas Authority on 13 June 2012.

Environmental planning context and issues

The Kinglake National Park is located north and east of the main transport corridors north of Melbourne, and is sufficiently distant from these transport corridors to avoid adverse impacts from transport infrastructure and other development.

Elsewhere, environmental constraints include wide areas of native vegetation, wetlands and creeks, which tend to be concentrated east and west of the existing primary transport routes. Ecologically valuable grasslands are found throughout the northwestern and northern entry areas to Melbourne.

The entry points to Melbourne from the north are generally through farmland and sparsely vegetated areas, with widely scattered concentrations of native vegetation along creek and fence lines. Key sensitive ecological resources include areas of River Red Gums, threatened communities of natural temperate grasslands and Grassy Eucalypt Woodland of the Victorian Volcanic Plain. These are typically excluded from planned growth areas.

Other sensitive and protected ecological species and communities in these areas include Craigieburn Grasslands, Stony Knoll Scrubland, Plains Grassland, Curly Sedge and matted flax lily. Creek environments support the Growling Grass Frog, which is nationally listed as ‘Vulnerable’ under the EPBC Act and listed as ‘Threatened’ and classified as ‘Endangered’ under Victoria’s *Flora and Fauna Guarantee Act 1988*⁷⁶. Existing highway and rail corridors tend to avoid these and other threatened species and communities, and provide opportunities for co-locating future transport infrastructure.

Assessment of potential station locations

Two station precincts were assessed: the Southern Cross station precinct, and a precinct adjacent to Dynon Road in North Melbourne, approximately two kilometres north of Southern Cross station. Within each precinct, two station sites were identified:

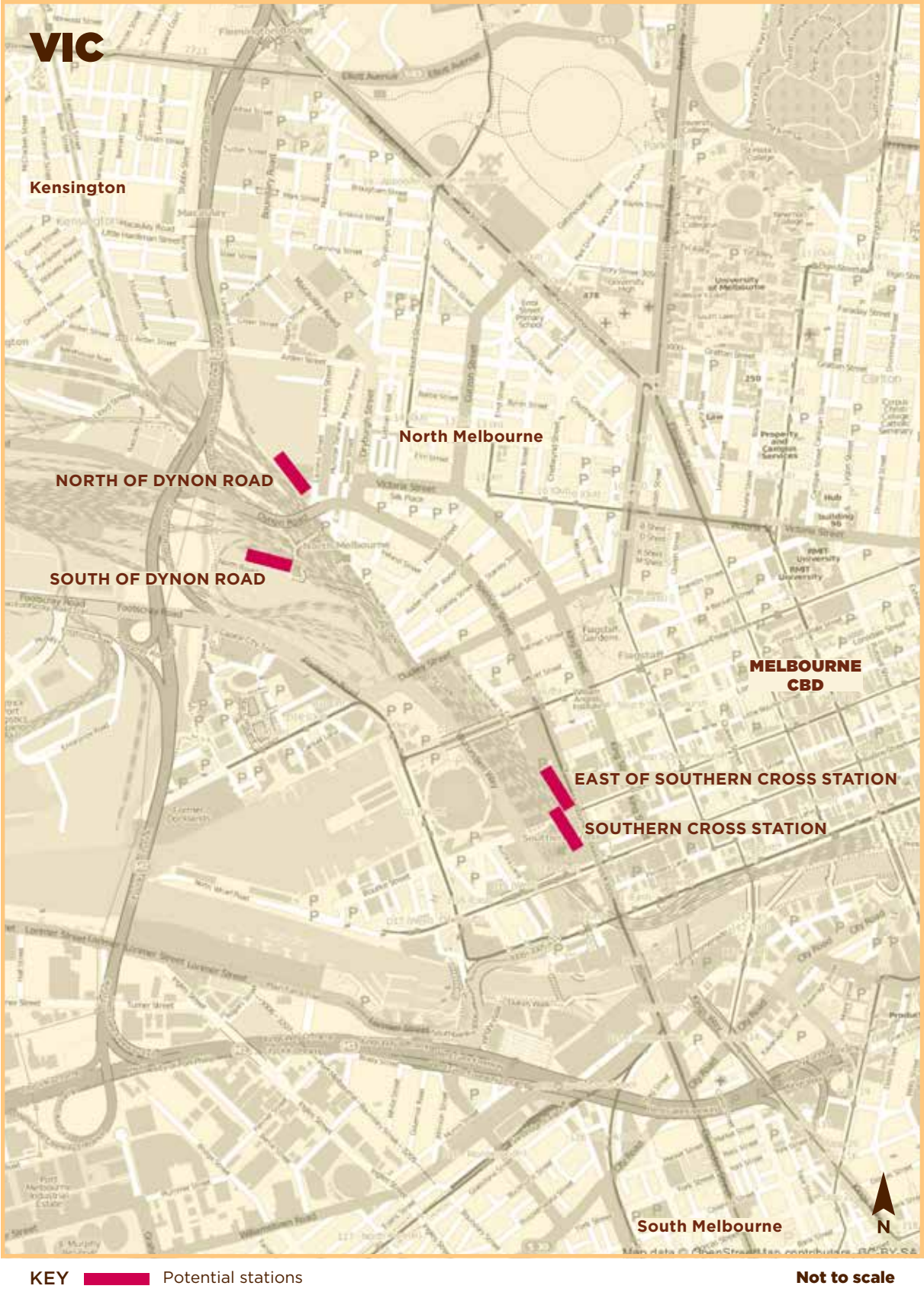
1. Southern Cross station
 - a. Existing platforms at Southern Cross station.
 - b. New platforms, to be constructed to the east of Southern Cross station, on the site of the current bus station.
2. North Melbourne
 - a. North of Dynon Road.
 - b. South of Dynon Road.

