4 Project development and alternatives

This chapter describes the alternatives that were considered as part of the project development process and explains how and why the project was selected as the preferred option. Design refinements for particular elements of the project are also addressed.

Table 4-1 sets out the Director-General's Requirements as they relate to alternatives and options development, and where in the environmental impact statement these have been addressed.

Table 4-1 Director-General's Requirements - project development and alternatives

Director-General's Requirement	Where addressed
An analysis of alternatives/options considered having regard to the project objectives (including an assessment of the environmental costs and benefits of the project relative to alternatives and the consequences of not carrying out the project), and the provision of a clear discussion of the route development and selection process, the suitability of the chosen alignment and whether or not the project is in the public interest.	**Chapter 4**

The project has a long history in relation to the evaluation of alternatives and options commencing with the *F3 to Sydney Orbital Link Study* (SKM, 2004) (the 2004 report) through to the recent design and construct tender process.

Figure 4-1 shows the alternatives and options development process undertaken for the project.

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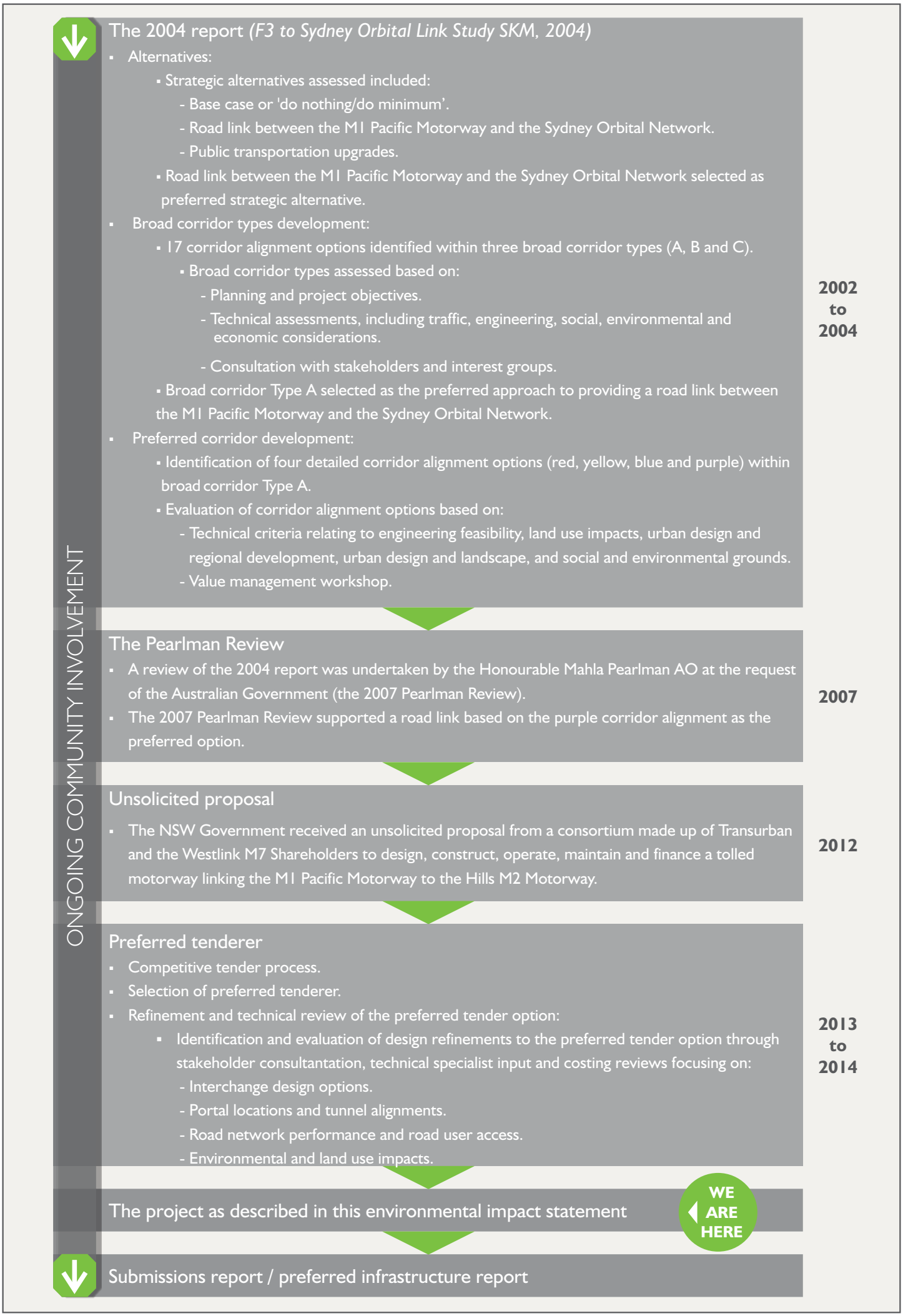

Figure 4-1 Project development process

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4.1 F3 to Sydney Orbital Link Study

In 2002, the Australian Government commissioned an investigation to identify a preferred option for a new link through northern Sydney between the F3 Freeway (now the M1 Pacific Motorway) and the Sydney Orbital Network (being the Hills M2 Motorway and the Westlink M7 Motorway). The findings and recommendations of this investigation are detailed in the *F3 to Sydney Orbital Link Study* (SKM, 2004) (the 2004 report).

The 2004 report established project and planning objectives, alongside urban design principles, to guide the selection of a preferred corridor for the new road link. The planning and project objectives of the 2004 report were:

- Alleviate existing poor travelling conditions (traffic congestion and high number of road crashes) on the interim National Highway and the surrounding network.
- Improve local amenity (reduce traffic, air and noise emissions; reduce severance) for people living and working along Pennant Hills Road.
- Improve travel reliability and reduce operating costs of long-distance commercial and freight transport on the National Highway.
- Provide a high standard link that integrates with the regional transport network.
- Minimise social and environmental impacts during construction and operation.
- Provide opportunities for improved public transport.
- Be economically justified and affordable to government.

The 2004 report considered a range of strategic alternatives to providing a road link including 'do nothing' and a public transport upgrade. The investigation also identified and assessed a number of broad corridor types followed by an examination of options within the preferred corridor.

4.1.1 Strategic alternatives

The strategic alternatives assessed as part of the 2004 report were:

- Base case or 'do nothing / do minimum'.
- Road link between the M1 Pacific Motorway and the Sydney Orbital Network.
- Rail and public transportation upgrades.

The base case or 'do nothing / do minimum'

The theoretical base case or 'do nothing' alternative was defined as the minimum possible upgrade to the existing road network, with no major capital or operating expenditures on roads in the existing corridor.

It was determined that this alternative would not provide a desirable outcome in terms of road alignment. Therefore, it was concluded that the 'do nothing' alternative would not provide a suitable long term solution from a strategic, regional, local planning or transport perspective.

Up to date traffic modelling has been undertaken for the 'do nothing' scenario which is provided in **Section 7.1** (Traffic and transport).

Road link between the M1 Pacific Motorway and the Sydney Orbital Network

The 2004 report identified that, following the completion of the Westlink M7 Motorway, the connection between the M1 Pacific Motorway and the Sydney Orbital Network (being the Hills M2 Motorway and the Westlink M7 Motorway) would represent an important 'missing link' in Sydney's motorway network. This would require traffic travelling to, from or through Sydney to share the section of Pennant Hills Road between the M1 Pacific Motorway and the Hills M2 Motorway. This would include traffic travelling to or from major cities and centres intrastate and interstate, such as the Central Coast and Newcastle, Brisbane and Melbourne.

