Transport for NSW

M1 Pacific Motorway extension to Raymond Terrace

Submissions Report - Appendix C

June 2022

Australian Government

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M1 Pacific Motorway extension to Raymond Terrace

Appendix C

Supplementary report - traffic and transport

June 2022

Executive summary

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). Approval is sought under Part 5, Division 5.2 of the *Environmental Planning and Assessment Act 1979* and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 19*99.

In accordance with the Secretary's Environmental Assessment Requirements (SEARs), an environmental impact statement (EIS) was prepared by Transport in July 2021 (*M1 Pacific Motorway extension to Raymond Terrace Environmental Impact Statement* (Transport for NSW 2021)) to assess the potential impacts of the project. The EIS was exhibited by the Department of Planning, Industry and Environment (DPIE) for 28 days from 28 July 2021 to 24 August 2021.

The *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs 2021) was prepared in support of the EIS for the project. The purpose of the assessment was to assess potential traffic and transport impacts from the project operation and construction, and where required, identify mitigation measures. The assessment was prepared to address the SEARs issued by DPIE for the project.

Following exhibition of the EIS, receipt of submissions and further consultation with stakeholders a number of refinements have been made to the project. The main refinements that potentially influence traffic and transport impacts include:

- Extension of ancillary facilities AS3 and AS13
- Removal of ancillary facility AS16
- Adjusted construction access movements for ancillary facilities AS3b, AS10, AS11, AS14, AS15, AS17, AS18 and AS19
- A two-staged opening for the project, whereby the northern section of the new M1 Pacific Motorway (Heatherbrae bypass) is opened to traffic first, followed by the southern section between Black Hill and Tomago
- Inclusion of temporary signalisation of Anderson Drive at the Tarro interchange to mitigate impacts on traffic from construction movements
- Refined cycleway strategy to improve safety and connectivity for cyclists.

This supplementary traffic and transport report has been prepared to respond to the submissions received and to assess the potential impacts of the refinements made to the project following public exhibition of the EIS. The following points summarise the outcomes of this supplementary report:

- The refinements to the ancillary facilities, construction access and the signalisation at the Tarro interchange are expected to have minimal impacts on traffic performance
- Two options have been assessed for a staged opening that achieves outcomes consistent with the EIS
- The refined cycleway strategy would generally achieve better safety and connectivity through minor changes to the alignment and cycle routes.

The refinements assessed in this supplementary traffic and transport report would have impacts that are consistent with those identified in the EIS for the project. The construction and operation impacts of the refinements have been assessed, and no additional environmental management measures have been identified as a result of these refinements.

Clarifications and additional information are also presented in response to EIS submissions and agency consultation, which has resulted in additional detail regarding heavy vehicle proportions and the Northbound Diverge at Black Hill interchange. No additional environmental management measures have been identified as a result of these clarifications.

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Glossary of terms and abbreviations

Term/ Acronym	Description
AADT	Average Annual Daily Traffic
ARTC	Australian Rail Track Corporation
DPIE	The NSW Department of Planning, Industry and Environment
EIS	Environmental Impact Statement
HCM	Highway Capacity Manual
LGA	Local Government Area
LoS	Level of Service
NEH	New England Highway
NLTN	National Land Transport Network
NSW	New South Wales
ONS	Outer Newcastle Study
OSOM	Oversize overmass
PCU	Passenger Car Units
STFM	Sydney Traffic Forecasting Model
TMP	Traffic Management Plan
Transport	Transport for NSW
VKT	Vehicle Kilometres Travelled

1 Introduction and background

1.1 The project

Transport for New South Wales (Transport) proposes to construct the M1 Pacific Motorway extension to Raymond Terrace (the project). The project would connect the existing M1 Pacific Motorway at Black Hill and the Pacific Highway at Raymond Terrace within the City of Newcastle and Port Stephens Council local government areas (LGAs). The project location is shown in **Figure 1-1**.

The project would include the following key features (see **Figure 1-2**):

- A 15 kilometre motorway comprised of a four lane divided road (two lanes in each direction)
- Motorway access from the existing road network via four new interchanges at:
  - Black Hill: connection to the M1 Pacific Motorway
  - Tarro: connection and upgrade (six lanes) to the New England Highway between John Renshaw Drive and the existing Tarro interchange at Anderson Drive
  - Tomago: connection to the Pacific Highway and Old Punt Road
  - Raymond Terrace: connection to the Pacific Highway.
- A 2.6 kilometre viaduct over the Hunter River flood plain including new bridge crossings over the Hunter River, the Main North Rail Line, and the New England Highway
- Bridge structures over local waterways at Tarro and Raymond Terrace, and an overpass for Masonite Road in Heatherbrae
- Connections and modifications to the adjoining local road network
- Traffic management facilities and features
- Roadside furniture including safety barriers, signage, fauna fencing and crossings and street lighting
- Adjustment of waterways, including Purgatory Creek at Tarro and a tributary of Viney Creek
- Environmental management measures including surface water quality control measures
- Adjustment, protection and/or relocation of existing utilities
- Walking and cycling considerations, allowing for existing and proposed cycleway route access
- Permanent and temporary property adjustments and property access refinements
- Construction activities, including the establishment and use of temporary ancillary facilities, temporary access tracks, haul roads, batching plants, temporary wharves, soil treatment and environmental controls.

A more detailed description of the project incorporating the refinements identified in **Section 1.2** is presented in Appendix A of the *M1 Pacific Motorway extension to Raymond Terrace Submissions Report* (Transport for NSW, 2022).

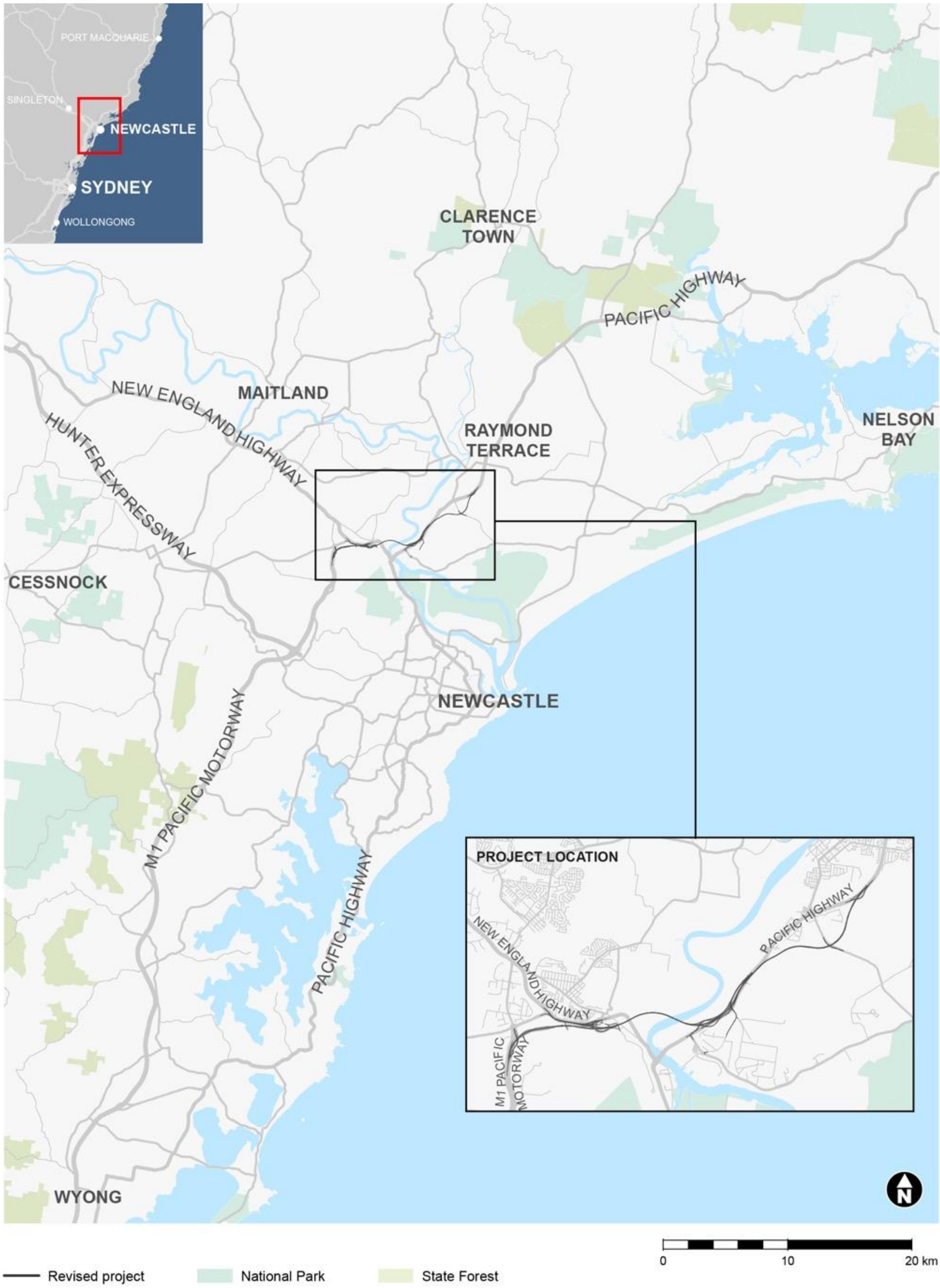

Figure 1-1 Regional context of the project

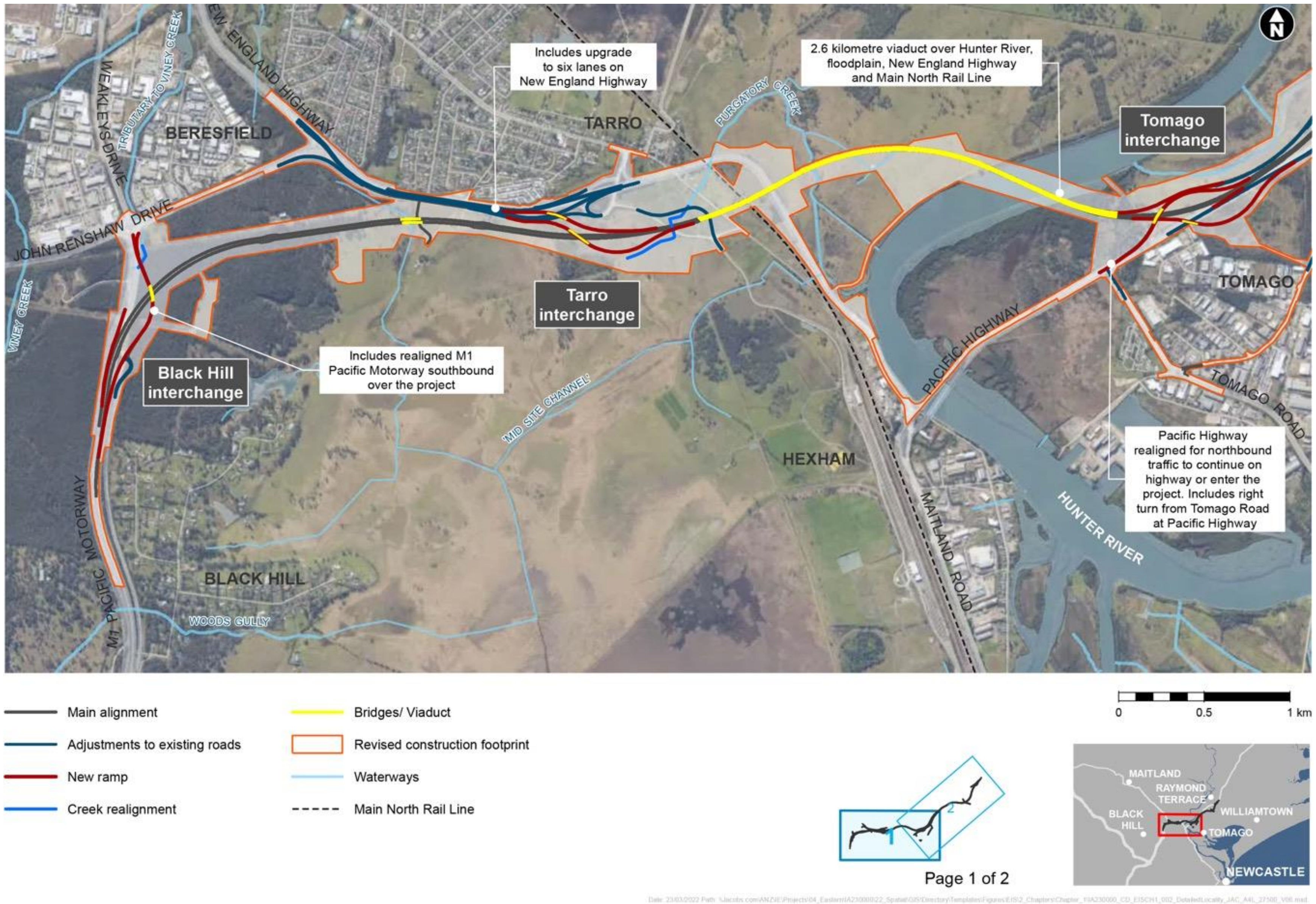

Figure 1-2 Project key features (map 1 of 2)

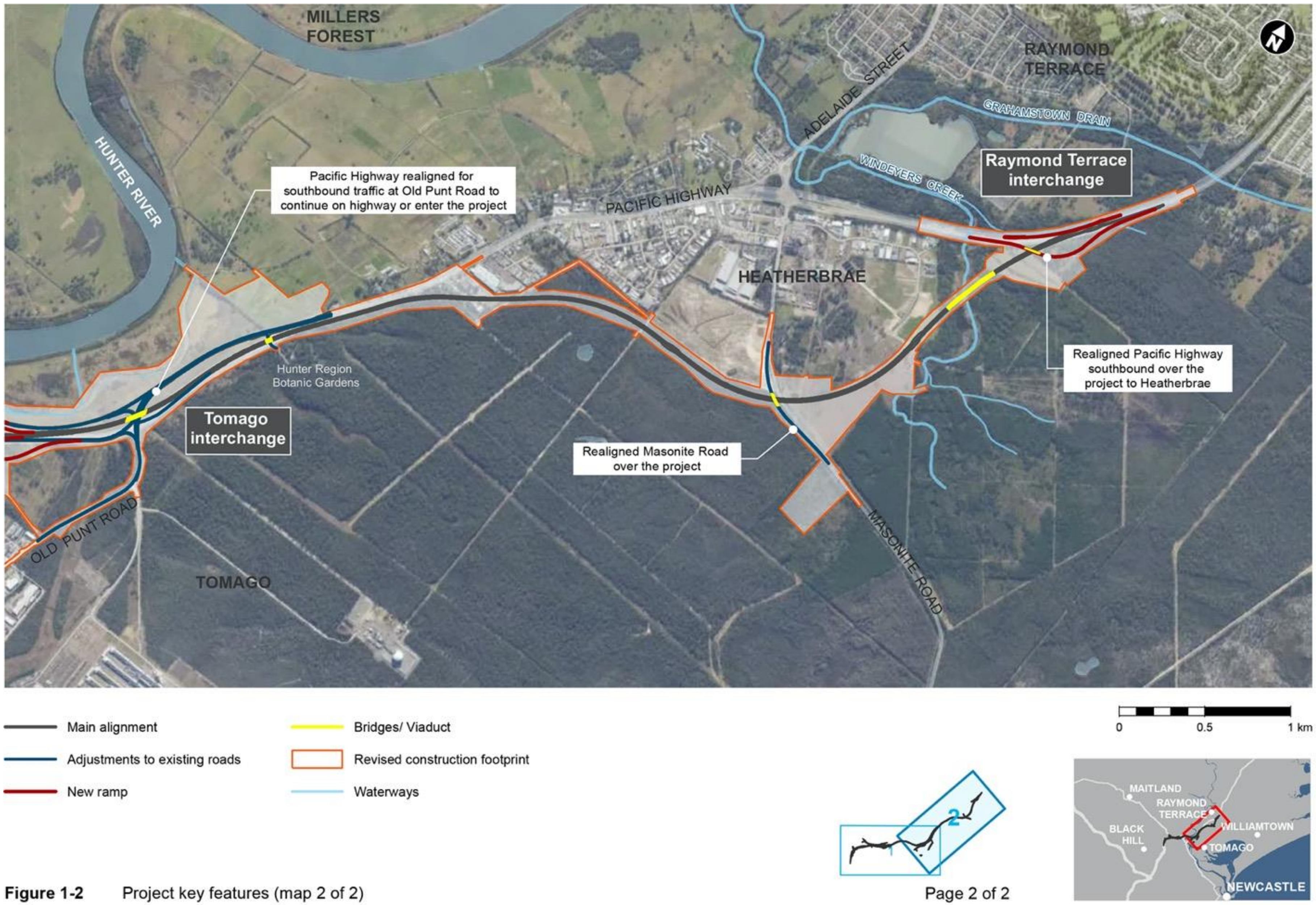

Figure 1-2 Project key features (map 2 of 2)

1.2 Project refinements

Transport has refined a number of aspects of the project as exhibited in the environmental impact statement (EIS). These refinements have arisen through the ongoing review of the concept design and construction methodology, identification of opportunities to reduce environmental impact, consultation with landowners and government agencies, and in response to issues raised during the EIS exhibition period. The project refinements are described below.

1.2.1 Design refinements

- Southbound M1 Pacific Motorway merge – a 200 metre extension of the merge lane for southbound traffic from the John Renshaw Drive/Weakleys Drive intersection to allow for improved capacity and safety
- Utilities strategy – key changes include grouping of utilities at Tarro and Tomago into utility corridors and extension of the construction footprint at Beresfield and Hexham to accommodate utility relocations
- Cycleway strategy – improvements to facilitate incorporation with the Richmond Vale Rail Trail and removal of the shared user path on the new Masonite Road bridge (bridge at Heatherbrae
- Drainage design at Heatherbrae – minor changes to basin locations and extension of drainage lines to minimise property and drainage impacts on adjacent properties
- Water quality basins – lining of temporary and permanent water quality basins which interface with ground water.

1.2.2 Construction refinements

- Ancillary facilities and site access – minor changes to the size, location and access arrangements of some ancillary facilities
- Earthworks management – identification of a borrow pit and sites for beneficial reuse of materials within the construction footprint.

1.2.3 Construction staging

- Staged project opening - the project would be delivered via two packages of work, the Southern (Black Hill to Tomago) and Northern (Heatherbrae bypass) works. The Northern section would likely have a shorter construction duration and could potentially be opened to traffic before the Southern section.

1.2.4 Project footprint refinements

- Consultation with landowners and the design and construction refinements to reduce property and biodiversity impacts have resulted in minor changes to the construction and operational project footprint.

1.3 Purpose of the document

The *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) was prepared in support of the EIS for the project. The purpose of the working paper was to provide an assessment of the traffic and transport related impacts and benefits that may result from the construction and operation of the project.

The assessment was prepared to address the Secretary's Environmental Assessment Requirements (SEARs) as described in Section 1.4 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021).

During the exhibition of the EIS, several submissions were made in relation to traffic and transport matters. These submissions have been addressed in the *M1 Pacific Motorway extension to Raymond Terrace Submissions Report* (Transport for NSW, 2022),

This supplementary traffic and transport report has been prepared to assess the potential impacts of the project refinements identified in **Section 1.2**. The project refinements affecting traffic and transport are presented in **Chapter 4** (assessment of construction impacts) and **Chapter 5** (assessment of operational impacts).

This supplementary report only includes information that has changed since the EIS and should be read in conjunction with the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) included in the EIS.

2 Existing environment

2.1 Overview

Information presented regarding the existing environment in Chapter 4 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) for the EIS included:

- The existing road network surrounding the project area
- Heavy vehicle and freight routes
- Existing land use in the project area
- Current road performance including traffic volumes, travel time, intersection performance and other key metrics
- Road safety and the crash history within the project area
- Public transport routes operating in the project area
- Active transport infrastructure in the project area
- Maritime traffic on the Hunter River and the impacts on the project area
- Future land use and traffic growth related to the project.

No submissions in response to the EIS were identified relating to the existing environment presented in Chapter 4 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021).

3 Clarifications and additional information

3.1 Clarifications

This section identifies minor errors, discrepancies and general clarifications identified either through further review by Transport or agency sought clarification prior to the receipt of formal submissions.

3.1.1 Heavy Vehicle Proportions

Section 4.2 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) provided details on heavy vehicle movements. The EIS included a general indication of heavy vehicle proportions. A more detailed breakdown of heavy vehicle volumes and proportions has been provided in this section. The summarised results present the total two-way traffic volumes and the proportion of heavy vehicles across five time periods:

- Daily
- Morning Peak (7-9am)
- Evening Peak (4-6pm)
- Day (7am-10pm)
- Night (10pm-7am).

For clarity, **Table** 3-1 and **Table** 3-2 summarise the 2028 and 2038 traffic volumes and heavy vehicle proportions across these time periods for the local road network.

