Transport for NSW

Beaches Link and Gore Hill Freeway Connection

6 – Assessment of road intersection operational performance

November 2021

Contents

6 Assessment of road intersection operational performance

6.1 Overview

The Beaches Link and Gore Hill Freeway Connection project would, by providing a new underground motorway bypass of the Military Road/Spit Road (A8) and Warringah Road (A38)/Eastern Valley Way corridors, substantially improve journey times and trip reliability for millions of freight vehicles, public transport users and other road users who rely on these transport links each year. The environmental impact statement indicates that some intersections in the vicinity of the project's surface connections would experience localised delays during operation. However, it also identifies that the substantial broader network benefits of the project would offset localised delays for the majority of road users.

Benefits and impacts are illustrated holistically throughout the environmental impact statement (in particular Appendix F (Technical working paper: Traffic and transport) and Chapter 9 (Operational traffic) of the environmental impact statement) by network speeds and corridor travel times. While there may be some localised intersection impacts in some instances, in many cases intersections in the network are expected to experience improved performance. In any one journey, it is likely that a customer would travel through several intersections, not just one, and this reinforces the need to consider traffic performance holistically (ie through network metrics and corridor travel times) rather than in isolation.

Notwithstanding, the Department of Planning, Industry and Environment has requested Transport for NSW to carry out additional analysis and provide additional information to confirm any potential impacts to individual intersections due to the delivery of the project, and on how any impacts would be managed:

> *Identify local road intersections impacted by traffic changes as a result of the operation of the project; consider and assess the impact of those changes and identify measures to mitigate the impacts.*

To address this requirement, additional review and assessment of the environmental impact statement operational traffic models has been carried out, including additional modelling (where considered necessary) to further refine the operational traffic models and provide further clarity on the modelling outcomes, including potential localised intersection performance benefits or impacts as a result of the project.

Section 6.2 outlines the approach for each study area, which are consistent with the study areas considered in the environmental impact statement:

- Warringah Freeway and surrounds
- Gore Hill Freeway and Artarmon
- Balgowlah and surrounds
- Frenchs Forest and surrounds.

6.2 Operational traffic modelling approach

Due to the uniqueness of the various study area models and based on the outcomes presented in the environmental impact statement, a specific approach for each study area has been adopted to inform this preferred infrastructure report. A summary of the approach carried out for each study area is outlined in this section, with full details presented in Section 2 of Appendix B of this preferred infrastructure report.

The review of environmental impact statement operational traffic modelling outcomes indicated that the Department of Planning, Industry and Environment's concerns were generally consistent for both 2037 and 2027 horizon years, with 2037 issues being of larger magnitude due to the additional assumed traffic demand growth. Due to this, the 2037 horizon year models are the focus of this assessment.

The operational traffic model scenarios considered in this preferred infrastructure report are consistent with the environmental impact statement modelling scenarios as follows (refer to Section 9.2.2 of the environmental impact statement for further detail on the projects included in each scenario):

- Without the project ('Do minimum')
- With the project ('Do something')
- With the project and other planned or proposed projects ('Do something cumulative').

The operational traffic modelling assessment presented in the environmental impact statement adopted an overarching strategy to optimise the performance of the broader road network/corridor, rather than a detailed review of individual intersection performance. Thus, while intersection performance metrics may not necessarily demonstrate improvements on an isolated basis, the focus was on ensuring that the typical customer experience over a broader journey would not be compromised after the project was introduced.

For all areas assessed, this preferred infrastructure report provides detail beyond that provided in the environmental impact statement to confirm localised performance outcomes in specific areas of concern.

For the Gore Hill Freeway and Artarmon, and Balgowlah and surrounds areas, the information provided in this preferred infrastructure report is additional, detailed metrics extracted from the operational traffic modelling carried out for and presented in the environmental impact statement. No additional operational traffic modelling has been carried out for these areas.

For the Warringah Freeway and surrounds, and Frenchs Forest and surrounds areas, additional operational traffic modelling has been carried out to further refine the modelling outcomes presented in the environmental impact statement. For these areas network optimisation through improved operation and coordination of traffic signals has been considered, and potential measures to further mitigate residual traffic performance impacts have also been explored.

6.2.1 Warringah Freeway and surrounds

In the Warringah Freeway and surrounds area, the environmental impact statement illustrated that although the project would generally improve network performance for roads within and around North Sydney, it would not resolve localised performance issues at several intersections. It is also noted that options to further improve traffic performance at intersections throughout the area have previously been investigated. However, these alternative options would result in further impacts on other customers or in other areas, and consequently create net disbenefits. The proposed works are

therefore considered to provide an equitable outcome from the perspective of maintaining a balanced and integrated transport network through the constrained urban environment of North Sydney, with further refinements to movement and place outcomes within the North Sydney CBD being delivered by works associated with the North Sydney Integrated Transport Program.

Notwithstanding this, further assessment was requested by the Department of Planning, Industry and Environment for the following locations where the environmental impact statement indicated potential localised intersection traffic performance impacts:

- Amherst Street: West Street to Miller Street (Local road corridor)
- Ernest Street: Merlin Street to Miller Street (Regional road corridor)
- Miller Street: Falcon Street to Pacific Highway (Regional road corridor)
- Brook Street: Merrenburn Avenue to Chandos Street (Regional road corridor).

