6. Project description

The M2 Upgrade project includes the upgrade construction works and operation of the M2 Motorway between Windsor Road and Lane Cove Road. The project also includes the development of all associated or ancillary works, activities, uses, structures and facilities. This chapter describes the project and its operation. A description of the construction of the project is provided in Chapter 7.

Director-General's Requirements	Where addressed
A description of the project including:	
Route alignment of the project, including an indication of areas for widened or new carriageways, on-ramps, off-ramps, breakdown lanes and associated and ancillary facilities.	*Sections 6.2, 6.3*
Key design elements of the project, including carriageway, tunnelling and bridging works.	*Sections 6.2, 6.3*
Ancillary operational components, including upgrades to the M2 Motorway's Intelligent Transport Systems, upgrades to toll facilities, park and ride facilities, cycle facilities, signals and connections with the surrounding road network.	*Section 6.4*
Operational traffic and transport implications – the assessment must also consider operational implications for public transport (particularly with respect to bus routes, interchanges and connections with the rail network), impacts on cyclists and cycle access, and any impacts on pedestrian access and safety (for those ancillary works around the M2 corridor, as relevant).	*Sections 6.3.2, 9.1.2*
Urban design and landscaping issues – the environmental assessment must include consideration of the urban design and landscape implications of the project, including identification of urban design and landscaping objectives to enhance the current road corridor and to demonstrate how the proposed urban design elements of the project would be consistent with the existing (and desired) character of the area.	*Sections 6.5.2, 9.6.2, 9.6.3*

6.1 Project overview

The M2 Upgrade project would extend for 14.5 kilometres along the M2 Motorway from Windsor Road, Baulkham Hills to Lane Cove Road, North Ryde. The project would be undertaken within a broader study area which extends from Abbott Road, Baulkham Hills, to the western portal of the Lane Cove Tunnel in North Ryde. An overview of the project location and alignment is provided in Figures 1 and 2.

The proposed upgrade would include the following key components:

- Widening and/or provision of a third lane along sections of the eastbound and westbound carriageways between Windsor Road and Lane Cove Road.
- Provision of new on and off-ramps at Windsor Road, new on-ramp at Christie Road and new off-ramp at Herring Road.
- Widening and provision of a third lane eastbound and westbound in the Norfolk Tunnel.
- Restoration of the westbound breakdown lane and provision of 3.5 metre wide traffic lanes between Lane Cove Road and Beecroft Road.
- Removal of the Beecroft Road bus on and off-ramp.

- Upgrade to the intersection of the M2 Motorway/Windsor Road, and the Christie Road/Talavera Road and Herring Road/Talavera Road intersections.
- Upgrade to the M2 Motorway Intelligent Transport System.

More detail on the extent and specific components of the project is presented in Figure 5.

The project defined in this environmental assessment is based on a concept design, which is consistent with the principles of ecologically sustainable development. The concept design presents a general arrangement for the upgrade, based on current information. This differs slightly from the project declared by the Minister and presented in the Preliminary environmental assessment as further investigations have resulted in design refinements leading to the deletion and addition of project components such as:

- The deletion of the park and ride facility.
- The addition of works to improve functionality at Christie, Herring and Talavera Roads.

The concept design would be further developed as the project progresses. However, the nature of such variations would be generally consistent with the concept design. More detail regarding the design process is provided in Section 6.5.

The NSW RTA is seeking approval for the construction and operation of the project including all associated or ancillary works, activities, uses, structures and facilities.

6.2 Route alignment and key features

The Director-General requires a description of the route alignments of the project including an indication of areas for widened or new carriageways, on-ramps, off-ramps, breakdown lanes and associated and ancillary features to be included in the environmental assessment. This information is provided in this section.

The project would be undertaken between Windsor Road and Lane Cove Road, and within a broader study area that extends from Abbott Road to the Lane Cove Tunnel. The broader study area has been separated into five precincts. These precincts and the works proposed within each precinct are shown in Figure 5 and described below.

6.2.1 Precinct 1 – Abbott Road to Windsor Road (chainage 3300 – 4000)

Proposed upgrade works within Precinct 1 include new west facing on and off-ramps between the M2 Motorway and Windsor Road and modifications to the current grade separated interchange. To accommodate the new west facing ramps, the M2 Motorway would be widened on the approach to the Windsor Road interchange (from just west of the Watkins Road overbridge at approximately chainage 3400 to Windsor Road at chainage 4000 (600 metres)). The Windsor Road overbridge would be widened on the western side and modified to provide additional through lanes at the intersection and accommodate adequate ramp turning lanes for the new ramps. Windsor Road would be widened between Woodlands Street and Oakland Avenue.

New barriers in the median of the M2 Motorway would not be provided west of Windsor Road given the existing width of the median through this section, which is sufficient to provide the required clear width to comply with design standards.

Section 6.3.2 provides further description of the Windsor Road ramp configuration and Section 6.3.6 describes the proposed Windsor Road bridge modification works.

6.2.2 Precinct 2 – Windsor Road to Pennant Hills Road (chainage 4000 – 9000)

Proposed upgrade works within Precinct 2 include widening of the road pavement to create an additional 3.5 metre wide eastbound lane from the end of the Windsor Road entry ramp to the Pennant Hills Road exit ramp. As a result of the upgrade, the eastbound mainline carriageway would comprise three 3.5 metre wide lanes, a single 3.5 metre wide bus lane and a single 2.5 metre wide breakdown lane that could be used by bicycle users. Traffic entering from Windsor Road would not have to merge and would run into its own lane. Essentially, the modification would result in a lane gain at the Windsor Road on ramp and a lane drop at the Pennant Hills Road exit ramp

Proposed works include modifications to Darling Mills Creek Bridge, Barclay Road overbridge and Yale Close Bridge (refer to Section 6.3.3 for a description of these bridges).

Widening of the road pavement would occur on the northern side of the M2 Motorway over Darling Mills Creek (bridge structure) and east of the creek from approximately chainage 4550 to 5950 (1,400 metres).

The M2 Motorway through this section, at approximately chainage 5900, would be typically widened on areas of cut, as can be seen in the typical cross-section in Figure 6.

Widening of the road pavement would occur to south of the M2 Motorway from approximately chainage 5800 to 7700 (1900 metres), east of the Barclay Road overbridge. The existing cutting to the south would be widened between approximately chainage 5830 and 6000 (170 metres). A typical cross-section of a cutting is illustrated in Figure 6. The existing median would be shifted to the south to create the additional eastbound lane. A small section of widening would occur to the north of the M2 Motorway from approximately chainage 7600 to chainage 7820 (220 metres), tying the additional eastbound lane into the off-ramp at Pennant Hills Road.

To accommodate the widening of the road pavement there would be concrete retaining wall supporting a widened earth embankment, and battering works required at various sections of the carriageway on the northern and southern sides of the M2. The nature of battering work would be finalised during the detailed design phase of the project.

Emergency stopping bays would be provided on the widened carriageway to match the existing locations and median barriers would be in place for the length of this section.

6.2.3 Precinct 3 – Pennant Hills Road to Beecroft Road (chainage 9000 – 11900)

Proposed upgrade works within Precinct 3 include widening to create an additional 3.5 metre wide lane eastbound and westbound.

The additional eastbound lane would extend from the Pennant Hills Road entry ramp to the Beecroft Road entry ramp. As a result of the upgrade, the eastbound mainline carriageway would provide three 3.5 metre wide lanes, a single 3.5 metre bus lane (terminating approximately 1200 metres west of Beecroft Road interchange) and a single 2.5 metre breakdown lane.

The additional westbound lane would extend from the Beecroft Road interchange to the Pennant Hills Road exit ramp. This is a distance of approximately 1300 metres of an additional lane gain. As a result of

the upgrade, the westbound mainline carriageway would comprise three 3.5 metre wide lanes, a single 3.5 metre wide bus lane (commencing approximately 650 metres west of Beecroft Road interchange) and a single 2.5 metre wide breakdown lane.

Where the bus lanes would terminate, both eastbound and westbound carriageways would provide three 3.5 metre wide lanes and a single 2.5 metre wide breakdown lane.

The M2 Motorway would be widened on the southern side to accommodate the additional westbound lane, from approximately chainage 9600 to 11360 (1760 metres), being west of the Kent Street footbridge. From the commencement of Devlins Creek Bridge at approximately chainage 9850, the gap between the eastbound and westbound carriageway bridge structures over Devlins Creek would be closed to accommodate a third lane eastbound. Modifications would also be required to Kirkham Street Bridge to accommodate widening works (refer to Section 6.3.6).

Earthworks embankment and battering works would be required at various sections of the carriageway along the alignment in this precinct. Emergency stopping bays would be provided on the widened carriageways to match the existing locations and median barriers would be in place for the length of this section. The nature of embankments and batters and the number and location of emergency stopping bays would be determined during the detailed design phase of the project.

6.2.4 Precinct 4 – Beecroft Road to Terrys Creek (including Norfolk Tunnel) (chainage 11900 – 13500)

Proposed upgrade works within Precinct 4 include widening of the road pavement to create an additional 3.5 metre wide lane eastbound from Beecroft Road to the Terrys Creek Bridge, including the 460 metre long Norfolk Tunnel. As a result of the upgrade, the eastbound mainline carriageway would comprise three 3.5 metre wide lanes and a single 2.5 metre breakdown lane.

Proposed upgrade works within Precinct 4 also include works to widen existing westbound lanes to 3.5 metres and reinstating the westbound breakdown lane from the Terrys Creek Bridge to the Beecroft Road interchange. As a result of the upgrade, the westbound mainline carriageway would provide three 3.5 metre wide lanes and a single 2.5 metre wide breakdown lane.

The bus ramp bridge near Beecroft Road bus bridge would be demolished and the existing eastbound bus lane would terminate west of Beecroft Road, convert to a normal traffic lane on the eastbound carriageway and the westbound bus lane would begin west of Beecroft Road. The outcome is the addition of a third lane in both directions without the need for widening of the carriageways (refer to Section 6.3.6). A central Beecroft Road bridge pier would replace the existing piers to facilitate the addition of the third lane and strengthening of the bridge would be required. Widening works would resume from approximately chainage 12200 at the western portal of the Norfolk Tunnel.

The Norfolk Tunnel would be widened to accommodate a third lane in the eastbound tube (widened to the north) and accommodate lane widening in the westbound tube to reinstate the breakdown lane (widened to the south). A typical cross-section of the Norfolk Tunnel is illustrated in Figure 7. The deep excavations in sandstone bedrock that form the tunnel approaches (the tunnel 'portals') would also be widened on the northern and southern sides to provide sufficient space for the additional road pavement. East of the eastern tunnel portal, the M2 Motorway would be widened on the southern and northern sides, to accommodate a third lane eastbound and reinstatement of the breakdown lane westbound. Widening to the north would extend from the tunnel portal to approximately chainage 13350, whilst widening to the south would extend to west of Terrys Creek.

Emergency stopping bays would be provided on the widened carriageways to match the existing locations and median barriers would be in place for the length of this section. The number and location of emergency stopping bays would be determined during the detailed design phase of the project.

6.2.5 Precinct 5 – Terrys Creek to Lane Cove Tunnel (chainage 13500 – 17700)

Proposed upgrade works within Precinct 5 include widening to create an additional 3.5 metre wide lane eastbound from the Terrys Creek Bridge to Lane Cove Road. As a result of the upgrade, the eastbound mainline carriageway would comprise three 3.5 metre wide lanes and a single 2.5 metre breakdown lane. One of the lanes would be marked as a T2 lane east of Terrys Creek Bridge to near Lane Cove Road. The exact location of the T2 lane commencement would be determined at the detailed design phase.