The station sites are shown in Figure 4-41, while Table 4-9 presents a summary of the station assessment.

Southern Cross station precinct

Two sites were considered within the Southern Cross station precinct, one using existing platforms within Southern Cross station, and the other immediately to the east, between the station proper and Spencer Street. Southern Cross station is close to the recently developed commercial and residential hubs of Docklands and Southbank, where significant investment has been made in tourism, sporting and entertainment facilities. Southern Cross station is also well connected to regional and interstate public transport, and existing road and pedestrian networks. It is the terminal for interstate rail services to Melbourne and the hub for the Victorian regional rail network (currently being expanded), and is served by tram and bus networks. Locating an HSR station at Southern Cross station is also consistent with Victorian Government policies that aim to reinforce the role of central Melbourne as a major employment centre.

Figure 4-41 Potential city centre station sites, Melbourne



Southern Cross station – existing platforms

The capital cost of an HSR station at Southern Cross station is estimated to be \$4.0 billion (\$3.9 billion for the urban access and \$0.1 billion for the station structure). There would be a marginal difference in user benefits for the two Southern Cross station options. Both would require relocation of the existing adjacent maintenance facility and stabling yards, as well as other rail infrastructure modifications, which have been priced in the final capital cost estimate.

East of Southern Cross station

Constructing an HSR station to the east of Southern Cross station is estimated to cost \$4.3 billion, \$0.3 billion more than putting the HSR platforms within the existing station, due to the need to demolish the existing bus terminal and construct an entirely new facility.

North Melbourne precinct

Two station options were considered in North Melbourne, to the north and south of Dynon Road. There is no difference between the two options in terms of capital cost or user benefits. When compared with the sites at Southern Cross station, however, they both result in a \$4.0 billion disbenefit to HSR passengers, mainly because of their distance from the CBD. An HSR station at North Melbourne is also not supported by current growth strategies for Melbourne, which do not identify North Melbourne as a significant centre.

North of Dynon Road

The site north of Dynon Road, between Arden Street, Laurens Street and Dynon Road, is currently a mix of industrial and low-medium density residential and commercial uses. There is likely to be demand for higher density development in the area in the future, although this would be from a relatively low base. Any opportunities for development would be restricted to the east of the existing metropolitan rail lines at surface level. This site has good connectivity to public transport and road networks, but poor pedestrian accessibility to the CBD. The proposed Melbourne Metro will pass to the north of the site, in an east-west direction along Queensberry Street.

South of Dynon Road

The site south of Dynon Road and west of the existing rail lines would require changes to the road and pedestrian infrastructure to improve its accessibility to the CBD and surrounding urban areas.

Preferred city centre station site

Southern Cross station has recently undergone redevelopment and, as such, operates well as an interchange. It would provide good accessibility between HSR and suburban and regional train services. Additionally, a number of bus and tram routes currently operate on Spencer Street outside the station.

The Southern Cross station precinct sites offer greater user benefits, such as better access and connectivity, than the North Melbourne precinct sites. An HSR station within the Southern Cross station precinct is likely to be a catalyst for more economic development and employment opportunities and is more closely aligned with Victorian Government planning policies.

Using the existing Southern Cross station platforms would be less costly, mainly due to the use of the existing and recently refurbished station structure. It also has less impact on surrounding land uses. The difference in user benefits between the Southern Cross station precinct sites would be marginal.