Pennant Hills Road, between the M1 Pacific Motorway and the Hills M2 Motorway, services both local and regional trip purposes and functions, and carries high volumes of traffic. It experiences congestion during peak periods, resulting in low average peak travel speeds, unreliable travel times and disruptions to inter-regional traffic movements. In addition, between 1 July 2008 and 30 June 2013, the section of Pennant Hills Road between the Pacific Highway and the Hills M2 Motorway had a total of 980 crashes, with one fatal and 342 injury crashes

The 2004 report identified that a high standard link between the M1 Pacific Motorway and the Sydney Orbital Network would improve local amenity, and travel safety and efficiency.

Rail and public transportation upgrades

The 2004 report investigated four rail and public transport options, being:

- No further rail capacity enhancements.
- Rail capacity enhancements to maintain market share.
- Investment to increase rail market share.
- Public transport only option, which included investment to increase market share in passenger and freight rail, as well as replacing the investment in the new link with a new passenger rail service.

The first three scenarios were tested in conjunction with a proposed project, whilst the public transport only option was investigated as an alternative to the project. As such, this alternative is discussed below.

The public transport only option was based on the implementation of all planned rail (passenger and freight) infrastructure improvements plus additional investment in lieu of expenditure on a road link. These improvements included:

- Rail:
  - North West Rail Link (Epping to Rouse Hill).
  - Full Chatswood to Parramatta rail link.
  - Epping to Thornleigh Third Track.
  - Main North Line upgrade between Hornsby and Wyong.
  - Quadruplication of Strathfield to Hornsby line, including the Epping to Thornleigh Third Track.
  - Two completely new train services linking the Central Coast with Parramatta and Western Sydney were included in the 2021 network.

- Bus:
  - Completion of the bus Transitways listed in Action for Transport 2010.

As traffic volumes grow, there would be greater pressure to improve the efficiency of the National Land Transport Network to service expanding commercial centres and to cater for local and district freight transport demands and in doing so, support the State's economy. Although these improvements would play an important role in servicing the corridor, the 2004 report found that public transport alone and in particular rail transport would be unlikely to satisfy future growth in transport demand.

In relation to rail freight, the investigation found that the high rail freight growth scenario would only remove around ten per cent of trucks from Pennant Hills Road per day. A significant number of trucks would continue to utilise Pennant Hills Road under this scenario.

A number of projects identified above, such as the North West Rail Link and the Epping to Thornleigh Third Track, have either commenced construction or are in the final stages of planning. These projects would be undertaken concurrently with the project. However, as stated above they would be unlikely to satisfy future transport demand and would cater for different markets and objectives than the project. Both of these rail projects would enhance the existing rail infrastructure however they would not directly improve conditions on Pennant Hills Road or provide a much needed link between the M1 Pacific Motorway and the Sydney Orbital Network.

Preferred strategic alternative

Based on the preceding comparisons it was concluded in the 2004 report that a road link between the M1 Pacific Motorway and Sydney Orbital Network would best meet the project objectives and was the preferred alternative as it would:

- Provide a high standard access controlled motorway that would integrate with the regional transport network.
- Improve the travel conditions, road safety and efficiency of Pennant Hills Road for motorists, road based public transport and cyclists.
- Support local and regional economic development.
- Provide opportunities for improved public transport in the area around Pennant Hills Road.
- Provide a motorway that is safe and reliable for road users.

A road link between the M1 Pacific Motorway and the Sydney Orbital Network would provide a preferred solution from a strategic, regional, local planning and transport perspective. The development of this road link was seen to be in the public interest.

4.1.2 Corridor options development process

Following the identification of a road link between the M1 Pacific Motorway and the Sydney Orbital Network as the preferred strategic option, a corridor options development process was undertaken as part of the 2004 report. This began with consideration of broad corridor types followed by examination of alignment options within the preferred broad corridor type.

The options development and assessment process considered the options against transport capacity, efficiency and safety, social effects, environmental issues and economic factors.

Broad corridor types

The 2004 report identified 17 alignment options within three broad corridor types (A, B and C) that provided feasible connections to the M1 Pacific Motorway and to the Sydney Orbital Network (refer to **Figure 4-2**). A number of the alignment options within these broad corridor types were suggested by members of the community during the consultation process associated with the corridor options development.

Type A corridors included more easterly alignment options, which generally formed a southern extension of the M1 Pacific Motorway corridor to connect with the Hills M2 Motorway. All Type A corridor options would be mostly in tunnel under existing roads and / or residential areas. The Type A corridor options continued to use the M1 Pacific Motorway as the major road transport link between Sydney and the north.

Type B corridors included alignment options within the central study area that connected the Sydney Orbital between Pennant Hills Road and Dean Park to the M1 Pacific Motorway between Wahroonga and the Hawkesbury River. The Type B corridor options bypassed the developed areas of Hornsby and generally consisted of aboveground sections and tunnels under existing residential areas. Type B corridor options continued to use the M1 Pacific Motorway corridor as the major road transport link between Sydney and the north.

Type C corridors included more westerly options which connected the Sydney Orbital between Windsor Road and Dean Park with the M1 Pacific Motorway north of the Hawkesbury River. All Type C corridor options consisted of aboveground and tunnelled sections, and a major new crossing of the Hawkesbury River. It was also assumed that some tunnel sections would be required under Marramarra National Park. Type C corridor options formed a second major road corridor between Western Sydney and the north. The Type C corridor options continued to use the M1 Pacific Motorway corridor as the major transport link between Sydney and the north.