Proposed upgrade works within Precinct 5 also include widening of existing westbound lanes to 3.5 metres and reinstatement of the westbound breakdown lane from Lane Cove Road to the Terrys Creek Bridge. As a result of the upgrade, the westbound mainline carriageway would comprise three 3.5 metre wide lanes and a single 2.5 metre wide breakdown lane allowing the speed limit to be increased from 70 kilometres per hour at the Terrys Creek Bridge westbound tunnel entry to 100 kilometres per hour.

The M2 Motorway would be widened to the north from approximately chainage 13500, just west of Terrys Creek, to approximately chainage 15370, at the western approach to the toll plaza (1,870 metres). At Culloden Road, west of the toll plaza, widening is proposed to north and south of the M2 Motorway. The toll plaza would be reconfigured, giving greater priority to electronic toll collection (ETC), with one cash booth retained in either direction. There would be three eastbound lanes as well as a breakdown lane under the Christie Road bridge.

The M2 Motorway west of the toll plaza, near Vimiera Road at approximately chainage 14000, would typically be widened on areas of fill, as can be seen in the typical cross-section in Figure 8.

A small section of median adjoining the eastbound Christie Road off-ramp would be modified to accommodate an additional lane eastbound beneath Christie Road Bridge.

The M2 Motorway would be widened to the north from approximately chainage 16100, Christie Road, to approximately chainage 17100 (1,000 metres), east of Khartoum Road, to accommodate a new eastbound on-ramp at Christie Road and an additional eastbound lane. Traffic from the Christie Road ramp would merge with the left eastbound lane of the M2 Motorway.

The M2 Motorway would be widened to the south from approximately chainage 16100, west of the toll plaza, to approximately chainage 17570 (1,470 metres), to accommodate the third westbound lane and the new Herring Road westbound off-ramp. Traffic on the westbound entry ramp merges with the left westbound lane.

The intersections at Herring Road / Talavera Road and Christie Road / Talavera Road would be modified. Talavera Road would be widened to create five traffic lanes between the access to the School of Management (west of Christie Road) and Alma Road. There would be four through lanes and a dedicated right turn lane. Christie Road would be widened to five lanes (three southbound, two northbound) and there would be a new set of traffic signals provided at the northern ramps (the existing exit ramp and proposed new entry ramp).

Emergency stopping bays would be provided on the widened carriageways to match existing locations. Median barriers would be in place for the length of this section with the possible exclusion of the toll plaza.

There would be no widening of or modification to the M2 Motorway between Lane Cove Road and the eastern end of the M2 Motorway near the Lane Cove River.

6.2.6 Alternative cycle route

Due to the occupation of the breakdown lanes for construction of the M2 Upgrade project, an alternative cycle route would be developed and implemented as an ancillary activity prior to construction on the M2 Motorway commencing. It is anticipated that the alternative cycle route would be used by cyclists for the duration of the construction phase.

A preferred cycle route has been determined with specialist input from GTA Consultants and in consultation with appropriate stakeholders, including local councils and cyclist interest groups. The preferred route is located primarily along local streets and other non-motorway roads between Abbott Road, Baulkham Hills and Delhi Road, North Ryde. The process of evaluating and selecting this preferred route is detailed in the *Alternative Cycle Route – Preferred Route Analysis Report* (GTA Consultants 2010).

The preferred alternative cycle route is illustrated in Figure 27. This route is subject to refinement and may change in its final alignment during detailed design. The final alignment of the alternative cycle route on non-motorway roads would form part of the M2 Upgrade project construction footprint and extent of works. Section 9.2.2 provides more information with respect to the alternative cycle route.

