3. Project alternatives

This section outlines the project development process, examines the possible alternatives to the project and explains the design decisions that have led to the formulation of the preferred project that is the subject of this environmental assessment.

Director-General's Requirements	Where addressed
Project justification	
This justification must include an assessment of alternatives considered	*Chapter 3*
demonstrate that the project will enhance the use of public transport	*Sections 3.1, 9.1*
demonstrate that the project will not unduly induce traffic and exacerbate congestion in the medium to longer term within the adjoining subregions	*Sections 3.1, 9.1*
The assessment must specifically address how the proposed park and ride facility will enhance public transport patronage, including a cost benefit analysis	*Section 3.1.3*

3.1 Alternatives to the project

As demonstrated in Chapter 2 of this report, there is a need to address existing constraints and traffic congestion on the M2 Motorway, as it currently operates as the second most trafficked corridor in Sydney. In its current form, the M2 Upgrade project provides an opportunity to better utilise an existing asset, by adding to it to increase its capacity.

A range of alternatives to the M2 Upgrade project were identified and considered as part of the development of the project, including the following:

- Alternative one – Do nothing.
- Alternative two – Other road based improvement options, including:
  - Line marking to add additional lanes within the existing carriageway.
  - Upgrade of the local sub-arterial and arterial road network.
- Alternative three – Provision of public transport – increase provision for public transport within the M2 Motorway catchment.
  - Rail based alternatives, including light rail and heavy rail.
  - Enhancement of existing road based public transport (bus lane and park and ride facility).
- Alternative four – Demand management, including differential tolling and amended toll structures.

These alternatives to the project were evaluated to identify the preferred strategic option and are discussed below.

It is noted that the preferred strategic option was then further refined through an evaluation of project options, which included the need for and location of additional ramps, bridges and sections of the M2 Motorway requiring widening works. Section 3.2 discusses the project options that were considered.

3.1.1 The base case or 'do nothing' alternative

This section considers the transport outcomes should the M2 Motorway remain in its current state into the future. The base case alternative involves retaining the existing M2 Motorway as a four lane dual carriageway motorway, with bus lanes in certain sections. This assumes that the interim widening that is currently in place between Lane Cove Road and Beecroft Road would remain, but that no other upgrade to the M2 Motorway would be undertaken.

- The 'do nothing' alternative would result in the following outcomes:
- Existing congestion on the M2 Motorway demonstrates that demand exceeds the current capacity in certain sections. With significant new commercial and residential development planned in the north west of Sydney and proximate to the M2 Motorway, traffic volumes would increase and the level of service provided by the M2 Motorway would continue to decline as demand increases into the future (refer to Technical Paper 1 for further description).
- As the travel time savings provided by using the M2 Motorway are diminished, due to increased congestion, there would be a greater propensity for traffic to use alternative routes. M2 Motorway access roads and intersection performance within the M2 corridor would continue to deteriorate.
- The interim widening that is currently in place between Lane Cove Road and Beecroft Road has resulted in reduced lane widths, removal of the breakdown lane and reduction of the speed limit. This is not consistent with the design standards in place along the remainder of the M2 Motorway and results in a reduced level of service for users.
- The interim widening that is currently in place between Lane Cove Road and Beecroft Road necessitates the diversion of westbound cyclists from a section of the M2 Motorway. This diversion provides a reduced standard of facility for cyclists and is not preferred as a long-term solution.

The 'do nothing' option would not satisfy the project objectives described in Section 2.3 of this report and, combined with the issues identified above, is not an acceptable solution.

3.1.2 Road based improvement

Line Marking

The 'line marking' alternative is a very low cost alternative comprising the provision of an additional (third) lane along sections of the M2 Motorway through reallocation of existing road space and modification to existing lanes (no M2 Motorway widening). For consistency with RTA Road Design Guide standards for motorways, this would involve narrowing of traffic lanes, loss of breakdown lanes and reduction of the speed limit to 80/70 kilometres per hour (a reduction of 20 to 30 kilometres per hour).

This alternative provides a similar outcome to the M2 Upgrade project in terms of the number of lanes available. However, the outcome would have shortcomings similar to that of the interim widening (line marking) already established between Lane Cove Road and Beecroft Road. These shortcomings are described below:

- The removal of the breakdown lane along the majority of the M2 Motorway would create significant limitations for responding to and managing incidents.
- As a result of reduced speed limits, travel time benefits of the M2 Motorway would be significantly reduced and the potential of the M2 Motorway to provide relief to surrounding local traffic routes would be reduced.
- Reduced speed limits are perceived as poor value for money due to reduced travel time savings by M2 Motorway users, particularly during off-peak periods when traffic flow is less likely to be compromised by congestion.
- The reallocation of road space would require the diversion of cyclists off the majority of the M2 Motorway. This diversion would result in cyclists not having access to the M2 Motorway, incurring a reduced standard of facility which is not a preferred outcome for these users.

The line marking option would not satisfy the objectives described in Section 2.3 of this report and, combined with the reasons outlined above, is not an acceptable solution.

Local sub-arterial and arterial road upgrade

The 'upgrading the local sub-arterial and arterial road network' alternative would involve the provision of additional road capacity in the M2 Motorway catchment area, by widening existing sub-arterial and arterial roads and removing bottlenecks by introducing potential grade separations and the provision of new links with improvements to existing intersections.

Alternatives for local road widening (including upgrades to appropriate intersections) would generally follow the existing alignment of the M2 Motorway where possible. Two alternatives for upgrading the local road networks were considered. These alternatives are described below and shown in Figure 3.

- Option one, involves the widening of:
  - Renown Road – Windsor Road to Barclay Road (north of the M2 Motorway, Baulkham Hills).
  - North Rocks Road, Plympton Road, Ray Road, Carlingford Road to link with Beecroft Road (south of the M2 Motorway, Epping).
  - Epping Road – Beecroft Road to Delhi Road (south of the M2 Motorway to cross the corridor at Delhi Road, Land Cove).
- Option two involves widening of:
  - Old Windsor Road – Abbott Road to the Cumberland Highway (Hart Drive) (south of the M2 Motorway, Northmead).
  - Pennant Hills Road (Cumberland Highway) – Old Windsor Road to Carlingford Road (South of the M2 Motorway, Beecroft).
  - Epping Road – Carlingford Road to Delhi Road (Macquarie Park).