Table 3-1 Traffic volumes and heavy vehicle proportions in 2028

Road	Daily (24 hour)		Morning peak (7-9am)		Evening peak (4-6pm)		Day (7am-10pm)		Night (10pm-7am)	
	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %
M1 Pacific Motorway, south of John Renshaw Drive	58,850	14.3%	5,440	13.9%	6,210	11.7%	34,320	13.4%	6,480	18.1%
John Renshaw Drive, west of Weakleys Drive	36,240	15.1%	3,350	15.3%	3,970	11.9%	20,490	15.0%	4,280	16.2%
Weakleys Drive, north of John Renshaw Drive	41,330	13.6%	4,170	12.3%	4,150	12.8%	25,260	12.4%	4,840	13.8%
New England Highway, west of Thornton Road	86,540	6.0%	8,820	5.8%	8,600	5.2%	52,020	6.1%	5,870	7.5%
John Renshaw Drive, west of New England Highway	55,300	15.9%	4,920	14.4%	5,910	11.1%	33,540	14.3%	6,320	21.6%
New England Highway, north of Pacific Highway	92,590	9.4%	10,240	7.7%	8,020	6.9%	59,280	8.6%	10,040	13.2%
Pacific Highway, 1km north of Hunter River Bridge	50,110	11.4%	4,790	10.1%	5,050	8.4%	30,870	9.6%	5,920	14.0%
Tomago Road, east of Pacific Highway	17,570	15.7%	1,870	19.8%	1,640	11.4%	9,600	13.9%	2,740	9.9%
Pacific Highway, south of Hank St	30,190	7.7%	2,770	6.4%	3,180	5.0%	18,960	6.8%	2,930	12.6%
Pacific Highway, north of Masonite Road	11,660	16.3%	1,050	14.7%	1,220	10.1%	7,500	16.4%	1,150	24.1%
Maitland Road, south of Old Maitland Road	119,620	8.1%	11,940	7.6%	12,260	6.7%	69,330	8.0%	12,020	9.8%

Table 3-2 Traffic volumes and heavy vehicle proportions in 2038

Road	Daily (24 hour)		Morning peak (7-9am)		Evening peak (4-6pm)		Day (7am-10pm)		Night (10pm-7am)	
	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %	Volume (veh)	Heavy vehicle %
M1 Pacific Motorway, south of John Renshaw Drive	68,060	14.9%	6,480	14.1%	7,130	11.9%	40,110	13.4%	7,470	16.7%
John Renshaw Drive, west of Weakleys Drive	55,490	16.5%	5,340	16.0%	5,780	13.5%	31,800	16.3%	6,730	18.0%
Weakleys Drive, north of John Renshaw Drive	48,960	14.1%	5,140	12.8%	4,630	13.0%	28,950	12.8%	5,560	14.3%
New England Highway, west of Thornton Road	101,520	6.8%	10,320	6.4%	10,090	6.1%	61,080	6.4%	9,000	7.8%
John Renshaw Drive, west of New England Highway	66,380	16.3%	5,940	14.3%	7,120	11.7%	40,800	14.6%	7,670	22.2%
New England Highway, north of Pacific Highway	117,310	9.6%	11,790	7.5%	11,670	7.3%	70,410	8.8%	11,790	13.8%
Pacific Highway, 1km north of Hunter River Bridge	60,050	11.0%	5,410	9.5%	6,350	8.3%	37,320	9.0%	6,910	13.3%
Tomago Road, east of Pacific Highway	24,140	14.2%	2,050	18.0%	2,770	11.3%	13,620	12.0%	3,400	8.7%
Pacific Highway, south of Hank St	33,260	6.6%	3,100	5.5%	3,430	4.7%	21,060	5.9%	3,290	10.7%
Pacific Highway, north of Masonite Road	13,010	15.6%	1,210	14.5%	1,330	9.5%	8,400	15.4%	1,300	29.3%
Maitland Road, south of Old Maitland Road	136,990	8.7%	13,940	7.6%	13,760	7.2%	75,690	8.5%	17,500	10.6%

3.1.2 Northbound Weakleys Drive diverge

A merge and diverge analysis was completed for the EIS, refer to Section 5.2.1 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021). The *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) reported on the Level of Service (LoS) and densities at all interchanges, however, it did not include information on the Northbound Diverge at Black Hill interchange due to a nearby downstream signalised intersection, as outlined in Table 5-14 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021).

To further assess the LoS of the Northbound Diverge at Black Hill interchange, analysis was carried out assuming the downstream signals do not exist. The results show that the northbound diverge is anticipated to perform at an LoS C or better when isolating the diverge from the downstream intersection in each modelled year (2028, 2038, 2048). The worst performing period for each scenario occurs during the evening peak between 5-6pm.

When tested in isolation the Weakleys Drive northbound diverge performs satisfactorily, although queueing at the southern approach to the Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection extends to the northbound Weakleys Drive diverge point, causing a negative impact on the operation of the junction. This is however consistent with the findings presented in the EIS.

4 Assessment of potential construction impacts

4.1 Ancillary facilities and site access

4.1.1 Description of refinements

Extension of ancillary facility AS3

The proposed design refinement includes an extension of the AS3 site, from 6.7 hectares to 10.7 hectares, with the new portion of the ancillary facility named AS3b (about four hectares) and located about 150 metres to the west of the AS3 site on the northern side of the main alignment (refer to **Figure 4-1**).

This extension is anticipated to support the delivery of materials and workers and would be utilised for laydown, stockpiling a small satellite office and parking.

Extension of ancillary facility AS13

The proposed design refinement includes an extension of the existing AS13 site from 1.3 hectares to 2.3 hectares, to occupy the entire area between the project and the Pacific Highway (refer to **Figure 4-1**). Access and utilisation of the site would remain unchanged.

Removal of ancillary facility AS16

The proposed design refinement includes the removal of AS16 located at Masonite Road Heatherbrae, reducing the project construction footprint by approximately 24.9 hectares (refer to **Figure 4-1**). The removal of AS16 would also avoid the requirement for an associated access point on Masonite Road.

Access refinements to ancillary facilities

To improve construction vehicle access some refinements are proposed to access arrangements of eight ancillary facilities. These are described below:

- AS3b – the construction access route off the westbound New England Highway would be extended for about 350 metres to the east to allow access to and from AS3b
- AS10/11 – additional access from Tomago Road via the Pacific Highway/Tomago Road intersection which would utilise the already proposed Pacific Highway access point as identified in the EIS (Transport for NSW, 2021)
- AS14/15 – addition of right in/right out turn movements to and from the Pacific Highway to the already identified left in/left turn movements at this access point
- AS17/18/19 - addition of right in/right out turn movements to and from Masonite Road to the already identified left in/left turn movements at these access points.

The revised access movements for the ancillary facilities are shown in **Figure 4-2**.

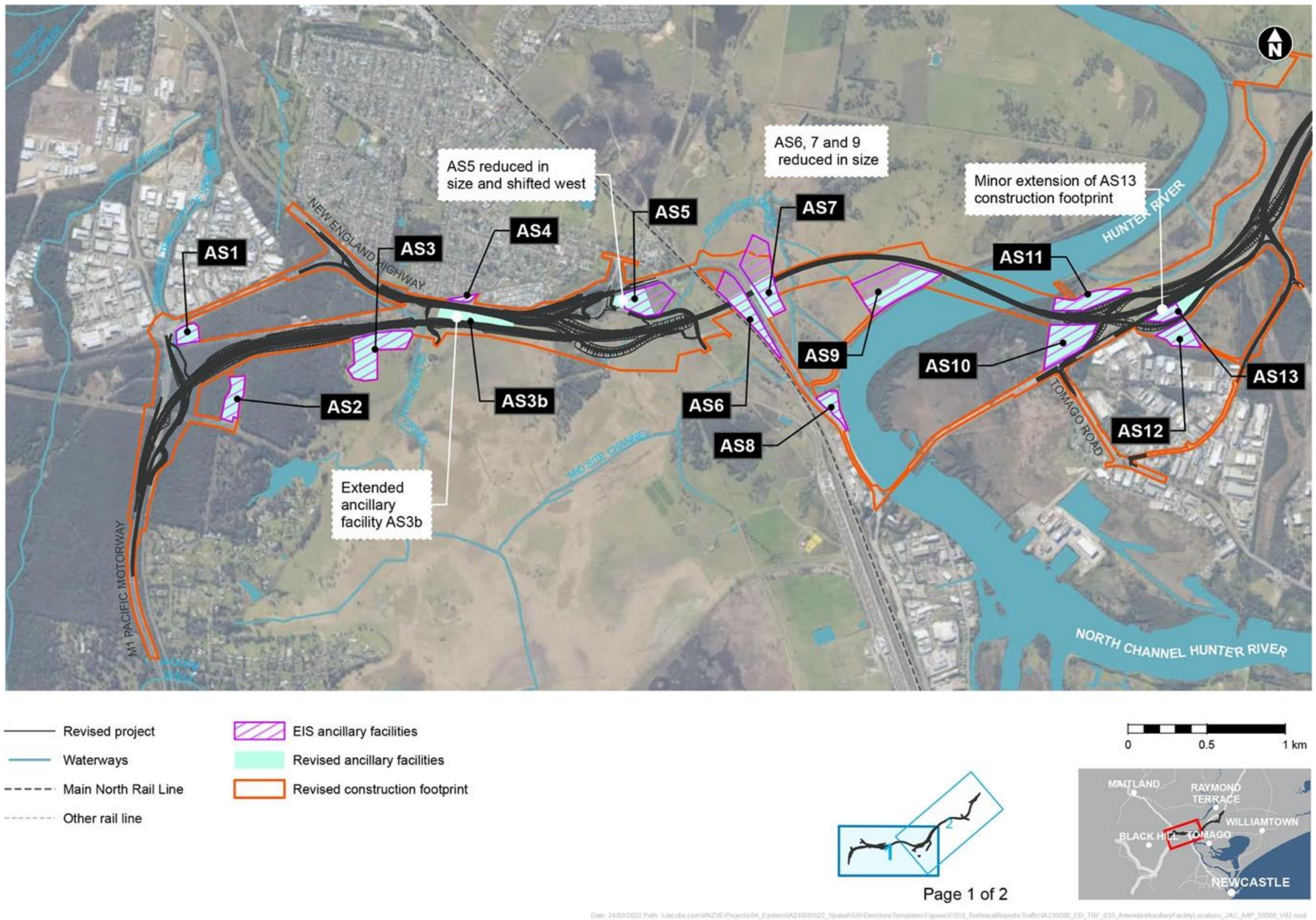

Figure 4-1 Amended ancillary facility locations (map 1 of 2)

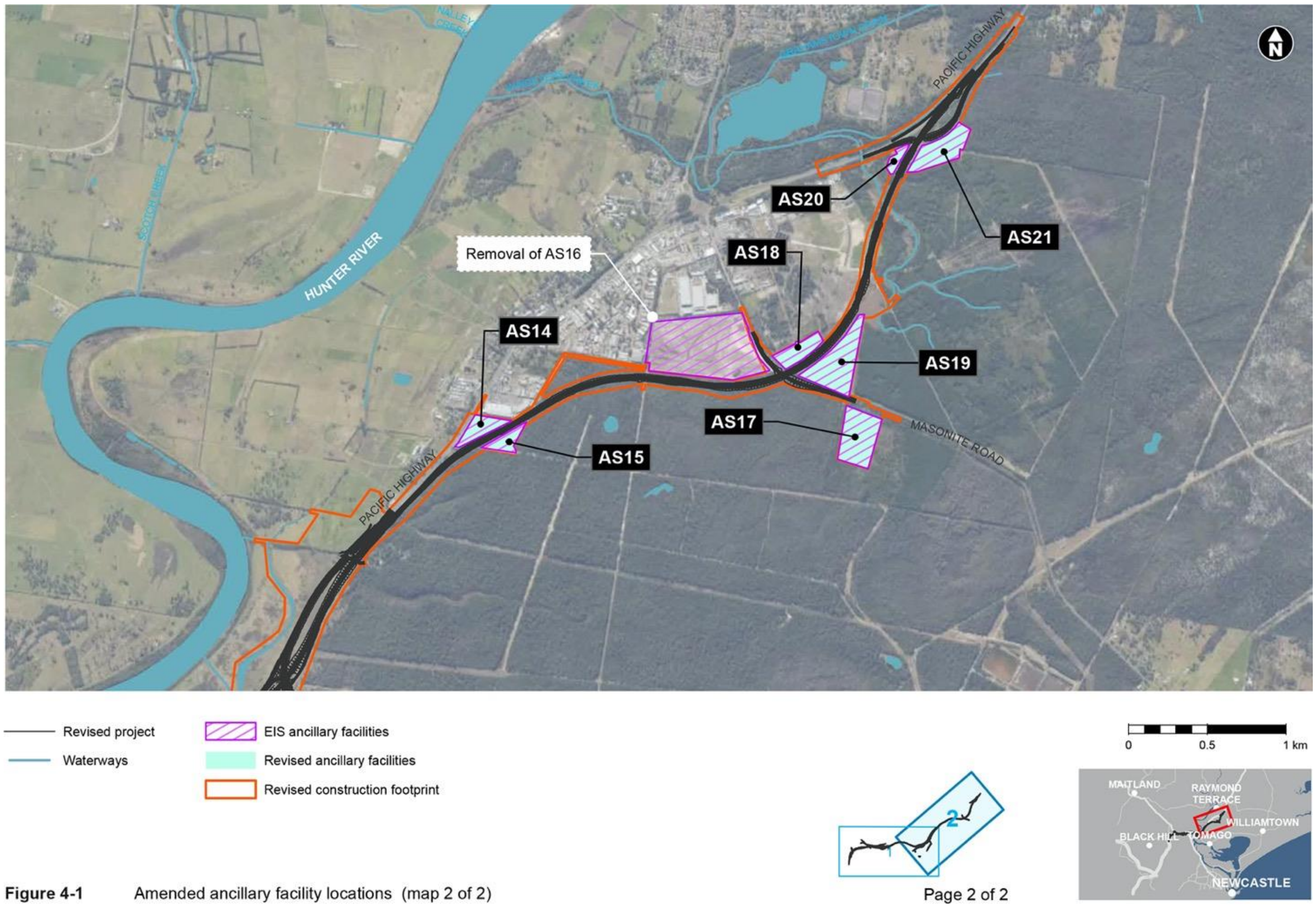

Figure 4-1 Amended ancillary facility locations (map 2 of 2)

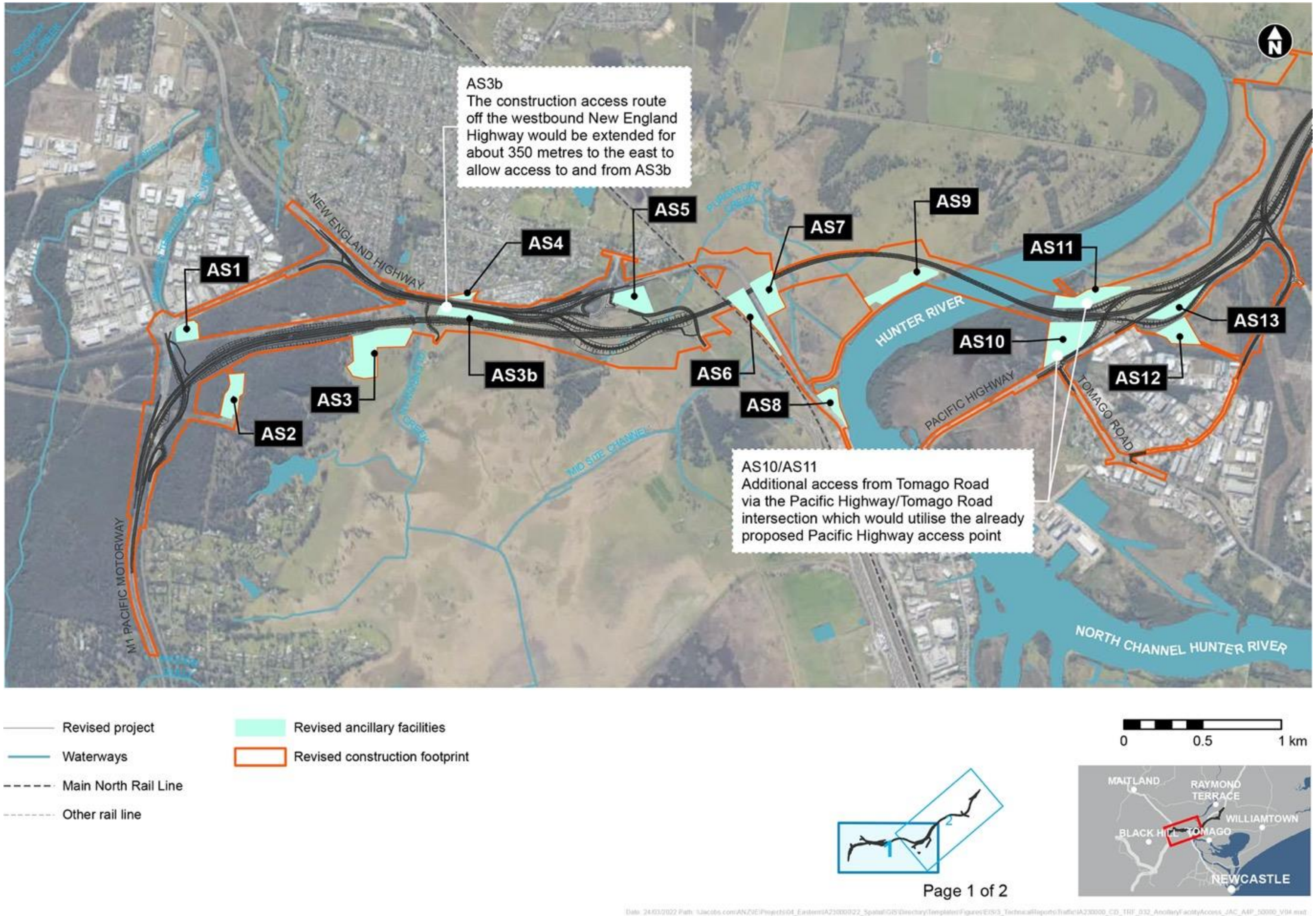

Figure 4-2 Access refinements for the ancillary facility locations (map 1 of 2)

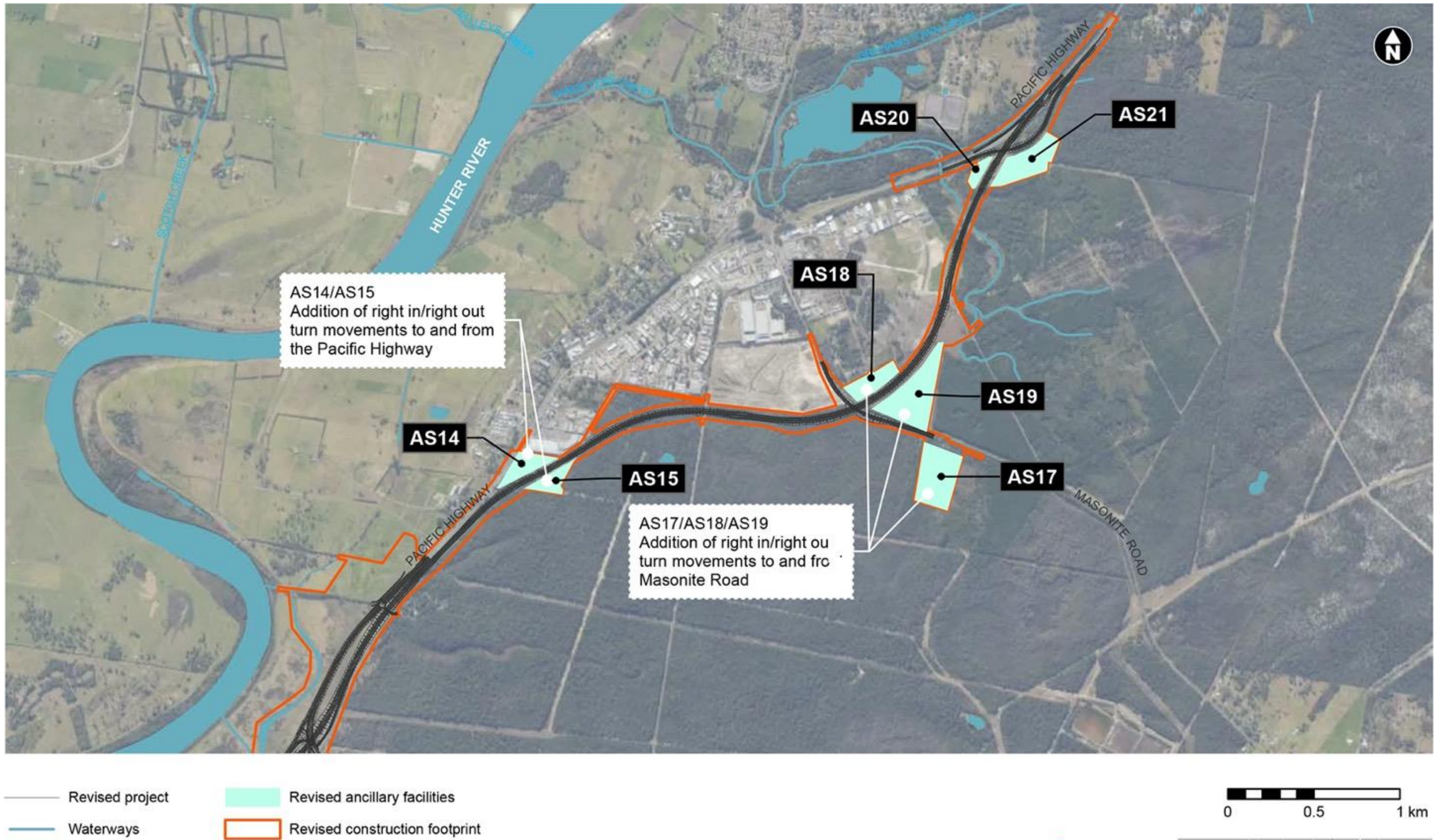

Figure 4-2 Access refinements for the ancillary facility locations (map 2 of 2)

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4.1.2 Assessment

Extension of ancillary facility AS3b

The extension of ancillary facility AS3 to include the AS3b site is not likely to result in an increase in the volume of construction traffic. The extension would instead more efficiently accommodate the delivery of materials and construction worker access that was already assessed for AS3 in the EIS. Additionally, no change to the mix of heavy/light vehicles accessing these sites is expected.