Figure 5: Map 1 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

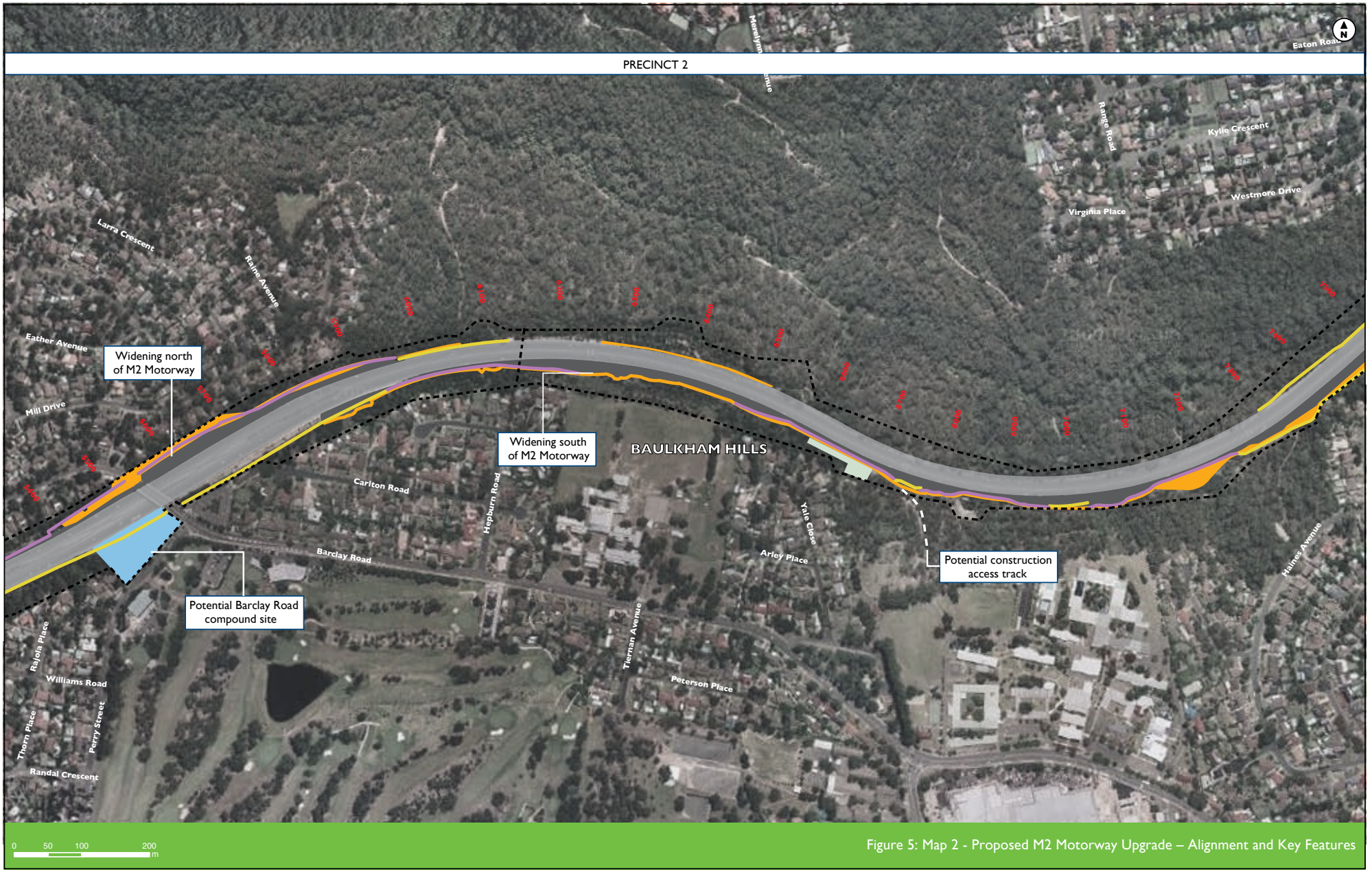


Figure 5: Map 2 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

Figure 5: Map 3 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

Figure 5: Map 4 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

Figure 5: Map 5 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

Figure 5: Map 6 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

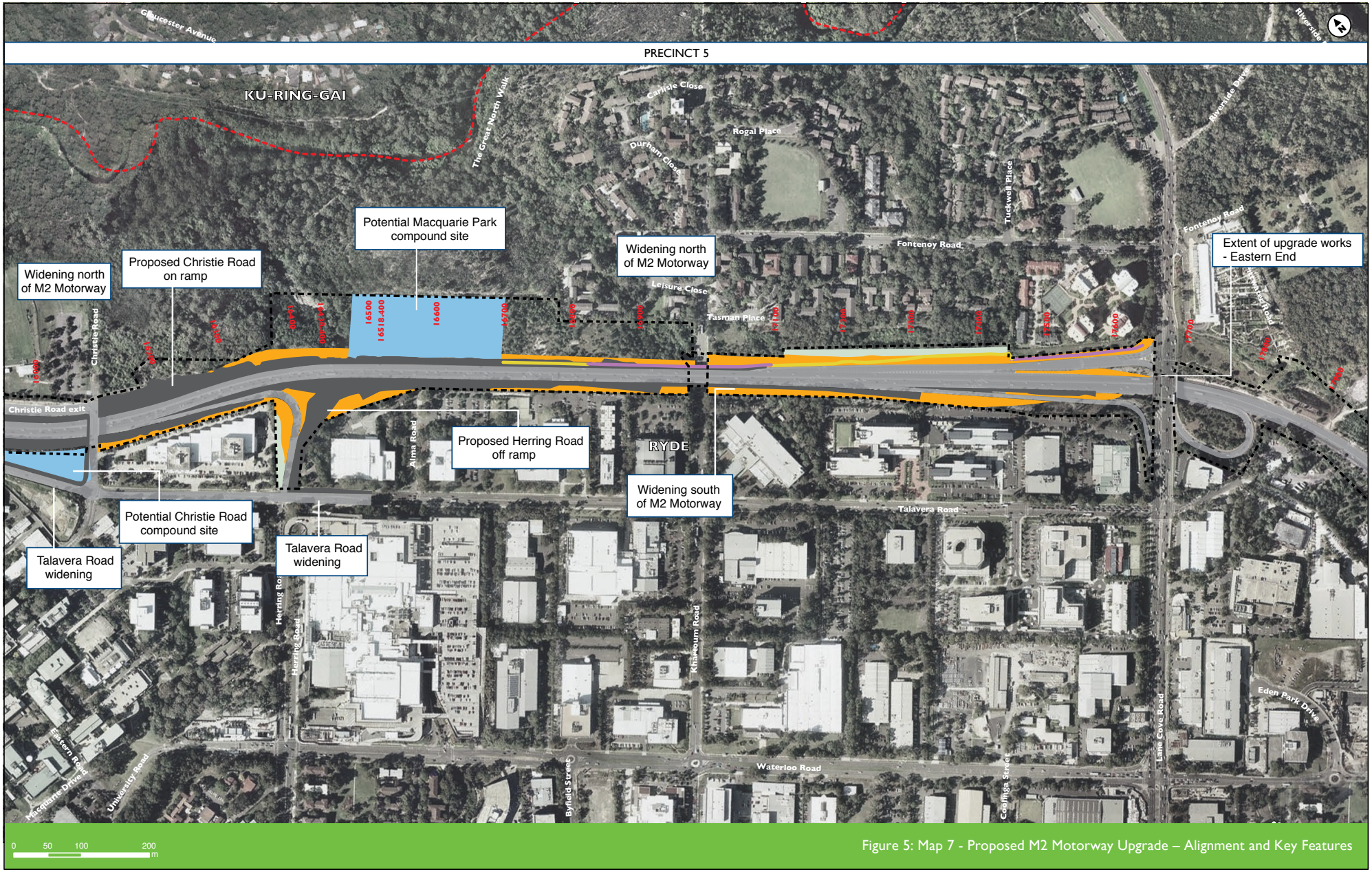


Figure 5: Map 7 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

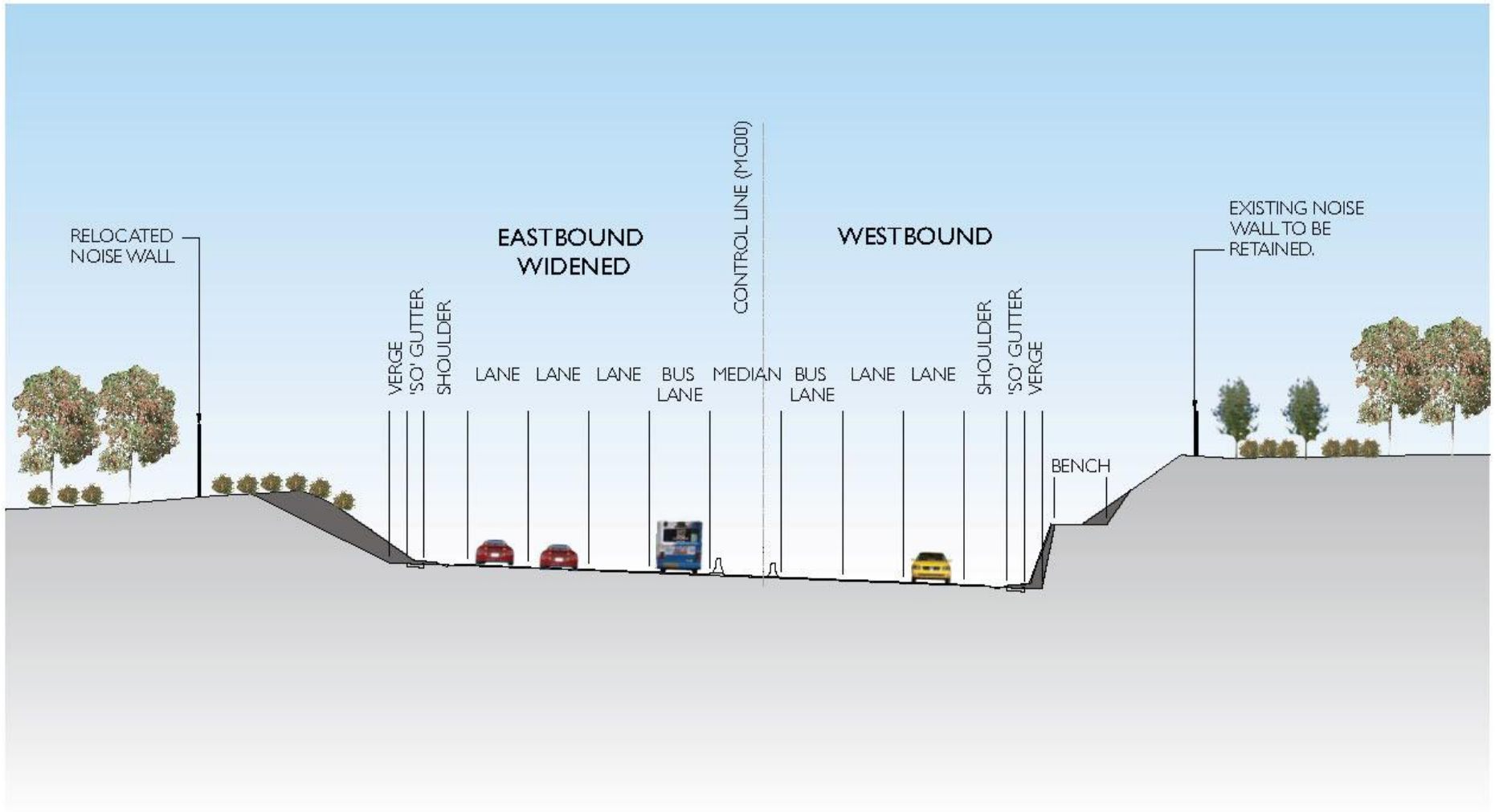
Source: RTA, 2010

Figure 5: Map 8 - Proposed M2 Motorway Upgrade – Alignment and Key Features

- Existing Motorway Carriageway
- Proposed Upgrade
- M2 Motorway Corridor (Lease Boundary)
- Indicative Cleared Area
- Temporary Clearing
- Indicative Site Compounds
- New / Modified Noise Wall
- Existing Noise Wall
- LGA Boundary
- 8000 Chainage

Source: RTA, 2010

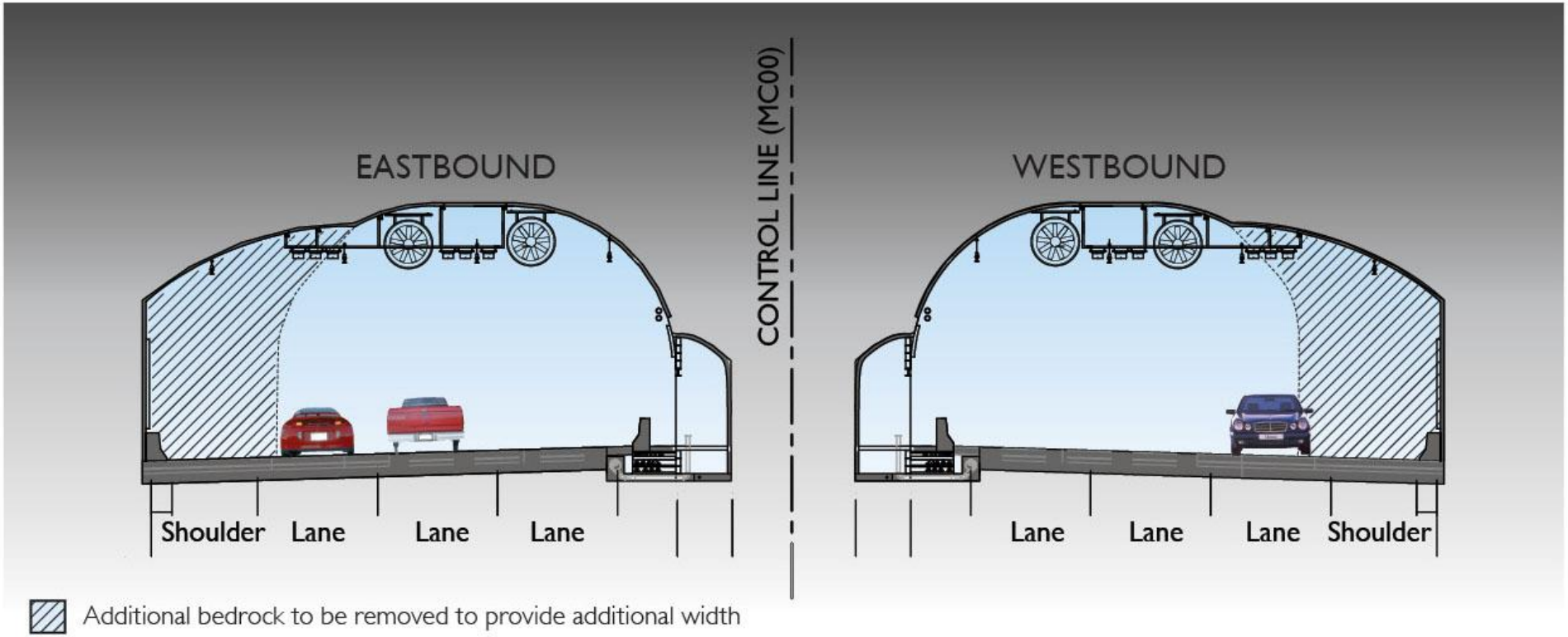
Figure 6 Typical cut cross section



Source: Tract, 2010

Note: This cross section shows a typical arrangement of the M2 Motorway. The final arrangement is subject to detailed design and may vary due to site constraints.

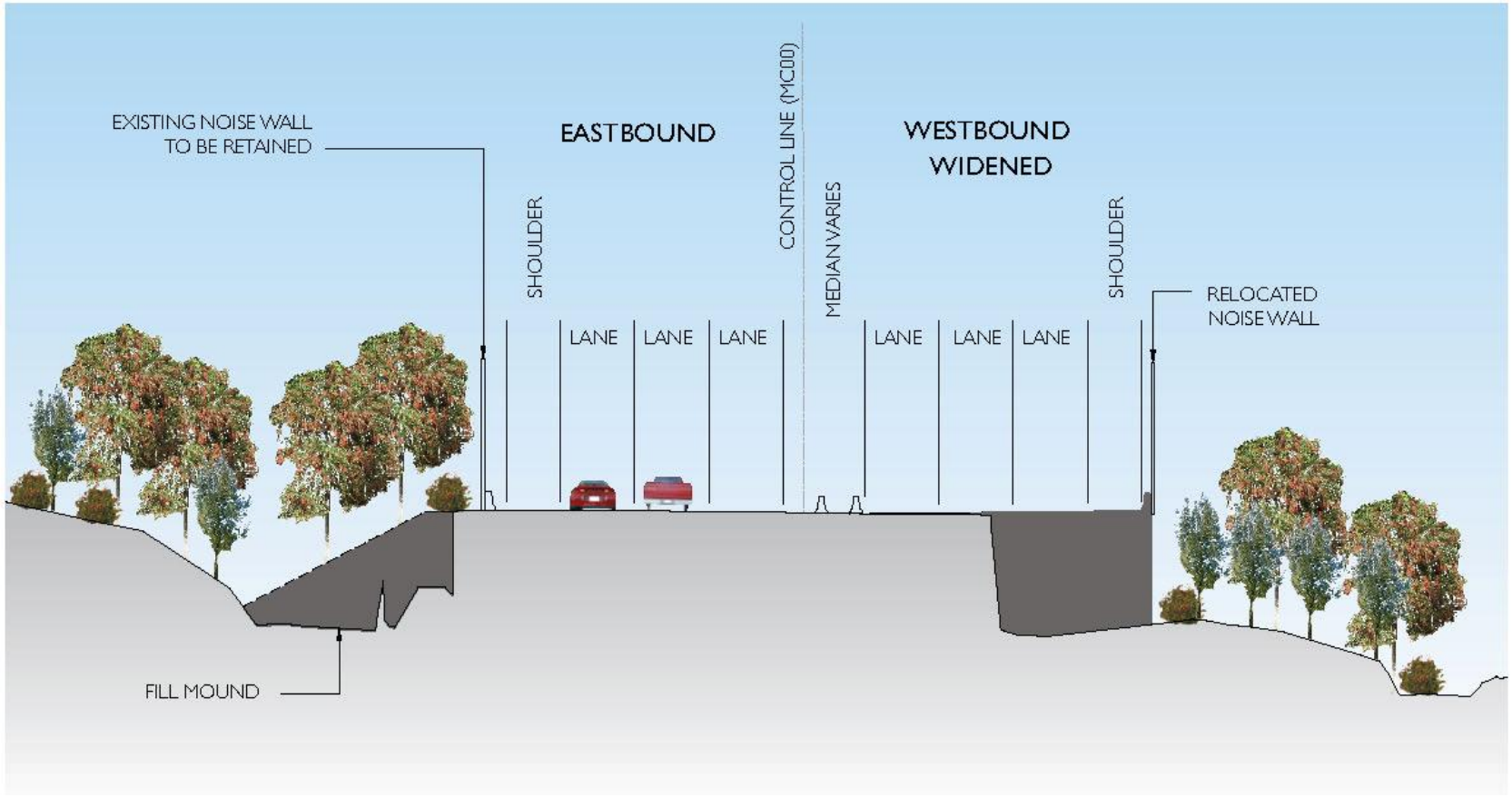
Figure 7 Typical Norfolk Tunnel cross section



Source: AECOM, 2010

Note: This cross section shows a typical arrangement of the M2 Motorway. The final arrangement is subject to detailed design and may vary due to site constraints.