With the exception of Epping Road, the other roads in Option one are sub-arterial roads under the care and control of the local council. All the roads in Option two are arterial (State) roads under the care and control of the RTA. Some sections of the sub-arterial roads are too narrow to be marked as four lane roads with a central median. Hence, property would need to be acquired along these roads to enable them to be upgraded to the minimum standard required for a reasonable alternative route to the M2 Motorway.

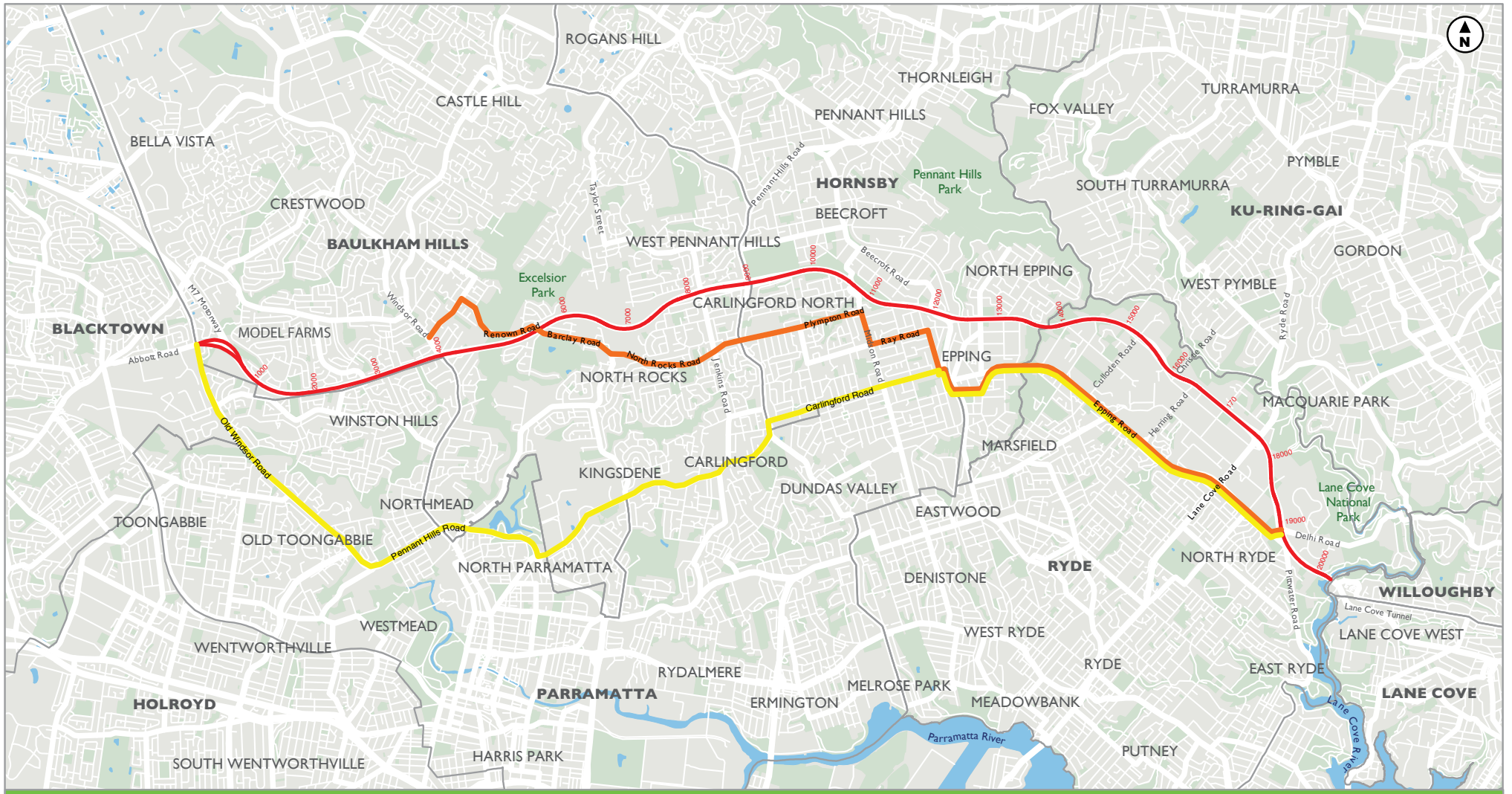

Figure 3 - Alternatives for Upgrading the Local Road Network

M2 Motorway
Option 1
Option 2
River/Waterway
Park/Open space
8000 Chainage (metres)
LGA boundary

Source: MapData, 2010

The two local road widening alternatives provide the most direct routes via the local sub-arterial and arterial road network from Windsor Road through to Delhi Road. Notwithstanding, the feasibility of upgrading the local road network is challenged by the potential impacts such an upgrade would have on surrounding land use, environmental features and property.

The key features of both routes are described as:

- The western section of both alternatives (west of Pennant Hills Road) is largely characterised by residential land use, with some sections containing mature native vegetation. Development of North Rocks Road and Carlingford Road would be heavily constrained due to residential development, schools and commercial land uses which are located along and adjacent to the dual carriageways.
- The eastern section of both alternatives (between Pennant Hills Road and Delhi Road) is characterised by residential and commercial (local business) land uses. Development of the southern side of Epping Road would be largely constrained by residential development and a densely vegetated area surrounding Terrys Creek. Land use north of Epping Road is characterised by residential development between Pennant Hills Road and Terrys Creek. East of Terrys Creek, educational and commercial land uses dominate the area and development of the local road network would be highly constrained by Macquarie University and Macquarie Business Park.

Upgrading the local sub-arterial and arterial road network would have the following impacts:

- The footprint of Carlingford, Beecroft and Epping Roads would increase, potentially impacting on the surrounding landscape and visual amenity.
- Residences, businesses and other commercial land uses located adjacent to the affected roads would potentially suffer local impacts such as property acquisition, construction impacts, amenity (noise) impacts and socio-economic impacts.
- Increased road width and traffic volumes would potentially exacerbate community severance and reduce amenity.

Widening of local roads is constrained by the proximity of surrounding land use and associated difficulties in obtaining land and/or minimising impacts on surrounding properties. Implementation of the alternative to 'upgrade the local road network' would consequently present limited opportunity to enhance the current public transport system due to carriageway constraints. The option of widening the M2 Motorway as opposed to the local arterial road network is a more feasible option as the M2 corridor exists, surrounding land uses are located outside the corridor, and the level of disturbance is considered to be less.