Construction access to AS3b is via New England Highway, with access to and from the site being extended about 350 metres. The EIS assessment addressing AS3 identified that less than 370 vehicles are associated with the site for construction work daily, which is approximately 40 vehicles during peak periods. This minimises the potential for delays to road users and therefore no change to the level of impact identified in the EIS is expected as a result of vehicles using these ancillary facilities.

Extension of ancillary facility AS13

The extension of ancillary facility AS13 is likely to result in no change/increase in the volume of construction traffic into and out of this site. The extension of this ancillary facility would provide additional space for storage which will be easier and safer to manage during construction. No significant refinements in the construction traffic or the mix of heavy/light vehicles accessing this site are anticipated as the purpose of the site has not changed, and the level of impact is therefore expected to remain as per the EIS.

Removal of ancillary facility AS16

The removal of AS16 would increase the volume of construction vehicles accessing the other nearby facilities AS17, AS18 and AS19. Construction vehicles and material storage required will still be needed even with the removal of AS16, thus, approximately 30 traffic movements during the peak periods will be redistributed across the three identified nearby facilities. Although AS16 and the associated access point will be removed, the traffic impacts are expected to remain relatively consistent with those identified in the EIS as a result of the redistribution of the AS16 construction traffic to the other nearby facilities.

Access refinements to ancillary facilities

Refinements to access arrangements were assessed either qualitatively or quantitatively based on the complexity of the change and the characteristics of the local traffic conditions. Qualitative assessments were carried out for the ancillary facilities that had simple access changes and typically low volume local traffic conditions. Whilst there have been modifications to some of the facilities relating to size and accessibility, the qualitative assessments have identified that the volumes of construction traffic and the mix of heavy/light vehicles are expected to remain consistent with the EIS. For more complex access arrangement changes and locations of high traffic volumes, a quantitative assessment involving SIDRA Intersection 9 modelling was completed. The assessment methodology carried out for each access refinement is identified in **Table** 4-1. A detailed breakdown of the modelling methodology and results are provided in Section A.1 and Section A.2 of **Appendix A**.

As per the EIS assessment, it is assumed that all ancillary facilities would be used during construction. This assessment is expected to be conservative as not all sites would necessarily be used during construction and not all sites would be functioning at the same time over the construction period.

Table 4-1 Summary of access refinements and assessment

Ancillary facility reference	Assessment methodology	Access identified in EIS	Refined access	Assessment
AS3b	Qualitative	N/A	• Left in from westbound New England Highway • Left out to westbound New England Highway • Construction access to and from westbound New England Highway extended for about 350m to the east	The extension of the construction access point on New England Highway for AS3b would not result in any changes to the impacts identified previously for AS3 in the EIS. AS3b is an extension of AS3, and therefore no additional construction traffic is anticipated for this site as it will be utilised primarily by vehicles already accounted for in the EIS.
AS10/11	Modelled	• Left in from northbound Pacific Highway • Left out to northbound Pacific Highway	• Left in from northbound Pacific Highway and through from northbound Tomago Road • Left out to northbound Pacific Highway and through to southbound Tomago Road	Intersection modelling was completed to assess the impacts of access into AS10/11, particularly for cross traffic (east-west) along the Pacific Highway. The refinement at this intersection would enable access for AS10/11 directly to/from Tomago Road during construction. The SIDRA modelling results with access at the Pacific Highway/Tomago Road/AS10/11 intersection show some impacts with the introduction of the AS10/11 movements. The overall impacts for each approach are minimal, with the most notable delay increase occurring for traffic turning right into Tomago Road from the Pacific Highway west of the intersection. During both the morning and evening peak periods, the intersection performance is relatively unchanged and achieves a LoS C or better, satisfying the minimum LoS C target set by Transport for NSW. LoS is linked to delay, and the intersection performance demonstrates that vehicles are expected to wait on average 4 to 6 seconds longer when compared to the existing conditions. All 95th percentile queue lengths are also satisfactory and do not exceed the available storage capacity of the roads. The worst outcomes are associated with traffic movements into and out of the AS10/11 construction access road, achieving as low as LoS E. This is expected due to the small volume of peak hour construction traffic utilising these movements, resulting in minimal

Ancillary facility reference	Assessment methodology	Access identified in EIS	Refined access	Assessment
				green time allocations at the signalised intersection. Whilst the LoS E would typically not be accepted, the phasing has prioritised traffic movements along the Pacific Highway to cater for the much higher volume of vehicles. It is recommended that the existing traffic along the Pacific Highway should be prioritised, although further refinements could be made to the phasing to achieve improved performance for the AS10/11 movements. Construction traffic from the Pacific Highway east of the intersection would be diverted down Old Punt Road for access to Tomago Road and into AS10/11. The Old Punt Road/Tomago Road roundabout would also enable construction vehicles to turn around to head in the opposite direction (as opposed to requiring U-turn bays on the higher speed dual carriageway roads). Whilst this would increase vehicles through this route, the Pacific Highway/Tomago Road/AS10/11 intersection is expected to perform with a LoS C or greater, with minimal impacts on delay and the existing performance.
AS14/15	Modelled	• Left in from southbound Pacific Highway • Left out to southbound Pacific Highway	• Left in from southbound Pacific Highway and right in from northbound Pacific Highway • Left out to southbound Pacific Highway and right out to northbound Pacific Highway	Intersection modelling was completed to determine if an intersection treatment is required to provide for right turn movements between the Pacific Highway and AS14/15. The modelling identified that signalisation at this intersection would be required. The outcomes for both the morning and evening peak periods are generally similar. Queues and delays are introduced along the Pacific Highway due to the conversion from free flow traffic movements to a signalised intersection. However, a LoS A is still achieved for the through traffic movements along the Pacific Highway even with the signalisation. The overall approach and intersection delays and LoS also have good outcomes, with the delay increasing slightly compared to existing conditions but still achieving LoS A (average delay less than 10 seconds). All 95th percentile queue lengths are also satisfactory and do not exceed the available storage capacity of the roads. The worst outcomes can be seen for traffic movements into and out of the AS14/15 construction access road, achieving as low as LoS E. This is expected due to the small volume of peak hour traffic utilising these movements, resulting in minimal green time allocations at the

<table>
<thead>
<tr><th>Ancillary facility reference</th><th>Assessment methodology</th><th>Access identified in EIS</th><th>Refined access</th><th>Assessment</th></tr>
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<tbody>
<tr><td></td><td></td><td></td><td></td><td>signalised intersection. Whilst the LoS E would typically not be accepted, the phasing has prioritised through traffic movements along the Pacific Highway to cater for the much higher volume of vehicles. It is recommended that the existing traffic along the Pacific Highway should be prioritised, although further refinements could be made to the phasing to achieve improved performance for the AS14/15 movement.

Even with the introduction of a signalised intersection, the provision of construction access to AS14/15 is expected to have negligible impacts on the high volume of through traffic along the Pacific Highway. It would therefore be appropriate for the intersection to be signalised, ensuring safety for commuters with minimal impacts on traffic movements.</td></tr>
<tr><td>AS17</td><td>Qualitative</td><td>• Left in from northbound Masonite Road
• Left out to northbound Masonite Road</td><td>• Left in from northbound Masonite Road and right in from southbound Masonite Road
• Left out to northbound Masonite Road and right out to southbound Masonite Road</td><td rowspan="2">AS17, AS18 and AS19 are in close proximity to each other, and construction access would be from Masonite Road. To support the removal of AS16, approximately 30 construction vehicles during the peak periods originally accessing this site will be redistributed to AS17, AS18 and AS19. These sites would also allow right turn movements to improve accessibility, essentially providing access from both directions of Masonite Road.

With a relatively low volume of vehicles travelling along Masonite Road, the increased construction traffic for these sites is expected to be minor. Following the removal of AS16, there would be approximately 660 total daily vehicles expected to access all three sites AS17, AS18 and AS19, which equates to about 66 vehicles per peak hour. Based on the evaluation of the critical acceptance gaps for right turning vehicles in accordance with the Guide to Road Design Part 4A: Unsignalised and Signalised Intersections, It is expected that the addition of the right turn allowances would have a minimal impact on queues, delays and travel times.</td></tr>
<tr><td>AS18/19</td><td>Qualitative</td><td>• Left in from southbound Masonite Road
• Left out to southbound Masonite Road</td><td>• Left in from southbound Masonite Road and right in from northbound Masonite Road
• Left out to southbound Masonite Road and right out to northbound Masonite Road</td></tr>
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4.2 New England Highway, Tarro - interchange off-ramp

4.2.1 Description of refinement

The refinement involves the signalisation of the westbound off-ramp at the existing New England Highway, Tarro interchange (Anderson Drive/New England Highway off-ramp intersection) as a temporary measure to manage traffic during construction. This would enhance access to AS5 and minimise direct access from the New England Highway as well as the use of Anderson Drive through Tarro and Beresfield, mitigating traffic disruption. The EIS did not consider any change to this intersection.

A summary of the proposed layout is shown in **Figure 4-3**.

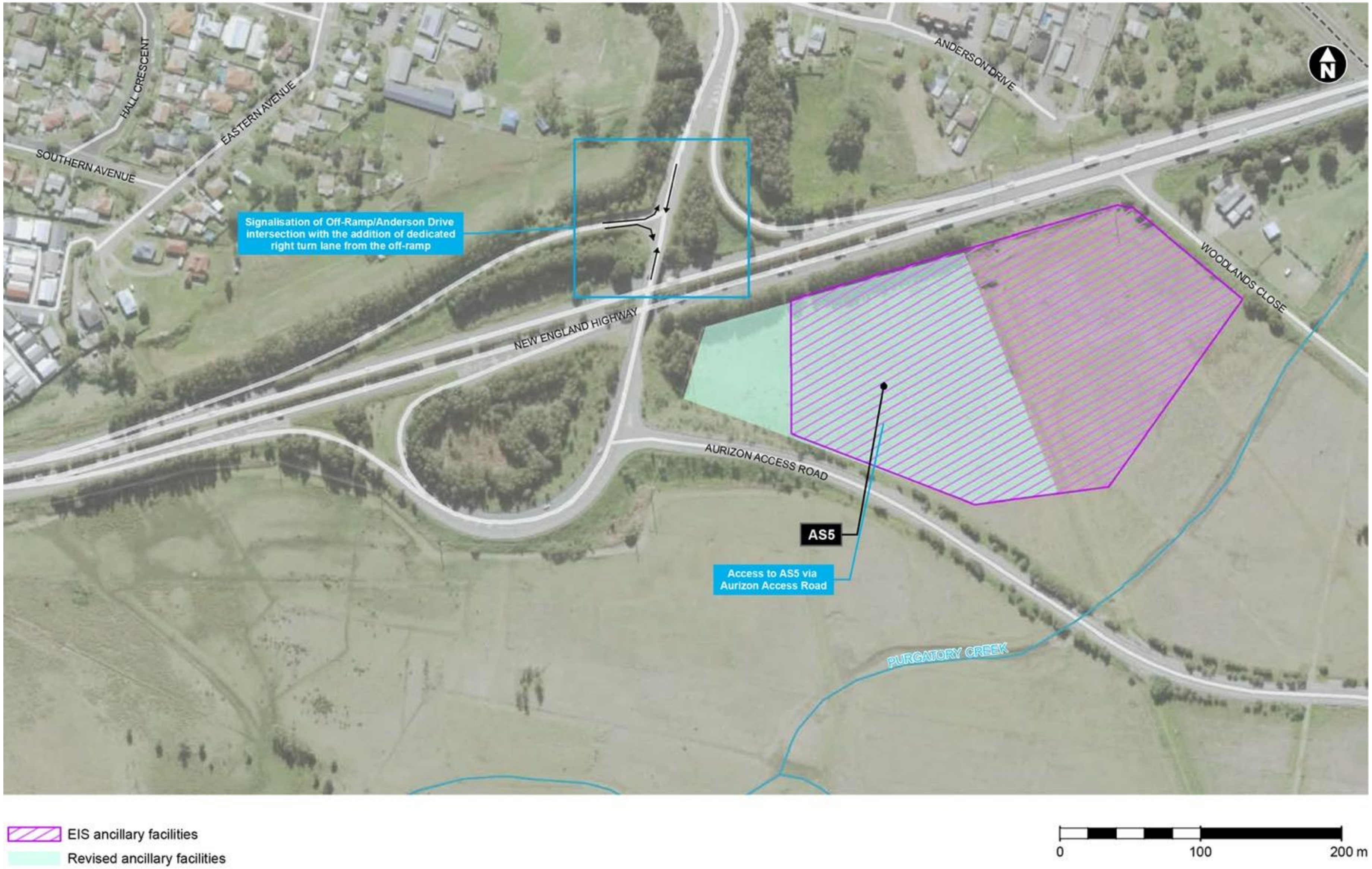


Figure 4-3 Proposed signalisation off-ramp at New England Highway, Tarro interchange

4.2.2 Assessment

Traffic modelling using VISSIM was completed to review the operation of temporary signalisation of the Anderson Drive/New England Highway westbound off-ramp intersection. The 2028 'Without Project' model which represents the envisaged network and demand conditions likely during the construction of the project was used as the foundation for the modelling. The modelling signalised the Anderson Drive/ New England Highway off-ramp intersection and includes a short 15 metre right turn lane from the off-ramp approach, to provide added capacity. To understand the impacts of the signalisation, the model outputs were reviewed. Intersection performance and queues were both considered in this analysis.

Twenty-five construction vehicles each hour were coded into the model to turn right from the off-ramp at this signalised intersection. The modelled layout and phasing are presented in Figure A-6 of **Appendix A**.

The key findings of the assessment are:

- Overall, during peak periods the intersection is expected to operate at a LoS B with the average delay per vehicle expected to be under 20 seconds
- The off-ramp has a storage capacity of approximately 500 metres, the maximum queue recorded from the new signalised intersection is approximately 105 metres, therefore queues are not expected to extend back to the New England Highway
- The queues extending to the north and south on Anderson Drive are not expected to extend to the downstream intersection.

The results of the SIDRA analysis for the signalised intersection for morning and evening peaks are presented in **Table** 4-2 and **Table** 4-3.

Table 4-2 Performance of signalised intersection in 2028 morning peak (8-9am)

From	To	Avg Delay (s)	Total Vehicles	LoS	Intersection Delay	Intersection LoS
Off Ramp (W)	Anderson Drive (N)	45	119	D	14	B
	Anderson Drive (S)	47	51	D		
Anderson Drive (N)	Anderson Drive (S)	4	374	A		
Anderson Drive (S)	Anderson Drive (N)	4	159	A		

Table 4-3 Performance of signalised intersection in 2028 evening peak (5-6pm)

From	To	Avg Delay (s)	Total Vehicles	LoS	Intersection Delay	Intersection LoS
Off Ramp (W)	Anderson Drive (N)	42	187	D	16	B
	Anderson Drive (S)	52	73	D		
Anderson Drive (N)	Anderson Drive (S)	5	296	A		
Anderson Drive (S)	Anderson Drive (N)	5	370	A		

The signalisation of the Anderson Road/New England Highway westbound off-ramp intersection in 2028 during construction is not expected to significantly impact adjacent roads. This refinement would not result in any outcomes that differ from the EIS (Transport for NSW, 2021).

Detailed modelling outputs are included in Section A.2 of **Appendix A**.

5 Assessment of potential operational impacts

5.1 Staged project opening

5.1.1 Description of refinement

The project would be delivered via two packages of work, the Southern (Black Hill to Tomago) and Northern (Heatherbrae Bypass) works with an interface at Heatherbrae, approximately 600 metres north of the access to the Hunter Region Botanic Gardens. The Northern works will likely have a construction duration less than the Southern works and therefore could potentially be opened to traffic early. An overview of the proposed Northern and Southern packages of work is shown in **Figure 5-1**. There are two options for opening the Northern package of works (Heatherbrae Bypass)' earlier than the remainder of the project. The two options include:

- Option 1: proposed to operate as a four-lane two-way Motorway with an exit ramp for northbound Heatherbrae traffic and a three-leg signalised intersection for southbound traffic from Heatherbrae. The proposed layout and operation of Option 1 is presented in **Figure 5-2**.
- Option 2: proposed to operate with a signalised intersection on Pacific Highway. Access from Pacific Highway to and from the Motorway would be provided for by a signalised channelised right turn-style intersection for northbound Motorway traffic, and a signalised merge for southbound-Motorway traffic. The proposed layout and operation of Option 2 is presented in **Figure 5-3**.

5.1.2 Assessment

To assess the performance of these options, traffic modelling was carried out in VISSIM (version 2020), with the models developed to represent 2028 conditions. Traffic modelling outputs have been used to understand the impact of the staged opening, model outputs such as network statistics, travel times and intersection delays were all key performance indicators.

The results from Option 1 and Option 2 were compared to investigate which resulted in better traffic outcomes. Key findings from this analysis include:

- **Network Performance**: both options displayed similar outcomes across all network statistics
- **Travel Time**: Travel time for Option 1 was observed to be less compared to Option 2. Option 1 was 17 seconds (2.8 per cent) faster for the morning peak, and 19 seconds (2.9 per cent) faster for the evening peak. Travel times across the broader network were similar for the two options
- **Intersection Performance**: The Option 1 and Option 2 intersections modelled both operate at LoS C, Option 1 shows slightly lower values of intersection delay for peak hours, however, delays are similar in magnitude. Across the broader network, there was minimal difference between intersection performance
- **Queues**: The average and maximum queues observed were within a reasonable range for both options. No special provision or geometrical modifications would be required to incorporate the maximum queue length on all approaches
- **Diverge Section**: The length of diverge ramp in Option 1 was found to be adequate to accommodate the maximum queue length observed in the morning and evening peaks.

Further information on network coding for each option is provided in **Appendix B**.