Figure 8 Typical fill cross section



Source: Tract, 2010

Note: This cross section shows a typical arrangement of the M2 Motorway. The final arrangement is subject to detailed design and may vary due to site constraints.

6.3 Key design elements

The DGRs require a description of the key design elements of the project, including carriageway, tunnelling and bridging works. This section addresses this requirement.

6.3.1 Design parameters

The design on which this environmental assessment is based, is a preliminary functional layout developed as part of the concept design and environmental assessment phase. It addresses constraints and principles identified during investigations. The concept design is intended to define a robust concept that provides:

- A clear description of the design principles, extent of impacts and mitigation measures.
- A sound basis for later development of the detailed design to a standard required to support project delivery.

The concept design for the proposed upgrade works has been developed in accordance with the RTA of NSW and AustRoads Design Guidelines. The design parameters adopted for the project are provided in Table 7.

Table 7 Engineering design parameters

Item	Element	Value
Length of M2 Motorway		
Design speed	Horizontal alignment	100 kilometres per hour
	Vertical alignment	100 kilometres per hour
Lane width	Main carriageway traffic lanes	3.5 metres
	Bus lanes	3.5 metres
	Shoulder/ breakdown lane	2.5 metres
Operation design life	Additional lane	Pavement configuration and details to match existing Motorway pavement
Grade	Main carriageway	To match existing
Drainage design life	New drainage structures	100 years
	Replacement drainage structures	100 years
Cycle access	Length of the M2 Motorway	Provided in the breakdown / shoulder lane
Stopping sight distance	Horizontal	150 metres
	Reaction Time	1.5 seconds
	Vertical	175 metres
Ramps – on and off		
Maximum vertical grade	On-ramps	6.0 percent
	Off-ramps	6.0 percent
Design speed	On	100 kilometres per hour
	Off	60 kilometres per hour

Bridges		
Design speed	Horizontal alignment – overbridges	60 kilometres per hour on local roads
	Horizontal alignment – underbridges	100 kilometres per hour on M2
	Vertical alignment – overbridges	60 kilometres per hour on local roads
	Vertical alignment – underbridges	100 kilometres per hour on M2 Motorway
Lane width	Traffic lanes	3.5 metres
Shoulder width	Outside shoulder	2.5 metres
	Inside shoulder	0.5 metres
Tunnel		
Headroom Clearances	Services	5.3 metres
	Motorway carriageways	4.6 metres for the working width envelope
Cutting and batters		
Batter slopes	Cut batters and embankments	Cut slope angle varies to suit geological conditions and embankments generally at 1(V) to 2(H)

6.3.2 M2 Motorway on and off-ramps

Windsor Road ramps

New west facing on and off-ramps would be constructed at the existing Windsor Road interchange. Various modifications are required to the existing intersection to accommodate the new ramps.

The new eastbound off-ramp alignment would commence as a single lane on the M2 Motorway for approximately 260 metres from Watkins Road to approximately chainage 3800, prior to splitting into three lanes. One lane would turn left onto Windsor Road northbound and two lanes would turn right onto Windsor Road southbound. To accommodate the new ramps and traffic lanes, the existing reinforced concrete retaining wall would be extended vertically and noise walls in this section would be relocated to the north and heightened.

The west facing on-ramp would be accessible to traffic travelling southbound and northbound along Windsor Road. The ramp would accommodate two lanes and would merge to one lane in the approach to the M2 Motorway. Both west facing on and off-ramp structures would be constructed on embankments connecting to the existing Windsor Road overbridge. Construction of the west facing on-ramp would require battering works in the approach to the M2 Motorway from Windsor Road northbound. The existing noise wall along the southern edge of the M2 Motorway along Junction Road would be relocated to the south, heightened and extended around the corner of Windsor Road but would not impact on Junction Road. The existing reinforced earth retaining wall would be extended vertically.

Refer to Figure 9 for an image of the Windsor Road ramp configuration.

Figure 9 – Proposed M2 Motorway Upgrade – Windsor Road Interchange

- M2 Motorway Corridor (Lease Boundary)
- Extent of Proposed Upgrade
- Cadastral Boundaries
- 3500 Chainage

Source: RTA, 2010

Figure 10 – Proposed M2 Motorway Upgrade – Christie and Herring Road Interchange

- M2 Motorway Corridor (Lease Boundary)
- Extent of Proposed Upgrade
- Cadastral Boundaries
- 16000 Chainage

Source: RTA, 2010

Christie Road and Herring Road ramps

An eastbound on-ramp would be constructed from Christie Road, which involves widening of the eastbound carriageway of the M2 Motorway from near chainage 16100, and cut and batter works. The new eastbound on-ramp has two traffic lanes at the Christie Road intersection departure side, and would merge to form one lane which would merge with the kerbside lane east of Christie Road.

A new east facing off-ramp would be provided to access Talavera Road at Herring Road. This would involve construction of a reinforced earth retaining wall and embankment to stabilise the new ramp. The ramp would consist of a diverge one lane exit before the ramp widens to three lanes at Talavera Road to accommodate left and right turn movements.

Figure 10 illustrates the configuration of the new Christie Road and Herring Road ramps.

6.3.3 Norfolk Tunnel widening

The Norfolk Tunnel (also known as the Epping Tunnel) would be widened to accommodate three trafficable lanes of 3.5 metres wide and a 2.5 metre wide breakdown lane. The two existing tunnel tubes would be widened on the northern (eastbound direction) and southern (westbound direction) sides to accommodate the additional road pavement. The sandstone bedrock would be cut away from within the tunnel tubes to provide the additional width. Road headers and excavators mounted with rock hammers would be used to cut the bedrock away. Existing support measures that are in place to stabilise the internal surfaces of the tunnels tubes such as rock bolts would remain in place as widening is progressed along the tunnel length. New support measures would be installed immediately following the widening so that structural integrity of the tunnel is maintained. A typical cross section of the widened tunnel is shown in Figure 7.

The deep excavations in sandstone bedrock that form the tunnel approaches (the tunnel 'portals') would also be widened to accommodate the additional road pavement. The large sloped cut faces on either side of the portals would be steepened to create the required space at the base of the cuttings for the additional road pavement without affecting the top of the cutting faces. The existing noise walls at the top of the cutting faces would remain unaffected by the proposed works. If necessary the faces may need to be stabilised, for example by using rock bolts.

The services currently installed on the slow lane side of each tunnel tube would need to be relocated to the opposite side of the tunnel tube in order to facilitate the proposed widening works. Additional tunnel supports would also need to be installed to support the additional width of the tunnel span. These works would need to occur prior to the commencement of the tunnel widening works. Full possession of a tube may be required during this process.

In addition to widening works and services relocation, the tunnel tubes would be lined and additional lighting installed to improve tunnel safety for road users. The existing cross passages between the tunnel tubes would also be modified. A new fire safety deluge system would be installed as part of the tunnel upgrade works. The lighting and deluge systems would be modified to meet the requirements of the wider tunnel.

There are no proposed changes to the tunnels' existing exhaust extraction system. The current system has excess capacity and would be sufficient for the widened tunnel. Further details of the proposed mechanical and electrical upgrades to the tunnel are provided in Section 6.4.2 (refer to Section 7.6.2 for further details regarding tunnel construction work hours).

6.3.4 M2 Motorway bridges

The project would require upgrades to bridge structures to accommodate the widening works. A typical cross-section of a bridge structure is illustrated in Figure 11.

The proposed bridge upgrades are discussed below in order of geographic location from west to east.

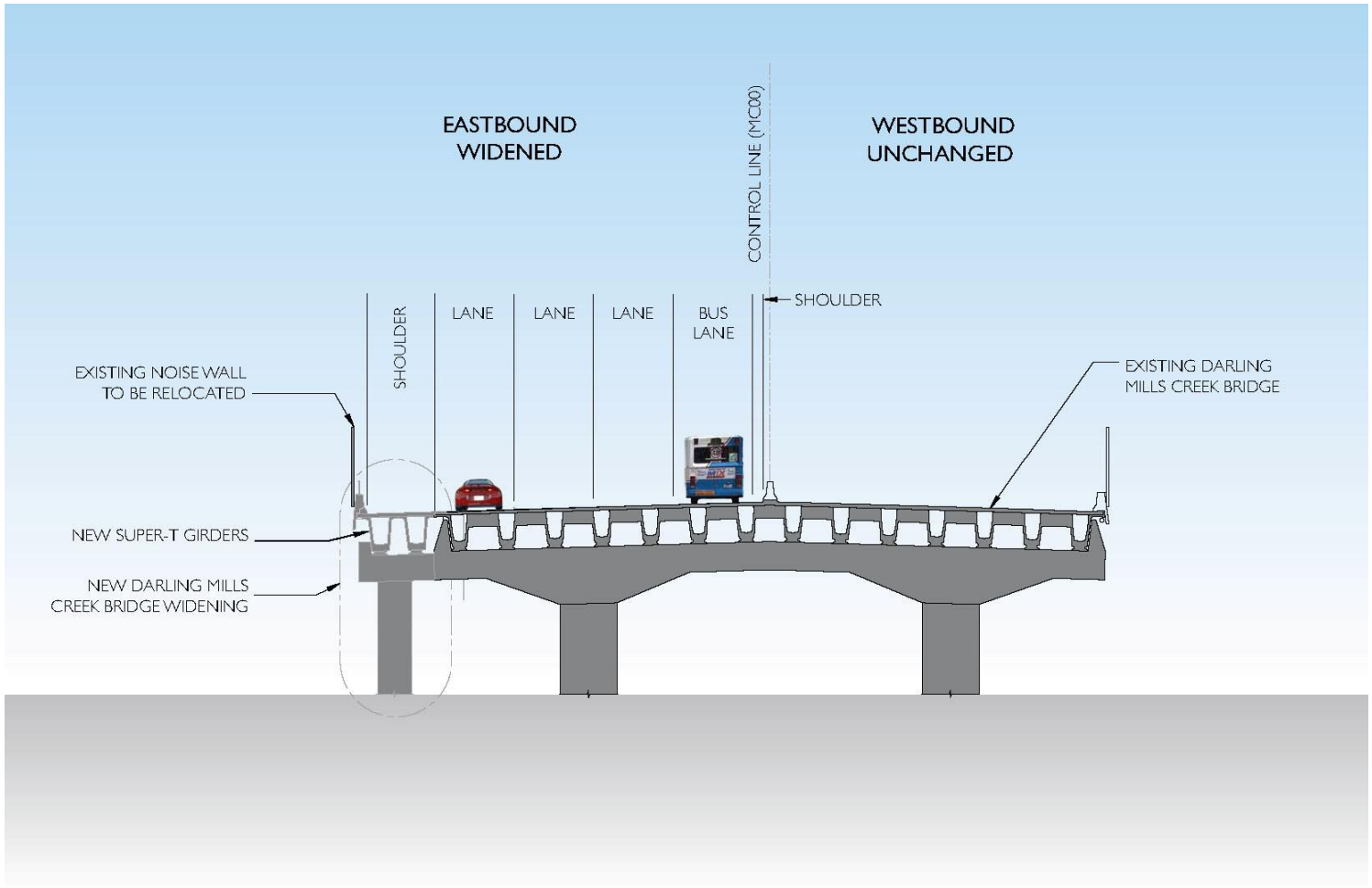
Darling Mills Creek Bridge

Darling Mills Creek Bridge is a five span Super-T bridge that extends approximately 161 metres in length over the valley at Darling Mills Creek. The bridge would be widened by approximately 3.5 metres on the north side. Works would involve widening the existing abutments by installing an additional pile and extending the existing reinforced earth retaining wall and extending the headstock. Each of the piers would be widened by constructing an additional column and foundation and extending the crosshead. The deck would also be widened by installing two Super-T beams across each span, removing the existing edge barrier, extending the deck slab and constructing a new edge barrier.