Further, the widening of local roads is likely to be more costly than upgrading the M2 Motorway, resulting in comparatively low value for money.

3.1.3 Provision of public transport

The 'increasing the provision of public transport within the M2 Motorway catchment' alternative has been considered for the purpose of achieving the objectives of the project as stated in Section 2.3. Two sets of alternatives under public transport provision schemes have been considered: rail based and road based.

Rail based public transport

The main public transport destinations for users within the M2 Motorway catchment are Macquarie Park and the CBD. In 2009, a rail line between Epping and Chatswood was completed with new train stations introduced at Macquarie University, Macquarie Park and North Ryde. This project involved major upgrades to Chatswood and Epping junction stations, and the rail line has increased the accessibility of Macquarie Park and the CBD to commuters from Sydney's north west. However, the provision of the

new line has not resolved congestion in the M2 corridor. These rail improvements were taken into consideration during assessment of the 'do nothing' option.

Even with a rail link to Sydney's north west, the M2 Motorway would still be subject to growth in traffic volumes over time with many trip origins and destinations of M2 Motorway users not effectively served by the selected route. In addition there are several trip purposes not suited to rail travel (for example, occupations that require transport of goods, or travel between several locations throughout the workday). These factors, combined with the existing levels of congestion, demonstrate the need for the project to proceed regardless of whether a heavy rail link is provided.

As part of the recently released *Metropolitan Transport Plan, t*he NSW government has committed to the construction of the North West Rail Link, with construction due to commence in 2017 for completion in 2024. The M2 Upgrade project would not preclude construction of the North West Rail Link or other such enhancements to public transport networks. The 14 year timeframe for commissioning of the North West Rail Link means that it would not be operational in time to avoid congestion on the M2 Motorway reaching an unacceptable level. The project, which has a two year construction program, remains the most effective means of reducing congestion on the M2 Motorway and enhancing transport networks that service Sydney's north west.

Another rail based public transport option is the introduction of light rail along the M2 Motorway. This option, however, is not a feasible option to consider unless it is introduced along the full length from the north west to the Harbour Bridge and the CBD. Introduction of limited light rail to the M2 corridor would not be an effective or feasible solution as it would have no direct links at either end of the corridor. At the time of preparing this assessment, there are no plans in place to introduce a light rail network connecting the end of the M2 corridor.

Road based public transport

Dedicated Bus Lane

This alternative would involve establishing a dedicated bus lane along the M2 Motorway, comprising either a dedicated bus lane or a separated rapid transit route, to link with the Lane Cove Tunnel and Epping Road at Lane Cove West and the CBD. This option would necessitate continuation of the existing bus lanes and would likely involve widening for the sections of the M2 Motorway that currently do not provide a bus lane.

A bus lane along the M2 Motorway is not the preferred option for alleviating congestion, for the following reasons:

- A typical AM peak bus trip from Sydney's north west, such as from Castle Hill, to the Sydney CBD via the M2 Motorway takes over an hour. The travel time improvements expected from a bus lane for the full length of the M2 Motorway is estimated to be around five minutes (less than 10 percent). Based on observed increases in public transport patronage due to changes in travel time (*Australasian travel demand elasticities - an update of the evidence* - Wallis I, 2003), a bus only lane would be expected to reduce the number of cars on the M2 Motorway by less than 100 vehicles per hour in the AM peak. This would have negligible benefits in terms of relieving congestion and improving the level of service for cars and trucks.
- Buses would not generate sufficient patronage to alleviate peak hour congestion on the existing M2 Motorway as there would be little travel time improvement from the 'do nothing' case for buses. Consequently, the mode shift from car to bus would not be significant enough to reduce congestion on the M2 Motorway.

- Cost effectiveness – this solution would not generate sufficient benefits to road users to justify the level of expenditure required and the potential environmental impacts generated by widening sections for the bus lane extensions.

A rapid bus transit system alternative is similar to the full length bus lane alternative with the difference being that buses would operate in a dedicated right of way (separated). There would be minimal travel time advantages over a dedicated bus lane as buses would be limited to the same speed. Accordingly, a rapid bus transit system is not preferred for the same reasons as described for the bus lane above.

A rapid bus transit system along the M2 Motorway would necessitate additional widening and civil works, beyond that of a dedicated bus lane, to establish physical barriers and entry / exit interchanges for buses using the transit system. This alternative would potentially generate additional environmental impacts as a result of additional widening. Hence, the costs of implementing this alternative would be higher than a full length bus lane but again would provide insufficient improvements in travel times to encourage enough mode shift to buses to improve traffic conditions for cars and trucks.

Park and ride

A park and ride and bus interchange facility was proposed during early project development stages and formed part of the project as declared by the Minister for Planning. The park and ride facility would have comprised a car park potentially able to accommodate up to 2500 vehicles and a bus interchange adjacent to the proposed east facing Herring Road ramps.

At that time, preliminary analyses indicated potential demand for commuters to utilise the parking facility and access the bus interchange to continue their journey to North Sydney or Sydney's CBD via bus or rail services (noting that the facility would also have been in proximity to the Macquarie University Rail Station). However, following more detailed analysis, this project element is no longer proposed.

It is noted that as the park and ride is no longer part of the project, a cost benefit analysis, which was identified in the Director-General's Requirements (DGRs), is not provided. Instead, the rationale for not proceeding with the park and ride and bus interchange facility, including consideration of costs and benefits and public transport patronage, is described below.

The objectives of the park and ride and bus interchange facility were to:

- Increase public transport opportunities between the north west and Macquarie Park by providing set down and pick up opportunities for buses.
- Provide an alternative for motorists from the north west with a destination of North Sydney or the Sydney CBD to use public transport (bus or rail) for the last leg of their journey between Macquarie Park and the CBD.
- Provide parking for the Macquarie Park area with access arrangements that would minimise local traffic impacts.
- Provide a funding source for the project that would offset (reduce) the toll price.

Analysis of the park and ride demand indicated that a substantial proportion of the demand would be generated by commuters travelling to Macquarie Park rather than park and ride users travelling to the CBD. The initial usage estimates by user group for the facility include:

- Park and Ride (bus) to CBD – 200 users per day.
- Macquarie Shopping Centre – potential usage by Macquarie Centre, which recently imposed limits on parking availability for staff. Estimated 250 users per day.
- Macquarie Park commercial – estimated 263 users per day (including new commercial developments).
- Very low patronage was anticipated for park and ride use by rail commuters due to the distance from the site to the rail station and inconvenience of interchanging to a shuttle bus as would be required.