To investigate and address these issues the following operational traffic model scenarios have been reviewed and refined to inform this preferred infrastructure report:

- 2037 'Do something' – morning and evening peaks
- 2037 'Do something cumulative' – morning and evening peaks.

Investigation to further improve the operating performance of the Warringah Freeway and surrounds study area in these scenarios has focussed on the application of additional traffic signal optimisation strategies (eg phase time redistribution, signal coordination and phasing arrangements) to improve alignment with/be reflective of existing Transport for NSW network management practices (eg network planning and management as implemented via the Sydney Coordinated Adaptive Traffic System (SCATS)). This means that there are no physical changes to the Reference Design presented in the environmental impact statement; only operational improvements were considered.

The outcomes of the refined Warringah Freeway and surrounds operational traffic modelling for the 2037 'Do something' and 2037 'Do something cumulative' scenarios are summarised in Section 6.3.1.

6.2.2 Gore Hill Freeway and Artarmon

The operational traffic modelling assessment presented in the environmental impact statement did not indicate the project would create material impacts on the local road network in the Gore Hill Freeway and Artarmon study area when compared to conditions without the project ('Do minimum'). Notwithstanding this, further information was requested by the Department of Planning, Industry and Environment for the following locations:

- Reserve Road: Barton Road to Dickson Avenue (Local road corridor).

Specifically, further clarification on the potential project impacts is presented in this preferred infrastructure report for the operational traffic model scenarios where high average intersection delays (ie Reserve Road intersections showing ">100 second" delays) were presented in the environmental impact statement. The relevant scenarios are as follows:

- 2037 'Do something' – evening peak only
- 2037 'Do something cumulative' – evening peak only.

For the purpose of the environmental impact statement, the presentation of intersection average delay was "capped" at >100 seconds to address the practical limitations of strategic traffic forecasting and downstream microsimulation modelling in instances where forecast peak hour demand exceeds practical capacity. These limitations can result in the absolute value of delay

simulated in microsimulation being distorted and potentially unrealistic. However, for the purpose of this preferred infrastructure report, the absolute values have been extracted and presented to demonstrate the relative benefit/impact of the project compared to conditions without the project – ie confirming if intersection performance is anticipated to improve or deteriorate as a result of the project, rather than presenting conditions both with and without the project as “>100 seconds”.

This additional information regarding average intersection delay for the 2037 ‘Do something’ and 2037 ‘Do something cumulative’ scenarios in the evening peak have been summarised in Section 6.3.2, reiterating that the environmental impact statement operational traffic models have not been modified for the Gore Hill Freeway and Artarmon study area.

6.2.3 Balgowlah and surrounds

For the Balgowlah and surrounds area, the environmental impact statement indicated that the operation of the project would facilitate additional traffic travelling through the corridor within the Balgowlah and surrounds area at greatly reduced levels of delay, and would benefit both regional and local trips. This would result in improved travel times on key routes through the area as a result of the project. However, further information was requested by the Department of Planning, Industry and Environment for the following locations:

- Sydney Road: Frenchs Forest Road to Wanganella Street (State road corridor).

Specifically, clarification on the potential project impacts is presented in this preferred infrastructure report for the operational traffic model scenarios where high average intersection delays (ie Sydney Road intersections showing “>100 second” delays) were presented in the environmental impact statement. The relevant scenarios are as follows:

- 2037 ‘Do something’ – evening peak only
- 2037 ‘Do something cumulative’ – evening peak only.

As explained above, for the purpose of the environmental impact statement the presentation of intersection average delay was “capped” at >100 seconds to address traffic forecasting and modelling limitations. However, for the purpose of this preferred infrastructure report, uncapped values have been presented to demonstrate the relative benefit/impact of the project.

This additional information regarding average intersection delay for the 2037 ‘Do something’ and 2037 ‘Do something cumulative’ scenarios in the evening peak have been summarised in Section 6.3.3, reiterating that the environmental impact statement operational traffic models have not been modified for the Balgowlah and surrounds study area.

6.2.4 Frenchs Forest and surrounds

For the Frenchs Forest and surrounds area, the environmental impact assessment strategic modelling indicated that road users would benefit from substantial travel time savings on the broader network due to the strategic benefits provided by the Beaches Link and Gore Hill Freeway Connection project. However, the changes to traffic patterns associated with the project could result in increased localised delays on the existing road network between Forest Way and Wakehurst Parkway and reduced travel speeds through the area during the busiest peak traffic periods. Consequently, further analysis was requested by the Department of Planning, Industry and Environment for the following locations:

- Frenchs Forest Road: Warringah Road to Gladys Avenue (Local road corridor)
- Warringah Road: Hilmer Street to Frenchs Forest Road (State road corridor).

The operational traffic modelling assessment presented in the environmental impact statement for the Frenchs Forest and surrounds study area suggested that the 'Do something' and 'Do something cumulative' scenarios may be subject to additional congestion on the road network when compared to conditions without the project ('Do minimum') in the morning and evening peaks due to changes in traffic volumes and patterns. As such, the following operational traffic model scenarios have been reviewed and refined to inform this preferred infrastructure report:

- 2037 'Do something' – morning and evening peaks
- 2037 'Do something cumulative' – morning and evening peaks.