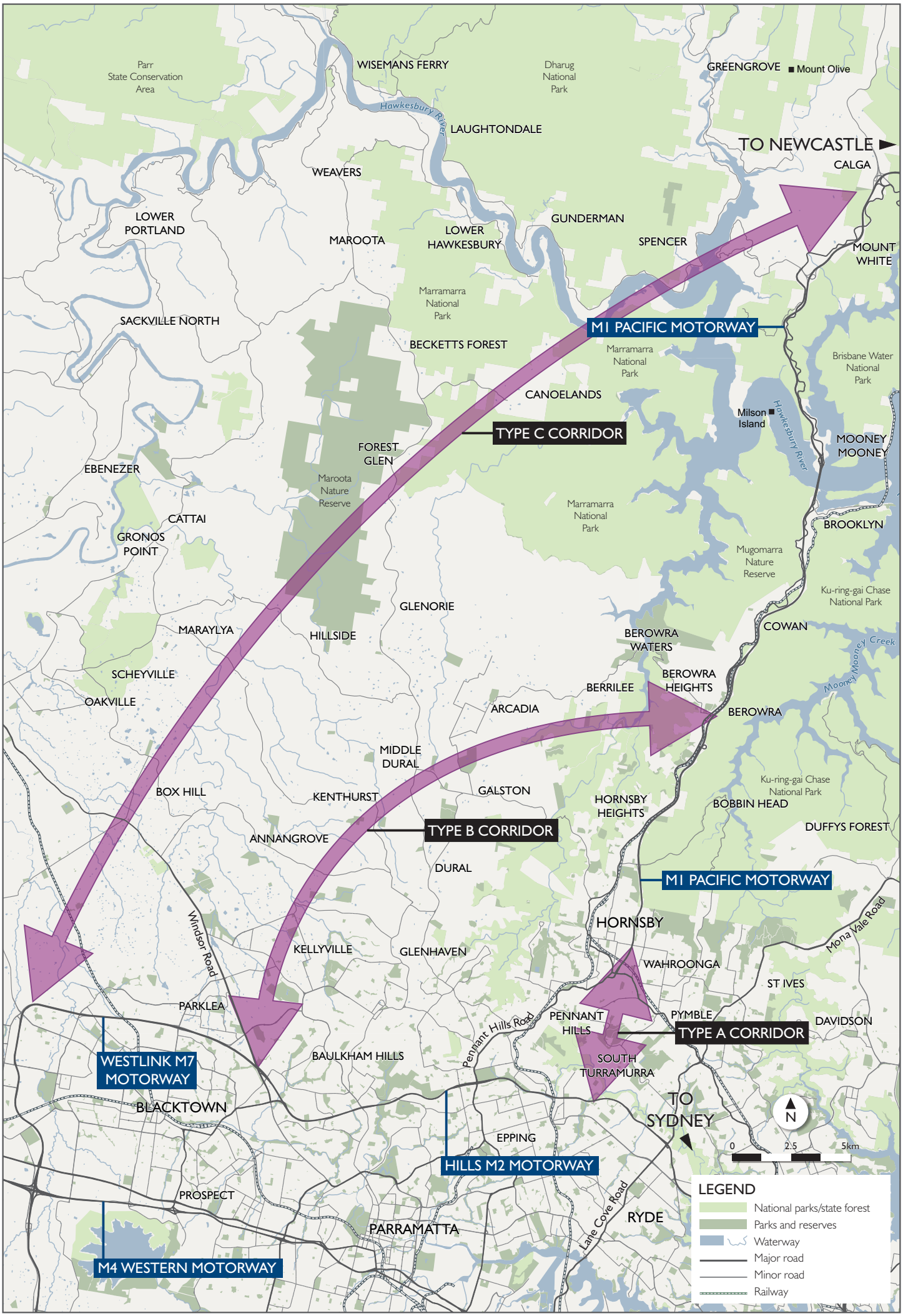

Figure 4-2 Broad corridor types (2004 report)

Source (SKM, 2004)

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Evaluation of the broad corridor types

The 2004 report assessed the broad corridor types based on consideration of a wide range of impacts, with the purpose of identifying a preferred option type to be taken forward for more detailed analysis. Key steps in the process included:

- Strategic assessment of broad corridor types against planning and project objectives.
- Technical assessments, including traffic and transport, strategic urban and regional development, engineering, social and environmental, urban design and landscape, capital costs and affordability, economic returns.
- Consultation with and feedback from stakeholders and interest groups.

The criteria used to assess the broad corridor types are shown in **Table 4-2**.

Table 4-2 Criteria to assess broad corridor types

Aspect	Criteria
Land use	• Avoidance of impacts on existing urban areas or areas in advanced stages of planning, particularly residential areas and property. • Avoidance of impacts on National Park, Nature Reserves, regional reserves and land zoned for environmental protection purposes.
Urban and regional development	• Support for regional, State and national development. • Access to ports, industrial and regional centres.
Engineering feasibility	• Constructability of tunnels, interchanges and bridges. • Terrain constraints. • Impact on existing roads. • Ability to stage construction of the project.
Urban design, landscape and visual factors	• Protecting existing built, natural, scenic and heritage values and views. • Fitting into Sydney's planned development areas. • Minimising severance and improving access including interconnectivity with the existing and planning transport network. • Minimising land form changes and visual impacts. • Regional and local land form and vidual assessment, including land form, structures, tree cover, activity, visibility.
Social and environmental considerations	• Potential for improving environment, especially conditions for local traffic, pedestrians and cyclists. • Social (including severance, accessibility, property impacts and regional access). • Environmental (including impacts on vegetation, reserves, fauna, habitat, water courses, water quality, heritage, and potential noise based on closeness to residential and employment land).

The analysis demonstrated that broad corridor Type A, which captured options that generally took the form of a southern extension of the M1 Pacific Motorway corridor to the Hills M2 Motorway, best satisfied the planning and project objectives.

The Type B corridor options would not satisfy the National Highway objectives on transport grounds and they would have a high capital and environmental cost. The Type B corridor options were also judged by the community to be unacceptable on environmental impact grounds.

While Type C corridor options were assessed as being able to provide more direct access to western Sydney for long distance travel (ie from outside of Sydney), analysis indicated that from an overall network assessment Type C options provided fewer transport benefits (including congestion relief and accident reduction for Pennant Hills Road) and would have higher construction costs and additional adverse community impacts (property and urban design impacts) compared to Type A corridors.

Type A corridor options

Following the identification of broad corridor Type A as the preferred approach to providing a road link between the M1 Pacific Motorway and the Sydney Orbital Network, further investigations developed four more detailed corridor alignment options that would be taken forward for further analysis, being:

- The red corridor alignment option, which extended from the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at Macquarie Park.
- The yellow corridor alignment option, which extended from the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway near North Epping.
- The blue corridor alignment option, which extended from the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at the Pennant Hills Road interchange.
- The purple corridor alignment option, which extended from the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at the Pennant Hills Road interchange and generally followed the alignment of Pennant Hills Road.

The four Type A corridor alignment options are shown in **Figure 4-3**.

In assessing the four Type A corridor alignment options, it was assumed that all four options would be in tunnel for the majority of their length and that connections to the existing road network would be mostly built within existing road reserves. The corridor alignment options were assessed against technical criteria relating to engineering feasibility, land use impacts, urban design and regional development, urban design and landscape, and social and environmental grounds.

These Type A corridor alignment options were publicly exhibited between July 2003 and October 2003 and were the subject of a value management workshop held over two days in September 2003. The value management workshop was attended by representatives from the Department of Transport and Regional Services, NSW Roads and Traffic Authority (now NSW Roads and Maritime), Rail Infrastructure Corporation and State Rail (now Sydney Trains), Department of Infrastructure, Planning and Natural Resources (now Department of Planning and Environment), NSW Environment Protection Authority, and NSW National Parks and Wildlife Services.

The value management workshop was used to review and assess the alignment options against the above technical criteria to assist with the evaluation of the alignment options. The outcome of the workshop was a consensus that the purple corridor alignment option best satisfied the project objectives.