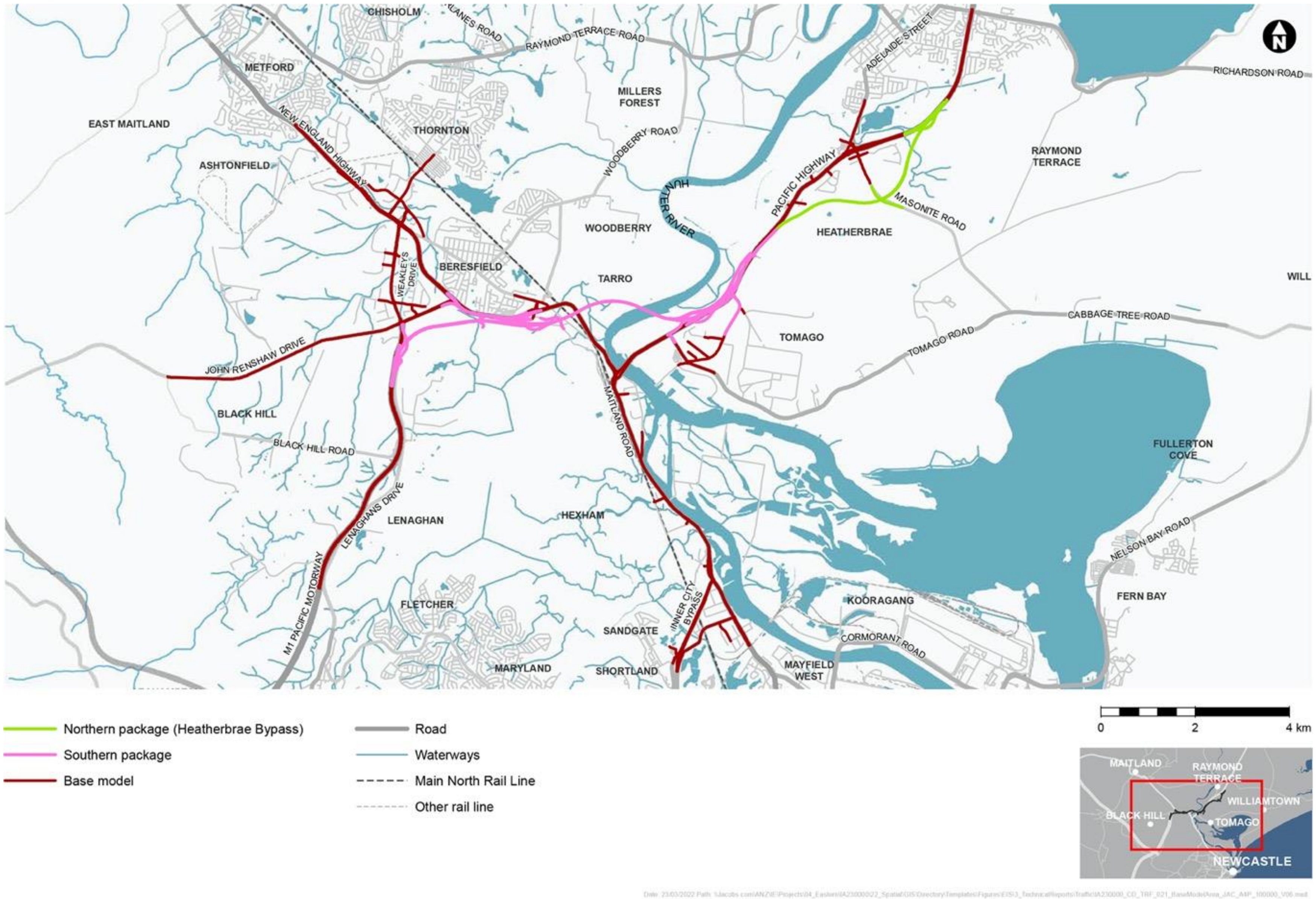


Figure 5-1 Staged project opening – Northern and Southern packages of work

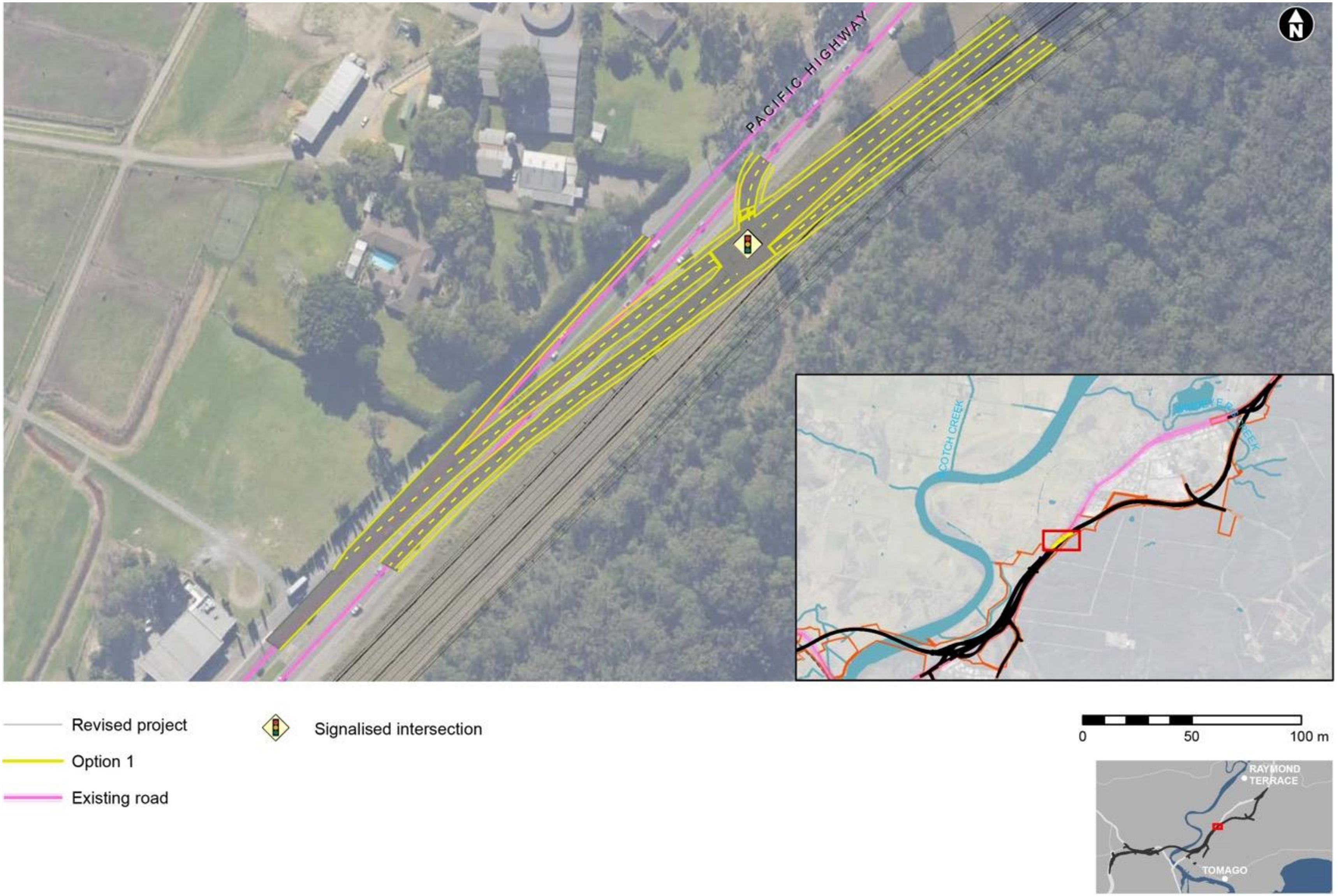


Figure 5-2 Proposed intersection layout of Option 1

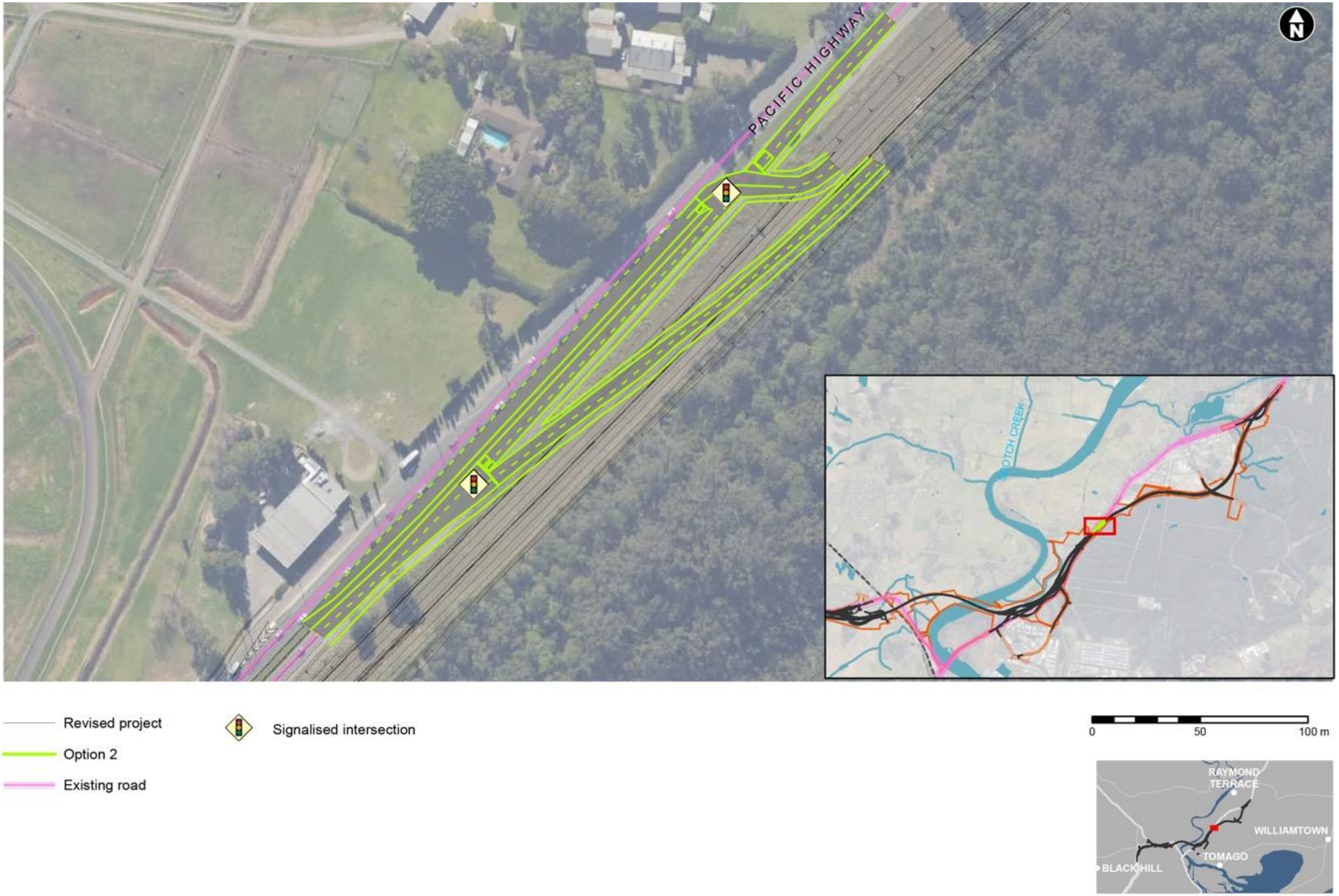


Figure 5-3 Proposed intersection layout of Option 2

Overall, both options displayed similar outcomes when tested in the model. Neither resulted in delays across the network, furthermore both options resulted in suitable traffic flow through the interchange. Option 1 was adopted as the preferred design for a staged opening as it resulted in quicker travel times across the network and offered better constructability with limited temporary work required. Detailed modelling outputs are included in **Appendix B**.

In addition, a comparison was carried out between the proposed staged Heatherbrae Bypass and the models ('Without Project' and 'With Project') presented in Section 5.2 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021).

In comparison to the 'Without Project' (i.e. no project) model, the Heatherbrae bypass marginally improves the average speed of vehicles in the network and results in a minor reduction of travel time across most assessed routes in the network.

In comparison to the 'With Project' (i.e. EIS project as a single delivery) model, an equivalent number of vehicles rerouted to travel on Heatherbrae Bypass, reducing traffic volumes travelling through Heatherbrae. Across the wider study area, travel time and intersection LoS benefits that occur in the 'With Project' model are not fully realised in the Heatherbrae Bypass model.

Overall, the results indicate from an operational traffic perspective, delivery of the Heatherbrae Bypass as the first stage of the project is feasible. The Heatherbrae bypass would deliver some of the benefits of the project and is not expected to negatively impact other roads in the study area.

5.2 Updated cycleway strategy

5.2.1 Description of refinement

The project's cycleway strategy has been refined since exhibition of the EIS. These refinements are focused on providing improved safety and connectivity for cyclists.

As outlined in the EIS, cyclists would to be able to use the shoulders provided on the motorway and entry/exit ramps.

A summary of the refinements includes.

- At the Tarro interchange, a new road culvert would be extended adjacent to the realigned Aurizon access road, to futureproof for the future Shortland to Tarro Cycleway (Newcastle City Council)
- At the Tomago interchange, additional cyclist provisions are provided between the M1 Pacific Motorway southbound exit and southbound entry ramps. Cyclists would be encouraged to exit the M1 Pacific Motorway via the southbound exit ramp to Old Punt Road, cross at the Old Punt Road Signalised intersection and then use southbound Pacific Highway entry ramp to re-join the M1 Pacific Motorway, thereby avoiding merge and diverge crossings on the Motorway
- Removal of shared user path on new Masonite Road bridge at Heatherbrae due to a change in the bridge design and negligible pedestrian demand, with cyclists able to instead utilise the shoulder.

5.2.2 Assessment

Overall, the updated cycleway strategy would improve safety outcomes for cyclists due to refinements to cycle lane alignment, crossing locations and improved connectivity. In addition, the cycleway strategy includes futureproofing for proposed future cycleways presenting opportunities to further enhance the region's cycling connectivity.

The updated cycleway strategy is shown in **Figure 5-4** with the updates shown in light yellow callout boxes.

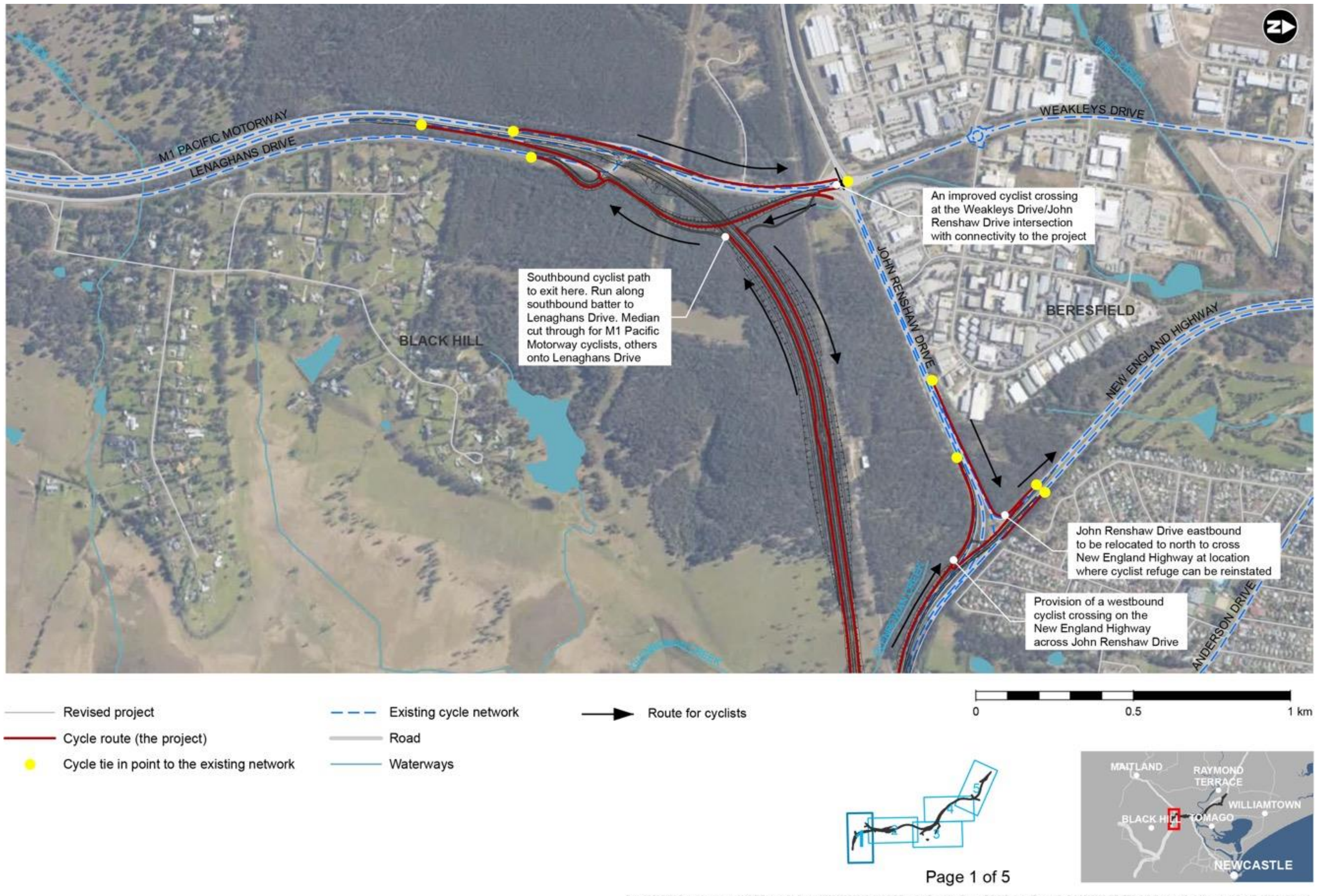


Figure 5-4 Updated cycleway strategy (map 1 of 5)

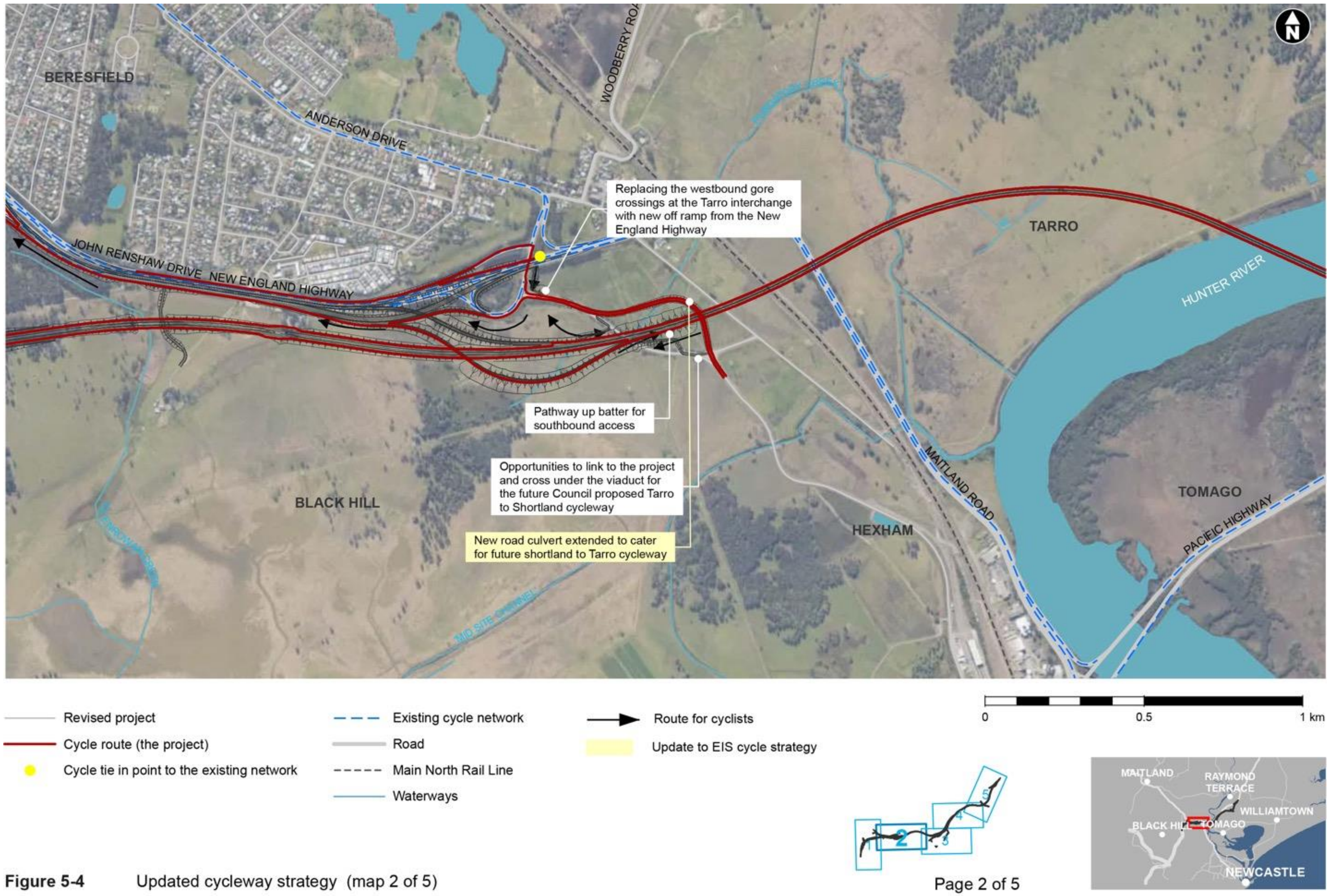


Figure 5-4 Updated cycleway strategy (map 2 of 5)

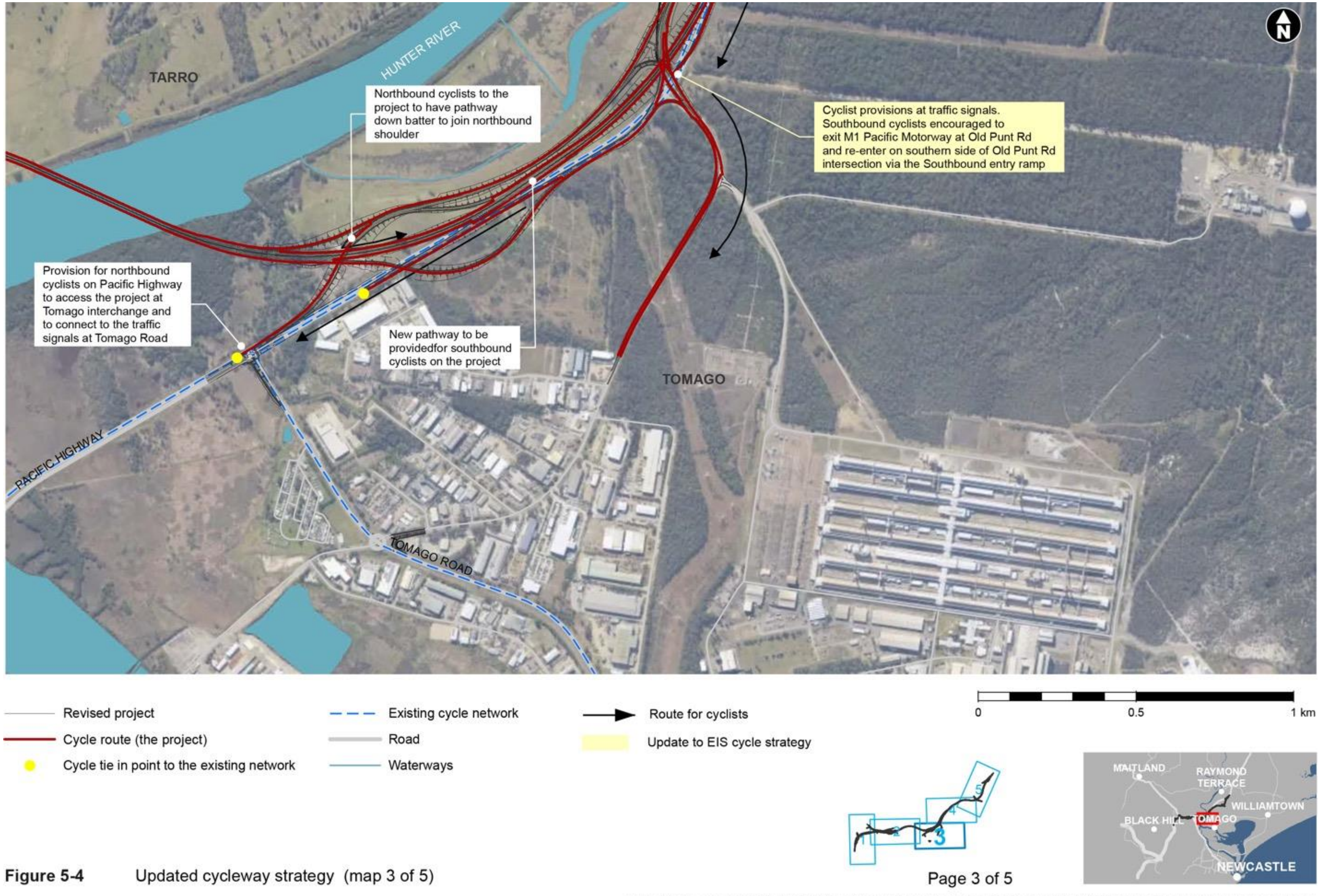


Figure 5-4 Updated cycleway strategy (map 3 of 5)