Similar to the Warringah Freeway and surrounds area, additional operational traffic modelling improvements for this preferred infrastructure report included investigation of additional traffic signal optimisation strategies (eg phase time redistribution, signal coordination and phasing arrangements).

In addition to operational improvements, as part of this preferred infrastructure report, further detailed analysis of expected future traffic demand levels and road network supply (or capacity) in the Frenchs Forest and surrounds study area has been considered and refined, including:

- The known existing and expected future capacity/operational road network constraints within the Frenchs Forest and surrounds area
- The potential Beaches Link express bus services (and other complementary public transport upgrades) that would service the Frenchs Forest and surrounds area
- Broader complementary transport strategies (eg *Future Transport Strategy 2056* (NSW Government, 2018)*, Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017b)) which promote and would provide complementary initiatives to encourage a higher shift to other sustainable modes of transport (away from private vehicle or car trips).

It is important to note that the environmental impact statement transport demand modelling assumed no material change to public transport provisions to and from the Northern Beaches (ie no Beaches Link express bus services nor improvements to existing surface routes). In this sense the environmental impact statement transport modelling is conservative as it assumes a relatively high private vehicle mode share/low public transport share, similar to existing conditions in this area. The introduction of Beaches Link express bus services and other public transport network enhancements and demand management initiatives would increase public transport demand and consequently reduce private vehicle demand.

Considering the above, the review of the Frenchs Forest and surrounds operational traffic models presented in this report assumes that total traffic demand forecast in the 2037 'Do minimum' scenario could provide a more reasonable vision/target of future private vehicle demand levels in the Frenchs Forest and surrounds study area. As such, traffic demand in the 2037 'Do something' and 2037 'Do something cumulative' scenarios has been scaled to match the 2037 'Do minimum' scenario in the respective morning and evening peaks. This approach preserves the project's forecast effects on traffic patterns within and through the Frenchs Forest and surrounds network. It is noted that no physical changes to the Reference Design scope presented in the environmental impact statement were considered in this preferred infrastructure report assessment.

The outcomes of this refined Frenchs Forest and surrounds operational traffic modelling assessment for the 2037 'Do something' and 2037 'Do something cumulative' scenarios have been summarised in Section 6.3.4.

6.3 Further detailed impact assessment outcomes

This section provides a summary of the key outcomes and considerations based on the refined operational traffic modelling for the Warringah Freeway and surrounds and Frenchs Forest and surrounds study areas. The environmental impact statement operational traffic models for the Gore Hill Freeway and Artarmon and Balgowlah and surrounds study areas have not been refined for the purpose of this preferred infrastructure report, however, additional detail and clarification on the outcomes for these areas are provided.

Further details of the operational traffic modelling assessment results and outcomes are provided in Section 3 and Section 4 of Appendix B of this preferred infrastructure report.

6.3.1 Warringah Freeway and surrounds

As discussed previously, the operational traffic modelling outcomes presented in the environmental impact statement for the Warringah Freeway and surrounds study area should generally be considered with the road network management and optimisation strategy in mind – ie overall network performance improvements are observed in the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to the 2037 'Do minimum', and micro-optimisation of individual intersections can cause broader network issues. Nevertheless, the refined operational traffic modelling assessment presented in this section demonstrates further opportunities to optimise traffic performance for specific road network corridors and intersections (ie Amherst Street, Ernest Street, Miller Street and Brook Street), while also not adversely impacting the performance of the surrounding road network and corridors nor the outcomes for other modes (eg buses and pedestrians).

This preferred infrastructure report operational traffic modelling assessment completed for the 2037 'Do something' and 2037 'Do something cumulative' scenarios (morning and evening peaks) in the Warringah Freeway and surrounds study area has necessarily adopted a similar road network optimisation strategy to the environmental impact statement, which requires consideration of the broader road network and corridor performance as well as individual intersection performance. Gaining localised performance benefits in one area of the network can cause broader (or downstream) impacts on the surrounding network, thus negating benefits that could be achieved or introducing new impacts in the local area. This is particularly pertinent for complex, constrained, and congested road networks such as the Warringah Freeway and surrounds study area, and as such this holistic network optimisation approach remains critical to ensure the efficient movement of people, goods, and services throughout the network.

Section 3 and Section 4 of Appendix B of this preferred infrastructure report presents the full suite of network, travel time and intersection performance results for the refined operational traffic modelling assessment completed for the 2037 'Do something' and 2037 'Do something cumulative' scenarios for all locations modelled for the environmental impact statement. Table 6-1 and Table 6-2 presents the updated intersection performance results (average delay and level of service (LoS)) for the locations where the environmental impact statement indicated potential localised intersection traffic performance impacts (ie Amherst Street, Ernest Street, Miller Street and Brook Street road corridors) in the morning and evening peaks, respectively.

It is noted that the intersection performance results presented in sections 7.4.3 and 8.4.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 6-1 and Table 6-2 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum'

scenario (this has been provided as a clarification within Section A5.1.5 of the submissions report) and the refined results for the 2037 'Do something' and 2037 'Do something cumulative' scenarios.