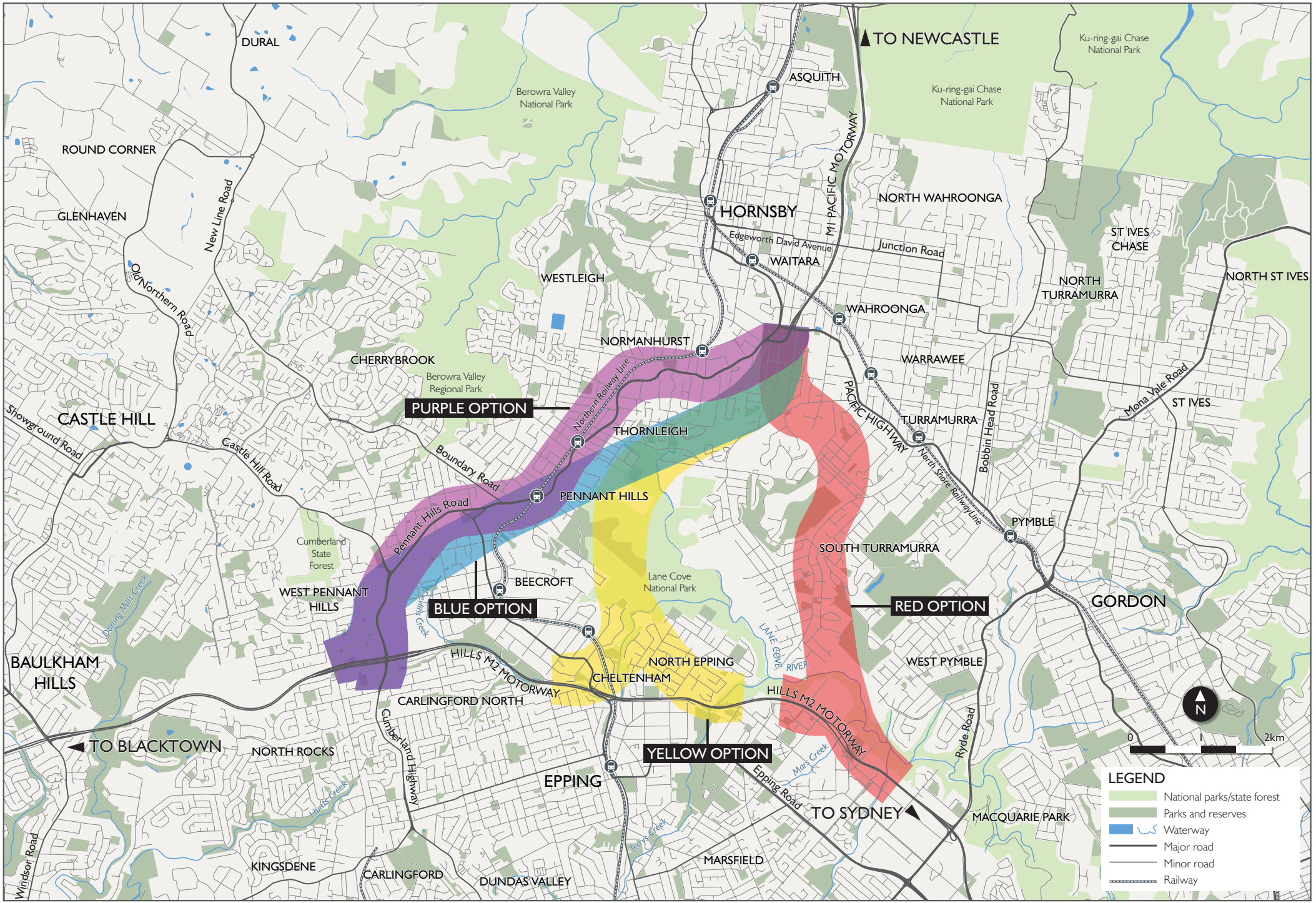

Figure 4-3 Type A corridor alignment options (2004 report)

Source (SKM, 2004)

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Evaluation of the Type A corridor alignment options

The evaluation of the Type A corridor alignment options in the 2004 report was informed by community feedback and a value management workshop. The evaluation concluded that:

- All four Type A corridor alignment options would provide similar road user benefits, however, the purple and blue corridor alignment options would provide the preferred route for trucks over the next 20 years. Further, it was acknowledged that the red corridor alignment option would provide similar benefits to the purple corridor alignment option in terms of network traffic effects. Overall, the purple corridor alignment option best satisfied the 2004 report transport objectives.
- The purple and blue corridor alignment options were preferred based on a consideration of social and environmental costs and benefits. These corridor alignment options would yield significant social benefits to people living and working along Pennant Hills Road as a result of the significant traffic relief along this corridor.
- On economic grounds, all corridor alignment options had relatively high capital costs. However, the purple corridor alignment option performed the best.

4.1.3 The 2004 report preferred corridor alignment option

The 2004 report concluded that the purple corridor alignment option was preferred as it satisfied the planning and project objectives better than the blue, yellow or red corridor alignment options. It was also concluded that the purple corridor alignment option performed best in terms of the technical criteria considered in the assessment and that the purple corridor alignment performed better than the other corridor alignment options in terms of social and environmental impacts based on the assessment conducted for the purpose of the study.

There have been amendments to the project objectives since the 2004 report in order to reflect current strategic planning policies. Despite this, the objectives are broadly consistent and the recommendations of the 2004 report remain sound and valid.

4.2 Review of the findings of the 2004 report

In 2007, a review of the 2004 report was undertaken by the Honourable Mahla Pearlman AO (former Chief Judge of the NSW Land and Environment Court) at the request of the Australian Government to confirm:

- The validity and reasonableness of the assumptions and data applied to the 2004 report.
- Whether the changes in the land use and transport assumptions since the 2004 report would alter the conclusions reached in the 2004 report.

The review process (the 2007 Pearlman Review) included a call for public submissions, public meetings, submissions analysis, obtaining data from relevant authorities and data analysis.

The 2007 Pearlman Review found that the assumptions and data used in the 2004 report were valid and reasonable based on:

- The standard approach adopted for the traffic modelling.
- The reinforcement of the assumptions about population growth and employment by the Transport Data Centre.
- The accuracy of the traffic volume forecasts with actual Roads and Traffic Authority (now Roads and Maritime) Average annual daily traffic (AADT) counts.
- The similarities between the distribution patterns of forecast car trips and the projections in the current Transport Data Centre data.
- The consistency of the commercial vehicle origin and destination projections with the Commercial Transport Study (DIPNR, 2003) origins and destinations.

The 2007 Pearlman Review also determined that the policy changes affecting land use and transport flows since the 2004 report reinforced the selection of the purple corridor alignment option for the following reasons:

- The shifting distribution of population and employment projected across the Sydney metropolitan region between 2001 and 2031, particularly within south-western and north-western Sydney.
- The lack of significant change from the person trips assumed in the 2004 report, based on a comparison of the 2001 data used in the 2004 report and the Transport Data Centre 2006 data. However, these changes reinforce the assumptions in the 2004 report regarding population growth in south-western Sydney, Inner Sydney and the Central Coast; and a shift in employment to western Sydney.
- The projection of more cars using the road network in 2021 than those forecast in the 2004 report.
- At the highest level, and speaking broadly, there is a similar pattern of distribution of car trips between the forecasts in the 2004 report and those projections in the Transport Data Centre 2006 data.
- The projection of car driver trip growth occurring in western and south western Sydney, as reflected in the Transport Data Centre 2006 data and the Metropolitan Strategy.
- The pattern of distribution of daily car trips from east to west across the Sydney metropolitan region rather than north to south.
- The minor changes in daily traffic counts since the opening of the Westlink M7 Motorway across all main roads and the motorways in the study area.
- The confirmation that the majority of heavy vehicles were travelling west of Pennant Hills Road rather than east.

The 2007 Pearlman Review also found that there was no case for altering the conclusions reached in the 2004 report and that a road link based on the purple corridor alignment option was preferred.

In summary, the 2007 Pearlman Review concluded that:

- The assumptions and data used in the 2004 report were valid and reasonable at the time of the study.
- There had been changes affecting land use and traffic flow assumptions since the 2004 report, but these changes reinforced the selection of the purple corridor alignment option.
- The purple corridor alignment option should be the preferred route and should progress to the next stage of design and development.
- Any future concept should consider east facing ramps at the Hills M2 Motorway to make the alignment option more attractive to motorists.
- A long term option, being the Type C corridor, should be planned for.

The 2007 Pearlman Review has since informed government strategic planning including documents such as the NSW Freight and Port Strategy (Transport for NSW, 2013b).

The Type C corridor, or the Outer Sydney Orbital, is a proposed road link of strategic significance to provide increased capacity and connectivity of the motorway network to meet the future demand of metropolitan Sydney, NSW and interstate transport. It is anticipated that the Outer Sydney Orbital will form part of a future north-south motorway link to bypass metropolitan Sydney to the west, connecting the Hume Highway in the south with the M1 Pacific Motorway in the north.

The Outer Sydney Orbital will provide increased capacity for the road network to improve accessibility to future housing and employment opportunities in Western Sydney. In particular it is expected to address the future demand from the South West and North West Growth Centres and the Western Sydney Employment Area, and provide a strategic link for both passenger and freight transport within the region.

Importantly, the Outer Sydney Orbital is anticipated to meet the demands of future transport requirements. The project would meet existing transport demands and relieve existing congestion issues on a key section of the National Land Transport Network.