Yale Close Bridge

The Yale Close Bridge is a 35 metre long, single span Super-T bridge that extends over Blue Gum Creek. The bridge would be widened approximately 3.5 metres on the south side and the median barrier relocated to accommodate the eastbound widening. The works would require widening of the existing abutments by installing an additional pile, extending the existing reinforced earth retaining wall and extending the headstock. The deck would be widened by the addition of two Super-T beams, removing the existing edge barrier, extending the deck slab and constructing a new edge barrier.

Figure 11 Typical Super-T bridge structure



Source: Tract, 2010

Note: This cross section shows a typical arrangement of the M2 Motorway. The final arrangement is subject to detailed design and may vary due to site constraints.

Devlins Creek Bridge

Devlins Creek Bridge is a two span Super-T bridge which extends over Devlins Creek valley. The eastbound bridge is a 383 metre long, 19 span structure and the westbound bridge is a 305 metre long, 15 span structure. The westbound bridge would be widened by 3.5 metres on the south side and the two bridge structures would be joined by infilling the central median.

Widening to the south (westbound), adjacent to the outer lane of the bridge, would require widening of the existing abutments by installing an additional pile, extending the existing reinforced earth retaining wall and extending the headstock. The piers would be widened by constructing an additional column and extending the crosshead. The deck would be widened by the addition of two Super-T beams each span, removing the existing edge barriers, extending the deck slab and constructing a new edge barrier.

The eastbound bridge would be widened by infilling the gap between the two bridge structures. The works would require connection of the existing abutments by installing an additional pile and infilling between the headstocks. The piers would be connected by constructing an additional column and foundation and infilling between the crossheads. The deck would be in-filled by the addition of two Super-T beams each span, removing the existing edge barriers, joining the deck slabs and constructing a new median barrier.

Somerset Street Suspended Structure

The M2 Motorway (at the eastern end of Somerset Street) would be supported on a series of columns, each with a single pile footing, over the existing drainage basin. The deck consists of beams parallel to the roadway with concrete slabs spanning between the beams. The adjacent reinforced soil retaining wall at this location would not be relocated due to the presence of the existing basin.

Terrys Creek Bridge

Terrys Creek Bridge is a five span Super-T bridge that extends 169 metres in length over Terrys Creek valley. The bridge would be widened approximately nine metres on the north side to accommodate widening of the eastbound and westbound carriageways, which would also involve shifting the median to the north. The works would involve widening of the existing abutments by installing additional piles, extending the existing reinforced earth retaining wall and extending the headstock. The piers would be widened by constructing an additional column and extending the crosshead. The deck would be widened by the addition of four Super-T girders each span, removing the existing edge barrier, extending the deck slab and constructing a new edge barrier.

Khartoum Road Bridge

Khartoum Road Bridge is a single span Super-T bridge, which extends approximately 31 metres in length, carrying the M2 Motorway over Khartoum Road. The bridge would be widened by approximately 3.5 metres on the north side to accommodate the third lane eastbound. The bridge would also be widened by approximately 3.5 metres on the south side to accommodate widening of the westbound carriageway.

The works would involve widening of the existing abutments by installing additional piles, extending the existing reinforced earth retaining wall and extending the headstock. The deck would be widened by the addition of two Super-T girders on the north side and two Super-T girders on the south side, removing the existing edge barriers, extending the deck slab and constructing new edge barriers.

6.3.5 M2 Motorway cycle access

Cycle access would be provided within the breakdown lane for the length of the M2 Motorway. In particular, the upgrade would reinstate access to the breakdown lane westbound between Lane Cove Road and Beecroft Road. This westbound lane has been subject to an interim widening scheme to provide a third lane since 2007 to improve traffic flow. In addition, cycle access would be provided to the breakdown lane through the Norfolk Tunnel in both the eastbound and westbound direction.

New access points to the M2 Motorway would be available to cyclists given the provision of the new access ramps at Windsor Road, Christie Road and Herring Road. Cycle access to the breakdown lane would be reinstated to a level equivalent to that prior to the interim widening plus the additional accesses at Windsor, Christie and Herring Roads. Cycle access during construction is discussed in Sections 7.3 and 9.2.

6.3.6 Local Road Upgrades

A number of local (non-motorway) roads would be upgraded and widened as part of the project. These works are associated with new and upgraded on and off-ramps and would accommodate additional movement between local roads and the M2 Motorway.

The widening and upgrade works would occur on the following local roads:

- Windsor Road.
- Christie Road.
- Herring Road.
- Talavera Road.
- Somerset Street (minor modifications at the intersection with Gloucester Road).

Windsor Road

Windsor Road interchange has three northbound through lanes that currently provides one right turn lane on the east facing M2 Motorway on-ramp. An additional right turn lane would be created, to provide two right turning lanes onto the east facing Motorway on-ramp. Both right turning lanes would extend approximately 50 to 70 metres south. An additional northbound lane would be created as a left turning slip lane, to access the new west facing on-ramp, commencing approximately 100 metres from the southern edge of the M2 Motorway. Refer to Figure 9 for illustration of proposed Windsor Road interchange.

Windsor Road interchange consists of three through lanes southbound, which currently merge into two lanes, approximately 40 metres after the intersection of the east facing Motorway off-ramp. This lane configuration would be retained. Three through lanes would cross the Windsor Road Bridge in both the northbound and southbound directions.

To accommodate traffic movements associated with the new west facing ramps, Windsor Road would be widened south of the M2 Motorway, between the M2 Motorway and Woodlands Street, to both accommodate northbound Windsor Road traffic movements accessing the new west facing on-ramp and to add an additional right turning lane for the existing east facing on-ramp. There would also be widening north of the M2 Motorway to Oakland Avenue on the western side. The extent of the Windsor Road widening is shown in Figure 9.

The upgrade work would involve new line marking on Windsor Road and realignment of the median. Line marking would occur south of the M2 Motorway to accommodate movement from the new west facing off-ramp toward the south. North of the M2 Motorway, new line marking would occur northbound and southbound to accommodate the new west facing on and off-ramps. Southbound on Windsor Road, the median strip would be paved and re-marked to accommodate two right turning lanes for the west facing on-ramp.

Christie Road

Christie Road, in its current configuration, consists of three lanes. One northbound lane begins at the intersection with Talavera Road and continues across the bridge and into Christie Park car park. Two southbound lanes originate from Christie Park and are joined by the two right turning lanes from the existing west facing off-ramp. The two lanes cross the bridge with one lane becoming a right turning lane onto Talavera Road and the second becoming a left turning lane onto Talavera Road.

Christie Road and the Christie Road Bridge would be widened from three existing lanes to five lanes between the Christie Park access and Talavera Road on the western side. The widening would accommodate northbound right turning lanes for the new east facing on-ramp and southbound turning lanes onto Talavera Road. There would be new traffic control signals at the existing off-ramp and new on-ramp. Refer to Figure 10 for an illustration of proposed Christie Road / Herring Road interchange.

Two northbound Christie Road lanes would provide access to the new east facing on-ramp. The left lane also continues straight to provide access to the Christie Park car park. There would be three southbound lanes including, two left turning lanes onto Talavera Road and one lane for through traffic to Technology Place as well as traffic turning right onto Talavera Road.

Herring Road

Herring Road would be widened on its eastern side between Talavera Road and the M2 Motorway to accommodate the new east facing off-ramp.

Herring Road currently comprises two lanes plus shoulder in this location accessing a west facing on-ramp (westbound), where the two lanes merge to one immediately after the road bends to be parallel with the M2 Motorway. This lane then becomes a single lane west facing Motorway on-ramp.

Widening of Herring Road would occur on the eastern side at the intersection with Talavera Road, with three additional lanes at the intersection approach from the new off-ramp. There would be two dedicated left turning lanes and one right turning lane from Herring Road onto Talavera Road.

Talavera Road

Talavera Road would be widened to support movements associated with the new Christie Road and Herring Road on and off-ramps as well as to accommodate the reconfiguration of Christie Road and Herring Road intersections.

Currently, Talavera Road has one traffic lane in either direction and one parking lane on either side of the road between 140 metres west of Christie Road. Between Christie Road and Alma Road, Talavera Road has two eastbound lanes. An eastbound right turn lane is provided from Talavera Road into the Macquarie Centre car park that originates approximately 100 metres west of Alma Road.

Talavera Road has two westbound lanes from Alma Road to Herring Road, which merge to one lane west of Herring Road to Christie Road. At the Herring Road intersection, one westbound Talavera Road lane travels through the intersection and the second becomes the right turning lane onto the Herring Road on-ramp to M2. A left turning lane originates approximately 90 metres east of the Herring Road intersection and turns into the Macquarie Centre car park approximately 18 metres from the intersection.

Talavera Road would be widened to the north to accommodate:

- Two eastbound lanes between 140 metres west of Christie Road (access to Graduate School of Management) and Alma Road, and an eastbound right turning lane into Technology Place.
- An eastbound bus only right turning lane into Herring Road.
- An additional westbound lane between Alma Road and Herring Road.
- A westbound right turn lane into Christie Road.
- An additional westbound right turn lane into Herring Road on ramp (two right turn lanes).

6.3.7 Local Road Bridge Upgrades

A number of local road bridges (overpasses) would require upgrades to accommodate the widening of the M2 Motorway. These are:

- Windsor Road Bridge.
- Barclay Road Bridge.
- Kirkham Street Bridge.
- Beecroft Road Bridge.
- Beecroft Road Bus Bridge.
- Culloden Road Bridge.
- Christie Road Bridge.

Each upgrade is discussed below and a typical cross-section of an overbridge is illustrated in Figure 12.

Barclay Road Bridge

Barclay Road Bridge is a two span Super-T bridge, which extends over the M2 Motorway. The north span of the bridge would be lengthened to accommodate the eastbound carriageway widening works occurring under the bridge. The existing deck would be retained and lengthened by modifying the north abutment to cantilever over the widened carriageway to support the deck. The abutment would be modified in two halves, in order to maintain two traffic lanes on the bridge during construction.

Kirkham Street Bridge

Kirkham Street Bridge is a three span Super-T bridge that extends over the M2 Motorway (refer to Figure 12). The Kirkham Street Bridge becomes Kirkham Street as it extends over the width of the M2 Motorway. The north span of the bridge would be lengthened to accommodate eastbound widening of the carriageway under the bridge. The existing girders would be retained and lengthening would be achieved by modifying the north abutment to cantilever over the widened carriageway to support the existing girders. The bridge would be modified in two stages to maintain one traffic lane with an alternate lane working on the bridge during construction. This would be coordinated with the south span modification.