Table 6-1: Modelled morning peak hour (8am to 9am) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Brook Street / Warringah Freeway on ramp	177	F	7	A	8	A
Brook Street / Warringah Freeway off ramp	67	E	10	A	11	A
Brook Street / Merrenburn Avenue	117	F	26	B	29	C
Amherst Street / West Street	4	A	6	A	18	B
Amherst Street / Miller Street	20	B	36	C	48	D
Miller Street / Warringah Freeway on ramp	6	A	3	A	4	A
Miller Street / Warringah Freeway off ramp	13	A	5	A	8	A
Miller Street / Ernest Street	32	C	38	C	45	D
Miller Street / Falcon Street	38	C	34	C	76	F
Ernest Street / Warringah Freeway on ramp	5	A	9	A	23	B
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	5	A	11	A	23	B
Berry Street / Miller Street	69	E	42	C	60	E
Pacific Highway / Miller Street / Mount Street	41	C	55	D	45	D
Miller Street / McLaren Street	72	F	48	D	59	E
Miller Street / Ridge Street	53	D	46	D	68	E
Miller Street / Carlow Street	13	A	9	A	28	B
Ernest Street / Ben Boyd Road	12	A	13	A	28	C

Table 6-2: Modelled evening peak hour (5pm to 6pm) intersection performance – Warringah Freeway and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Brook Street / Warringah Freeway on ramp	17	B	8	A	5	A
Brook Street / Warringah Freeway off ramp	20	B	18	B	19	B
Brook Street / Merrenburn Avenue	13	A	53	D	23	B
Amherst Street / West Street	10	A	5	A	5	A
Amherst Street / Miller Street	31	C	39	C	33	C
Miller Street / Warringah Freeway on ramp	6	A	7	A	7	A
Miller Street / Warringah Freeway off ramp	15	B	9	A	8	A
Miller Street / Ernest Street	43	D	36	C	38	C
Miller Street / Falcon Street	49	D	62	E	49	D
Ernest Street / Warringah Freeway on ramp	15	B	13	A	14	A
Ernest Street / Warringah Freeway off ramp (off ramp in evening, on ramp in morning)	17	B	14	A	16	B
Berry Street / Miller Street	70	F	58	E	58	E
Pacific Highway / Miller Street / Mount Street	58	E	69	E	63	E
Miller Street / McLaren Street	55	D	59	E	65	E
Miller Street / Ridge Street	91	F	19	B	54	D
Miller Street / Carlow Street	19	B	7	A	7	A
Ernest Street / Ben Boyd Road	94	F	36	C	58	E

The key outcomes of the refined operational traffic modelling, which reflects typical network management and traffic signal optimisation strategies, are summarised as follows when comparing the refined 2037 'Do something' and 2037 'Do something cumulative' scenarios with the 2037 'Do minimum' scenario:

- Overall, the operational improvements applied to this preferred infrastructure report operational traffic modelling are not expected to result in any material adverse impacts when compared to the traffic performance outcomes presented in the environmental impact assessment
- Consistent with the environmental impact statement results presented, the refined operational traffic modelling for the 2037 'Do something' and 2037 'Do something cumulative' scenarios in the morning and evening peaks generally result in an improvement to overall road network performance compared to the 2037 'Do minimum' scenario with a decrease in the total number of stops, lower average trip times through the network and higher average trip speeds
- Consistent with the overall network performance results, corridor travel times are also generally expected to be maintained or improved in the refined 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to 2037 'Do minimum' scenarios
- Generally, the refined operational traffic modelling indicates that the performance of intersections in focus on Brook Street, Amherst Street, Ernest Street, and Miller Street would be maintained or improved when comparing the 2037 'Do something' and 2037 'Do something cumulative' scenarios to the 2037 'Do minimum' scenario, and/or maintained at an acceptable LoS D or better, with the following exceptions:
    - Miller Street/Ridge Street (morning peak)
    - Miller Street/Falcon Street (morning peak)
    - Miller Street/McClaren Street (evening peak)

At the Miller Street/Ridge Street intersection average delay in the morning peak is shown to improve from 53 seconds in the 2037 'Do minimum' scenario to 46 seconds in the 2037 'Do something' scenario, with LoS D in both cases. However, in the 2037 'Do something cumulative' scenario average delay is expected to marginally increase to 68 seconds when compared to the 2037 'Do minimum' scenario, resulting in LoS E.

At the Miller Street/Falcon Street intersection average delay in the morning peak is shown to be consistent between the 2037 'Do minimum' and 2037 'Do something' scenarios (LoS C). However, this intersection is expected to approach capacity in the 2037 'Do something cumulative' scenario (LoS F during the busiest peak periods) as a result of:

- Accommodating additional traffic coming from the Western Harbour Tunnel to Falcon Street off-ramp in the 2037 'Do something cumulative' scenario
- Road network optimisation and demand management strategies assumed and implemented in this part of the network which prioritise the management of congestion and queuing on higher order roads such as Miller Street (classified as a Regional road) in order to minimise potential congestion and queuing impacts on the connecting local road corridors (eg Amherst Street).

At the Miller Street/McClaren Street intersection, average delay in the evening peak is shown to marginally increase from 55 seconds (LoS D) in the 2037 'Do minimum' scenario to 59 seconds in the 2037 'Do something' scenario and 65 seconds in the 2037 'Do something cumulative' scenario (both LoS E). These differences in isolated intersection delays are considered immaterial; more importantly from a corridor perspective, travel time results along Miller Street between Berry Street and Amherst Street would be comparable with the 2037 'Do minimum' scenario.