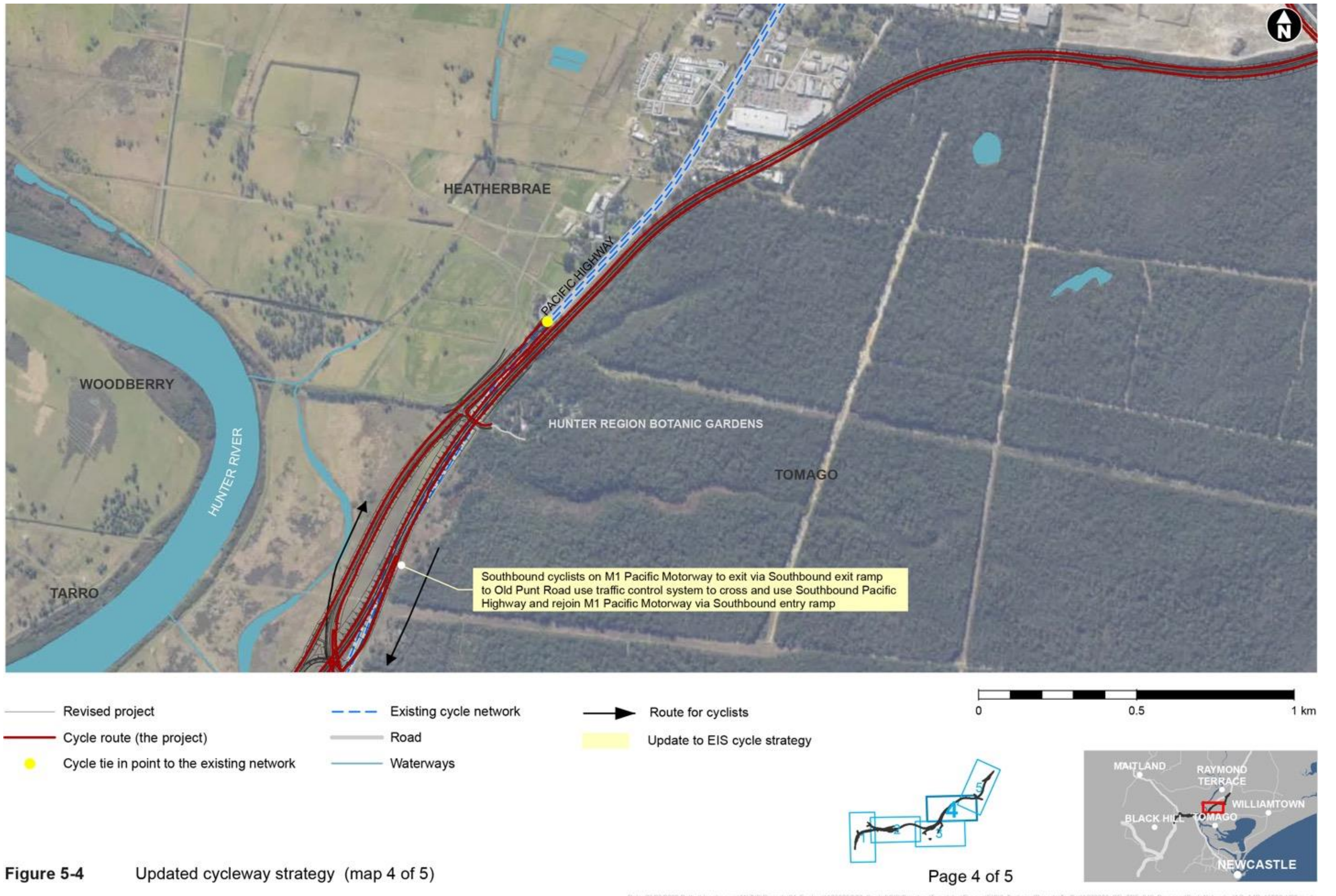


Figure 5-4 Updated cycleway strategy (map 4 of 5)

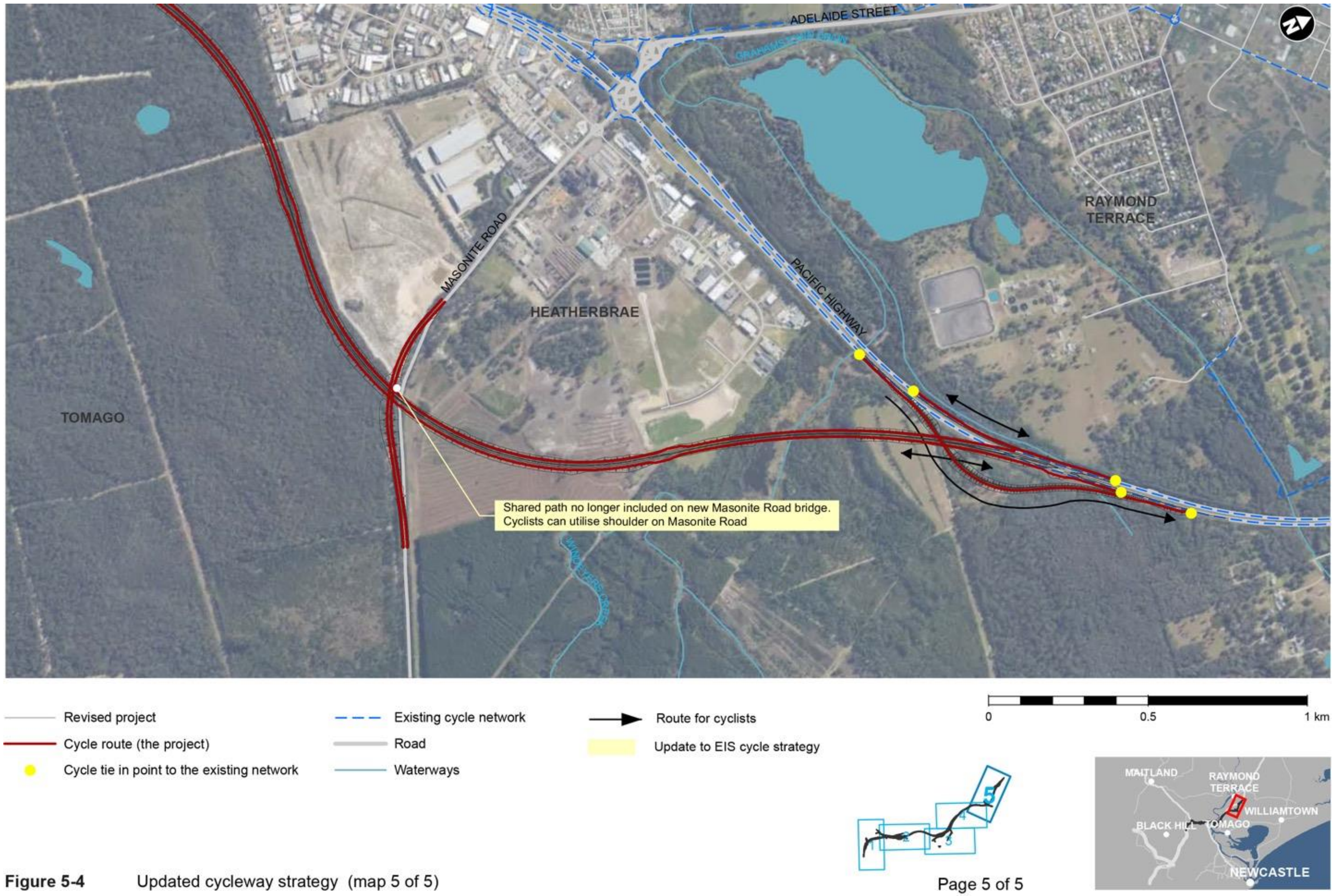


Figure 5-4 Updated cycleway strategy (map 5 of 5)

6 Revised environmental management measures

The environmental impact statement for the project identified a range of environmental outcomes and management measures that would be required to avoid or reduce the environmental impacts.

The project refinements assessed in this report do not require any revisions to the environmental management measures in Chapter 6 of the *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper* (Jacobs, 2021) were identified.

7 Conclusion

A review of both the construction and operational impacts associated with the project refinements has determined that the outcomes remain consistent with the EIS.

Qualitative and quantitative assessments were completed for ancillary sites to understand the potential impacts of refinements on construction access. The changes from the construction access as previously identified in the EIS were generally minimal and a qualitative assessment was found to be sufficient for most locations. Where more complex changes were identified, SIDRA modelling was completed. The impacts were found to be consistent with those identified in the EIS and traffic movements would be relatively unaffected by the refinements.

Traffic modelling was completed using VISSIM to assess the potential signalisation of the off-ramp at the Tarro interchange during construction. The modelling demonstrated no significant impacts on the adjacent roads, and the outcomes align with the EIS.

A staged project opening was also assessed with an interface at Heatherbrae. The staged approach is expected to allow for the northern section of the project to be opened earlier due to a shorter construction duration than the southern section. Two options were assessed, and both demonstrated suitable traffic flows through the interchange with no expected delays across the network. The results indicate that the staged opening would have similar outcomes to the approach outlined in the EIS and would not negatively impact the western portion of the study area.

Refinements were also made to the project's cycleway strategy which focused on improving safety and connectivity for cyclists and consisted of alignment and route refinements.

For both the construction and operation stages of the project, the proposed refinements presented in this supplementary traffic and transport report align with the project outcomes identified in the EIS. No additional environmental management measures were identified.

8 References

Jacobs, 2021. *M1 Pacific Motorway extension to Raymond Terrace Traffic and Transport Working Paper*

Transport for NSW, 2021. *M1 Pacific Motorway extension to Raymond Terrace Environmental Impact Statement*

Transport for NSW, 2022*. M1 Pacific Motorway extension to Raymond Terrace Submissions Report*

Transportation Research Board, 2016. *Highway Capacity Manual 2016*

Appendix A Construction impacts

The project refinements with construction impacts are associated with improving accessibility for the ancillary sites.

Access to ancillary facilities for construction vehicles and staff are summarised in **Table** A-1. This includes a comparison between the entry and exit methods as shown in the EIS and with the refined designs. It identifies the proposed accessibility improvements and captures if modelling was completed. These items are more thoroughly explored in **Section 4.1**.

Access points at each of the ancillary facilities frontages would be provided with adequate sight distances relating to the posted speed limit. This would allow vehicles on the road network to see vehicles exiting from the ancillary facilities and would allow sufficient room to slow down and stop if necessary. This approach would also provide vehicles waiting to exit from the ancillary facilities with adequate sight distance to see approaching vehicles and determine acceptable gaps. It should be noted that ancillary facilities are generally connected, which would mean that construction traffic movements may fluctuate as they move between sites internally.

Table A-1 Ancillary facility's updated access and their assessment methodology

Ancillary facility reference	Direct entry access		Direct exit access		Assessment methodology	Comments
	Original	Updated	Original	Updated		
AS3b	N/A	Left in from westbound New England Highway, extension of New England Highway access point	N/A	Left out to westbound New England Highway, extension of New England Highway access point	Qualitative	Minor impacts only as this is an extension to AS3.
AS10 and AS11	Left in from northbound Pacific Highway	Left in from northbound Pacific Highway and through from northbound Tomago Road	Left out to northbound Pacific Highway	Left out to northbound Pacific Highway and through to southbound Tomago Road	Modelled	Modelling completed to accommodate for more efficient access to and from the sites during construction.
AS14 and AS15	Left in from southbound Pacific Highway	Left in from southbound Pacific Highway and right in from northbound Pacific Highway	Left out to southbound Pacific Highway	Left out to southbound Pacific Highway and right out to northbound Pacific Highway	Modelled	Modelling completed to accommodate for more efficient access to and from the sites during construction.
AS16	Left/right in from Masonite Road	N/A	Left out to northbound Masonite Road	N/A	Qualitative	Site removed.
AS17	Left in from northbound Masonite Road	Left in from northbound Masonite Road and right in from southbound Masonite Road	Left out to northbound Masonite Road	Left out to northbound Masonite Road and right out to southbound Masonite Road	Qualitative	Minor changes only to allow for right turn movements into and out of the site.
AS18 and AS19	Left in from southbound Masonite Road	Left in from southbound Masonite Road and right in from northbound Masonite Road	Left out to southbound Masonite Road	Left out to southbound Masonite Road and right out to northbound Masonite Road	Qualitative	Minor changes only to allow for right turn movements into and out of the sites.

A.1 SIDRA assessment of construction access

To understand the impacts of changes to accessibility, modelling was completed at the sites where more complex impacts from access changes were expected. As a result, traffic modelling using SIDRA Intersection 9 was carried out at the locations presented in **Table** A-2.

Table A-2 Ancillary facilities which were modelled using SIDRA intersection

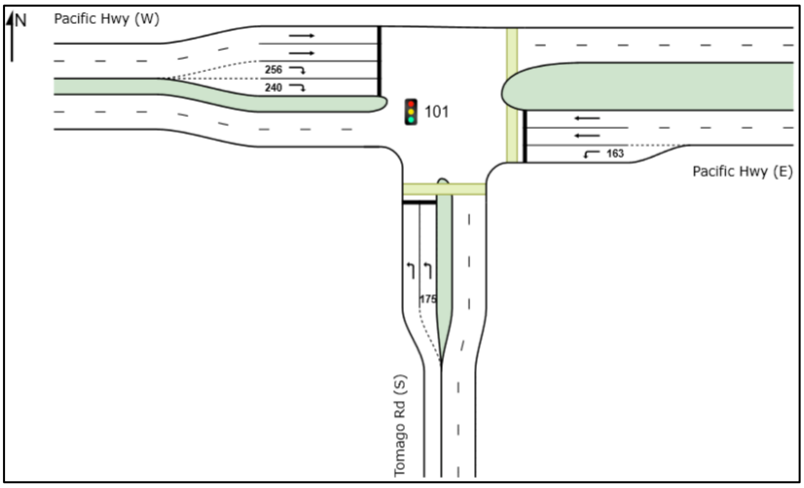
Ancillary facility reference	Purpose
AS10/11	Intersection modelling to allow cross traffic (east-west) at the intersection for entry and exit, with the addition of AS10/11 access to the north. This would enable access during construction and can be adapted for the final design.
AS14/15	Intersection modelling to determine if intersection treatment is required to provide for right turn movements between the Pacific Highway and AS14/15.

For the two construction site access locations, a base model was first developed to represent the road conditions for 2028 under the 'Without Project' scenario. The SIDRA base model was validated against the existing VISSIM model in terms of delays and Level of Service (LoS). These models were used as the foundation to develop future construction models which included construction vehicles and access to the ancillary sites.

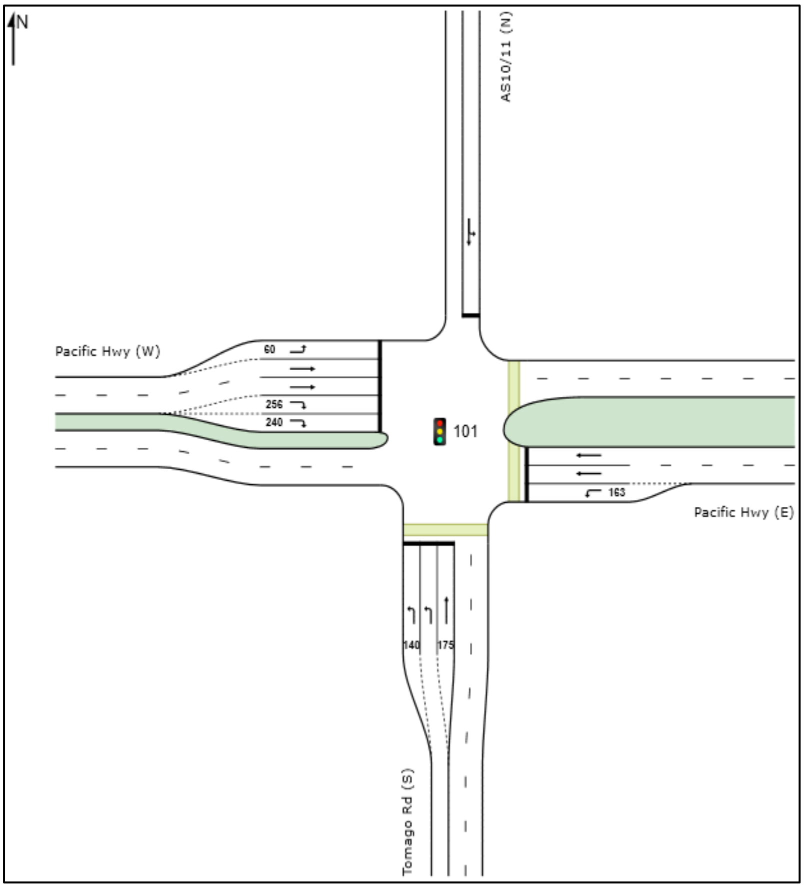
There were several assumptions in the development of the models, such as the length and placement of lanes as identified in the site layouts. These are further identified in the following sections where applicable for each set of models. Signal phasing for the construction access models was optimised by SIDRA to obtain outputs that aligned reasonably with the base models.

A.1.1 AS10/11

The site layouts for the Pacific Highway/Tomago Road/AS10/11 intersection are presented in **Figure** A-1. These indicate the approximate design of the intersection with the Pacific Highway and Tomago Road as per the base model, as well as with the addition of construction access to AS10/11 in the construction models.



Base Model



Construction Model

Figure A-1 Layout of the Pacific Highway/Tomago Road/AS10/11 intersection in base conditions and during construction

The following assumptions were made in the development of the Pacific Highway/Tomago Road/AS10/11 models:

- The SIDRA model was validated against the 2028 future 'Without Project' model, and therefore the signal cycle time was assumed to be 90 seconds in the morning peak and 100 seconds in the evening peak to align with this
- SCATS data was used to determine approximate phase timings in the base model
- Phase timings were optimised by SIDRA in the construction model
- Assumed travel speed of 40km/h on the AS10/11 access road
- Conservatively assumed 50 additional vehicles per peak at the intersection for access into and out of the AS10/11 access road despite only 36 vehicles anticipated per peak.

The phasing summary utilised for the A10/11 base and construction models are presented in **Figure** A-2 and **Figure** A-3 respectively.

The phasing sequences for the base models were developed from the SCATS information, although a modification was required to correctly validate the base models. This included changing the through traffic movement from the Pacific Highway to the west of Tomago Road to continuous rather than signalised due to a limitation within SIDRA where red time is automatically allocated. As per the current operation, it is expected that the movement operates continuously unless the crossing on the Pacific Highway east of the intersection is called, which is expected to be infrequent and would not occur every cycle. With these movements modelled as signalised instead of continuous, SIDRA automatically forces the crossing to be activated for a minimum of 1 second per cycle, inducing queues and delays on the western leg that would not be typically experienced. By utilising this continuous modelling approach, the base models could be more adequately validated, allowing for an effective comparison against the construction models. These two movements have been marked by an asterisk (*).

This limitation did not impact the construction models due to the introduction of additional phases and movements. The phasing for the construction models was adapted from this base model to include the AS10/11 access movements.

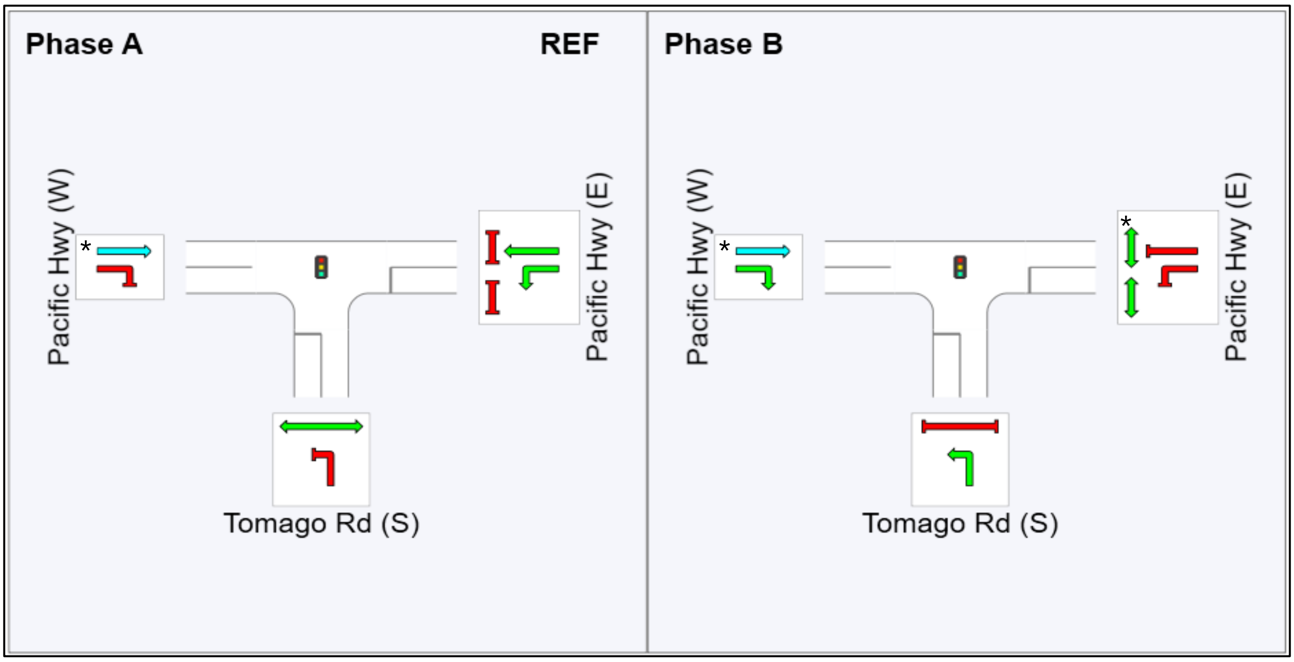


Figure A-2 Pacific Highway/ Tomago Road intersection phasing in the base model

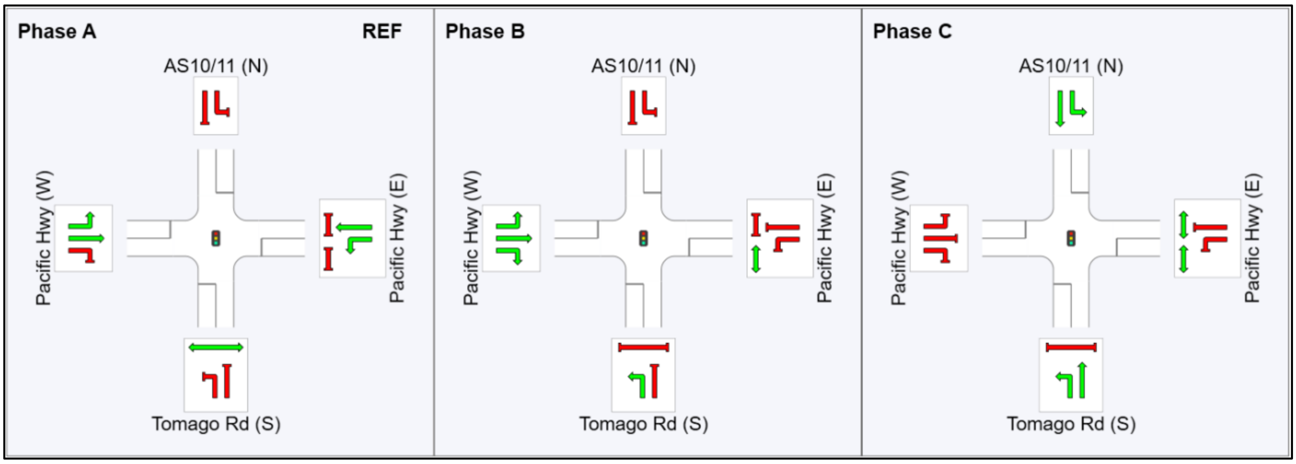


Figure A-3 Pacific Highway/Tomago Road/AS10/11 access intersection phasing in the construction model

A validation process of the SIDRA models was completed for the Pacific Highway/Tomago Road intersection by comparing against the existing ‘Without Project’ VISSIM models for 2028. A similar process was not completed for the location where access is to be provided to AS14/15 as this is currently unsignalised.