Both sites in the North Melbourne precinct perform less favourably against the criteria than the Southern Cross station sites. The North Melbourne sites have therefore not been carried forward for further assessment.

The preferred station site option is the Southern Cross station precinct, using the existing platforms.

Table 4-9 Assessment of potential city centre station sites, Melbourne

Objective	Criteria	Southern Cross station		North Melbourne	
		Existing platforms	East of Southern Cross station	North of Dynon Road	South of Dynon Road
Economics and connectivity	Difference in user benefits from Southern Cross (\$b)	-	-	-4	-4
	Pedestrian access to CBD	High	High	Moderate	Moderate
	Public transport access (existing)	High	High	Moderate-high	Low
	Parking availability (existing)	Low	Low	Moderate	Low
	Proximity to residential centre	Moderate-high	Moderate-high	Low	Low
	Connectivity to arterial roads	Moderate	Moderate	Low	Low
	Overall accessibility	High	High	Low	Low
Infrastructure	Capital cost (\$b) (station basic structure)	0.1	0.4	0.2	0.2
	Capital cost (\$b) (access corridor)	3.9	3.9	3.8	3.8
	Capital cost (\$b) (total)*	4.0	4.3	4.0	4.0
	Constructability**	2	3	3	2
Sustainability, land use planning & policy fit***	Maintain existing land use	3.8	3.2	3.8	3.4
	Maintain community function	3.5	3.0	2.5	4.0
	Promote economic development	7.0	7.0	5.7	5.7
	Summary	Slightly beneficial	Neutral – slightly beneficial	Neutral	Neutral – slightly beneficial
Conclusions		Preferred	-	-	-
Principal reasons for non-selection			Capital cost	Lower user benefits and accessibility	Lower user benefits and accessibility

* Highest cost preferred access corridor used for consistent comparison purposes.

** Constructability is assessed and scored between 1 and 5, with the higher score reflecting more construction complexity.

*** Sustainability, land use and policy fit is assessed and scored between 1 (highly detrimental) and 7 (highly beneficial).

Assessment of urban access alignments

In arriving at the preferred HSR urban access alignments, existing and proposed Victorian Government infrastructure schemes were examined for synergies, in terms of both shared infrastructure and shared sites for peripheral stations, while ensuring the HSR would not adversely impact these schemes.

The relatively straight highway and rail corridors linking metropolitan Melbourne with towns in northern Victoria present opportunities to co-locate HSR in outer urban areas, helping to minimise environmental and land use impacts. Similarly, consideration was given to minimising impacts on existing inner urban development by co-locating alignments within, adjacent to or below existing rail and road corridors. Viaducts were also considered, but were found to cost as much as tunnelling in urban areas, because of their additional land requirements and the need for complex grade separated crossings at major intersections.

A particular constraint on Melbourne's inner urban rail system is the large number of existing level crossings. Therefore, bored tunnel inner urban alignments were preferred from a sustainability, land use, environmental and policy perspective, to eliminate or reduce impacts to level crossings. However, where the alignment emerges from a tunnel, or where the radius of an existing corridor is too tight for high speed trains, there would be increased environmental impacts including property acquisition and demolition as the result of the necessarily widened corridor.

Ten potential alignments were identified to access the Melbourne station at the Southern Cross station precinct. Details and comparative evaluations of these can be found in **Appendix 3A**.

Preferred urban access alignment

The environmental and land use impacts of the various options are very similar. The main factors determining the shortlist were capital cost, user benefit and constructability. Three urban access alignments were selected for more detailed investigation:

- Via Craigieburn and Jacana (shown in green on **Figure 4-42**).
- Via Craigieburn and Upfield (shown in red on **Figure 4-42**).
- Via Yuroke (shown in blue on **Figure 4-42**).

These were extended to a common point at Wallan (to the north), to enable identification of the best overall access to Melbourne. Further detail of this process can be seen in **Appendix 3A**.

The alignments via Craigieburn (shown in green and red on the map) were preferred over the blue alignment, as they would have lower capital cost and would offer time savings.

Of these two alignments, the green alignment has the advantage of providing a shared corridor and, potentially, shared infrastructure with a future express rail link between Melbourne Airport and Southern Cross station. The Victorian Government has already allocated funding to plan for a rail link to Melbourne Airport.

However, for HSR alone, the least costly and most efficient urban alignment is via Upfield, shown in red. This alignment would deliver a time and cost benefit, with less complex construction, when compared to the alternative green alignment. This alignment forms part of the overall HSR capital cost estimate in **Chapter 6**. The cost estimate does not include peripheral costs of additional links.