Intersections along the Brook Street corridor also generally demonstrate improved intersection performance in the refined 2037 'Do something' and 2037 'Do something cumulative' scenarios compared to the 2037 'Do minimum' scenario. As a result of strategic traffic distribution changes

across the network, some relatively minor residual impacts are observed in the refined 2037 'Do something' scenario at the Brook Street/Merrenburn intersection in the evening peak. Nevertheless, the intersection is still expected to operate at LoS D or better which is considered an acceptable outcome particularly given the constrained nature of the network.

As indicated in the above discussion, there are a small number of locations where residual impacts to isolated intersection delay are reported. To address these residual issues Transport for NSW will continue to investigate further opportunities to provide additional benefits or mitigate residual impacts within the Warringah Freeway and surrounds study area through the Western Harbour Tunnel and Beaches Link program and/or other existing relevant processes. Given the context of this complex and constrained urban area, additional mitigations would focus on multi-modal transport and demand management strategies to reduce private vehicle demand rather than seek to deliver further road capacity upgrades, consistent with the North Sydney Integrated Transport Program.

6.3.2 Gore Hill Freeway and Artarmon

For the Gore Hill Freeway and Artarmon area additional metrics and details have been extracted from the environmental impact statement operational traffic modelling to demonstrate project benefits in this area. The additional analysis for the 2037 'Do something' and 2037 'Do something cumulative' evening peak scenarios re-emphasises the environmental impact statement outcomes; that the project would not have an adverse impact on the local road corridor in focus – ie Reserve Road between Barton Road and Dickson Avenue – as well as the broader network considered in the Gore Hill Freeway and Artarmon study area.

Table 6-3 presents the intersection performance results for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak scenarios. Additional modelling has not been carried out for this study area, and as such these results are unchanged from the environmental impact statement. However, the uncapped intersection average delay values have been presented to demonstrate the relative benefit/impact of the project.

It is noted that the intersection performance results presented in sections 7.5.3 and 8.5.3 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement have some minor inconsistencies with the model outputs. As such, Table 6-3 presents the corrected and uncapped intersection performance results for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak hour scenarios (this has been provided as a clarification within Section A5.1.6 of the submissions report).

Table 6-3: Modelled evening peak hour (5pm to 6pm) intersection performance – Gore Hill Freeway and Artarmon study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Epping Road / Longueville Road / Parklands Avenue	75	F	71	F	82	F
Longueville Road / Pacific Highway	44	D	42	D	70	F
Pacific Highway / Howarth Road / Norton Lane	8	A	6	A	5	A
Pacific Highway / Gore Hill Freeway interchange	30	C	38	C	41	C
Reserve Road / Gore Hill Freeway interchange	64	E	47	D	52	D
Reserve Road / Dickson Avenue	96	F	66	E	101	F
Reserve Road / Barton Road [1]	298	F	141	F	203	F

[1] Reserve Road/Barton Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

For the 2037 'Do something' scenario in the evening peak, general road network performance can be expected to operate at a comparable (or better) level than the 2037 'Do minimum' scenario. More specifically, the environmental impact statement operational traffic model findings indicate that intersection performance along the Reserve Road corridor is expected to improve when compared to the 2037 'Do minimum' scenario noting the following:

- The Reserve Road/Barton Road intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something' scenarios. However, average intersection delay is approximately halved in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario (an approximately 2.5 minute improvement in average intersection delay, from around 5 minutes to 2.5 minutes)
- The Reserve Road/Gore Hill Freeway interchange performance can be expected to improve in the 2037 'Do something' scenario compared to the 2037 'Do minimum' (64 seconds (LoS E) to 47 seconds (LoS D)). An improvement in average intersection delay of approximately 15 to 20 seconds is expected
- The Reserve Road/Dickson Avenue intersection can be expected to improve in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario (from 96 seconds (LoS F) to 66 seconds (LoS E)). An improvement in average intersection delay in the order of 30 seconds is expected.

Traffic performance is expected to reduce in the 2037 'Do something cumulative' scenario compared to the 2037 'Do something' scenario due to the potential for additional demand from Western Harbour Tunnel. However, the operational traffic model findings also demonstrate net overall benefits along the Reserve Road corridor when compared to the 2037 'Do minimum' scenario, noting the following:

- The Reserve Road/Barton Road intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something cumulative' scenarios. However, average intersection delay is also expected to improve significantly in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario (an approximately 1.5 minute improvement in average intersection delay, from 5 minutes to around 3.5 minutes)
- The Reserve Road/Gore Hill Freeway interchange performance can be expected to marginally improve in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' (LoS E to LoS D). An improvement in average intersection delay of approximately 10 seconds is observed
- The Reserve Road/Dickson Avenue intersection is also expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something cumulative' scenarios. A marginal increase in average intersection delay (5 seconds) can be expected in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario, however, this difference in intersection delay is considered negligible.

Overall, the additional information extracted and provided confirms the operational traffic modelling outcomes for the Gore Hill Freeway and Artarmon study area as presented in the environmental impact statement, specifically that the project (and broader Western Harbour Tunnel and Beaches Link program of works) are not expected to adversely impact the performance of the local road network (specifically Reserve Road).