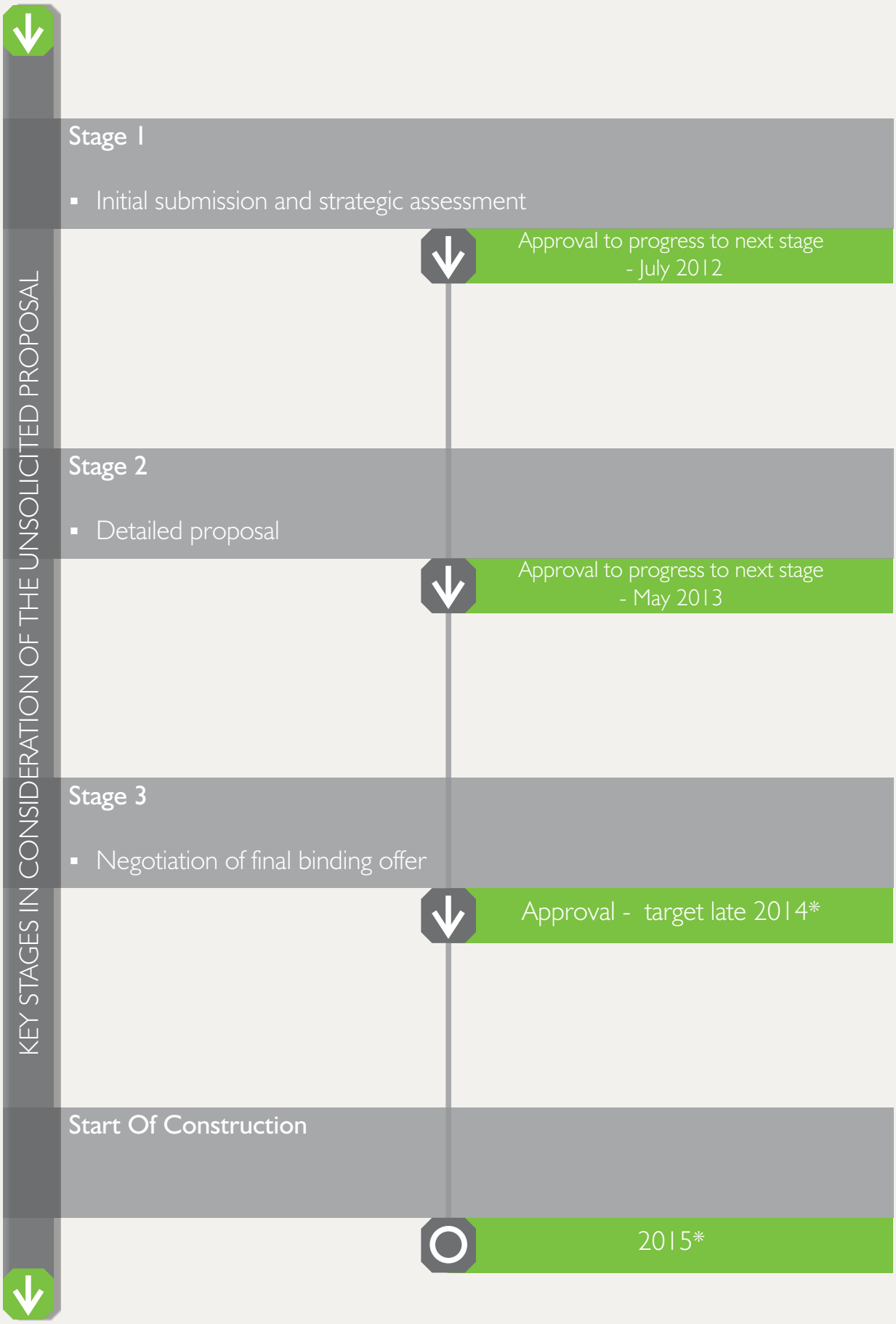
4.3 Unsolicited proposal design

In March 2012, the NSW Government received an unsolicited proposal from Transurban to design, construct, operate, maintain and finance a tolled motorway linking the M1 Pacific Motorway at Wahroonga to the Hills M2 Motorway at West Pennant Hills in northern Sydney. The Westlink M7 Shareholders later joined Transurban to form a consortium to finance the project.

The proposal is currently being assessed by the NSW Government in accordance with the three stages specified in *The Guide for Submission and Assessment of Unsolicited Proposals* (NSW Government, 2012). The process and timeline for this specific project, is shown in **Figure 4-4**, and generally involves:

- ***Stage 1: Initial submission and strategic assessment*** – includes a comprehensive initial assessment of the proposal to identify the potential benefit to Government of further consideration and development with the Proponent. The outcome is advice to the Proponent of progression to Stage 2, or that the Government does not wish to proceed.
- ***Stage 2: Detailed proposal*** – requires the Proponent and Government to work cooperatively in the development and assessment of a Detailed Proposal. The outcome is advice to the Proponent of progression to Stage 3, or that the Government does not wish to proceed.
- ***Stage 3: Negotiation of final binding offer*** – involves the finalisation of all outstanding issues with a view to entering into a binding agreement, should the Government accept the final offer.

The process and associated timeframes are subject to the planning process under the *Environmental Planning and Assessment Act 1979*.



Note: Dates are subject to the planning process under the *Environmental Planning and Assessment Act 1979*.

Figure 4-4 NSW Government unsolicited proposal process

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4.3.1 Stage 1 unsolicited proposal

The submission of an unsolicited proposal in March 2012 was the first stage of the three stage assessment process. The unsolicited proposal submitted by Transurban and the Westlink M7 Shareholders was broadly based on the purple corridor alignment option discussed above, noting that this option would be subject to further detailed design and refinement through progression of Stages 2 and 3 of the unsolicited proposal process, and the outcomes of the environmental planning approvals process.

4.3.2 Stage 2 design development

Following progression to Stage 2 of the unsolicited proposal assessment process, further design development and due diligence investigations were conducted to enable submission of a more detailed proposal by Transurban and the Westlink M7 Shareholders. These investigations included further consideration of design issues and funding mechanisms for the project. Design development during Stage 2 of the unsolicited proposal process included consideration of three key design issues:

- The need for an intermediate interchange to connect the main alignment tunnels to the surface road network between the northern and southern interchanges.
- The need for east facing ramps to connect the main alignment tunnels to the Hills M2 Motorway east of Pennant Hills Road.
- The number of lanes within the main alignment tunnels.

Intermediate interchange location

As part of the 2004 report, a preliminary design was developed for the purple corridor alignment option which included an intermediate interchange to connect the main alignment tunnels to the surface road network. The intermediate interchange was in addition to and between the northern and southern interchanges.

The intermediate interchange contemplated in the 2004 report included tunnel access points at around the midpoint of the tunnel, at Thornleigh. Preliminary design of the interchange included north facing ramps surfacing at Pennant Hills Road, near the Pennant Hills Railway Station, and south facing ramps surfacing at Railway Parade. An intermediate interchange would provide access opportunities for additional motorists that would otherwise need to travel to either the northern or southern interchange to access the main alignment tunnels.

The preliminary design of the intermediate interchange was reviewed as part of the Stage 2 unsolicited proposal process. This review identified that:

- The difference in grade between the surface and the main alignment tunnels would likely result in environmental costs associated with significant additional lengths of tunnelling works to implement the intermediate interchange, or steep grades on the ramps resulting in operational inefficiencies and potential air quality impacts.
- Additional property acquisition would likely be required to facilitate the traffic arrangements around the interchange.
- The proximity of the works to the Northern Railway Line would introduce additional constructability challenges, engineering risks and project costs.

Further, a consideration of local and regional traffic conditions and forecast patronage of an intermediate interchange indicated there would only be limited traffic benefits associated with an interchange at this location.

On balance it was concluded that, although an intermediate interchange would provide some limited traffic benefits, these benefits were not sufficient to outweigh the additional impacts, the significant risks and the additional cost associated with constructing the intermediate interchange. The intermediate interchange was therefore removed from the scope of the project.

East facing ramps connecting to the Hills M2 Motorway

The 2007 Pearlman Review recognised that the purple corridor alignment option did not provide for a motorway standard east facing connection between the purple corridor and the Hills M2 Motorway. The 2007 Pearlman Review suggested that the provision of such a connection could make the purple corridor more attractive to motorists who might otherwise travel along the Pacific Highway. It was recommended that such a connection be examined in any future concept design.

A review of an east facing connection between the purple corridor and the Hills M2 Motorway was conducted as part of the Stage 2 unsolicited proposal design development process. Analysis of the traffic implications associated with east facing ramps indicated that:

- East facing ramps connecting to the Hills M2 Motorway would only provide minor travel time benefits for motorists, compared with requiring this traffic to emerge from the main alignment tunnels and use existing arrangements to access the Hills M2 Motorway east of Pennant Hills Road.
- The minor nature of incremental travel time benefits would not be sufficient to attract additional users and provide any further material congestion relief to the Pacific Highway.