The preferred urban access alignment is via Craigieburn and Upfield, shown in red on Figure 4-42.

Future opportunities for synergies between HSR and a Melbourne Airport rail link should be investigated further as the Victorian Government finalises its proposals.

Figure 4-42 Preferred alignments to Southern Cross station, Melbourne



Peripheral station assessment

Two potential peripheral locations were identified on the preferred route: one at Craigieburn and the other at Campbellfield. The selection process is outlined in **Appendix 3A**.

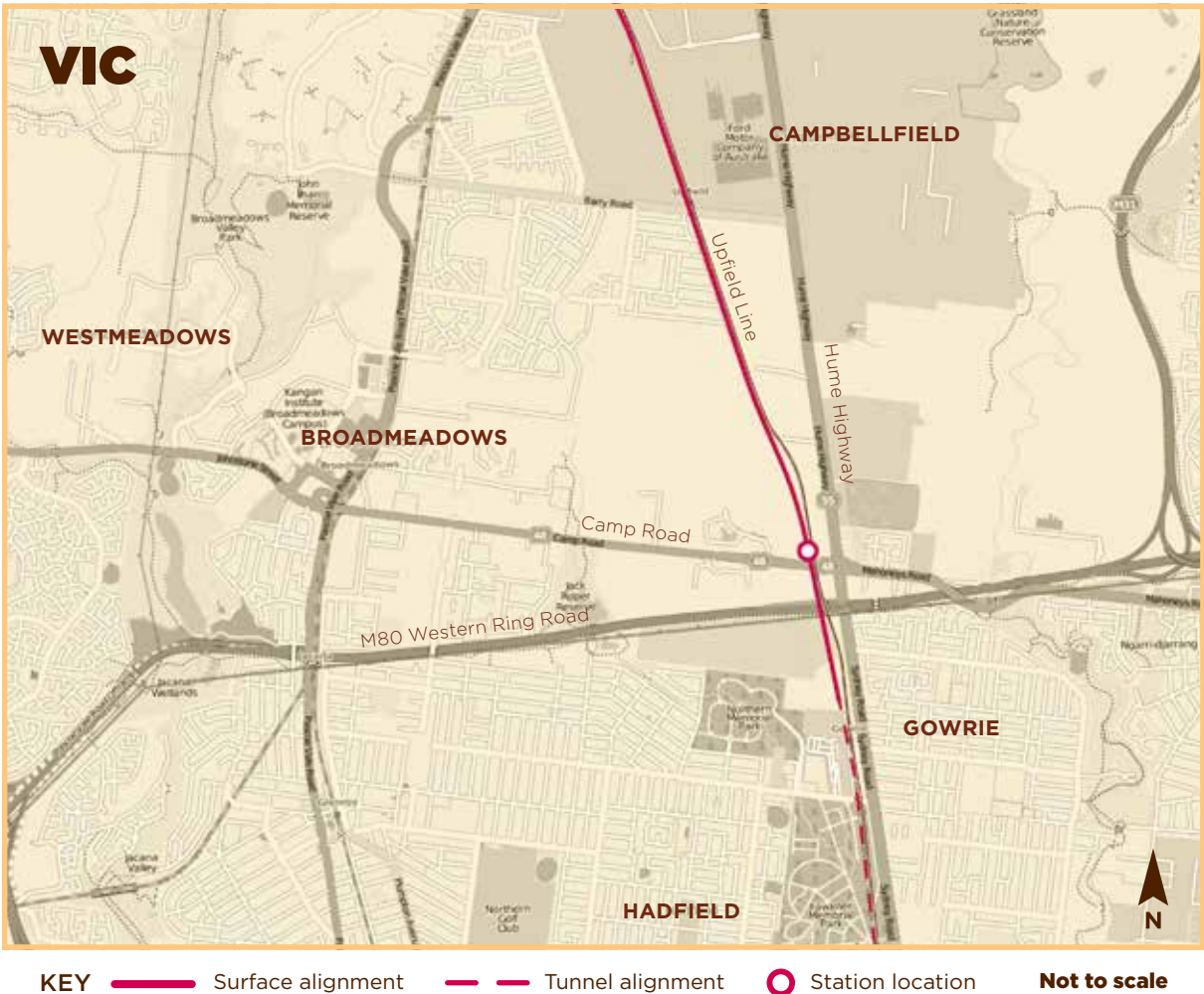
The preferred peripheral station is Campbellfield, near the M80 Western Ring Road.

The site is located north of Gowrie, to the west of the intersection of Camp Road and the Hume Highway, as shown in **Figure 4-43**. The station would be constructed at ground level, oriented north–south.