6.3.3 Balgowlah and surrounds

For the Balgowlah and surrounds area additional metrics and details have been extracted from the environmental impact statement operational traffic modelling to further demonstrate project benefits in this area. Network performance metrics for both the 2037 'Do something' and 2037 'Do something cumulative' scenarios indicate that these scenarios would improve road network performance across the entire Balgowlah and surrounds study area, noting reductions to average trip time through the network by approximately 1.5 minutes and increases to average trip speeds of approximately 10 kilometres per hour, or approximately 50 per cent.

The additional analysis for the 2037 'Do something' and 2037 'Do something cumulative' evening peak scenarios further emphasises the environmental impact statement outcomes that the project would not have an adverse impact on the local road network in focus – ie Sydney Road between Frenchs Forest Road and Wanganella Street – as well as the broader network considered in the Balgowlah and surrounds study area.

Table 6-4 presents the intersection performance results for the 2037 'Do minimum', 2037 'Do something' and 2037 'Do something cumulative' evening peak scenarios. Additional modelling has not been carried out for this study area, and as such these results are unchanged from the environmental impact statement. However, the uncapped intersection average delay values have been presented to demonstrate the relative benefit/impact of the project.

Table 6-4: Modelled evening peak hour (5pm to 6pm) intersection performance – Balgowlah and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Sydney Road / Manly Road / Burnt Bridge Creek Deviation	104	F	93	F	73	F
Frenchs Forest Road / Sydney Road [1]	151	F	163	F	172	F
Sydney Road / Wanganella Street	14	B	15	B	15	B
Sydney Road / Condamine Street	40	C	48	D	45	D
Condamine Street / Burnt Bridge Creek Deviation	16	B	38	C	41	C
Access Road / Sydney Road / Maretimo Street	30	C	27	B	31	C
Access Road / Bridge Creek Deviation [2]	-	-	12	A	11	A

[1] Frenchs Forest Road/Sydney Road is an unsignalised intersection (roundabout) and as such intersection performance is reported for the worst performing approach.

[2] The 'Do minimum' scenario does not include the Access Road approach and is an unsignalised intersection. As such intersection performance is reported for the worst performing approach.

For the 2037 'Do something' scenario in the evening peak, general road network performance can be expected to significantly improve compared to the 2037 'Do minimum' scenario. For the area of focus of this assessment, the operational traffic model findings indicate that intersection performance along the Sydney Road corridor is expected to be consistent with the 2037 'Do minimum' scenario noting the following:

- The Sydney Road/Access Road/Maretimo Street intersection has been modified from an unsignalised intersection in the 2037 'Do minimum' scenario to a signalised intersection in the 2037 'Do something' scenario to accommodate the new Access Road (north approach) proposed by the project. Intersection performance is expected to improve marginally in the 2037 'Do something' scenario (from LoS C to LoS B)
- Intersection performance at the Sydney Road/Wanganella Street intersection would be maintained at LoS B in the 2037 'Do something' scenario when compared to the 2037 'Do minimum scenario
- The Sydney Road/Manly Road/Burnt Bridge Creek Deviation intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something' scenarios. However, average intersection delay is expected to improve marginally in the 2037 'Do something' scenario compared to the 2037 'Do minimum' scenario (approximately 10 second improvement)
- The Sydney Road/Frenchs Forest Road intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something' scenarios. However, average intersection delay is expected to increase marginally by approximately 10 seconds in the 2037 'Do something' scenario.

The road network performance impacts in the 2037 'Do something cumulative' scenario demonstrates similar outcomes to the 2037 'Do something' scenario. Net overall benefits can be

expected along the Sydney Road corridor when compared to the 2037 'Do minimum' scenario, noting the following:

- The Sydney Road/Access Road/Maretimo Street intersection performance is expected to be very similar to the 2037 'Do minimum' despite the modified configuration (ie LoS C)
- The Sydney Road/Wanganella Street intersection is expected to operate at a comparable level to the 2037 'Do minimum' and 2037 'Do something' scenarios (ie LoS B)
- The Sydney Road/Manly Road/Burnt Bridge Creek Deviation intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something cumulative' scenarios. However, a notable improvement to average intersection delay is expected in the 2037 'Do something cumulative' scenario compared to the 2037 'Do minimum' scenario (approximately 30 second improvement)
- The Sydney Road/Frenchs Forest Road intersection is expected to operate at LoS F in the 2037 'Do minimum' and 2037 'Do something' scenarios. However, average intersection delay is expected to increase by approximately 20 seconds in the 2037 'Do something cumulative' scenario.