The south span of the bridge is to be lengthened to accommodate westbound widening of the carriageway under the bridge. The existing deck would be retained and the lengthening achieved by moving Pier 1 and replacing Span 1 with beams which cantilever over the widened carriageway to support the existing deck. The new Pier 1 would be constructed with three columns and a headstock. The deck would be modified independently to maintain one traffic lane with an alternate lane working on the bridge during construction. This would be coordinated with the south span modification.

Windsor Road Bridge

Windsor Road Bridge is a two span Super-T bridge that extends over the M2 Motorway. The bridge is to be widened on the western side to accommodate the new west facing on-ramps. The widening works would require extending the abutment by installing additional piles, construction of a reinforced earth retaining wall and extending the headstock. The central pier would have additional columns and the headstock would be extended. The deck would be widened by adding Super-T beams and extending the existing deck.

Beecroft Road Bridge

Beecroft Road Bridge is a 66 metre long three span pre-stressed beam and slab bridge over the M2 Motorway. The existing two rows of piers would be replaced by a single central row of piers to accommodate eastbound and westbound widening to three lanes plus the shoulder under the bridge. The new central piers would be constructed with new columns and headstocks at each beam position. The existing deck beams would be modified to suit the new pier positions and be strengthened with external post-tensioning.

Bus Ramp Bridge near Beecroft Road

The Bus Ramp Bridge extends 196 metres in length and is an eight span pre-stressed concrete voided slab bridge. The bus ramp bridge currently provides bus access to Epping Station from the M2 Motorway. Under the proposed upgrade the Bus Ramp Bridge would be demolished.

Culloden Road Bridge

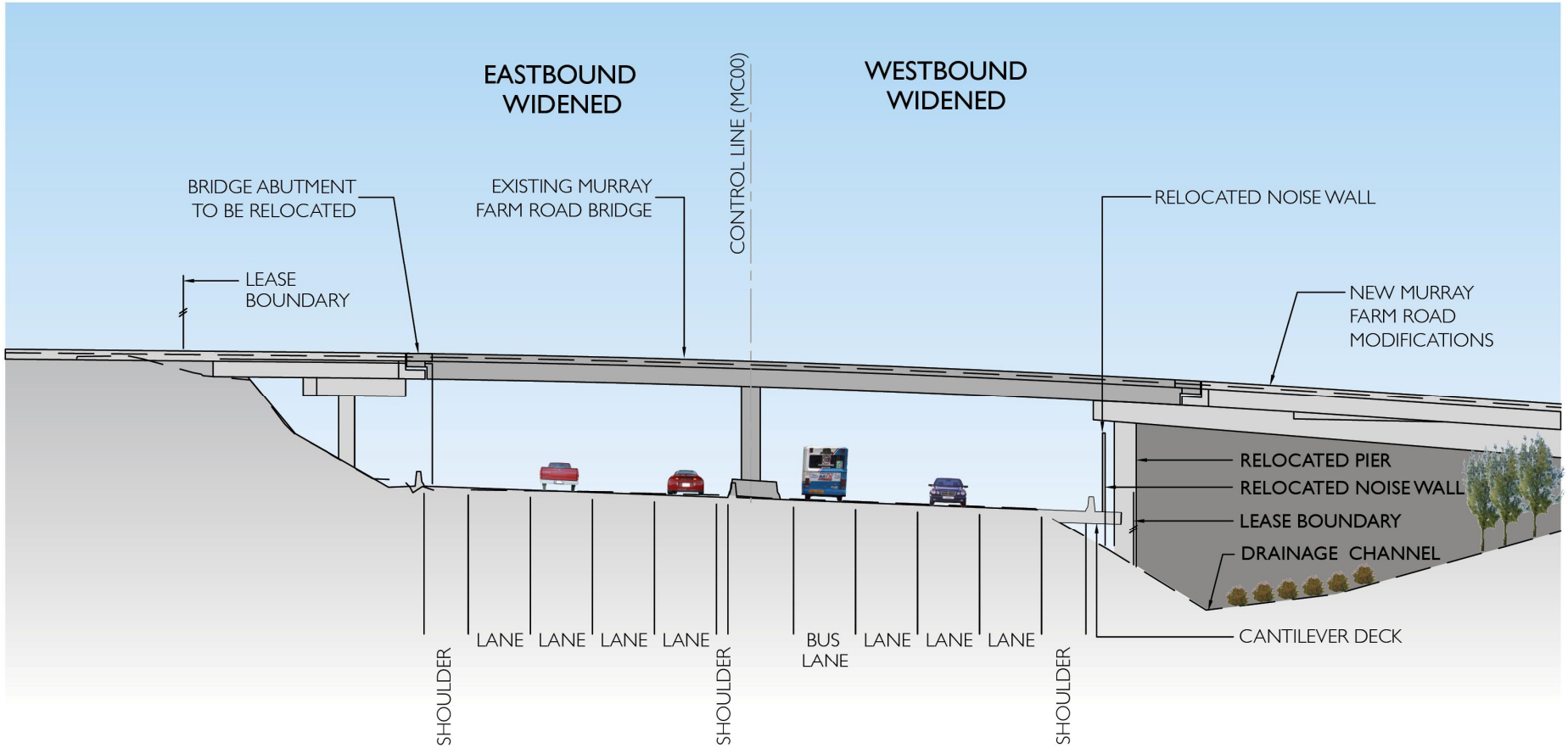
Culloden Road Bridge is a single span Super-T bridge that extends over the M2 Motorway. The existing rock slope at the northern and southern abutments would be cut and vertically supported by rock anchors to accommodate the M2 Motorway widening under the bridge.

Christie Road Bridge

Christie Road Bridge is a two span Super-T bridge that extends over the M2 Motorway (Refer to Figure 12). The existing rock slope at the northern abutment would be trimmed and vertically supported by rock anchors to accommodate eastbound carriageway widening. The southern span would be lengthened to accommodate westbound carriageway widening under the bridge. The existing deck would be replaced and lengthened by shifting the southern abutment to the south.

Christie Road Bridge would be widened to provide two additional lanes over the bridge. The works would require widening of the existing abutments by installing an additional pile and extending the headstock. The pier would be widened by constructing an additional pier and extending the crosshead. Each span of the deck would be widened with the addition of Super-T girders, removing the existing edge barrier, extending the deck slab and constructing a new edge barrier.

Figure 12 Typical overbridge structure



Source: Tract, 2010

Note: This cross section shows a typical arrangement of the M2 Motorway. The final arrangement is subject to detailed design and may vary due to site constraints.

6.3.8 Pavement

M2 Carriageways

The existing M2 Motorway pavement is a Plain Concrete Pavement (PCP) with a Lean Mix Concrete (LMC) sub-base. New road pavement installed as a result of the widening works would be constructed using similar materials and typical composition to the existing pavement. A sub-surface drain would be provided between the existing and new pavements.

Ramps

The pavement structure proposed for the ramp works comprises deep-lift asphalt pavements with a design life of 40 years.

Bridge Decks

Asphalt overlay would be provided on the bridge widening sections in accordance with RTA bridge specifications. In order to achieve the appropriate design levels for the project, asphalt overlay would be applied to areas requiring some upgrade works, including toll plaza areas.

Local roads

The local roads would be asphaltic pavement which has a design life of 20 years. Details would be determined in conjunction with the appropriate road authority.

6.3.9 Noise barriers

The M2 Motorway has existing noise barriers (some on retaining wall structures) located along the alignment. As part of the upgrade some existing noise barriers and retaining walls located along the alignment would require relocation or modification to accommodate widening works. Proposed modifications to noise barriers along the M2 Motorway are described in Table 8 and illustrated in the route alignment figures (refer to Figure 5). A detailed description of noise barrier modifications, including heights, is provided in Section 9.3 and Technical Paper 2.

Table 8 Noise walls – location and associated works

Noise Wall Ref.	Approximate Chainage	Location	Length (metres)	Reason	Approximate height of New Noise Wall[1]
Eastbound Carriageway					
NW-E-1001	3500-3900	New Windsor Road off-ramp	388	Re-located	Same as existing noise wall at western end, reduced in height from 3 metres to 2.4 metres at eastern end
NW-E-1002	5100-5950	Barclay Road	849	Re-located/Heightened	Same as existing noise wall for majority of wall. Increased in height from 4.2 metres to 4.8 metres between chainage 5400 and 5500
NW-E-1003	7600-7700	Westmore Drive	132	Re-located	Same as existing noise wall
NW-E-2001	10700-10800	Kirkham Street	92	Re-located	Same as existing noise wall
NW-E-2002	12350-12500	West Tunnel Portal	134	Re-located	Same as existing noise wall
NW-E-2003	13300-13900	East Tunnel Portal	606	Re-located	Same as existing noise wall
NW-E-3001	14850-15050	Busaco Road	208	Re-located	Same as existing noise wall
NW-E-3002	16700-17100	Khartoum Road	399	Re-located	Same as existing noise wall
NW-E-3003	17450-17600	Lane Cove off-ramp	170	New	2.4 metres
Westbound Carriageway					
NW-W-1001	3500-4000	New Windsor Road on-ramp	491	Re-located	Same as existing noise wall at western end, reduced in height from 4 metres to 2.4 metres at eastern end
NW-W-1002	5900-6200	Hepburn Road	287	Re-located	Same as existing noise wall
NW-W-1003	6450-6700	Yale Close	264	Re-located	Same as existing noise wall
NW-W-1004	6750-6950	RIDBC	207	Re-located	Same as existing noise wall
NW-W-1005	7000-7200	RIDBC	245	Re-located	Same as existing noise wall
NW-W-1006	7500-7650	Boundary Road	120	Re-located	Same as existing noise wall

Noise Wall Ref.	Approximate Chainage	Location	Length (metres)	Reason	Approximate height of New Noise Wall[1]
NW-W-2001	9600-10150	Lamorana Avenue	560	Re-located	Same as existing noise wall
NW-W-2002	10440-10450	Ferndale Road	16	Re-located	Same as existing noise wall
NW-W-2003	10550-11150	Kirkham Street	634	Re-located	Same as existing noise wall
NW-W-2004	11300-11350	Kent Street Overpass	76	Re-located	Same as existing noise wall
NW-W-2005	12350-12500	East Tunnel Portal	144	Re-located	Same as existing noise wall
NW-W-2006	13250-13650	West Tunnel Portal	417	Re-located	Same as existing noise wall
NW-W-3001	14250-14400	Vimiera Road	140	New	3 metres
NW-W-3002	15250-15350	Culloden Road	110	Re-located	Same as existing noise wall
NW-W-3003	15700-16050	Christie Road	368	Re-located	Same as existing noise wall

Note 1: Noise walls are built from modular 0.6 metre panels, therefore the noise walls are specified in 0.6 metre increments.

Other noise treatments to mitigate noise impacts are discussed in Section 9.3.

6.3.10 Drainage

Drawings showing the locations of detention basins and drainage works are provided in Technical Paper 6 and discussed in more detail in Section 9.8 and 10.1 of this environmental assessment.

Precinct 1 – Abbott Road to Windsor Road

Drainage works for Precinct 1 predominantly involve the adjustment of existing, and provision of additional, inlet pits with associated pipes to drain the pavement area of the new west facing ramps. This longitudinal drainage system would drain to the existing water quality basin (8b) located near chainage 3580 on the eastbound side of the M2 Motorway. It is proposed to modify the existing basin inlet/outlet to provide for changes to the drainage system. Alternatively, some earthworks may be required to increase the storage volume. There are no transverse culvert works proposed or required within Precinct 1.