Although objectives one and two would be met by a park and ride facility, the demand for parking by users with a final destination of Macquarie Park would exceed use by patrons connecting to public transport services to North Sydney and the CBD. The analysis anticipated very low patronage for park and ride use by rail commuters due to the distance from the site to the rail station and inconvenience of interchanging to a shuttle bus as would be required. It is also noted that the layout and utility of the park and ride would have been constrained by project elements identified during further development of the concept design for the new Herring Road and Christie Road ramps (refer Section 6.3.2 of this report for discussion regarding the Christie Road / Herring Road interchange).

The outcomes of the demand analysis indicated forecasts for the facility would not be adequate to subsidise (reduce) the M2 Motorway toll (objective four), the analysis did indicate the facility would be commercially viable in its own right to mainly accommodate demand for commercial parking in the Macquarie Park area.

A parking facility at this site would have benefits over other parking facilities in the Macquarie Park area as it would provide for direct access from the M2 Motorway and hence minimise traffic impacts on the local road network.

The M2 Motorway operator intends to monitor the parking supply and demand balance in the Macquarie Park area with a view to future consultation with stakeholders (City of Ryde, RTA and local business groups and the community) regarding consideration of the site in future parking strategies developed for the area.

3.1.4 Demand management tolling options

Travel demand management, by means of introducing a variable time of day toll, was considered as an option but not proposed for the M2 Upgrade project. While a tolling regime of this nature could assist in spreading the demand for peak travel to less congested time periods, it's effectiveness would be limited by other constraints, such as availability of other travel modes at the user's origin and destination and flexibility of working arrangements. Time-of-day tolling would not reduce demand during the peak periods to the extent that widening would not be required.

Another alternative tolling scheme that was considered but not proposed by the M2 Motorway operator was distance based tolling. This scheme would result in some users benefiting from lower tolls (short trips) and others being charged higher tolls (longer trips). In terms of demand management such a scheme could have undesired impact of additional congestion in the highest demand section of the M2 Motorway (at the Norfolk Tunnel – east of Beecroft Road). This would be due to additional short trips (from Beecroft Road) attracted by a lower toll resulting in additional congestion that would discourage utilisation of the M2 Motorway for some longer trips.

The above tolling options would require implementation of Full Electronic Toll Collection (FETC). Currently the toll collection points on the M2 Motorway at Pennant Hills Road and the main toll plaza at North Ryde accept electronic payment (tag) or cash. Although there are new toll roads in Australia that have been constructed in recent years utilise FETC (cashless), it was decided that a move to electronic only payment would not be included as part of the M2 Upgrade project.

There are still a large number of existing users that do not use the M2 Motorway regularly and prefer to pay the toll with cash rather than electronic payment. The M2 Motorway operator would only consider removing the cash option of payment for these customers when the number of cash users dropped to such a level that retention of this payment method could not be justified. . The M2 Upgrade project does not preclude FETC or the above tolling strategies being implemented at some time in the future, however this would be the subject of further consideration including costs of implementation (system installation and toll revenue) and impacts on the traffic network in the M2 corridor.

3.1.5 Comparison of the alternatives with the project

Following an assessment of the alternatives against the project objectives and on performance and environmental grounds, alternatives one to four were eliminated. The reasons for this are given below.

- Alternative one (do nothing) would not address the growing traffic and public transport problems along the M2 corridor and may result in a deteriorating situation for both buses and general traffic.
- Alternative two (road based improvement – line marking) - may result in a reduced level of service for M2 Motorway users including motorists, cyclists and those commuting by public transport. Safety and the ability to manage incidents may be compromised by the removal of the break down lane.
- Alternative two (road based improvement – local sub-arterial and arterial road upgrade) would potentially have social and economic impacts as existing development adjacent to local sub-arterial and arterial roads would necessitate the acquisition of property to enable these roads to be widened. This may impact on individual property owners and the character of the area, and would be a costly exercise, therefore not providing value for money. Construction impacts such as noise may also be potentially significant.
- Alternative three (provision of public transport – rail) would not address the growing traffic and public transport problems along the M2 corridor and may result in a deteriorating situation for both buses and general traffic. Rail projects such as the North West Rail Link would not be constructed in time to alleviate growing congestion on the M2 Motorway. Additionally, rail is not suited to multi-stop or freight related trips. Light rail would be largely ineffective unless it was extended beyond the M2 Motorway and there are currently no plans for this to occur.
- Alternative three (provision of public transport – road) – would not significantly alleviate the growing traffic and public transport problems along the M2 corridor. Construction of a dedicated bus lane along the length of the M2 Motorway may generate additional environmental impacts and require significant expenditure. This is not considered to be justified as it would provide insufficient improvements in travel times to encourage enough mode shift to buses to improve traffic conditions for cars and trucks. A park and ride facility would not change this situation as analysis shows that the park and ride facility would be primarily utilised by commuters with a final destination of Macquarie Park with only minor usage by commuters on-travelling to alternative destinations.
- Alternative four (demand management – tolling options) would result in a number of potential changes to commuter behaviour which may result in changed patterns of congestion and even avoidance of the M2 Motorway. It is not considered that this option would achieve the traffic related project objectives.

The project is consistent with relevant State Government plans, strategies and polices and would not preclude other transport solutions for Sydney's north west. The project meets requirements for the projected growth in traffic and transport on the M2 Motorway by providing additional motorway capacity

that meets appropriate RTA design standards. When compared to other alternatives and assessed against the project objectives and other environmental factors, widening of the M2 Motorway is preferred in relation to social, environmental, design and economic considerations.

Options for widening the M2 Motorway are assessed in Section 3.2 below.

3.2 Motorway widening options

The evaluation of project alternatives described in Section 3.1 above identified widening of the existing M2 Motorway as the preferred solution. A more detailed analysis of project options was then considered to identify the preferred project option for key sections of the M2 Motorway. The following sections described the criteria used and the key findings from the analysis of project options.

3.2.1 Option evaluation criteria

To achieve the project objectives (described in Section 2.3 of this report), a range of criteria have been formulated to evaluate options for the project. These criteria target an appropriate balance of community, natural resource and economic imperatives as well as applying RTA and AustRoads road design guidelines.