Through this process, the SIDRA models were identified to be fit for purpose, and the comparisons are provided in **Table** A-3 and **Table** A-4 for the morning and evening peaks. It should be noted that the VISSIM models did not record any vehicles utilising the left turn from the Pacific Highway (E) to Tomago Road (S) during the modelled time. To achieve a conservative outcome, 20 vehicles were included for the SIDRA models.

The SIDRA results for Pacific Highway/Tomago Road/AS10/11 access are summarised in **Table** A-5 and **Table** A-6 for both the morning and evening peak periods.

Table A-3 Pacific Highway/Tomago Road validation comparison between SIDRA and VISSIM in the morning peak

Validation of Pacific Highway/Tomago Road – Morning Peak								
Model	**From**	**To**	**Avg Delay (s)**	**LoS**	**Overall Delay (s)**	**Overall LoS**	**Intersection Delay (s)**	**Intersection LoS**
VISSIM	Tomago Road (S)	Pacific Highway (W)	27	C	27	C	18	B
	Pacific Highway (E)	Pacific Highway (W)	23	C	23	C		
		Tomago Road (S)	-	-				
	Pacific Highway (W)	Pacific Highway (E)	<10	A	13	B		
		Tomago Road (S)	38	D				
SIDRA	Tomago Road (S)	Pacific Highway (W)	28	C	28	C	16	B
	Pacific Highway (E)	Pacific Highway (W)	22	C	22	C		
		Tomago Road (S)	19	B				
	Pacific Highway (W)	Pacific Highway (E)	<10	A	10	B		
		Tomago Road (S)	33	C				

Table A-4 Pacific Highway/Tomago Road validation comparison between SIDRA and VISSIM in the evening peak

<table>
<tr><th colspan="9">Validation of Pacific Highway/Tomago Road – Evening Peak</th></tr>
<tr><th>Model</th><th>From</th><th>To</th><th>Avg Delay (s)</th><th>LoS</th><th>Overall Delay (s)</th><th>Overall LoS</th><th>Intersection Delay (s)</th><th>Intersection LoS</th></tr>
<tr><td rowspan="5">VISSIM</td><td>Tomago Road (S)</td><td>Pacific Highway (W)</td><td>37</td><td>D</td><td>37</td><td>D</td><td rowspan="5">17</td><td rowspan="5">B</td></tr>
<tr><td rowspan="2">Pacific Highway (E)</td><td>Pacific Highway (W)</td><td>20</td><td>B</td><td rowspan="2">20</td><td rowspan="2">B</td></tr>
<tr><td>Tomago Road (S)</td><td>-</td><td>-</td></tr>
<tr><td rowspan="2">Pacific Highway (W)</td><td>Pacific Highway (E)</td><td><10</td><td>A</td><td rowspan="2"><10</td><td rowspan="2">A</td></tr>
<tr><td>Tomago Road (S)</td><td>36</td><td>D</td></tr>
<tr><td rowspan="5">SIDRA</td><td>Tomago Road (S)</td><td>Pacific Highway (W)</td><td>36</td><td>D</td><td>36</td><td>D</td><td rowspan="5">15</td><td rowspan="5">B</td></tr>
<tr><td rowspan="2">Pacific Highway (E)</td><td>Pacific Highway (W)</td><td>19</td><td>B</td><td rowspan="2">19</td><td rowspan="2">B</td></tr>
<tr><td>Tomago Road (S)</td><td>18</td><td>B</td></tr>
<tr><td rowspan="2">Pacific Highway (W)</td><td>Pacific Highway (E)</td><td><10</td><td>A</td><td rowspan="2"><10</td><td rowspan="2">A</td></tr>
<tr><td>Tomago Road (S)</td><td>36</td><td>D</td></tr>
</table>

Table A-5 Pacific Highway/Tomago Road/AS10/11 access SIDRA delay and LoS results in the morning peak

Pacific Highway/Tomago Road/AS10/11 – Morning Peak										
Model	**From**	**To**	**95% Back of Queue (m)**	**Avg Delay (s)**	**Total Vehicles**	**LoS**	**Overall Delay (s)**	**Overall LoS**	**Intersection Delay (s)**	**Intersection LoS**
Base	Tomago Road (S)	Pacific Highway (W)	41	28	299	C	28	C	16	B
	Pacific Highway (E)	Pacific Highway (W)	220	22	1,409	C	22	C		
		Tomago Road (S)	<10	19	20	B				
	Pacific Highway (W)	Pacific Highway (E)	<10	<10	1,449	A	10	B		
		Tomago Road (S)	97	33	654	C				
Construction	Tomago Road (S)	Pacific Highway (W)	40	27	299	C	28	C	22	C
		AS10/11 (N)	<10	49	25	D				
	Pacific Highway (E)	Pacific Highway (W)	244	27	1,409	C	27	C		
		Tomago Road (S)	<10	20	20	B				
	Pacific Highway (W)	Pacific Highway (E)	91	<10	1,449	A	18	B		
		Tomago Road (S)	129	49	654	D				
		AS10/11 (N)	<10	<10	25	A				
	AS10/11 (N)	Pacific Highway (E)	20	51	25	D	49	D		
		Tomago Road (S)	20	47	25	D				

Table A-6 Pacific Highway/Tomago Road/AS10/11 access SIDRA delay and LoS results in the evening peak

Pacific Highway/Tomago Road/AS10/11 – Evening Peak										
Model	**From**	**To**	**95% Back of Queue (m)**	**Avg Delay (s)**	**Total Vehicles**	**LoS**	**Overall Delay (s)**	**Overall LoS**	**Intersection Delay (s)**	**Intersection LoS**
Base	Tomago Road (S)	Pacific Highway (W)	84	36	538	D	36	D	15	B
	Pacific Highway (E)	Pacific Highway (W)	237	19	1,537	B	19	B		
		Tomago Road (S)	<10	18	20	B				
	Pacific Highway (W)	Pacific Highway (E)	<10	<10	1,690	A	<10	A		
		Tomago Road (S)	71	36	434	D				
Construction	Tomago Road (S)	Pacific Highway (W)	86	37	538	D	38	D	19	B
		AS10/11 (N)	11	55	25	D				
	Pacific Highway (E)	Pacific Highway (W)	223	17	1,537	B	17	B		
		Tomago Road (S)	<10	16	20	B				
	Pacific Highway (W)	Pacific Highway (E)	117	<10	1,690	A	14	B		
		Tomago Road (S)	92	54	434	D				
		AS10/11 (N)	<10	<10	25	A				
	AS10/11 (N)	Pacific Highway (E)	23	58	25	E	56	E		
		Tomago Road (S)	23	54	25	D				

**Cells with pink shading represent intersections where performance is worse than LoS D*

The SIDRA modelling results with access at the Pacific Highway/Tomago Road/AS10/11 intersection show some impacts when comparing the base model to the construction model. With the introduction of new signalised movements for access into and out of AS10/11, modifications have been made to the phasing which has resulted in increased queues and delays, particularly along the Pacific Highway to the west of the intersection. However, the overall impacts for each approach are minimal, with the most notable delay increase occurring for traffic turning into Tomago Road from the Pacific Highway west of the intersection. During both the morning and evening peak periods, the intersection performance is relatively unchanged and achieves a LoS C or better, satisfying the minimum LoS C target set by Transport for NSW. All 95th percentile queue lengths are also satisfactory and do not exceed the available storage capacity of the roads.

The worst outcomes are associated with traffic movements into and out of the AS10/11 construction access road, achieving as low as LoS E. This is expected due to the small volume of peak hour construction traffic utilising these movements, resulting in minimal green time allocations at the signalised intersection. Whilst the LoS E would typically not be accepted, the phasing has prioritised traffic movements along the Pacific Highway to cater for the much higher volume of vehicles. It is recommended that the existing traffic along the Pacific Highway should be prioritised, although further refinements could be made to the phasing to achieve improved performance for the AS10/11 movements.

As a right turn movement from the eastern leg of the Pacific Highway into the AS10/11 sites would not be permitted, it is expected that construction traffic from this direction would instead be diverted down Old Punt Road. This detour route would provide access to the Old Punt Road/Tomago Road roundabout through which construction vehicles can access the northbound Tomago Road through movement into AS10/11. The Old Punt Road/Tomago Road roundabout would also enable construction vehicles to turn around to head in the opposite direction (as opposed to requiring U-turn bays on the higher speed dual carriageway roads). Whilst this would increase vehicles through this route, the Pacific Highway/Tomago Road/AS10/11 intersection is expected to perform with a LoS C or greater, with minimal impacts on delay and the existing performance.

A.1.2 AS14/15

The site layouts modelled in SIDRA for construction access into AS14/15 are presented in **Figure** A-4. This figure indicates the approximate design at the location along the Pacific Highway as per the existing conditions and with the addition of construction access to AS14/15. As captured in the intersection design, this section of the Pacific Highway currently allows for free flow traffic movements which would potentially be converted to a signalised intersection to provide construction access.

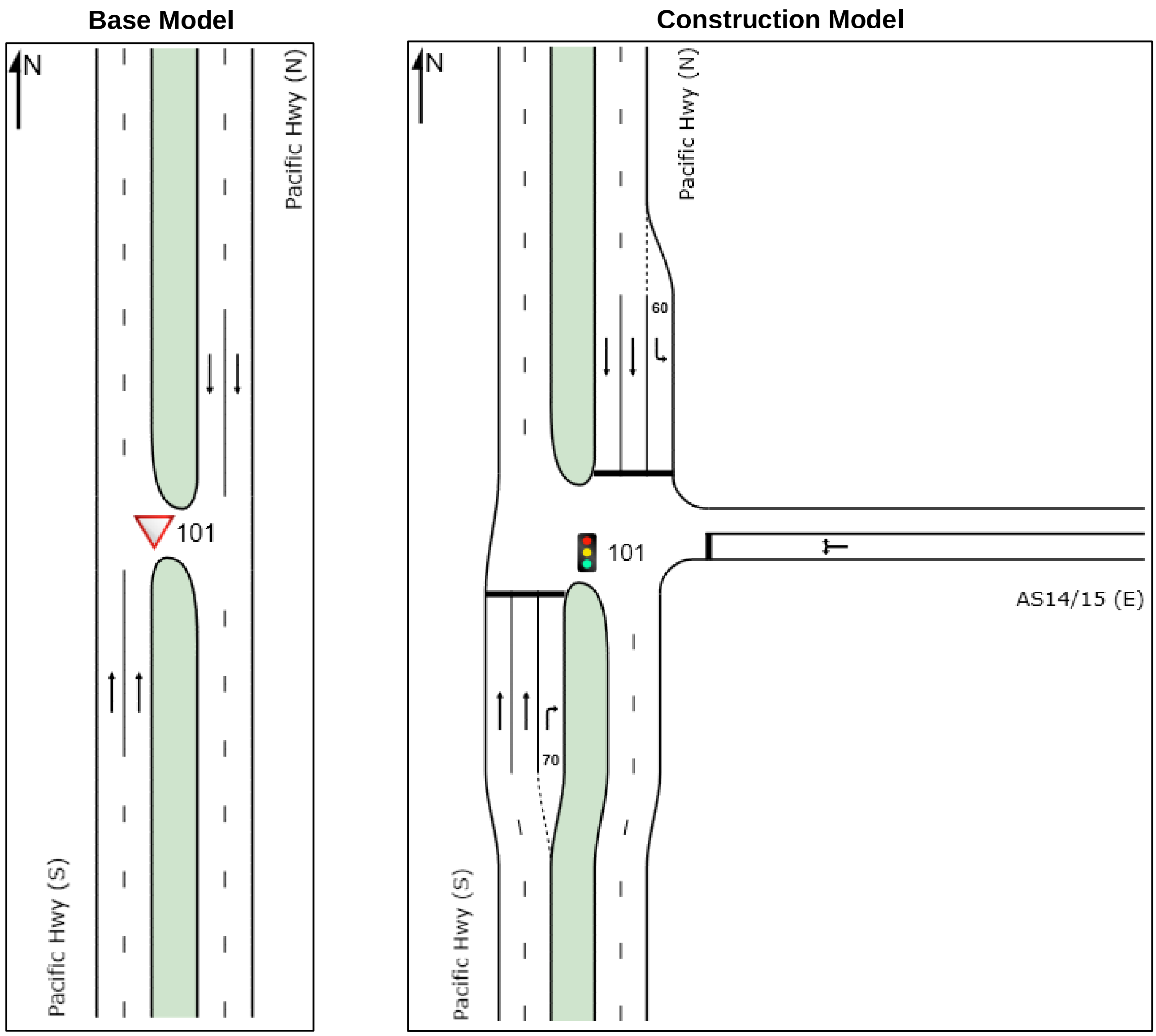


Figure A-4 Layout of the Pacific Highway/AS14/15 access intersection in base conditions and during construction

The following assumptions were made in the development of the Pacific Highway/AS14/15 models:

- Although the location is not signalised for the base models, a cycle time of 130 seconds was assumed for the construction models to align with the Pacific Highway/Hank Street intersection located nearby
- Phase timings were optimised by SIDRA in the construction model
- The approach lanes into AS14/15 from both directions of the Pacific Highway were assumed based on the available space. This was determined by the medium strip for the south leg (approximately 70 metres) and the distance to the next driveway on the north leg (approximately 60 metres)
- Assumed travel speed of 40km/h on the AS14/15 access road
- Conservatively assumed 50 additional vehicles per peak at the intersection for access into and out of the AS14/15 access road despite only 12 vehicles anticipated per peak.

The phasing summary utilised for the A14/15 construction models are presented in **Figure** A-5. A phasing sequence is not provided for the base model as it operates under free flow conditions. The phasing sequence for the construction model was manually determined to minimise the number of phases in a cycle.

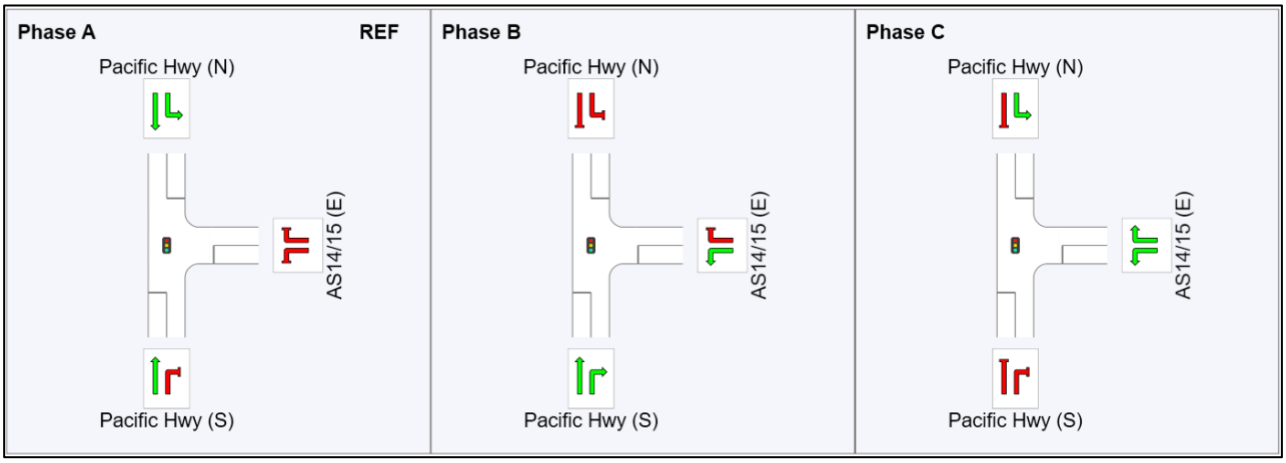


Figure A-5 Pacific Highway/AS14/15 access intersection phasing in the construction model

The SIDRA results for the Pacific Highway/AS14/15 intersection are summarised in **Table** A-7 and **Table** A-8 for both the morning and evening peak periods.

The outcomes for both the morning and evening peak periods are generally similar. Queues and delays are introduced along the Pacific Highway due to the conversion from free flow traffic movements to a signalised intersection. However, a LoS A is still achieved for the through traffic movements along the Pacific Highway even with the signalisation in the construction models. The overall approach and intersection delays and LoS also have good outcomes, with the delay increasing slightly but still achieving LoS A. All 95th percentile queue lengths are also satisfactory and do not exceed the available storage capacity of the roads.

The worst outcomes can be seen for traffic movements into and out of the AS14/15 construction access road, achieving as low as LoS E. This is expected due to the small volume of peak hour traffic utilising these movements, resulting in minimal green time allocations at the signalised intersection. Whilst the LoS E would typically not be accepted, the phasing has prioritised through traffic movements along the Pacific Highway to cater for the much higher volume of vehicles. Additionally, due to the low volumes and queue lengths for vehicles accessing AS14/15, no significant wider impacts are expected on nearby points of access, such as Hank Street and the Bunnings Heatherbrae service entry. It is recommended that the existing traffic along the Pacific Highway should be prioritised, although further refinements could be made to the phasing to achieve improved performance for the AS14/15 movements.

Table A-7 Pacific Highway/AS14/15 access SIDRA delay and LoS results in the morning peak

Pacific Highway/AS14/15 – Morning Peak										
Model	**From**	**To**	**95% Back of Queue (m)**	**Avg Delay (s)**	**Total Vehicles**	**LoS**	**Overall Delay (s)**	**Overall LoS**	**Intersection Delay (s)**	**Intersection LoS**
Base	Pacific Highway (S)	Pacific Highway (N)	<10	<10	1,464	A	<10	A	<10	A
	Pacific Highway (N)	Pacific Highway (S)	<10	<10	1,526	A	<10	A		
Construction	Pacific Highway (S)	Pacific Highway (N)	96	<10	1,464	A	<10	A	<10	A
		AS14/15 (E)	14	77	25	E				
	Pacific Highway (N)	Pacific Highway (S)	166	<10	1,526	A	<10	A		
		AS14/15 (E)	<10	<10	25	A				
	AS14/15 (E)	Pacific Highway (S)	28	71	25	E	71	E		
		Pacific Highway (N)	28	71	25	E				

**Cells with pink shading represent intersections where performance is worse than LoS D*

Table A-8 Pacific Highway/AS14/15 access SIDRA delay and LoS results in the evening peak

Pacific Highway/AS14/15 – Evening Peak										
Model	**From**	**To**	**95% Back of Queue (m)**	**Avg Delay (s)**	**Total Vehicles**	**LoS**	**Overall Delay (s)**	**Overall LoS**	**Intersection Delay (s)**	**Intersection LoS**
Base	Pacific Highway (S)	Pacific Highway (N)	<10	<10	1,876	A	<10	A	<10	A
	Pacific Highway (N)	Pacific Highway (S)	<10	<10	1,545	A	<10	A		
Construction	Pacific Highway (S)	Pacific Highway (N)	148	<10	1,876	A	<10	A	<10	A
		AS14/15 (E)	14	77	25	E				
	Pacific Highway (N)	Pacific Highway (S)	163	<10	1,545	A	<10	A		
		AS14/15 (E)	<10	<10	25	A				
	AS14/15 (E)	Pacific Highway (S)	28	71	25	E	71	E		
		Pacific Highway (N)	28	71	25	E				

Cells with pink shading represent intersections where performance is worse than LoS D

A.2 Tarro interchange off-ramp

The signalisation of the off-ramp at the existing Tarro interchange is proposed as a temporary measure to effectively manage traffic during construction. Signalisation of the Tarro interchange off-ramp/Anderson Drive intersection would enable a right turn from the Tarro interchange off ramp, catering for access to the nearby ancillary site. This would minimise direct access from the New England Highway. The modelled layout and phasing to support the methodology in **Section 4.2** are presented in **Figure** A-6.