Precinct 2 – Windsor Road to Pennant Hills Road

An existing 1200 millimetre diameter pipe culvert near chainage 5250 is to be extended by approximately six metres on the downstream outlet (eastbound) side. The works would incorporate a new headwall into the proposed retaining wall for the widening works with new energy dissipation and scour protection. At approximately chainage 7560 it is proposed to extend the inlet of an existing

(1500 millimetres x1200 millimetres) box culvert by up to five metres on the westbound side, along with replacement of the inlet scour protection.

A new culvert parallel to the M2 Motorway is proposed at the Barclay Road overbridge (approximately chainage 5520 to 5550), which would provide connectivity of catch drains to tie in with drains being relocated at the top of the cutting due to the road widening.

The existing M2 corridor is typically constrained in terms of width or available land space, which severely limits the opportunity for increasing basin footprints. Wherever possible or practical, it is therefore generally proposed to modify the basin inlet/outlet arrangements (by changing the inlet/outlet levels, dimensions or similar) to better utilise spare volume capacity that currently exists as freeboard (up to one metre of airspace). This approach would be dependent on the existing levels of key basin features compared to the elevation of the M2 Motorway and drainage system upstream. It is envisaged that some earthworks would be possible/required in some locations to obtain additional storage volume. This would be minimised to avoid impacts on the surrounding vegetation.

Within Precinct 2, there are eleven existing water quality basins which would require modification works to provide additional volume for treatment purposes. The additional volumes required vary considerably from zero up to approximately 600 cubic metres. A new basin may be required on the eastbound side at approximately chainage 4800 to minimise the need for upgrading the drainage system across the M2 Motorway, which would require enlarging an existing basin on the opposite side of the M2 Motorway.

Precinct 3 – Pennant Hills Road to Beecroft Road

Within Precinct 3, Devlins Creek runs parallel to the M2 Motorway and crosses back and forth through large precast concrete arch structures on three occasions. Only the existing drainage structure (12.4 x 4 metres) near chainage 10550 would be affected by the widening works, which would require extension by approximately five metres. A gabion wall and open channel immediately downstream of the outlet would require reconstruction or modification to suit. A tributary creek near chainage 11640 is served by a four by 1350 millimetres diameter reinforced concrete pipe culvert which would require extending up to six metres at the inlet and reconstruction of the existing scour protection.

Two of the four existing water quality basins are likely to require earthworks to obtain additional storage volume (basins 23b and 27b). The existing basin 22b near chainage 9730 may be impacted (reduced) due to the widening works. If it is not possible to achieve the appropriate storage volume through earthworks modifications, it may be necessary to extend a retaining wall to limit the footprint of the widening. Basin 25b at chainage 11310 is likely to contain sufficient storage volume but may require modification of the inlet/outlet.

Precinct 4 – Beecroft Road to Terrys Creek Bridge (including Norfolk Tunnel)

Within the vicinity of the bend in Somerset Street (at the projected intersection with Gloucester Road), the M2 Motorway widening is likely to impact on the existing local street drainage system. The works would involve relocation or reconfiguration of some pit and pipe elements away from the M2 Motorway.

The three cell box culvert outlet (2400 x 1800 millimetres) located near chainage 13500 is proposed to be extended approximately eight metres on the westbound side. Works would involve reconstructing the outlet scour protection measures and reconstruction of 30 metres of the existing concrete/rock mattress open channel from the local road drainage system.

There are two water quality basins in Precinct 4. The existing volume for basin 28f at chainage 12230 is likely to be sufficient, but, if minor augmentation is required, modification of the inlet/outlet may be required. Otherwise space is likely to be available to enlarge the footprint by earthworks.

Basin 30b near chainage 13470 is located at the end of the Norfolk Tunnel drainage system. The road widening is proposed to pass over this basin on a cantilevered roadway to avoid impact (reduction) on the existing basin volume. The basin inlet/outlet is proposed to be modified to better utilise the spare volume available. Additional modifications to the basin would also be required to capture and treat the tunnel wash prior to discharge either to the nearby sewer system or local drainage to Terrys Creek.

Precinct 5 – Terrys Creek to Lane Cove Tunnel

The upstream inlet of the existing three cell box culvert (2400 x 1800 millimetres) near chainage 16220 is proposed to be extended 2.4 metres on the westbound side and the downstream outlet is to be extended 17.1 metres under the new Christie Road on-ramp, on the eastbound side.

The Shrimptons Creek catchment drains to a large precast concrete arch (20 x 6 metres) under the M2 Motorway near chainage 16450. The M2 Motorway widening works at this location include the provision of a westbound off-ramp to Herring Road, which would necessitate an upstream extension of the arch by 18 metres.

There are six existing water quality basins in Precinct 5 with at least five requiring some form of augmentation. It is proposed that this would be achieved through modification of the inlet/outlet arrangement for three of the basins (33c, 34b and 35b) while earthworks would be involved for the remaining two (35, and 36b). All of the basins are located on the northern side of the M2 Motorway.

6.4 Ancillary operational components

The Director-General requires a description of the ancillary operational components of the project to be included in the environmental assessment. This description including upgrades to the M2 Motorway's Intelligent Transport Systems, upgrades to toll facilities, cycle facilities, signals and connections with the surrounding road networks. This section addresses this requirement.

It should be noted that the Park and Ride facility has been excluded from the project for reasons detailed in Chapter 3, and has not been discussed in this section.

6.4.1 Intelligent Transport System

The M2 Motorway Intelligent Transport System (ITS) comprises traffic control and monitoring equipment, plant control and monitoring equipment, communications equipment and tolling equipment that are deployed along the M2 Motorway to:

- Detect incidents and facilitate the effective management of incidents on the M2 Motorway.
- Monitor and control traffic systems and traffic movements on the M2 Motorway including the ramps.
- Monitor and control mechanical and electrical systems in the Norfolk Tunnel.

The existing ITS components would be relocated or upgraded for the widened Motorway, from Windsor Road to Lane Cove Road, including upgrades to:

- Cableway route.
- Driver Advisory Systems.
- Traffic monitoring and surveillance systems.
- Centralised control and monitoring systems.
- Tunnel monitoring and control systems.
- Tolling systems.
- Communications systems.

The proposed upgrades to the existing ITS equipment are described in the following sections.

Cableway

A combination of upgrades to the existing cableway, a new cableway and backbone cable route would be constructed from approximately chainage 4300 to 18250 to service ITS requirements along M2 corridor. The cableway would be constructed (by trenching) in the sequence described in Table 9.

Table 9 Cableway upgrade locations

Approximate chainage	Carriageway location	Upgrade details
4300 – 6040	▪ Eastbound (northern)	▪ Upgrade to backbone cableway with new conduits and pits. Additional power supply points would be provided along the M2 Motorway.
6040 – 12000	▪ Westbound (southern)	
12000 – 15000	▪ Eastbound (northern)	
15000 – 17600	▪ Westbound (southern)	
17600 – 18250	▪ Westbound (southern)	

Toll collection equipment

Existing toll collection equipment consists of Electronic Toll Collection (ETC) and cash at the following locations:

- Toll plaza – ETC and cash.
- Pennant Hills Road ramps – ETC and cash.

Proposed new toll collection equipment would consist of ETC only equipment mounted on gantries at the following locations:

- Windsor Road ramps – ETC points would be constructed on both west facing on and off-ramps at Windsor Road.
- Herring Road ramp – ETC point would be constructed on the new east facing off-ramp.
- Christie Road ramp – ETC point would be constructed on the new west facing on-ramp.

The existing toll plaza tolling equipment would be realigned located to suit the proposed road realignment.

Closed Circuit Television

A Closed Circuit Television (CCTV) system currently exists to provide surveillance of the M2 Motorway. It comprises CCTV monitors and video equipment in the toll plaza control room and cameras primarily mounted on poles on either side of the M2 Motorway. The video equipment in the toll plaza control room would be modified to accommodate the new cameras.

Additional pan, tilt and zoom (PTZ) CCTV cameras would be installed at the new west facing entry and exit ramps at Windsor Road and at the new east facing exit ramp at Herring Road (two cameras in total).

Additional fixed head mounted CCTV cameras would be installed in each of the widened Norfolk Road tunnel tubes at approximately every 60 metres (16 cameras in total) to view the traffic from the rear and provide full CCTV coverage to the widened Norfolk Road tunnel.

Motorist Emergency Telephone System (METS)

The M2 Motorway presently has a Motorist Emergency Telephone System (METS) consisting of telephone handsets mounted on stands. The METS are positioned at one kilometre intervals on both carriageways. The telephones would be re-located to accommodate the re-aligned sections of the M2 Motorway. Existing emergency telephones in the widened Norfolk Road tunnel must be removed and replaced with telephones at approximately every 60 metres (16 telephones in total).

Variable Message Signs

There are currently four Variable Message Signs (VMS) on the M2 Motorway. The VMS are mounted on gantries positioned to the side of the M2 Motorway or above the tunnel portals and provide information messages to motorists. As part of the project, three additional VMS would be installed at the following locations:

- On the mainline carriageway before the new west facing Windsor Road exit ramp.
- At the eastbound entry of the Norfolk Tunnel.
- At the westbound entry of the Norfolk Tunnel.

Variable Speed Limit Signs

Variable Speed Limit Signs (VSLS) on the M2 Motorway display regulatory speed limits. Four existing VSLS would be relocated and eight additional VSLS's would be provided, as follows:

- Existing VSLS upstream of the entry to each of the Norfolk Tunnel portals would be relocated to be mounted on the new overhead structure over the eastbound and westbound mainline carriageways of the M2 Motorway (a total of four).
- Two additional VSLS would be mounted at each of the eastbound and westbound entry portals of the Norfolk Tunnel tubes (a total of four).
- Two additional VSLS would be mounted inside each of the Norfolk Tunnels at approximately 300 metres from the entry portal (a total of four).

Traffic monitoring

The traffic monitoring consists of vehicle detector systems that provide traffic data to be used for automatic incident detection, and congestion detection. The traffic data are acquired via vehicle detector loops embedded in the road. These loops are connected by electrical cabling to microprocessor-based equipment installed inside cabinets on the side of the road. Traffic monitoring sites are located at 500 metre intervals along the M2 Motorway and on-ramps. Existing systems would be relocated as required and additional loops added for new lanes and ramps.

Tunnel Message Signs

The Norfolk Tunnel would have the following Tunnel Message Signs (TMS):

- One additional row of two TMS would be installed in a back to back configuration in each of the Norfolk Tunnels carriageways (a total quantity of four). The TMS must be located at a maximum spacing of 120 metres along the length of the Norfolk Tunnel carriageways.
- The existing two rows of back to back TMS are to be repositioned (a total quantity of eight).

Lane Usage Signs

The Norfolk Tunnel would have the following Lane Usage Signs (LUS):

- Additional LUS would be installed allowing for an additional row in each tunnel and the additional lane in the eastbound tunnel. LUS are to be mounted over each lane in a back to back configuration (a total quantity of 18). The LUS must be located at a maximum spacing of 120 metres along the length of the Norfolk Tunnel carriageways.
- The existing three rows of back to back LUS are to be repositioned (a total quantity of 30).

Other tunnel systems

The Norfolk Tunnels would be fitted with the following ITS equipment:

- Tunnel Public Address (PA) System.
- Radio Re-broadcasting (RRB) system installed inside the tunnel.
- Plant Monitoring and Control System (PMCS) consisting of PLC based equipment primarily located inside the tunnel and Eastern Portal Building.
- Existing Changeable Diversion Signs, one set located on each approach toward the tunnel to be relocated and upgraded allowing for the additional lane.