Criteria used to assess the options include:

- Meet design criteria and geometry standards – Demonstrates compliance with RTA Road Design and AustRoads design guidelines. Maintaining or enhancing operation efficiency, safety and functionality of the M2 Motorway during and post construction.
- Maximise cost effectiveness – Maximises cost effectiveness and value for money of public infrastructure.
- Constructability, operation and maintenance – The proposed design can be constructed in a practical manner whilst minimising disruption to traffic flows and impacts on social, economic and environmental values. Maximises efficiencies of operation and maintenance activities, including minimising the requirement for maintenance where practical.
- Minimise impact on natural resources and ecology – Minimises impacts on natural resources, environmental and heritage values during construction and operation.
- Minimise property impacts – Minimises direct property impacts.
- Minimise social and economic impacts – Minimises impacts on land use, local business, provision of safe and convenient public transport, pedestrian and cyclist accessibility.
- Promote sustainable development – Implements principles of Ecologically Sustainable Development and sustainability (including minimising Greenhouse Gas Emissions) within design solutions.

The project options were assessed against these criteria in order to select the best design solution.

3.2.2 Motorway widening design options

The following sections summarise the factors that influence the need for widening relevant sections of the M2 Motorway. When referring to motorway widening, the design options described in this section generally comprise the following (or a combination).

- For eastbound widening, the M2 Upgrade project could involve either:
  - widening to north to create a wider eastbound carriageway;
  - widening to the south and moving the median to the south to create a wider eastbound carriageway; and/or
  - narrowing of the median to create a wider eastbound carriageway.
- For westbound widening, the M2 Upgrade project could involve either:
  - widening to south to create a wider westbound carriageway;
  - widening to north and moving the median to the north to create a wider westbound carriageway; and/or
  - narrowing of the median to create a wider westbound carriageway.

Abbott Road to Windsor Road

No widening is proposed westbound or eastbound from Abbott Road to Windsor Road, for the following reasons:

- Traffic demand is lower than available capacity in this section in the eastbound direction during the AM peak period, even taking into account the proposed west-facing ramps at Windsor Road. A large number of vehicles enter from Windsor Road and travel eastbound resulting in the volumes in downstream section (Windsor Road to Pennant Hills Road) exceeding capacity. This capacity constraint results in queues extending back to this section from the Windsor Road merge. This constraint would be removed with the project as eastbound traffic entering from Windsor Road would enter the M2 Motorway in an added lane rather than merging with the mainline traffic.
- Additional lane capacity in this section would not provide road user benefits to warrant widening.
- At the Windsor Road interchange, current westbound traffic volumes using the off ramp would be higher than the predicted volumes of traffic entering at the new westbound on ramp. Therefore there would be lower traffic volumes in this section than the upstream section (Pennant Hills Road to Windsor Road).

Works associated with the west-facing ramps at Windsor Road are discussed in Section 6.3.2.

Windsor Road to Pennant Hills Road

Eastbound widening

Eastbound widening from Windsor Road to Pennant Hills Road is proposed for the following reasons:

- Merging traffic from the existing Windsor Road on ramp creates substantial eastbound congestion during the morning peak hour period, resulting in traffic queues often extending back to the M7 Motorway. Provision of a third eastbound lane would increase the capacity east of the Windsor Road merge and substantially improve the level of service.
- The steep incline approaching the Barclay Road overbridge causes a large number of trucks to reduce speed, which increases congestion and limits the capacity of the M2 Motorway in this section. Widening of this section would provide additional overtaking opportunities (two lanes for other

vehicles to overtake instead of one), hence reducing the impacts slow vehicles have in reducing capacity in this section.

The preferred design for eastbound widening between Windsor Road and Barclay Road is widening to the north, for the following reasons:

- Due to the large cutting to the south of the carriageway, widening to the south would involve more intensive earthworks than widening to the north. Widening to the south would require more complex, lengthy and costly construction to undertake earthworks, which would necessitate implementing additional traffic management measures during construction to maximise traffic safety.
- Existing dwellings are located near the top of the cutting. Widening to the south may generate additional impacts, such as noise and vibration impacts during construction, compared to widening to the north.
- Existing bus stops in the M2 Motorway median at Windsor Road and Barclay Road limit the potential alignment options. To provide safe lane dimensions and curve radii, it is not possible to widen to the south in this section and tie in to the existing lanes adjacent to the bus stop. Realignment of the bus stops is limited due to the bridge structure at Barclay Road.
- Currently, the Windsor Road eastbound on ramp determines the position of the M2 Motorway median. Widening to the north minimises works required to the westbound off ramp compared to widening to the south, which would require reconfiguration of this ramp. Impact on the westbound off ramp would increase construction time, cost and materials.
- Widening to the north is the most cost effective option as it avoids impact to bus stops, existing Windsor Road ramps and the large cutting to the south. Widening to the south, which would involve relocating the existing Windsor Road and Barclay Road bus stops, reconfiguring the east facing Windsor Road on ramp and intensive earthworks at the large cutting, would increase the cost of the project.

Widening to the south between Windsor Road and Barclay Road does not meet design criteria and geometry standards and decreases the cost effectiveness of the project. Whereas widening to the north improves constructability and reduces property impacts.

The preferred design for eastbound widening between Barclay Road and Pennant Hills Road is widening to the south, for the following reasons:

- Darling Mills State Forest is located to the north of the M2 Motorway. Widening to the north would require large amounts of vegetation removal for construction and access, whereas, widening to the south would minimise the vegetation removal required.
- The large sections of existing retaining walls to the north would require demolition and relocation if widening was to occur to the north. This would increase the cost, materials and construction time of the project. Widening to the south would reduce the cost and materials by avoiding these existing retaining walls.

Due to steep topography, which slopes down from south to north, access for works to bridge structures on the north side of the M2 Motorway through Darling Mills State Forest would be difficult and would require greater earthworks and vegetation removal. In comparison, construction to the south can be achieved utilising local roads for construction access, generating less potential impact on natural areas. Widening to the south between Barclay Road and Pennant Hills Road minimises impact on natural resources and maximises the cost effectiveness in this section. Whereas widening to the north decreases constructability and cost effectiveness of the upgrade.