When considering the above it is important to understand that there are limitations in the reporting of isolated intersection performance metrics particularly for complex networks that have a number of closely spaced intersections, and queues that have the potential to extend beyond two or more of these intersections – eg the intersections of Sydney Road/Manly Road/Burnt Bridge Creek Deviation and Sydney Road/Frenchs Forest Road. For these reasons, intersection performance metrics should not be solely relied on to demonstrate the performance benefits of the intersections and/or network, and in this context are considered secondary metrics. This places further emphasis on the need to concurrently review network performance and corridor travel time metrics to demonstrate the impact of the project in the Balgowlah and surround study area. In this regard, additional metrics and outputs from the environmental impact statement operational traffic models for the 2037 'Do something' and 2037 'Do something cumulative' scenarios indicate the following:

- Travel times recorded on key road corridors along Frenchs Forest Road, Sydney Road, Manly Road and Burnt Bridge Creek Deviation generally indicate an expected improvement to local travel times compared to the 2037 'Do minimum'
- While congestion is observed on the Sydney Road west approach to the Sydney Road/Manly Road/Burnt Bridge Creek Deviation intersection with queues that extend beyond the Frenchs Forest Road/Sydney Road roundabout, the extent of queues and congestion in the 2037 'Do something' and 2037 'Do something cumulative' scenarios are less than that observed in the 2037 'Do minimum' scenario. This is indicated by an overall reduction to travel times for the Spit Bridge to Wakehurst Parkway/Judith Street route which includes travel on Sydney Road through the intersections with Frenchs Forest Road and Burnt Bridge Creek Deviation (ie the western section of the corridor in focus).

The above is supported by the additional analysis of the environmental impact statement operational traffic models (average speed plots) presented in Section 3 and Section 4 of Appendix B of this preferred infrastructure report which indicate the following:

- Notable improvements to average speed are expected on Manly Road and Burnt Bridge Creek Deviation (northbound and southbound) in both the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to the 2037 'Do minimum' scenario
- Slightly higher average speeds are expected on Sydney Road between Frenchs Forest Road and Burnt Bridge Creek Deviation in the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to the 2037 'Do minimum' scenario. In particular, the expected improvements on the Sydney Road west approach to the Sydney Road/Manly Road/Burnt Bridge Creek Deviation intersection also results in an improvement to Frenchs

Forest Road performance in the southbound direction travelling towards Sydney Road (ie higher average speeds and a reduction in the extent of queues in the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to the 2037 'Do minimum' scenario)

- On Sydney Road between Burnt Bridge Creek Deviation and Wanganella Street, the average speeds along the corridor are generally comparable between the 2037 'Do something' and 2037 'Do minimum' scenarios, including the effects of the new traffic signals in the 2037 'Do something' scenario at Sydney Road/Maretimo Street/Access Road. The 2037 'Do something cumulative' scenario is expected to have a slight reduction to average speed along this section of the corridor compared to the 2037 'Do something' and 2037 'Do minimum' scenarios. However, average speed plots illustrate that congestion (or queues) are localised and would not impact broader network performance.

Overall, the additional information provided confirms the operational traffic modelling outcomes for the Balgowlah and surrounds study area as presented in the environmental impact statement. Specifically, that the project (and broader Western Harbour Tunnel and Beaches Link program of works) would not adversely impact the performance of the local road network, in particular Sydney Road.

It is acknowledged that the intersection (roundabout) of Sydney Road/Frenchs Forest Road is an existing network pinch point which creates congestion and queuing, and consequently has a material influence on broader network performance; although the project is expected to relieve some demand at this intersection, existing congestion issues would not be fully mitigated by the project. Sensitivity testing indicates that if the capacity of this intersection was improved, the benefits of the project in the area would be further amplified. Transport for NSW will continue to work with Northern Beaches Council through relevant forums and processes in developing solutions for local area traffic issues such as this, which are beyond the scope of the project.

6.3.4 Frenchs Forest and surrounds

The refined operational traffic modelling assessment completed for the 2037 'Do something' and 2037 'Do something cumulative' scenarios (morning and evening peaks) in the Frenchs Forest and surrounds study area has been based on the assumption that total future traffic demand in the 2037 'Do something' and 2037 'Do something cumulative' scenarios would be consistent with the 2037 'Do minimum' scenario. This assumption is subject to the implementation of future bus service upgrades and other travel demand management strategies within the Frenchs Forest and surrounds study area (and beyond) which would increase public transport demand and consequently reduce private vehicle demand.

The full suite of model results for the refined operational traffic models are provided in Section 3 and Section 4 of Appendix B of this preferred infrastructure report. Table 6-5 and Table 6-6 presents the intersection performance results of the refined 2037 'Do something' and 2037 'Do something cumulative' scenarios and compared to the 2037 'Do minimum' scenario in order to demonstrate the localised intersection performance benefits/impacts in the morning and evening peaks, respectively, with a focus on the Frenchs Forest Road and Warringah Road corridors.

It is noted that these model performance metrics represent the refined 2037 'Do something' and 2037 'Do something cumulative' scenarios, compared against the benchmark 2037 'Do minimum' scenario which is unchanged from the environmental impact statement (noting the following differences in the way the model outcomes are presented).

There are some minor inconsistencies between the model outputs and results presented in section 7.7 and 8.7 of Appendix F (Technical working paper: Traffic and transport) of the environmental impact statement due to the way model outcomes are presented. The environmental impact

statement network performance results included inconsistent calculations for specific metrics which have been corrected in the preferred infrastructure report. The environmental impact statement intersection level of service was calculated inclusive of traffic travelling through the grade separated section of Warringah Road, to demonstrate the benefit of the Northern Beaches Hospital Road Upgrade compared to pre-upgrade network conditions. However, for the preferred infrastructure report, intersection level of service has been presented excluding traffic travelling through the grade separated section, to provide a better understanding of the impacts of the project on network performance; potential project impacts are limited to the non-grade separated areas of the network. The updated results are not materially different to the environmental impact statement and do not change the overall outcomes of the environmental impact statement assessment.