Motorway Network Communications System

A Motorway Network Communications System (MNCS) comprising a new fibre optic cable backbone installed in an underground cableway and associated electronic transceiver equipment co-located in a number of roadside cabinets would be installed or relocated along the widened sections of the M2 Motorway.

6.4.2 Norfolk Tunnel services

The Norfolk Tunnel widening works would require mechanical and electrical (M&E) upgrades, including the relocation, modification, removal of existing tunnel services and the supply and the installation of new tunnel services.

The following works would be required for the tunnel upgrade:

- Incoming 11kV feeder cables would require relocation to accommodate the tunnel widening.
- Main switchboard would require modifications and Tariff Metering Panel would be relocated.
- Modifications to the UPS Distribution Board and extension floor support frame would be installed.
- Environmental monitoring instrumentation would require relocation.
- New distribution boards.
- New Tunnel Ventilation Motor Control Centres.
- New sub-main cabling.
- New lighting support systems and tunnel luminaires (upgraded to AS/NSZ 1158.5 Lighting for Roads and Public Spaces Part 5: Tunnels and Underpasses).Relocation of jet fans.
- Relocation of Intelligent Transport Systems (ITS) (refer to Section 6.4.1).
- Fire protection and detection systems.

6.4.3 Services and utilities

Existing services and utilities

The majority of the existing utility services in the M2 corridor were relocated during the initial construction of the M2 Motorway. The services that remained inside the M2 corridor were laid in a manner that considered future road work, at depth and perpendicular to the M2 corridor or concrete encased.

Where feasible, the project widening works would avoid or accommodate the existing services. The key work elements within the M2 corridor that would impact on the utility services include retaining walls, ramps and bridge adjustments. Widening works outside the M2 corridor on Talavera Road would require major changes to the utility services due to the provision of an additional lane.

Consultation is currently underway with utility providers who own services within the M2 corridor. The nature and extent of utility relocations would be finalised in consultation with relevant authorities and organisations through the detailed design and construction of the project. The key services that would be likely to require relocation (temporary or permanent) are summarised in Table 10.

Table 10 Existing utilities and services potentially affected by the project

Section (Chainage)	Description	Service provider
3620	Goodin Avenue	▪ Sydney Water (sewer/water)
3730	Horwood Avenue ducts	▪ Telstra (telecoms) ▪ Jemena (gas) ▪ Integral Energy (elect)
4000	Windsor Road Bridge ducts	▪ Telstra (telecoms) ▪ Jemena (gas) ▪ Integral Energy (elect) ▪ Sydney Water (water/sewer)
4300	Russell Street to Petrina Court	▪ Sydney Water (water/sewer)
4650	Darling Mills Creek	▪ Sydney Water (water/sewer)
5260	Rajola Place	▪ Sydney Water (water/sewer)
5540	Barclay Road ducts	▪ Telstra (telecoms) ▪ Integral Energy, Hutchison, Energy Australia (elect) ▪ Sydney Water (water/sewer)
6020	Hepburn Road	▪ Sydney Water (water/sewer)
6760	Yale Close ducts	▪ Optus (telecoms) ▪ Sydney Water (sewer/water)
7000	Gossell Grove	▪ Sydney Water (water/sewer)
7630	Boundary Road (Kirkham Street)	▪ Sydney Water (water/sewer)
7930	Carmen Drive	▪ Sydney Water (water/sewer)
9660	Orchard Road	▪ Sydney Water (water/sewer)
9850	Devlin's Creek / Burns Road	▪ Sydney Water (water/sewer)
10350	Saracen Road	▪ Sydney Water (water/sewer)
10470	Ferndale Road	▪ Sydney Water (water/sewer)
10640	Murray farm Road/Kirkham Street duct	▪ UEComm (telecoms) ▪ Jemena (gas) ▪ Energy Australia (elect) ▪ Sydney Water (sewer/water)
11150	Kerry Avenue	▪ Sydney Water (water/sewer)
11200	Kent Street ducts	▪ Telstra, Hutchison, Optus and Vodafone (telecoms) ▪ Sydney Water (water/sewer)
12230	Beecroft Road / Old Beecroft Road ducts	▪ Telstra, Optus (telecoms) ▪ Energy Australia (elect) ▪ Sydney Water, Hills M2 (water/sewer)
12380 / 12500	Somerset Street ducts	▪ Telstra (telecoms) ▪ Sydney Water (sewer/water)
12430	Derby Street ducts	▪ Energy Australia
12620	Norfolk Tunnel ducts	▪ Telstra, Optus, Vodafone and Telstra (telecoms)

Section (Chainage)	Description	Service provider
13060	Gillard Way / Devon Street / Somerset Street	▪ Sydney Water (water/sewer)
13120	York Street ducts	▪ Energy Australia (elect)
13800	Terrys creek west of Crimea Road	▪ Sydney Water (water/sewer)
14500	Vimiera Road ducts	▪ Telstra, Vodafone, Optus and Telstra (telecoms) ▪ Sydney Water (water/sewer)
15000	Busaco Road ducts	▪ Telstra (telecoms) ▪ Jemena (gas) ▪ Energy Australia (elect) ▪ Sydney Water (water/sewer)
15300	Culloden Road ducts	▪ Hutchison (telecoms) ▪ Sydney Water (water/sewer)
16090	Christie Road	▪ Telstra, Optus (telecoms) ▪ Energy Australia (elect) ▪ Sydney Water (water/sewer)
16100	Talavera Road ducts	▪ Telstra, Optus, PowerNet, UEComm and AARNet (telecomms) ▪ Jemena (gas) ▪ Energy Australia (elect)
16230	Herring Road to Alma Road	▪ Sydney Water (water/sewer)
16480	Alma Road	▪ Sydney Water (water/sewer)
16980	Khartoum Road ducts	▪ Telstra (telecoms) ▪ Jemena (gas) ▪ Energy Australia (elect) ▪ Sydney Water (water/sewer)
17670	Lane Cove Road ducts	▪ Optus (telecoms)

There are no services owned by public utility providers within the M2 corridor that run parallel to M2 corridor. The only services that run parallel to the M2 Motorway are RTA or Hills M2 services that supply and control systems, including CCTV, VMS and tolling. These services are located in the existing road verge and would be affected by the works. The services would be re-laid in the new road shoulder.

Service and utility relocations

The proposed upgrade does not provide a dedicated M2 corridor for new services for external utility providers. The proposed alignment is tightly constrained and widths have been kept to a minimum to reduce the footprint of the proposed upgrade and associated impacts.

Services required (either short or long term) for operation of the proposed upgrade would include power for lighting and traffic information systems and communications cabling. It is proposed that conduits for each of the required services would be located within the verge of the road, with provision made for compatibility or conversion requirements for the ultimate configuration.

6.4.4 Lighting and signage

The proposed upgrade would generally be unlit. As an exception, at particular areas, lighting would be required for safety reasons, such as converging and diverging traffic streams. The areas where lighting is required are as follows:

- Windsor Road ramps and interchange.
- Herring Road / Christie Road interchange.
- Existing toll plazas.
- Norfolk Tunnel.

A road signage strategy would be developed for permanent road signage for the proposed upgrade. The road signage strategy would include a combination of directional signage to provide clear guidance to local and Motorway traffic. The strategy would be considered further during detailed design and all road signage for the project would be in accordance with RTA requirements. Some of these signs would be located off the M2 Motorway on approaches to the entry ramps.

6.5 Staged opening

It is proposed to open sections of the M2 Upgrade project in stages. Staged opening would be determined as part of detailed design phase and would be generally consistent with the M2 Motorway precincts (as described in Section 1.5).

The indicative staged opening would likely be as follows:

- Windsor Road on- and off-ramps (approximate timing would be 14 to 15 months after commencement of construction).
- Christie Road on-ramp and Herring Road off-ramp, including associated local road widening (approximate timing would be 21 months after commencement of construction).
- Windsor Road to Pennant Hills Road eastbound (approximate timing would be 15 to 18 months after commencement of construction).
- The remainder of the M2 Upgrade project (approximate timing would be 24 months after commencement of construction).

To facilitate the staged opening of the M2 Upgrade project, associated works would be completed, such as noise walls, landscaping, signage and the like.

6.6 Design process

This section further describes the design process that has been undertaken to date and outlines how the concept design assessed in this environmental assessment would be developed and refined.

6.6.1 Urban and landscape design strategy

Urban design and landscape objectives were identified for the project, which aim to improve the presentation of the section of the M2 Motorway impacted by the M2 Upgrade project. The vision for the urban and landscape design outcomes of the upgrade of the M2 Motorway is to reflect the vegetated landscape and the uniqueness of the topography in the area while minimising potential adverse impacts. The seven objectives adopted for this project are as follows.

- Upgrade works are to improve the visual appearance and character of the road corridor and create a recognisable identity for the M2 Motorway – through the use of contextually appropriate design and materials, and by conserving and enhancing historically significant aspects.
- Motorway elements are to complement the surrounding setting – through the use of appropriate colour and form and emphasising the sandstone geology of the ridge lines.
- Maintain a safe and accessible corridor – designs are to encourage safe driver behaviour, emphasise road geometry and retain views for safety.
- Improve accessibility – for nearby communities for pedestrians, cyclists and public transport.
- Revegetation strategies need to relate to scale, composition and colour of the adjacent built form – planting to be robust and manageable with on-going weed management.
- Protect and enhance the natural systems and ecology of the Corridor – works are to strengthen the existing landscape by using soft engineering, enhancing natural vegetation, managing weeds.
- Maintenance of hard and soft landscape elements must be accessible and maintainable with minimal resources – designs to accommodate maintenance requirements.

Section 9.6 of this environmental assessment and Technical Paper 4 present the urban design and landscape strategy that has been formulated for this project. The strategy is based on the abovementioned objectives and the assessment of visual amenity and landscape impacts of the project. The concept urban and landscape design would be further refined during the detailed design phase.

Note only those areas that are proposed to be upgraded as part of this project are subject to the urban design and landscape measures outlined.

6.6.2 Concept design refinement and detailed design

General

The design on which this environmental assessment is based was developed as part of the concept design and environmental assessment project phase. The design responds to the constraints of the M2 corridor and the design and engineering principles identified and developed during investigations. The intent of the concept design is to provide:

- A clear description of the design principles, extent of impacts and impact management requirements.
- A flexible approach to detailed design hinging on the outcomes of the environmental assessment and subsequent conditions of approval.
- A definable construction footprint to determine temporary and permanent property access and acquisition requirements.
- A firm platform from which the concept design can progress into detailed design and beyond to a standard required to support project delivery.

The detailed design phase of the proposed upgrade of the M2 Motorway would involve survey, geotechnical investigations and design activities prior to the commencement of construction.

Key requirements for detailed design

The detailed design phase would be guided by key design and engineering principles developed during concept design and the outcomes of the environmental assessment process. Development of the detailed design would be required to:

- Address the principles of ESD.
- Ensure that there is consistency with the design criteria and the principles on which the concept design was based, as described in the environmental assessment.
- Ensure that issues associated with the development of the concept design as proposed in the environmental assessment are appropriately addressed.
- Ensure that Conditions of Approval arising from the approval process under Part 3A of the EP&A Act are met.
- Ensure that environmentally sensitive areas are avoided.
- Ensure that appropriate mitigation measures are implemented where impacts cannot be avoided.
- Ensure that risk management is appropriately addressed during both construction and operation.
- As indicated in Section 6.5, during the detailed design process, components of the concept design may be refined and optimised. For this reason, these elements may change in the future. Changes would be implemented in such a way that would improve or enhance the project.