In addition, significant engineering and environmental constraints were identified (including the presence of Pennant Hills Golf Course and Devlins Creek) that would need to be overcome at significant cost in order to provide east facing ramps. On balance, these constraints and the limited traffic benefits of east facing ramps supported exclusion of this design option from the scope of the project at this time.

Despite this, the project does allow for motorists travelling south on the project to continue their journey on the Hills M2 Motorway eastbound. Motorists would be able to leave the project via the southbound off-ramp to Pennant Hills Road and then join the Hills M2 Motorway using the existing Pennant Hills Road eastbound on-ramp.

It is acknowledged that traffic growth and a change in motorist demand for this movement may warrant construction of this direct connection in the future despite the constraints identified above. As such, the project has been designed to enable the future provision of these ramps.

Number of main alignment tunnel lanes

The capacity of the project was reviewed as part of design development during Stage 2 of the unsolicited proposal process. In particular, the need for two lanes or three lanes in each main alignment tunnel was reviewed.

Traffic analysis demonstrated that two lanes in each direction would provide adequate capacity for several decades based on expected traffic growth. On this basis, the project has been taken forward with a design involving two lanes in each direction at the time of opening.

Notwithstanding, it was considered prudent to future proof the project by designing and constructing the main alignment tunnels to be large enough to accommodate three lanes of traffic in each direction. If a third lane is required in one or both directions in the future, it would be subject to separate assessment and approvals processes.

4.3.3 Progression to Stage 3

A cross-agency committee was established and worked with Transurban and the Westlink M7 Shareholders to develop and assess the unsolicited proposal, culminating in the progression of the proposal to Stage 3 in May 2013.

The Stage 3 unsolicited proposal assessment involves the negotiation and submission of a final binding offer. The key steps include:

- Negotiations between Government, Transurban and the Westlink M7 Shareholders to finalise and agree commercial terms and conditions.
- Obtaining planning approval for the project.
- Obtaining a firm price for the project.
- Agreeing a program to deliver the project.

The Stage 3 assessment process is currently underway and is likely to progress until around late 2014. This environmental impact statement forms one component of the Stage 3 assessment process, and has been prepared to support obtaining planning approval for the project.

4.4 Design and construct tender process

Following agreement between the NSW Government, Transurban and the Westlink M7 Shareholders to proceed to Stage 3 of the unsolicited proposal process, a competitive design and construct tender process was undertaken in order to identify an innovative, cost effective and environmentally-responsive design within the purple corridor alignment option as identified and endorsed by the 2004 report and the 2007 Pearlman Review respectively.

Three separate tenders, including individual tender designs were received by Transurban and the Westlink M7 Shareholders on 29 November 2013. These tenders were subject to several stages of evaluation to arrive at the preferred tender design which has formed the basis of this environmental impact statement and the project going forward.

The tender evaluation was separated into categories including engineering design, environmental and social performance and project cost (including upfront capital expenditure and ongoing operational expenditure). Each of these categories was divided into a number of sub-categories to allow comparison between the tenders. Relevant technical specialists were used to undertake the tender evaluation. Guidance and technical input was also provided by Roads and Maritime throughout the evaluation process.

The evaluation of engineering design requirements involved an assessment of the tenders against a set of mandatory functional requirements, the performance of the engineering aspects of the tender designs and the identification of risks within the tender designs. This involved separate assessments for each engineering aspect such as road geometry, drainage, structural elements and ventilation systems.

The environmental and social category evaluation involved an assessment of the tenders for environmental and social performance (costs and benefits) and the identification of potential environmental and social impacts and risks. The environmental and social evaluation considered all relevant sub-categories including:

- Air quality and human health.
- Noise and vibration.
- Traffic and transport.
- Land acquisition and land use.
- Urban design and visual amenity.
- Biodiversity.
- Aboriginal and non-Aboriginal heritage.
- Groundwater, soils and contaminated land.
- Surface water.
- Social and economic impacts.
- Resource consumption and waste generation.
- Hazard and risks.

The performance of each sub-category was considered for both the construction and operational phases of the project.

Each sub-category was scored according to how well the minimum requirements were met or exceeded. The score for each evaluation category was then weighted to provide an overall score and ranking of each tenderer.

The preferred tenderer was chosen based on the outcome of this thorough evaluation of the three tender submissions. This process provided a balanced consideration of engineering design requirements, project cost (including upfront capital expenditure and ongoing operational expenditure), and environmental and social impacts.

4.4.1 Design refinements

Various options within the purple corridor were considered in order to balance cost, engineering design, environmental and social outcomes. The key factors in arriving at the preferred tender design included:

- Safety in design, delivery, and operation and maintenance.
- Financial viability.
- Minimising environmental and community impacts.
- Traffic functionality and integration with the road network.
- Sympathetic architectural and landscape design.
- Continuity of access, connectivity and amenity for local residents, visitors, pedestrians and cyclists.
- Minimising impacts on existing motorways during construction.
- Maximising the long term sustainability of the asset throughout design, construction and operation.
- Minimising whole of life costs.
- Maximising durability and safety for optimum operations and maintenance.
- A positive and safe customer experience that delivers value and encourages repeat patronage.

The options considered included tunnel length and alignment, the locations of surface infrastructure, and the tunnel construction methodology.

Two tunnel construction options were considered, being excavation by tunnel boring machines and excavation by road headers. Although tunnel boring machines would have a faster excavation rate, tunnel boring machines would, when compared to a road header option, result in:

- A larger tunnel cross section and, subsequently, increased spoil generation.
- Greater volumes of material required for tunnel lining.

Additionally, the cross section required for the road tunnel varies due to features such as maintenance bays and cross passages. Unlike road headers, tunnel boring machines are unable to alter their excavation cross section to accommodate these features.

Due to the above, excavation by road header was selected as the preferred option.

Tunnel length

Two tunnel length options were developed and examined including a ‘long’ tunnel option and a ‘short’ tunnel option in relation to the tie-in point to the M1 Pacific Motorway.

It was determined that the 'short' tunnel option would result in a reduction in capital cost compared to the 'long' tunnel option whilst resulting in workable traffic arrangements around the northern interchange. The 'short' tunnel option however, would result in increased adverse environmental and planning impacts. These impacts would primarily relate to the extent of land acquisition and associated land use and property implications during construction and operation. Taking into account a balanced assessment of these factors, it was concluded that the capital cost savings that may result from pursuing the 'short' tunnel option would be insufficient to offset increased environmental and planning impacts.

As a result, the 'long' tunnel option has been pursued as the preferred design configuration. Although this option would involve a higher capital cost, the benefits in terms of reduced property acquisition and the associated reduction in adverse community impacts were seen to provide a superior outcome overall.

Tunnel alignment

Design factors considered when determining the location of the main alignment tunnels and on and off-ramps included:

- Avoidance of surface disruption to Pennant Hills Golf Course.
- Avoidance of the defined zone of the North West Rail Link.
- Avoidance of impacts on the Northern or North Shore railway lines.
- Avoidance of land reserved under the *National Parks and Wildlife Act 1974*.
- Constructability issues.
- Minimisation of disruption to existing road users.
- Minimisation of property acquisition and property impacts.

The options identification and assessment process undertaken for the tunnel alignment specifically considered safety, traffic operations and performance, public transport operations, environmental costs and benefits, future proofing and constructability.

Horizontal alignment

The key factors that were considered in the design of the main alignment tunnels with respect to horizontal geometry were:

- Provide the shortest tunnel length for both northbound and southbound carriageways, taking into account the interchange layouts and the location of ventilation sites.
- Follow topography that provides optimal vertical geometry in terms of length and vertical grade, and cover to surface.
- Provide access to surface shaft locations.
- Avoid identified constraints, including unfavourable geology near Pennant Hills Railway Station, the North West Rail Link tunnel alignment and the landfill contamination underlying Brickpit Park in Thornleigh.