Westbound widening

Widening westbound between Pennant Hills Road and Windsor Road was presented as an optional widening in the preliminary environmental assessment (RTA, 2009). Upon detailed investigation, it was decided not to widen westbound between Windsor Road and Pennant Hills Road, for the following reasons:

- Travel time surveys undertaken in 2009 indicate average peak hour speeds are typically higher than 80 kilometres per hour with congestion not observed in this section despite high volumes.
- Widening of the M2 Motorway in this section, in addition to the widening required for the additional lane eastbound, would generate additional impacts on natural vegetation and habitat in the Darling Mills Creek and Bidjigal Reserve area.
- Additional lane capacity in this section would not provide road user benefits to warrant widening. Traffic in this section experiences an earlier PM peak hour than the rest of the M2. Although future traffic growth could lead to some congestion in this section during the PM peak the earlier timing and relatively short duration of this would not justify the additional expenditure ($40 -$50 million) required for widening.

The potential F3 Freeway to M2 Motorway link may result in additional westbound traffic between Windsor Road and Pennant Hills Road and could require additional capacity to be provided in this section at some point in the future, although currently no funding has been committed to this project. Peak period traffic impacts on this part of the M2 Motorway could be reassessed when funding is committed to the F3 Freeway to M2 Motorway link and project alignment is confirmed.

Pennant Hills Road to Lane Cove Road

Eastbound widening

Widening is proposed eastbound from Pennant Hills Road to Lane Cove Road, for the following reasons:

- There are major, recurrent congestion issues extending west from the Beecroft Road merge and the Norfolk Tunnel.
- Widening through this section would resolve the current traffic constraints and resulting congestion.
- The new lane extending from the Pennant Hills Road on ramp would result in safer access conditions. Traffic entering the M2 Motorway from this ramp would not need to merge into the heavily congested mainline flow.
- Additional travel time saving would be provided for buses and vehicles with two or more people via a transit lane from Terrys Creek to Lane Cove Road.

Westbound widening

Widening is proposed westbound from Lane Cove Road to Pennant Hills Road, for the following reasons:

- Demand in this section is already near/at capacity especially west of Beecroft Road.
- An interim solution has been in place to accommodate the additional traffic between Beecroft Road and Lane Cove Road. This involved re-line marking the existing pavement with three traffic lanes. The arrangement required narrower traffic lanes, reduced speed limits and the loss of the breakdown lane. The removal of the breakdown lane resulted in the provision of an off-motorway route for cyclists.

- Widening of this section would allow traffic arrangements (such as lane width and speed limit) to be restored to an acceptable Motorway standard. This would relieve the congestion and improve travel times during the afternoon peak period.
- The following discusses options in the various sections for both eastbound and westbound described from west to east.

Devlins Creek Bridge

As the existing M2 Motorway over Devlins Creek is comprised of separate eastbound and westbound bridge structures, widening of the M2 Motorway to provide additional lanes eastbound and westbound would involve either:

- Widening north and south of the M2 Motorway, providing a single additional outside lane in both directions.
- Closing the existing gap between bridge structures and widening in the existing median and to the south.

The preferred design is to close the gap to provide the new eastbound lane in the existing median and widening westbound to the south, for the following reasons:

- Widening to the north would result in partial clearing for carriageway and construction access adjacent to an area of Blue Gum High Forest, an Endangered Ecological Community, located adjacent to Pennant Hills Golf Course (refer to Technical Paper 3 for discussion of significance of vegetation). Widening to the south would avoid impacts on this community.
- Closing the existing gap between the eastbound and westbound bridge structures would allow eastbound construction activities to take place from the M2 Motorway carriageway, reducing the impact on surrounding bushland.
- Devlins Creek is located to the north of the M2 Motorway. Widening to the north would come into direct contact with Devlins Creek near Kirkham Street, requiring the construction of new culverts which would potentially impact water quality of the creek during construction.
- Closing the gap reduces the impact to higher value riparian vegetation north of the M2 as opposed to lower value vegetation under the bridges. The vegetation under and between the bridges is considered to be of a lower value due to limited exposure to light and disconnection from surrounding vegetation. The vegetation to the north of the M2 Motorway is considered to be of higher value because it has greater potential for rehabilitation due to greater exposure to light and greater accessibility.

The preferred option was chosen because it is the only option that meets design criteria and minimises constructability issues. This option has the lowest impact on properties, natural resources and ecology, and best meets the principles of Ecologically Sustainable Development.

Bus lane termination between Kirkham Street and Beecroft Road

Design options considered for this section of the M2 Motorway, eastbound, include widening to the north or terminating the bus lane to provide three general purpose traffic lanes. The preferred design option is to terminate the bus lane (eastbound and westbound) west of Beecroft Road, to utilise the existing carriageway to provide three general purpose traffic lanes and a breakdown lane on both the eastbound and westbound carriageways. This design option is preferred for the following reasons:

- Utilising the bus lane does not require widening. It would avoid impact to existing noise walls and retaining walls, which would minimise the time, cost, and materials required for construction. Widening to the north or south would increase construction cost, time and materials. Widening to the south would have the greatest cost as it would require widening, earthworks and moving the M2 Motorway median to the south.
- Devlins Creek is situated to the north of the M2 Motorway through this section. Avoiding widening would reduce the impact on Devlins Creek as the construction of new culverts would not be required and construction impacts on the water quality would be avoided. Widening to the north would be difficult as Devlins Creek restricts access for construction and would result in greater ecological impacts.
- Use of the bus lane is enabled through removal of the Beecroft Road bus ramp, which is currently underutilised. The project improves bus access to Macquarie Park via Christie Road, which provides direct bus access between the M2 Motorway and the bus station at Macquarie Centre. Refer to Section 6.3.6 of this report for discussion regarding removal of the Beecroft Road bus ramp.
- Whilst use of the bus lane and removal of the Beecroft Road bus ramp would require replacement of the existing piers at Beecroft Road with one row of central piers, this would eliminate the need to rebuild both abutments of Beecroft Road bridge, reducing the cost and time of construction.
- The westbound Motorway after Kent Street has reduced stopping sight distances for general traffic and therefore would be retained for buses as it is currently utilised.
- The bus lane would be terminated and utilised as the third general traffic lane east from Kent Street to minimise impact on Epping Heights Public School, located at Chainage 11500, and avoid other impacts as discussed above. Widening to the south would require moving the noise walls closer to the school buildings and a reduction in the land able to be used by the school.
- Widening to the north for both eastbound and westbound carriageways would be the most costly and hardest to construct as it would require earthworks within bushland areas and moving the M2 Motorway median to the north.