The site has potential access to the Hume Highway to the east and Camp Road to the south. These roads provide access to the M80 Western Ring Road/Hume Highway interchange for regional road network access throughout Melbourne. Local car parking access roads would be required. There is potential for a future interchange between the HSR station and the urban rail network which passes to the east of the site.

The site is adjacent to land currently occupied by light industrial units. Location of an HSR station in Campbellfield could stimulate future development and increase land use densities. Provision of an HSR station in Campbellfield would yield user benefits of \$3 billion.

Figure 4-43 Location of Campbellfield peripheral station, Melbourne



The station site at Craigieburn is adjacent to both the Hume Highway and Hume Freeway, providing good access to the regional road network to northern Melbourne. The proposed Outer Metropolitan Ring Road (E6), adjacent to the existing suburban Craigieburn station, would further increase regional road accessibility and provide a direct interchange with the existing rail network.

The site is largely brownfield and includes a light industrial property. This area is planned as a major growth centre for Melbourne, with a future town centre to the west of the HSR station site. The appraisal found that an HSR station in Craigieburn could yield user benefits of \$1.8 billion – considerably lower than the Campbellfield site.

Melbourne – preferred station site and urban access alignment

A city centre station at Southern Cross station is preferred over North Melbourne. It would generate greater economic benefits and be better aligned with Victorian Government planning policies than the options at North Melbourne. It would also provide better connectivity with Melbourne CBD and nearby complementary infrastructure, and yield greater user benefits than the North Melbourne options.

If the Melbourne Airport Rail Link project were to proceed, combining the rail link and HSR projects into the same corridor could be cost efficient, minimise social impacts through the use of one corridor, and offer a better planning solution for access to Melbourne CBD. The overall net benefit of developing the two projects together may be higher than developing the projects separately.

The access corridor via Craigieburn is preferred over the corridor via Yuroke, as it has a lower capital cost and would offer time savings.

For HSR alone, the least costly and most efficient urban alignment would be via Upfield.

The Jacana alignment has the advantage of providing a shared corridor and, potentially, shared infrastructure with a future express rail link between Melbourne Airport and Southern Cross station. Future opportunities for synergies between HSR and a Melbourne Airport rail link should be investigated further as the Victorian Government finalises its proposals.

Campbellfield on the Upfield alignment is the current preferred peripheral station for Melbourne, adjacent to the M80 Motorway. This option has good accessibility to the regional road network via the M80 Motorway (Western Ring Road) and provides opportunity for access to the urban rail network via the Upfield line.

4.12 Conclusion

The process of identifying, evaluating and selecting the alignment and station options for the HSR system has been extensive and detailed, even at this early strategic stage.

As noted at the beginning of this chapter, a range of alternative alignments and station locations were analysed and compared to select the preferred HSR alignment, with the aim of:

- Maximising the value of each option in serving travel demand.
- Avoiding significant adverse environmental impacts.
- Minimising the acquisition of private property.
- Supporting land use planning strategies where feasible.
- Limiting construction risks, including impacts on existing railway operations and major roads.

The methodology employed to analyse the various options focused on achieving maximum value from each option, minimising environmental impacts and the need to acquire land, supporting existing land use planning strategies and limiting construction risks, including impacts on existing railway operations and major roads.

International experience shows that HSR journeys of less than three hours can attract over 50 per cent of the travel market mode share. The focus throughout much of this stage of the study has therefore been on selecting an alignment that is capable of achieving high average speeds, so that the HSR can compete with other travel modes, particularly air.

The track geometry required to achieve these speeds would make a surface alignment highly disruptive in densely populated areas, would require extensive land acquisition (and associated costs), and would result in noise impacts, community severance and poor visual amenity to a large number of people, particularly where the route would pass through the middle and inner suburbs of the capitals. In densely populated areas such as Sydney and Melbourne, tunnelling would alleviate these impacts, and would also allow for sufficient operating speeds to connect the capital cities within three hours and remain competitive with air travel.

The analysis considered the costs, user benefits, accessibility, and environmental and social impacts of each alternative, as well as the associated risks during construction. These criteria are explained in the introduction to this chapter, and detailed more fully in **Appendix 3A**.

The selected alignment serves the major cities, but also importantly the key regional areas, across three states and the ACT. The preferred alignment and station locations have been identified through a rigorous selection process that was based on well-proven engineering, and which balances environmental, social and cost considerations.

The preferred alignment described throughout this chapter has been used to generate the capital cost estimate in **Chapter 6**.