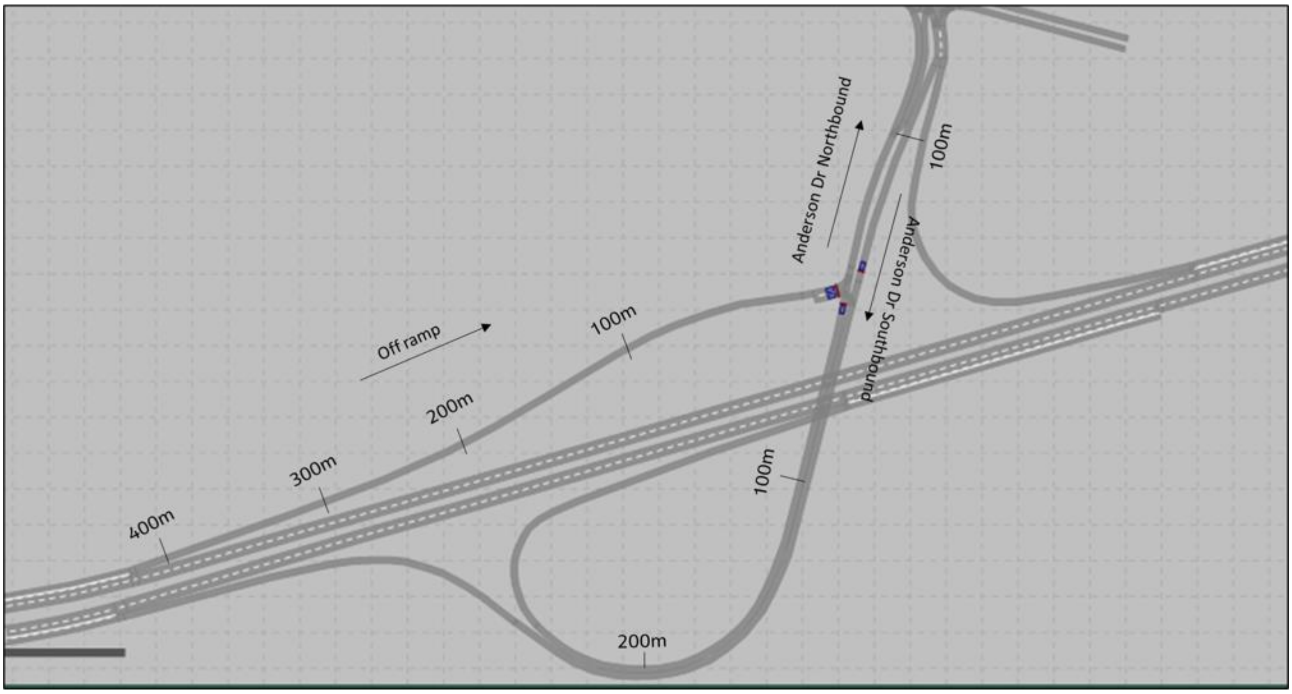


Figure A-6 Modelled off-ramp at Tarro interchange

A.2.1 Model outputs

To understand the impacts of the signalisation, model outputs were assessed. Intersection performance and queues have both been considered in this analysis.

Intersection performance

The LoS and Delays at the signalised intersection are presented in **Table** A-9 and **Table** A-10. Key findings from this analysis include:

- As the north-south movement has higher traffic volumes, it has been prioritised during the intersection signal coding, which results in low delays for the movement and an LoS A
- The movement from the off-ramp operates at an LoS D during the peak periods
- Overall, the intersection is expected to operate at a LoS B with the average delay per vehicle expected to be under 20 seconds, further signal modification could be implemented to optimise movements as required.

Table A-9 Performance of signalised intersection in 2028 morning peak (8-9am)

From	To	Avg Delay (s)	Total Vehicles	LoS	Intersection Delay	Intersection LoS
Off Ramp (W)	Anderson Drive (N)	45	119	D	14	B
	Anderson Drive (S)	47	51	D		

From	To	Avg Delay (s)	Total Vehicles	LoS	Intersection Delay	Intersection LoS
Anderson Drive (N)	Anderson Drive (S)	4	374	A		
Anderson Drive (S)	Anderson Drive (N)	4	159	A		

Table A-10 Performance of signalised intersection in 2028 evening peak (5-6pm)

From	To	Avg Delay (s)	Total Vehicles	LoS	Intersection Delay	Intersection LoS
Off Ramp (W)	Anderson Drive (N)	42	187	D	16	B
	Anderson Drive (S)	52	73	D		
Anderson Drive (N)	Anderson Drive (S)	5	296	A		
Anderson Drive (S)	Anderson Drive (N)	5	370	A		

Queues

The queues at the signalised intersection are presented in **Table** A-11 and **Table** A-12.

Key findings from this analysis include:

- The off-ramp has a storage capacity of approximately 500m, the maximum queue recorded from the new signalised intersection is approximal 106m, thus queues are not expected to extend back to the Pacific Highway
- The queue extending to the north is not expected to reach the Anderson Drive/Woodberry Road intersection
- The queue extending to the south is not expected to extend to the nearest intersection.

Table A-11 Intersection queues in the 2028 morning peak (8-9pm)

Location	Avg Queue Length (m)	Max Queue Length (m)
Off-ramp (W)	16	73
Anderson Drive (N)	<10	70
Anderson Drive (S)	<10	23

Table A-12 Intersection queues in the 2028 evening peak (5-6pm)

Location	Avg Queue Length (m)	Max Queue Length (m)
Off-ramp (W)	20	106
Anderson Drive (N)	<10	78
Anderson Drive (S)	<10	67

Appendix B Operational impacts

B.1 Staged opening

B.1.1 Introduction

Transport is considering delivering the project under two contracts, with an interface at Heatherbrae at approximate location MC10 Ch 10000. It is considered that the northern contract (the 'Heatherbrae Bypass') may have a construction duration less than the southern contract and therefore could potentially be opened to traffic early. The study carried out in the report aims to access two options for opening the "Heatherbrae Bypass' earlier than the remainder of the project.

The network layout for the modelled Heatherbrae Bypass is shown in **Figure** B-1.

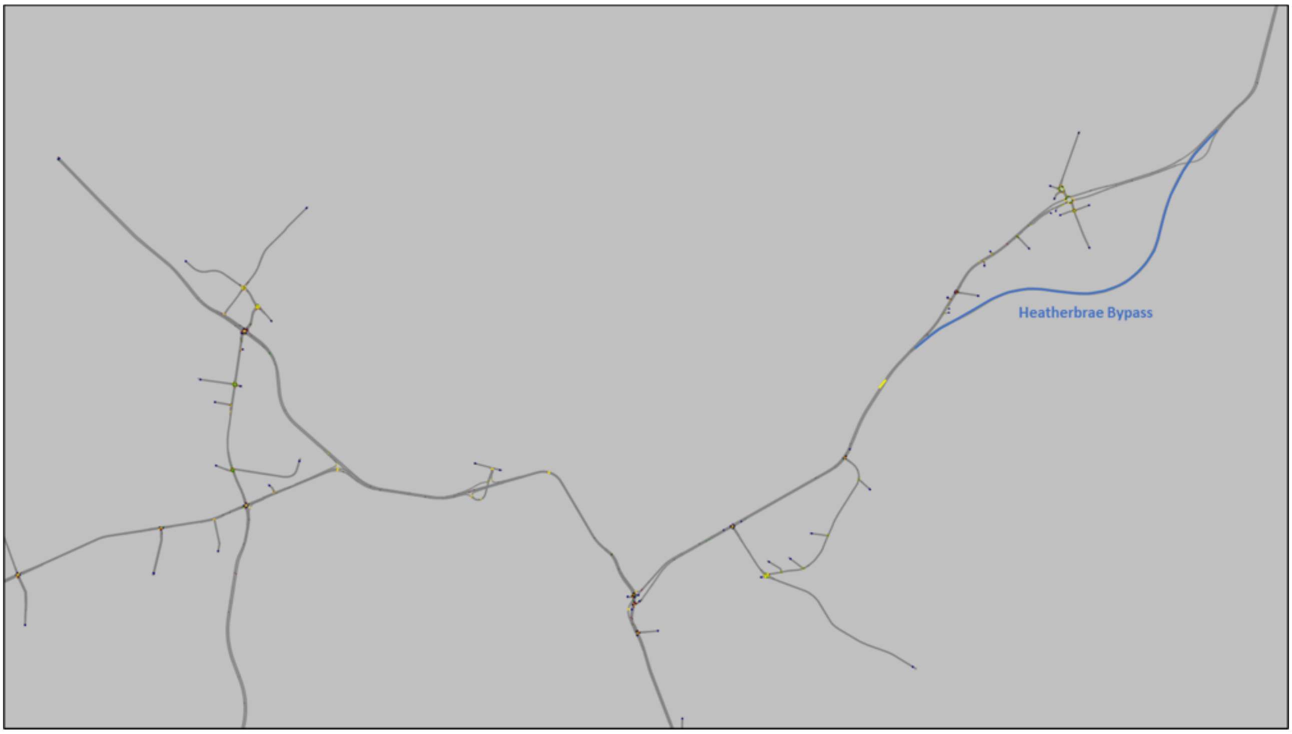


Figure B-1 Network layout for the Heatherbrae Bypass

B.1.2 Methodology

To assess the performance of these options, traffic modelling was carried out in PTV VISSIM (version 2020), with the models developed to represent 2028 conditions. The project model was used as the foundation for constructing the two traffic models, with model parameters such as signal phasing, speed profiles, modelled periods retained. The modelled period and the peak hour used for this assessment are shown in **Table** B-1.

Table B-1 Modelled peak periods

Period	Morning Peak	Evening Peak
Modelled period	6-9am	3-6pm
Peak hours (assessment periods)	8-9am	5-6pm

To understand the impact of the staged opening, model outputs such as network statistics, travel times and intersection delays were all key performance indicators.

B.1.3 Option 1

Option 1 is proposed to operate as a four-lane two-way Motorway with an exit ramp for northbound Heatherbrae traffic and a three-leg signalised intersection for southbound traffic from Heatherbrae.

The proposed layout and operation of Option 1 is presented in **Figure** B-2.

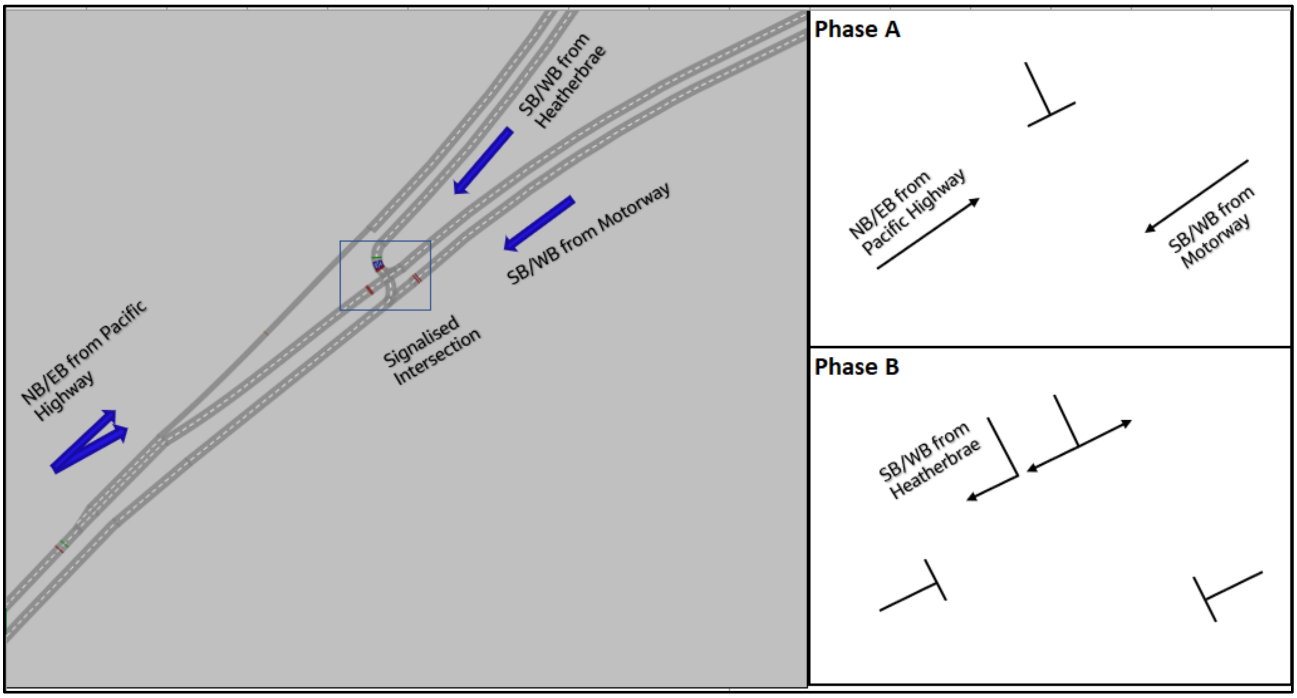


Figure B-2 Network coding overview for Option 1

The traffic signals for Option 1 were coded with VISVAP with 2 phases running at 120 seconds cycles. The mainline Motorway through movement (Phase A) was given priority and the Heatherbrae approach (Phase B) was activated when demand was detected through a detector-based approach. Any unused green time from the Heatherbrae approach (Phase B) was given back to the Motorway through movement (Phase A).

B.1.4 Option 2

Option 2 is proposed to operate with a signalised intersection on Pacific Highway. Access from Pacific Highway to and from the Motorway would be provided for by a signalised channelised right turn-style intersection for northbound Motorway traffic, and a signalised merge for southbound-Motorway traffic.

The proposed layout and operation of Option 2 is presented in **Figure** B-3.

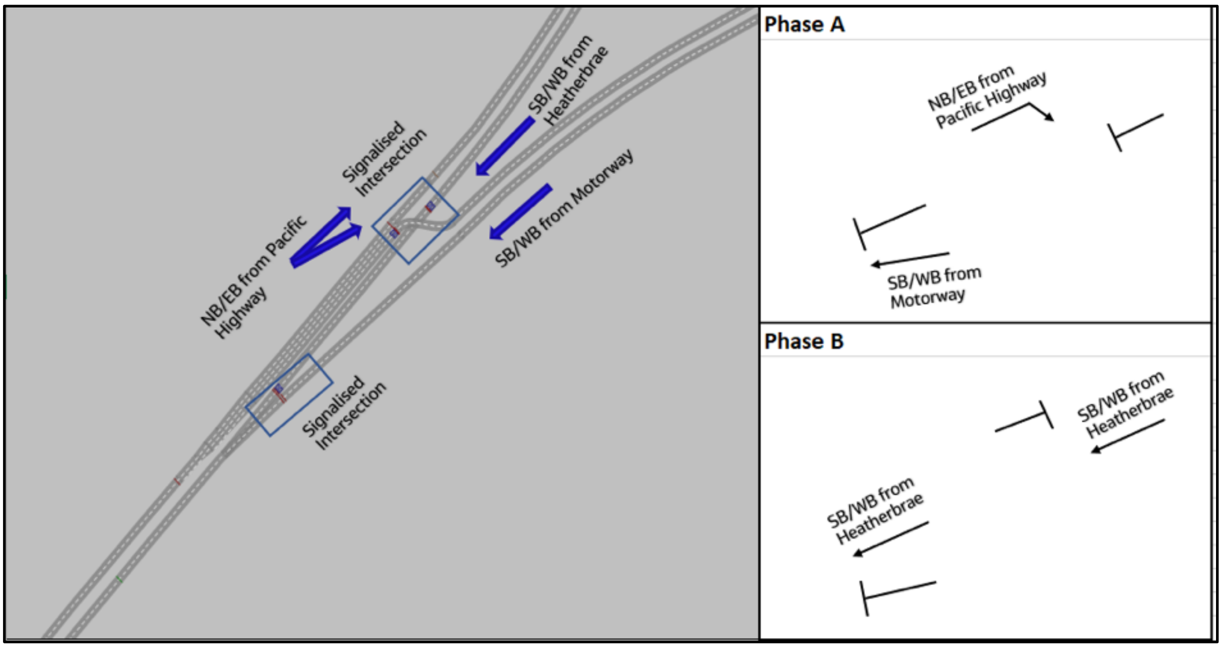


Figure B-3 Network coding overview for Option 2

The traffic signals for Option 2 were coded with VISVAP with two signals running on a single controller for 120 seconds cycle lengths. The eastbound approach from Pacific Highway and the westbound approach from the Motorway was given priority (Phase A). The westbound approaches from the Pacific Highway were modelled as detector-based approaches (Phase B). Any unused green time from the Westbound Pacific highway approach would be transferred back to the mainline (Phase A).

B.1.5 Road network performance

This section presents the VISSIM modelling results comparing Option 1 and Option 2. It focuses on network stats, travel times, queue and diverge analysis.

Traffic volumes

Modelled peak hour volumes for the various scenarios in 2028 are presented in **Figure** B-4. Traffic volumes from the Option 1 model have been included as a representation of the Heatherbrae Bypass. Analysis of the modelled traffic flows in 2028 shows the following key impacts throughout the network:

- The Heatherbrae Bypass reduces traffic on the Pacific Highway travelling through Heatherbrae
- The Heatherbrae Bypass does not result in increased traffic in the western area of the road network. Volumes are comparable to the ‘’Without Project’ model.

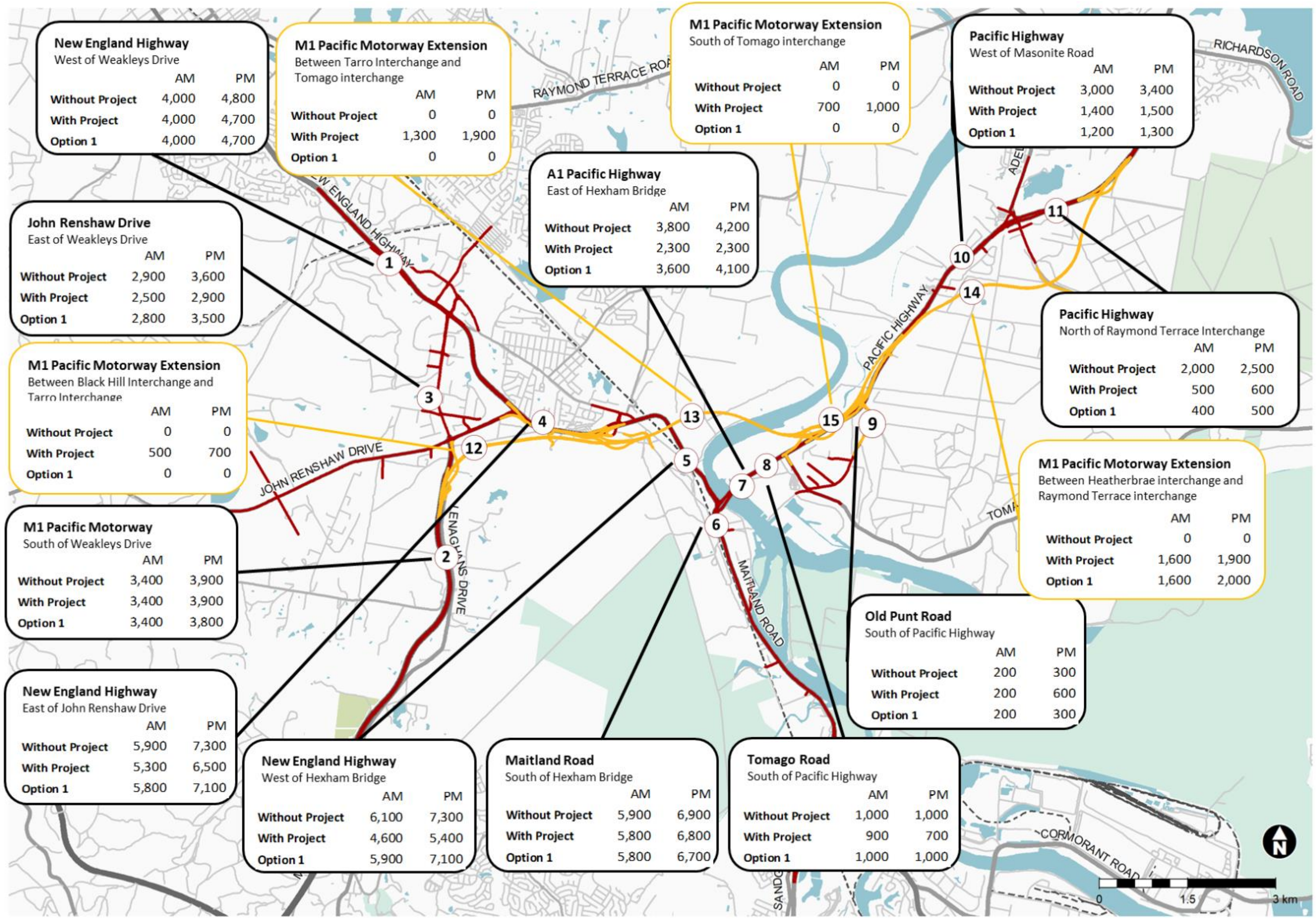


Figure B-4 2028 Peak period traffic volumes (8-9am and 5-6pm)

Travel time performance

For the Heatherbrae Bypass, a travel time comparison between Option 1 and Option 2 for eastbound and westbound movements was carried out for the route shown in **Figure** B-5. A comparison between the travel times from 'Without Project' and 'With Project' scenarios across the wider network is provided in **Figure** B-7 and **Figure** B-8. These figures display the travel times in the most congested hour during the morning and evening peak, which are 8-9am for the morning and 5-6pm for the evening peak. The figure displays the origin of vehicles at the bottom x-axis value and the destination as the top x-axis value.