- Avoid long term community and environmental costs associated with the removal of community facilities, the exposure to operational traffic noise and the removal of Blue Gum High Forest as a result of the open cut section at Brickpit Park / Kenley Park.
- Integrate with the northern and southern interchange arrangements.
- Provide appropriate horizontal curves to maintain safe line of sight distances.

Vertical alignment

The key factors that were considered in the design of the main alignment tunnels with respect to vertical geometry were:

- Avoid steep vertical grades which would cause heavy vehicles to decelerate.
- Limit lengths of roadway with grades above 2.5 per cent as much as practicable.
- Provide minimum grades of 0.5 per cent to facilitate drainage.
- Maximise the extent within competent rock.
- Ensure sufficient cover to the surface in order to minimise settlement impacts.
- Provide clearance to the North West Rail Link tunnel.
- Reduce overall life cycle cost for ventilation purposes.
- Water inflow issues.

Optimum vertical geometry is beneficial to heavy vehicles using the tunnel as it minimises the speed differentials between trucks and cars and limits the vehicle emissions generated by heavy vehicle traffic on long and steep uphill grades.

The geology of the area was influential in determining the tunnel vertical alignment. Hawkesbury Sandstone is considered an excellent tunnelling and excavation medium as it is high strength with relatively widely spaced defects. In comparison, Ashfield Shale is also of high strength but has a deeper soil profile, closer spaced defects (commonly affected by faulting) and the fresh shale can readily deteriorate on exposure. As a result, the tunnel has been designed to maximise the length of tunnel within Hawkesbury Sandstone and minimise the length within Ashfield Shale.

The main alignment tunnels have been located to cross below the alignment of the North West Rail Link tunnel, based principally on geotechnical considerations in this area. Specifically, crossing underneath the North West Rail Link maximises the amount of tunnel in the more favourable Hawkesbury Sandstone.

Surface infrastructure

Surface infrastructure required for the project would include the northern and southern interchanges, as well as operational ancillary facilities such as ventilation infrastructure and the motorway control centre. The locations of these facilities have been carefully considered during the development of the design, including consideration of the following factors:

- Minimise impacts on property and the surrounding environment.
- Minimise impacts on the existing Hills M2 Motorway and M1 Pacific Motorway.
- Limit impacts at the currently congested M1 Pacific Motorway / Pacific Highway interchange and the Pacific Highway / Pennant Hills Road intersection.
- Retain existing bus lanes, bus interchanges and cycle access along the Hills M2 Motorway.
- Minimise the need for property acquisition.

Interchanges

As well as the general considerations for surface infrastructure listed above, key factors that were considered in the design of the southern and northern interchanges were:

- Optimise traffic performance.
- Maximise safety.
- Minimise impacts on existing infrastructure and properties.
- Minimise impacts during construction on existing traffic on the Hills M2 Motorway and Pennant Hills Road (southern interchange).
- Minimise impacts during construction on existing traffic on the M1 Pacific Motorway, Pacific Highway and Pennant Hills Road (northern interchange).
- Ensure constructability within geotechnical and topographical constraints.
- Environmental impacts such as noise and visual effects.
- Maintain pedestrian and cyclist access.

Land acquisition at the southern interchange has been limited by utilising properties already owned by Roads and Maritime. Only a limited number of additional properties would be required in this area. Property acquisition has also been limited at the northern interchange by designing the main alignment tunnels and ramps to emerge within existing road corridors.

Ventilation facilities

The primary drivers when considering the location of ventilation facilities were minimising local and regional air quality impacts and maximising the operational efficiency of the tunnel ventilation system. Vehicles travelling through the tunnels create a piston effect which draws air in the direction of travel. Consequently, the most efficient location for ventilation facilities is as close to the tunnel exit portals as possible. This minimises the length of tunnel where the air flow must be forced, by jet fans within the tunnels, against traffic flow back to the ventilation point. The reduced use of tunnel ventilation fans increases the performance of the tunnels, reduces operational power consumption and reduces the cost associated with operation.

The southern ventilation facility has been located on land currently owned by Roads and Maritime on the north-western corner of the current Hills M2 Motorway / Pennant Hills Road interchange. This facility has also been co-located with other operational ancillary facilities further reducing the amount of land acquisition required.

The northern ventilation facility has been located primarily above the cut and cover section of the northbound main alignment, near the connection with the M1 Pacific Motorway. This location provides optimal ventilation performance, eliminates the need to construct additional shafts and tunnels between the tunnel and the ventilation facility and has reduced the amount of land acquisition required.

Tunnel support facilities

Safe tunnel operation requires specific infrastructure and equipment. A key aspect is a facility to efficiently remove smoke should there ever be a fire incident in the tunnel. For this length of tunnel two tunnel support facilities are required. Due to the constrained nature of the corridor, limited opportunities exist along the alignment for the location of the facilities. For operational and safety reasons these facilities are required to be located at around third points along the main alignment tunnels and preferably directly above the main alignment tunnels for operational efficiency and to minimise spoil generation.

Two options have been investigated for the location of the southern tunnel support facility, being on Lilla Road and on Wilson Road, in Pennant Hills. Both options provide similar benefits in relation to location directly above the main alignment tunnels. Both site options also provide access directly from the arterial road network, which is important during construction and for access during operation. The Lilla Road site option, however contains a non-Aboriginal heritage item and heritage listed street trees. As such, Wilson Road was chosen as the preferred site for the southern tunnel support facility.

Two options have also been investigated for the northern tunnel support facility, being Terra Street and Trelawney Street, in Thornleigh. The Terra Street site would provide some benefits in terms of limiting impacts associated with land acquisition, however this site is not located directly above the tunnel and is located immediately adjacent to a known contaminated site. Although use of the Trelawney Street site would result in additional land acquisition requirements, this site has been identified as the preferred location of the northern tunnel support facility due to avoiding potential interactions with known contaminated land and being located directly above the main alignment tunnels.

Motorway control centre

The proposed location for the motorway control centre is predominately on land currently owned by Roads and Maritime. Its location near the southern interchange allows shorter distances for tolling equipment and cabling between the motorway control centre and the tolling points around the southern interchange. This location, in close proximity to the southern interchange, also provides efficient access to the tunnels for emergency and incident response.

Operational water management

Wherever feasible and reasonable, collected groundwater and surface water could potentially be re-used for operational activities such as landscape maintenance. However, expected groundwater inflow into the main alignment tunnels is likely to exceed operational requirements (refer to **Section 7.8** Hydrogeology and soils). As such, there would be surplus water generated during operation of the project above what is necessary for everyday operation and maintenance activities. Several options have been considered in relation to the management of surplus operational water, including re-injection of the water into the groundwater aquifer, tankering of untreated water off-site, discharge to sewer and treatment and disposal of water to the local stormwater system (with subsequent discharge to the environment).

Re-injection of the water into the groundwater aquifer would be a cost intensive and technically challenging option. This option would typically only be adopted as a last resort where maintenance of existing groundwater levels is required to mitigate potential groundwater drawdown impacts. Because the project involves drained tunnels, re-injected water would be eventually drawn back into the tunnels and would not result in beneficial mitigation of groundwater drawdown impacts. As a result, this option was not considered a necessary, appropriate and viable water management approach for the project.

Tankering of untreated water off-site for disposal would generate significant heavy vehicle traffic impacts (around 190 vehicles a day) on the local road network, and would generate amenity impacts for surrounding residential receivers. This option would also require capital investment in on-site infrastructure for tanker loading and additional water storage capacity, as well as the ongoing operational cost associated with tanker operations. This option was discounted based on the cost of tankering water off-site and the environmental costs of this approach, relative to other water management options.