Terminating the bus lane to form the third general traffic lane was the preferred option as it is the most cost effective option and it removes the potential need for property acquisition in this section.

Norfolk Tunnel

Design options considered for widening the Norfolk Tunnel include:

- Tunnel widening – 100 kilometres per hour design speed, with lane width and configurations as follows:
  - 3 x 3.5 metre wide lanes.
  - 1 x 0.5 metre wide shoulder lane.
  - 1 x 2.5 metre wide breakdown lane (cycle access provided to breakdown lane through Tunnel).
  - 1 x 1.05 metre wide walkway including concrete barrier.

- Partial tunnel widening – 80 kilometres per hour design speed, with lane width and configurations as follows:
  - 3 x 3.5 metre wide lanes.
  - 2 x 0.5 metre wide shoulder lane.
  - 1 x 1.05 metre wide walkway.
  - Cycle bypass (via local streets and ramps over tunnel).
- No tunnel widening – 70 kilometres per hour design speed, with re-line marked lane widths and configurations as follows:
  - 3 x 3.1 metre wide lanes.
  - 1 x 0.25 metre wide shoulder (no breakdown lane and no cycle access through Tunnel)
  - 1 x 1.1 metre wide kerb line.
  - 1 x 0.6 metre wide walkway.
  - Cycle bypass (via local streets and ramps over tunnel).

The preferred design is full tunnel widening, for the following reasons:

- To provide consistency for M2 Motorway users, the project would provide a 100 kilometre per hour speed limit along the M2 Motorway between Windsor Road and Lane Cove Tunnel.
- Tunnel widening is the safest option as it provides a full 2.5 metre wide breakdown lane. It would allow for a car to stop safely in the tunnel without disrupting the traffic flow and without becoming a hazard to vehicles travelling past at the 100 kilometre per hour speed limit. While partial tunnel widening provides the equivalent general traffic lanes, the breakdown lanes are narrower and so the 100 kilometre per hour speed limit would not be achieved. Partial and no tunnel widening are the less safe options with narrow shoulder lanes that would not provide adequate space for a car to stop safely in the tunnel. This would require a lower speed limit as traffic incidents in the tunnel would interrupt the traffic flow.
- Reinstatement of the westbound breakdown lane in the tunnel would eliminate the existing operational requirement for an incident response crew on standby during peak periods.
- The wider shoulder allows cyclists to access the breakdown lane, which would decrease travel time for cyclists travelling between the CBD and Sydney's north west. Partial or no tunnel widening would require cyclists to bypass the tunnel either via a diversion through local roads or via ramps to carry cyclists over the tunnel, which would increase the travel time for cyclists utilising the M2 Motorway. Cycle ramps over the M2 Motorway would be difficult to construct and likely to be avoided by commuter and training cyclists who would risk travelling through the tunnel to avoid the ramps.
- The impacts that would be experienced by the local community during construction such as increased noise and dust emissions and an increase to the toll would be more likely to be accepted by the community if a 100 kilometres per hour design is provided.

While no tunnel widening is the least costly option, it does not meet the project's design criteria and geometry standards. Tunnel widening is the only option that meets design criteria for safety and required speed limit and is the only option that justifies the increased toll following completion of the project.

Terrys Creek to Toll Plaza

Design options for widening this section of the M2 Motorway include widening to the north, widening to the south or widening to the north and south.

The preferred design is to widen to the north, for the following reasons:

- Due to the existing noise walls on the southern side of the M2 Motorway, widening to the south would require costly and lengthy construction as these noise walls would need to be relocated. Widening to the north minimises the time, cost and materials required for construction as it avoids impact to these noise walls.
- Three westbound lanes must be maintained during construction at peak times. Widening to the south while meeting these operational criteria would be extremely difficult due to the constraints in this section where the breakdown lane has been removed and lane widths are already below motorway standards.
- Due to the large cutting to the south of the carriageway, widening to the south would involve more intensive earthworks than widening to the north. Widening to the south would require more complex, lengthy and costly construction to undertake earthworks, which would necessitate implementing additional traffic management measures during construction to maximise traffic safety. The northern carriageway was initially constructed on an area of fill, therefore, widening to the north would be more cost effective and easier to construct.
- Construction access is difficult on the southern side due to the large cutting.
- Widening to the south would require more extensive vegetation removal than widening to the north.
- Approaching the Toll Plaza, widening would occur to the north and south of the M2 Motorway in order to align with the Toll Plaza lanes and avoid the need to adjust the existing central piers of the Culloden Road overbridge.

Widening to the south would not be cost effective and construction and access would be difficult. Widening to the north minimises cost, constructability issues and vegetation impact on natural resources.

Lane Cove Road to Lane Cove Tunnel

No widening is proposed between Lane Cove Road and Lane Cove Tunnel, for the following reasons:

- An acceptable level of service has been experienced through this section since the opening of the Lane Cove Tunnel.
- The traffic demand is not high enough to warrant widening.
- Widening through this section would require the lengthening of Lane Cove Road bridge. The cost and construction impact associated with this is not considered warranted given the current traffic demand.

3.2.3 Interchange and ramp options

The M2 Motorway comprises a number of interchanges, two of which are subject to the proposed upgrade, with new access ramps being incorporated and some modified. The interchange access ramps subject to the proposed upgrade works are:

- Windsor Road west facing on and off ramps, including widening of Windsor Road near the M2 Motorway to provide adequate ramp turning lanes, at the Windsor Road grade separated interchange.
- Herring Road and Christie Road ramps to facilitate access between the M2 Motorway and Macquarie Park.

New ramps were also considered at the Beecroft Road and Lane Cove Road interchanges. An assessment of ramp options is provided below.

Windsor Road west facing ramps

West facing ramps are proposed at the existing Windsor Road interchange. The primary purpose of the proposed Windsor Road west facing ramps is to provide motorists with the ability to exit on to Windsor Road when travelling from the west (from Abbott Road, Old Windsor Road and M7 Motorway) and also to provide access to the western carriageway of M2 from Windsor Road to access Abbott Road, Old Windsor Road and M7 Motorway. Currently there is no opportunity for motorists to exit the Sydney Orbital network between Norwest Boulevard (if on the M7 Motorway), Old Windsor Road and Pennant Hills Road, a distance of approximately 12 kilometres. Also there is no opportunity to enter the M2 Motorway westbound west of Pennant Hills Road, which reduces access to the westbound M7 Motorway.