Table 6-5: Modelled morning peak hour (8am to 9am) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	66	E	42	C	40	C
Warringah Road / Allambie Road	45	D	51	D	40	C
Wakehurst Parkway / Warringah Road	116	F	95	F	99	F
Warringah Road / Hilmer Street	87	F	32	C	67	E
Warringah Road / Forest Way	34	C	26	B	37	C
Forest Way / Naree Road	27	B	36	C	52	D
Warringah Road / Brown Street / Currie Road	23	B	17	B	14	A
Warringah Road / Starkey Street	26	B	19	B	18	B
Warringah Road / Darley Street	30	C	25	B	25	B
Warringah Road / Forestville Avenue	13	A	14	A	14	A

Table 6-6: Modelled evening peak hour (5pm to 6pm) intersection performance – Frenchs Forest and surrounds study area

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Wakehurst Parkway / Frenchs Forest Road East	46	D	37	C	40	C
Warringah Road / Allambie Road	49	D	46	D	44	D
Wakehurst Parkway / Warringah Road	65	E	55	D	50	C
Warringah Road / Hilmer Street	19	B	18	B	17	B

Intersection	2037 'Do minimum'		2037 'Do something'		2037 'Do something cumulative'	
	Average delay (sec)	LoS	Average delay (sec)	LoS	Average delay (sec)	LoS
Warringah Road / Forest Way	42	C	31	C	33	C
Forest Way / Naree Road	27	B	25	B	28	B
Warringah Road / Brown Street / Currie Road	11	A	9	A	8	A
Warringah Road / Starkey Street	19	B	20	B	19	B
Warringah Road / Darley Street	19	B	16	B	15	B
Warringah Road / Forestville Avenue	46	D	26	B	28	B

Based on the refined operational traffic modelling assumptions, the updated operational traffic modelling results indicate that all performance metrics (ie network performance, general traffic travel times, intersection performance and bus travel times) would result in comparable or improved performance in the 2037 'Do something' and 2037 'Do something cumulative' scenarios when compared to the 2037 'Do minimum' scenario in both the morning and evening peaks. This includes performance along the key road corridors in question – ie Frenchs Forest Road and Warringah Road – whereby average intersection delay and level of service are generally comparable or improved in all instances when compared to the 2037 'Do minimum' scenario, and/or intersection LoS D or better is expected.

As noted in the environmental impact statement, Transport for NSW is continuing to investigate options to mitigate potential localised network performance issues in the area, and further leverage the overall benefits and opportunities of the project. This work is consistent with and reliant on the *Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017b), which highlights that future precinct development is dependent on further delivery of improved transport infrastructure and a continued modal shift from private to public transport. It defines the desired future land uses and consequent multi-modal transport operation and infrastructure requirements to, from, and through the area. It also acknowledges that a suite of regional transport network upgrades including both public transport and road upgrades would be required to maintain effective transport connections to, from, and through the area in the medium to long-term.

As such, the road infrastructure and operational enhancements proposed by the project are considered appropriate to manage the expected level of future traffic demand growth in the area as part of an integrated and multi-modal transport strategy. In particular, the network improvements on the northbound approach to the Wakehurst Parkway/Warringah Road intersection and access to the Warringah Road underpass offers a suitable package of mitigation works to accommodate the likely change in traffic volumes and distribution expected in the 2037 'Do something' and 2037 'Do something cumulative' scenarios as a result of the project's connection to Wakehurst Parkway.

The introduction of Beaches Link express bus services and other public transport network enhancements and demand management initiatives would increase public transport demand and reduce private vehicle demand. Noting this, and given the context of this complex, constrained, urban area, additional mitigations would focus on multi-modal strategies to reduce private vehicle demand rather than seek to deliver further road capacity upgrades, consistent with ongoing strategic planning for the *Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017b).

6.4 Additional environmental management measures

The additional traffic modelling and analysis carried out for this preferred infrastructure report demonstrates that the project is not expected to create significant residual adverse impacts on local roads within the study area. This is consistent with the findings presented in the environmental impact statement.

In the two areas where there is the potential for relatively minor adverse impacts – Warringah Freeway and surrounds, and Frenchs Forest and surrounds – any potential residual impacts should be mitigated by complementary public transport and demand management initiatives. This is consistent with the approach currently proposed by relevant, separate projects and processes in these areas. It is also cognisant of the need to balance movement and place outcomes in constrained urban areas, especially the North Sydney and Cammeray areas.

Transport for NSW would continue to collaborate with relevant stakeholders through existing processes and forums (such as the North Sydney Integrated Transport Program and *Northern Beaches Hospital Precinct Structure Plan* (Northern Beaches Council, 2017b) forums) to implement public transport and demand management initiatives to mitigate any residual impacts and pinch points and improve movement and place outcomes.

In addition to continued collaboration in these integrated and multi-modal plans and processes, it is noted that the project proposes operational traffic environmental management measures to address any unexpected project-specific issues on the road network, should they occur.

In summary it is considered that the current suite of project-specific environmental management measures in addition to separate existing projects and processes provide substantial mitigation against any potential or unforeseen residual impacts. As such, no additional environmental management measures beyond those described in Appendix C of this preferred infrastructure report are considered to be required.