Discharge of water to the local sewerage system, with or without treatment, was discounted based on the ongoing cost of a trade waste licence and the potential need to invest in augmentation of the sewerage system. It was also considered undesirable to consume part of the capacity of the local sewerage system and processing capacity of regional sewage treatment plants with water generated by the project.

In comparison to tankering and discharge to sewer, management of surplus operational water on-site was identified as a preferable approach in terms of cost and overall environmental impact. The option of treatment and disposal of water to the local stormwater system or environment would provide a long-term solution for water management. Although this option would result in increased flows within local watercourses, it has been adopted as the most viable long-term solution for the project, coupled with potential beneficial re-use on the site and / or off-site within the local community (eg Pennant Hills Golf Club, playing fields or parks). The potential impacts arising from increased flows in the local watercourses are assessed in **Section 7.6** (Biodiversity) and **Section 7.9** (Surface water).

The proposed location of the operational water treatment plant is near the southern interchange and would be co-located with the motorway control centre and other operational ancillary facilities. This land is currently owned by Roads and Maritime which limits the amount of land acquisition required. The southern interchange is also the lowest topographical point along the project alignment, which would allow the main alignment tunnels to be drained via gravity to a sump located at the tunnel low point, thereby reducing operational water pumping costs.

Temporary ancillary construction facilities

Several temporary ancillary construction sites would be required for the project. The primary driver for the location of these sites is the objective of minimising environmental and community impacts. Wherever possible, ancillary construction facilities have been co-located within the footprint of the future operational ancillary facilities to minimise the overall land acquisition requirements, as well as impacts on heritage items and ecologically sensitive areas.

Where temporary ancillary construction facilities could not be co-located within the footprint of the future operational ancillary facilities, following was considered when selecting the location of these facilities:

- Locating the facilities within existing road reserves or other land owned by Roads and Maritime in order to minimise land acquisition requirements.
- Locating the facilities in previously disturbed areas, such as the footprint of compounds previously utilised as part of the recently completed Hills M2 Motorway Upgrade project.
- Locating spoil extraction sites immediately adjacent to the arterial road network to reduce the impacts of spoil haulage and other heavy vehicle movements.
- Avoiding known heritage items and significant ecologically sensitive areas as far as possible.

The project design incorporates a shaft in lieu of a decline to access the tunnels at the Wilson Road and Trelawney Street compounds. This has resulted in a reduction in land required and the minimisation of associated impacts on property. In general, the use of a vertical shaft with the spoil extracted via cranes requires less surface land than a decline which allows trucks to drive into the tunnels.

4.5 Ecologically sustainable development

Ecological sustainable development (ESD) is development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends. The principles of ecological sustainable development have been considered throughout the development of the project.

The *Environmental Planning and Assessment Act* (EP&A Act) recognises that ecological sustainable development requires the effective integration of economic and environmental considerations into decision making processes. The EP&A Act identifies four principles to assist in the achievement of ecological sustainable development:

- The precautionary principle.
- Inter-generational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation and pricing and incentive mechanisms.

Precautionary principle

If there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

The precautionary principle has been applied throughout the design and development of the project.

The alternatives and options analysis as part of the 2004 report considered environmental impacts, evident through the selection of an option which minimised surface disturbance and potential impacts to National Parks and other ecologically sensitive areas.

The design has first aimed to avoid, to the greatest extent practicable, known areas or items of environmental value. Where avoidance was not possible, mitigation measures have been identified to manage the identified risks (as detailed in each impact assessment chapter).

This environmental impact statement details the evaluation of environmental impacts associated with the project and has been undertaken using the best available technical information and adoption of best practice environmental standards, goals and measures to minimise environmental risks. The environmental impact assessment has been undertaken in collaboration with key stakeholders and relevant statutory and agency requirements.

Inter-generational equity

The present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

One of the key objectives of the project is to assist in a reduction in traffic congestion along Pennant Hills Road and provide shorter travel times for road users. The project is anticipated to:

- Improve local air quality along the Pennant Hills Road corridor. Further information on local air quality improvements are provided in **Section 7.3** (Air quality).
- Improve noise amenity along the Pennant Hills Road corridor. Further information on local noise amenity improvements is provided in **Section 7.2** (Noise and vibration).
- Improve road safety along the Pennant Hills Road corridor. Further information on road safety improvements are provided in **Section 7.1** (Traffic and transport).
- Result in reduced operational greenhouse gas emissions when compared to the project not being built. For the year 2029 the savings in greenhouse gas emissions with the project are predicted to be around 68,600 tonnes CO_2-e when compared to the without project scenario. Further information on greenhouse gas emissions and savings are provided in **Section 8.1** (Greenhouse gas and climate change).

As a result the project would provide benefits for current and future generations and is considered to be in the public interest.

Conservation of biological diversity and ecological integrity

Conservation of biological diversity and ecological integrity is a fundamental consideration of the project.

The alternatives and options analysis as part of the 2004 report considered ecological integrity, evident through the selection of an option which minimised potential impacts to National Parks and other ecologically sensitive areas.

The design avoids impacts to areas of high ecological value as far as practical. This environmental impact statement provides a detailed ecological assessment (**Section 7.6** Biodiversity) which identifies flora and fauna impacts and provides a range of mitigation measures to further avoid and minimise these potential impacts. For example, the design has avoided impacts to the Blue Gum High Forest at Kenley Park and Brickpit Park.

Improved valuation and pricing of environmental resources

Environmental factors should be included in the valuation of assets and services. Such as:

- Polluter pays (ie those who generate pollution and waste should bear the cost of containment, avoidance, or abatement).
- The users of goods and services should pay prices based on the full life cycle of costs of providing the goods.
- Environmental goals, having been established, should be pursued in the most cost effective ways.

The value placed on the environment is evident in the development of design features and also in the extent of environmental investigations. In addition the costs associated with the planning and design of measures to avoid or minimise adverse environmental impacts and the costs to implement them have been built into the overall project costs. For example, the long tunnel option, despite its high capital cost, has been selected over the short tunnel option, which would have resulted in increased environmental and social impacts associated with land acquisition (refer to **Section 4.4.1**).

The provision of a toll on the project supports the concept of users of goods and services paying prices based on the full life cycle of costs of providing the goods. Whilst the upfront capital costs would be provided by a combination of private funding and a contribution from the NSW and Australian Governments, this funding would be recouped through a toll to cover the upfront construction, and ongoing operation and maintenance costs.

4.6 The project

The project would include the following elements:

- Twin motorway tunnels up to around nine kilometres in length with two lanes in each direction. The tunnels would be constructed with provision for a possible third lane in each direction if required in the future.
- A northern interchange with the M1 Pacific Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps, which also facilitate access to and from the Pacific Highway.
- A southern interchange with the Hills M2 Motorway and Pennant Hills Road, including sections of tunnel for on-ramps and off-ramps.
- Integration works with the Hills M2 Motorway including alterations to the eastbound carriageway to accommodate traffic leaving the Hills M2 Motorway to connect to the project travelling northbound, and the provision of a new westbound lane on the Hills M2 Motorway extending through to the Windsor Road off-ramp.
- Tie-in works with the M1 Pacific Motorway extending to the north of Edgeworth David Avenue.
- A motorway operations complex located near the southern interchange on the corner of Eaton Road and Pennant Hills Road that includes operation and maintenance facilities.
- Two tunnel support facilities incorporating emergency smoke extraction outlets and substations.
- Ancillary facilities for motorway operation, such as electronic tolling facilities, signage, ventilation systems and fire and life safety systems including emergency evacuation infrastructure.
- Modifications to service utilities and associated works at surface roads near the two interchanges and operational ancillary facilities.
- Modifications to local roads, including widening of Eaton Road near the southern interchange and repositioning of the Hewitt Avenue cul-de-sac near the northern interchange.
- Ancillary temporary construction facilities and temporary works to facilitate the construction of the project.