The 'do-nothing' option limits the ability of the surrounding road system to cater for the increasing M7 Motorway traffic, thereby increasing travel time, travel distance, congestion of the local road system and accident potential.

Whilst ramps could be constructed in the middle of the M2 Motorway (in the median area) it is more appropriate to put the ramps on the sides of the M2 Motorway for the following reasons:

- Allows future provision of bus only ramps (as on the eastern side of Windsor Road) if these are warranted in the future.
- Ensures the M2 Motorway/Windsor Road intersection operates efficiently.

The installation of west facing ramps at Windsor Road would improve access to Sydney's north west and the Sydney Orbital network generally, while reducing travel time and providing a more efficient link for motorists in the ramp catchment area.

Beecroft Road west facing ramps

While provision of west facing ramps at Beecroft Road would facilitate greater accessibility to areas off the M2 Motorway (via Pennant Hills Road, Windsor Road and Abbott Road), the Sydney Orbital network and the north west generally and would potentially decrease the amount of vehicles on Beecroft Road South and Carlingford Road. The preferred solution is to maintain the current configuration, for the following reasons:

- The current composition of the interchange is spatially constrained by the location of Devlins Creek and associated riparian vegetation, required land acquisition and the existing curve of Beecroft Road.
- New west facing ramps would require a complete re-configuration of Beecroft Road intersection and providing new ramps at Beecroft Road would not be cost effective.

In reviewing the nature of these spatial constraints, the level of potential impact and how the design meets the principles of Ecologically Sustainable Development, this option was excluded from further consideration.

Christie Road and Herring Road ramps

The primary purpose of the proposed Christie Road and Herring Road ramps is to provide improved access and accessibility between Macquarie Park, Macquarie Centre and the M2 Motorway. Currently there is no opportunity to access the M2 Motorway eastbound or exit the M2 Motorway westbound in Macquarie Park. A number of options have been considered for such ramps in the vicinity of Christie Road and Herring Road to provide an eastbound on ramp and a westbound off ramp. Two of the options considered also include access to a park and ride facility which no longer forms part of the project scope.

Design options for Christie Road and Herring Road interchanges include:

- A new eastbound on ramp and new westbound off ramp at Herring Road.
- A new eastbound on ramp at Christie Road and a new westbound off ramp at Herring Road.

The preferred design is a split interchange configuration, with an eastbound on ramp at Christie Road and westbound off ramp at Herring Road, for the following reasons:

- The split interchange utilises existing pavement as far as practical and generates the least increase in construction footprint, minimising vegetation clearance.
- Involves at grade ramps, with minor widening works to Christie Road Bridge, thereby minimising cost, construction time and materials compared to the Herring Road interchange option that would have required a new bridge over the M2 Motorway at Herring Road.
- There is reduced impact to Shrimptons Creek culvert.
- The eastbound on ramp at Christie Road is a larger distance from the eastbound off ramp at Lane Cove Road, providing the greatest merging distance between the two ramps, which improves traffic safety and flows.

Lane Cove Road

While provision of east facing ramps at Lane Cove Road (a major arterial road) would facilitate greater accessibility to the M2 Motorway in close proximity to Lane Cove Tunnel, the preferred solution is to maintain the current configuration, for the following reasons:

- An east facing entry ramp from Lane Cove Road to the eastbound M2 Motorway may be feasible but there would be issues with provision of such a ramp that would need further consideration, including required works on the M2 Motorway east of the ramp and potential impacts on the adjoining road network (such as increased traffic on routes leading to Lane Cove Road) and the local environment.
- An east facing exit ramp at Lane Cove Road would necessitate a major reconfiguration of the interchange, including:
  - Adjustment of the existing loop entry that is used for westbound traffic that approaches from the north and enters the M2 Motorway via loop ramp.
  - Potential property acquisition to connect ramp to Talavera Road.
  - Potential reconfiguration of road space and traffic lights on Lane Cove Road.
- An eastbound on ramp to accommodate left only entries from Lane Cove Road could be considered in the future if traffic demand was adequate to justify construction and the issues mentioned above can be satisfactorily resolved. The M2 Motorway operator has recently had discussions with the RTA to preserve the option for future provision of this ramp.
- The proposed east-facing ramp connecting to Herring Road would possibly provide this exit ramp although traffic wanting to access Lane Cove Road would need to travel east along Talavera Road for nearly 1.5 kilometres.

Accordingly, the preferred option for the M2 Motorway/Lane Cove Road interchange at this time is to maintain the current interchange configuration.

3.2.4 Main compound site alternatives

The TIDC compound in the Macquarie Park industrial area (near the corner of Epping Road and Delhi Road) is preferred as the primary construction compound due to its potential to be the least intrusive of four potential sites considered. The alternative main compound sites are described below together with a summary of why each was not preferred:

- Macquarie compound (vacant land on northern side of M2 Motorway in proximity to Herring Road), is not preferred due to the close proximity of medium density housing along Khartoum Road and the lack of local road access.
- The Cemetery site (land at the end of Wicks Road, adjacent to Macquarie Cemetery), is not preferred due to the sensitive nature of the adjacent cemetery and as a large proportion of this site was originally a landfill site it would necessitate specific leachate treatment if used as a compound site.
- The Parramatta to Epping rail link compound site (TIDC owned land) on Waterloo Road in Macquarie Park was not selected due to the close proximity to local businesses, it has no direct access onto the M2 Motorway, and the potential disruption generated by construction traffic moving in and out of a busy commercial and retail centre.

The TIDC M2 Motorway compound is preferred due to the following key characteristics:

- The ease of access onto the M2 Motorway, via a direct access point onto the westbound on-ramp at Delhi Road.
- It has been previously used as a construction compound for the Epping to Chatswood rail link.
- The relative size of the land available provides suitable space for compound activities.
- The comparatively low prevalence of sensitive receivers in close proximity (the only residential properties in close proximity are located at the extreme southern end of the compound on the opposite side of the busy Epping Road.

Other work sites and compounds proposed as part of the M2 Upgrade project were subject to a similarly rigorous process of consideration, based upon other alternatives available, proximity to the M2 Motorway, location and relative number of adjacent sensitive receivers, as well as the level of environmental values present on the land in question. Refer to Section 7.8 for further discussion regarding compound sites.