Key travel time outcomes include:

- In the eastbound direction, travel time in Option 1 is approximately 15 seconds (15 per cent) faster than Option 2 in both peak periods. This travel time difference can be attributed to the requirement for the right turning movement in Option 2 to access the Motorway from the Pacific Highway, whereas in Option 1 this turning movement is not required to access to the Motorway
- In the westbound direction, travel time differences were minor as the difference between Option 1 and Option 2 results was under 2 to 3 seconds
- Travel times across the wider network are similar for Option 1 and Option 2, with minor variations occurring on some routes. Travel times for both Heatherbrae Bypass models are generally equal to, or less than those in the 'Without Project' scenario, indicating the staged opening would not negatively impact other areas of the wider road network.

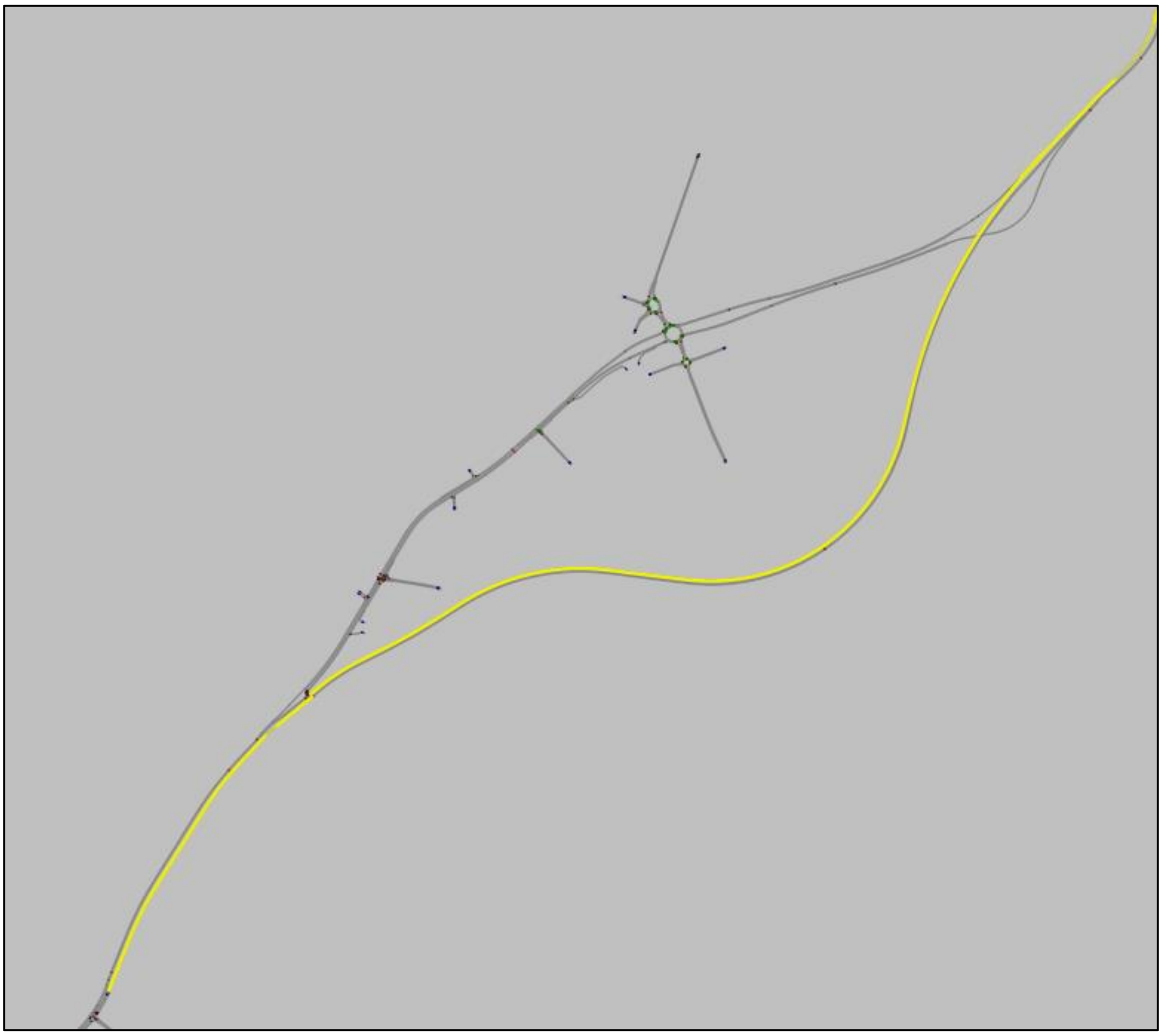


Figure B-5 Travel time route for the Heatherbrae Bypass

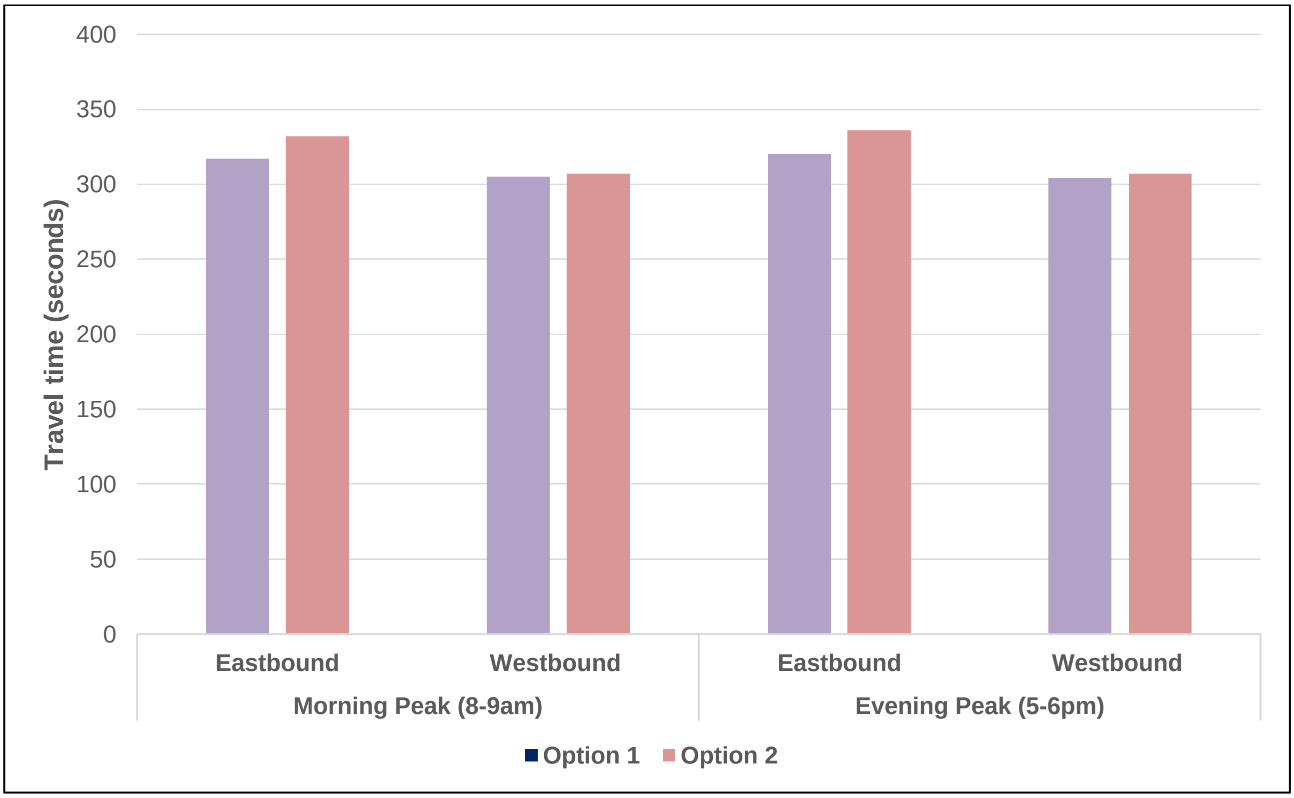
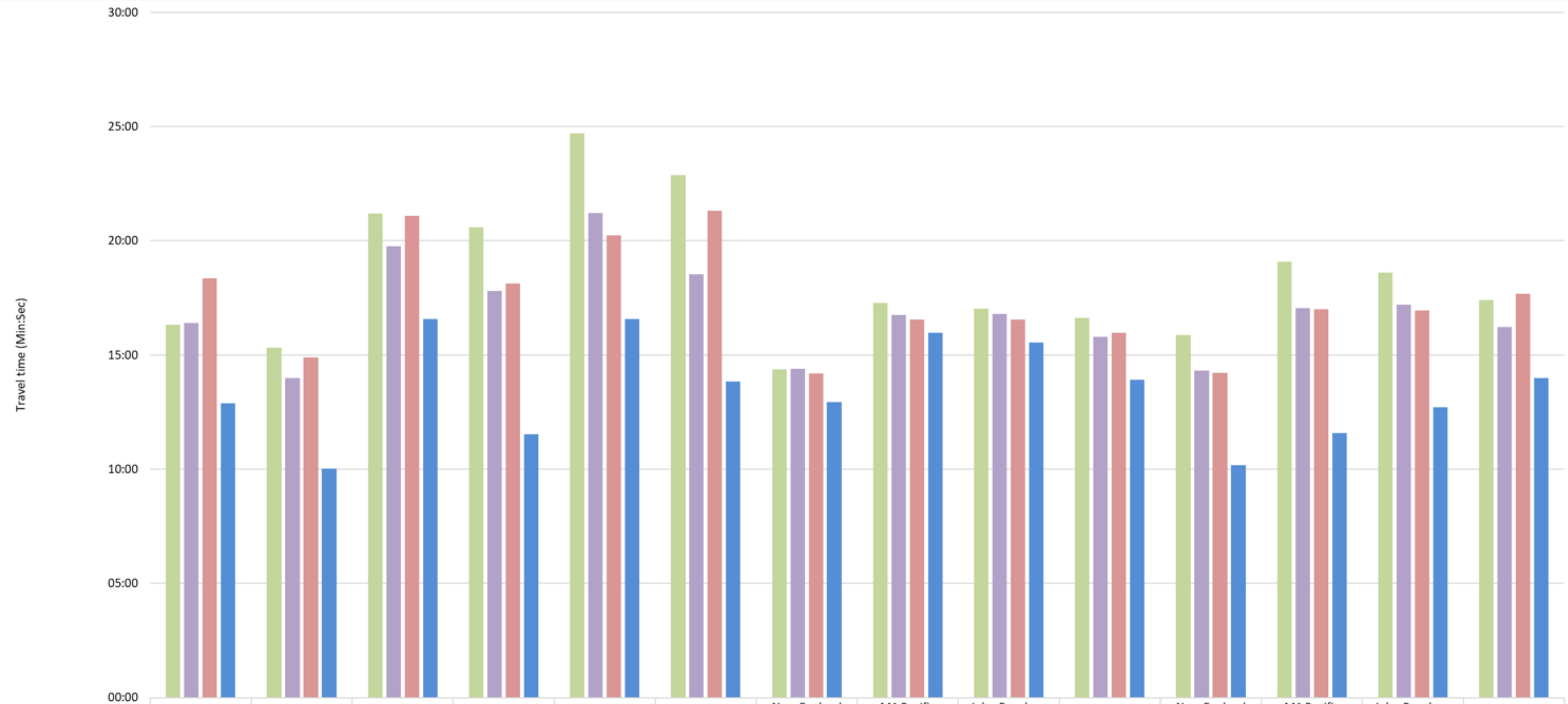
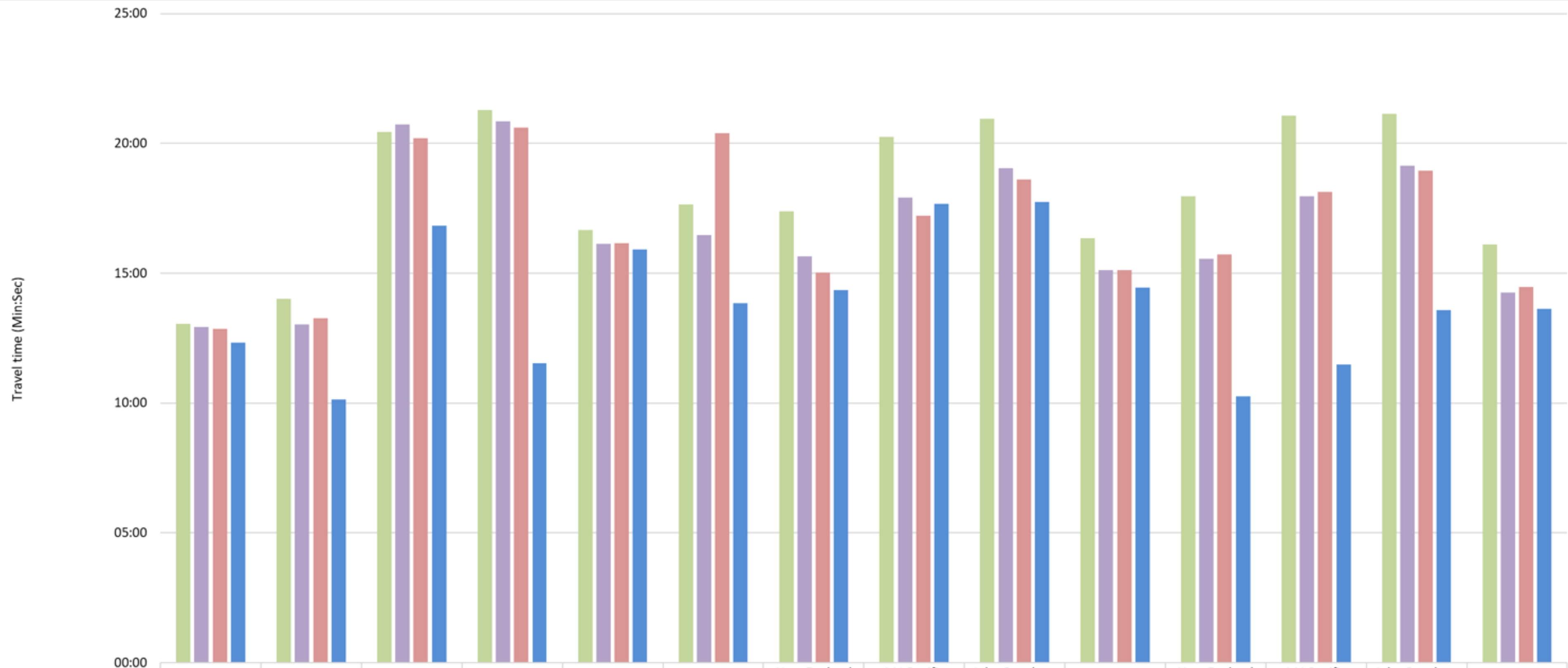


Figure B-6 Average travel time observed in seconds for morning and evening peak hours



Destination	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Maitland Road
Origin	New England Highway		M1 Pacific Motorway		John Renshaw Drive		Maitland Road				Pacific Highway			
2028 Without Project	16:20	15:20	21:11	20:35	24:43	22:53	14:23	17:16	17:02	16:37	15:52	19:05	18:37	17:24
2028 Option 1	16:24	13:59	19:46	17:49	21:13	18:32	14:24	16:45	16:47	15:48	14:19	17:03	17:12	16:14
2028 Option 2	18:22	14:53	21:05	18:08	20:14	21:19	14:11	16:33	16:33	15:58	14:13	16:59	16:57	17:41
2028 With Project	12:54	10:02	16:34	11:32	16:35	13:51	12:56	15:59	15:33	13:55	10:10	11:34	12:43	14:00

Figure B-7 Morning peak (8-9am) travel times across the network



Origin	New England Highway		M1 Pacific Motorway		John Renshaw Drive		Maitland Road				Pacific Highway			
Destination	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Maitland Road
2028 Without Project	13:03	14:01	20:26	21:17	16:39	17:39	17:23	20:14	20:57	16:21	17:58	21:04	21:07	16:07
2028 Option 1	12:55	13:02	20:44	20:51	16:08	16:28	15:39	17:55	19:02	15:07	15:33	17:57	19:08	14:15
2028 Option 2	12:52	13:16	20:12	20:36	16:08	20:24	15:01	17:13	18:36	15:07	15:43	18:07	18:57	14:28
2028 With Project	12:20	10:07	16:49	11:32	15:55	13:51	14:21	17:40	17:44	14:27	10:16	11:29	13:34	13:37

Figure B-8 Evening peak (5-6pm) travel times across the network

Network statistics

Network statistics provide an overview of the performance of the road network and is used to compare the performance of each modelled scenario. A comparison of the network statistics between the 'Without Project' (No project), 'With Project' (EIS project as single delivery), 'Option1' and 'Option 2' scenarios are provided in **Table** B-2.

Comparison of the network statistics outputs for the 2028 horizon year indicates that:

- The two options display similar outcomes in terms of network performance
- For both the options, the average network speed is approximately 60 km/hr in the morning peak hour and 56 km/hr in the evening peak hour
- Both models have similar levels of throughput
- There is a slight decrease in the total throughput for Option 1 and Option 2 in comparison to the' Without Project' scenario. The Heatherbrae Bypass improves the ability for vehicles to travel to the southern extent of the model where higher levels of congestion occur, this results in an increase in latent demand at the southern extent of the model at Maitland Road. The levels of latent demand are not impacted by either of the two options.

Table B-2 Network statistics from models

Network statistic	Morning peak				Evening peak			
	Without Project	With Project	Option 1	Option 2	Without Project	With Project	Option 1	Option 2
Total throughput	42,801	42,927	42,372	42,392	47,787	48,048	47,382	47,517
Network speed (km/h)	59	64	60	60	55	61	56	56

Intersection performance

The performance of the new intersection on Pacific Highway required to deliver the staged open in both Option 1 and Option 2 is shown in **Table** B-3. The operational performance at key intersections in the wider network is presented in **Table** B-4, LoS D is generally the accepted target performance level.

Analysis of the modelled intersections shows that the key differences in intersection performance are primarily at the following locations:

- In terms of intersection performance, Option 1 and Option 2 operate at a LoS C in morning and evening peaks. Option 1 displayed slightly lower levels of intersection delay in both peak periods
- Across the network, Option 1 and Option 2 display similar delays at the assessed signalised intersection.

Table B-3 Intersection delay and LoS

Intersection Name	Morning Peak (8-9am)		Evening Peak (5-6pm)	
	Overall Delay (S)	Overall LoS	Overall Delay (S)	Overall LoS
Option 1	22	C	21	C
Option 2	23	C	23	C

Table B-4 Performance of modelled intersections in 2028

Intersection	Type	2028 'Without Project'				2028 'With Project'				2028 Option 1				2028 Option 2			
		8-9am		5-6pm		8-9am		5-6pm		8-9am		5-6pm		8-9am		5-6pm	
		Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS	Avg delay (sec)	LoS
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	83	F	93	F	60	E	62	E	62	E	90	F	73	E	91	F
New England Highway/Weakleys Drive, Beresfield	Signalised	18	B	20	B	28	C	33	C	31	C	43	D	27	C	20	C
New England Highway/Maitland Road/Pacific Highway	Signalised	18	B	48	D	23	C	30	C	17	B	33	C	18	B	34	C
Pacific Highway/Tomago Road, Tomago	Signalised	18	B	18	B	17	B	15	B	16	B	18	B	16	B	17	B
Pacific Highway/Old Punt Road, Tomago	Signalised	10	A	9	A	5	A	5	A	8	A	7	A	9	A	7	A
Old Punt Road/Tomago Road, Tomago	Roundabout	4	A	3	A	3	A	5	A	0	A	0	A	0	A	0	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	12	B	10	B	11	B	9	A	12	B	10	A	12	B	10	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	17	B	3	A	4	A	3	A	3	A	3	A	3	A

* *Cells with pink shading represent intersections where performance is worse than LoS D*

Queues

To understand the performance of the two proposed Heatherbrae Bypass options, queues at the proposed intersections were evaluated. For Option 1, the storage capacity was found to be sufficient to accommodate maximum queues. A length of 183 metres from the stop line has been provided as shown in **Figure** B-9, whereas the maximum queue length observed was 105 metres in the morning peak and 140 meters in the evening Peak.

The average and maximum modelled queues were found to be within a reasonable range. No special provision or geometrical modifications would be required to incorporate the maximum queue length on any approach. The average and maximum queue length observed has been summarised in **Table** B-5.

Figure B-9 Length of diverge ramp in Option 1

Table B-5 Average and maximum queue observed in the morning peak

Scenario	Approach name	Morning peak (8-9am)		Evening peak (5-6pm)	
		Average queue length (m)	Max. queue length (m)	Average queue length (m)	Max. queue length (m)
Option 1	Pacific Highway Diverging Ramp (EB) -TH	7	105	14	140
	Motorway (WB)- TH	6	81	7	119
	Pacific Highway (SB) - LT+RT	32	125	32	115
Option 2	Motorway Western Intersection (WB) - TH	11	111	11	140
	Pacific Highway Western Intersection (WB) - TH	3	29	2	29
	Pacific Highway Eastern Intersection (WB)- TH	23	107	23	99
	Pacific Highway Eastern Intersection (EB) - TH + RT	12	107	22	143

Interchange analysis

A merge and diverge analysis was carried out at the newly proposed motorway entry and exit ramp to the Heatherbrae Bypass. This determined the performance of the ramp-motorway junction (merge/diverge influence area) by assessing the density of vehicles in the influence area and the volume to capacity ratio (V/C) of the entry and exit ramps. Analysis was based on calculations for motorway merge and diverge segments stipulated in the Transportation Research Board's 'Highway Capacity Manual 2016' (HCM 2016) (Transportation Research Board 2016).

Table B-6 presents the analysis results for merge and diverge segments in the Heatherbrae Bypass in 2028. The results indicate that the diverge and merges associated with the Heatherbrae Bypass are expected to perform satisfactorily in 2028 during each peak period.

Table B-6 Performance of modelled interchanges for 2028

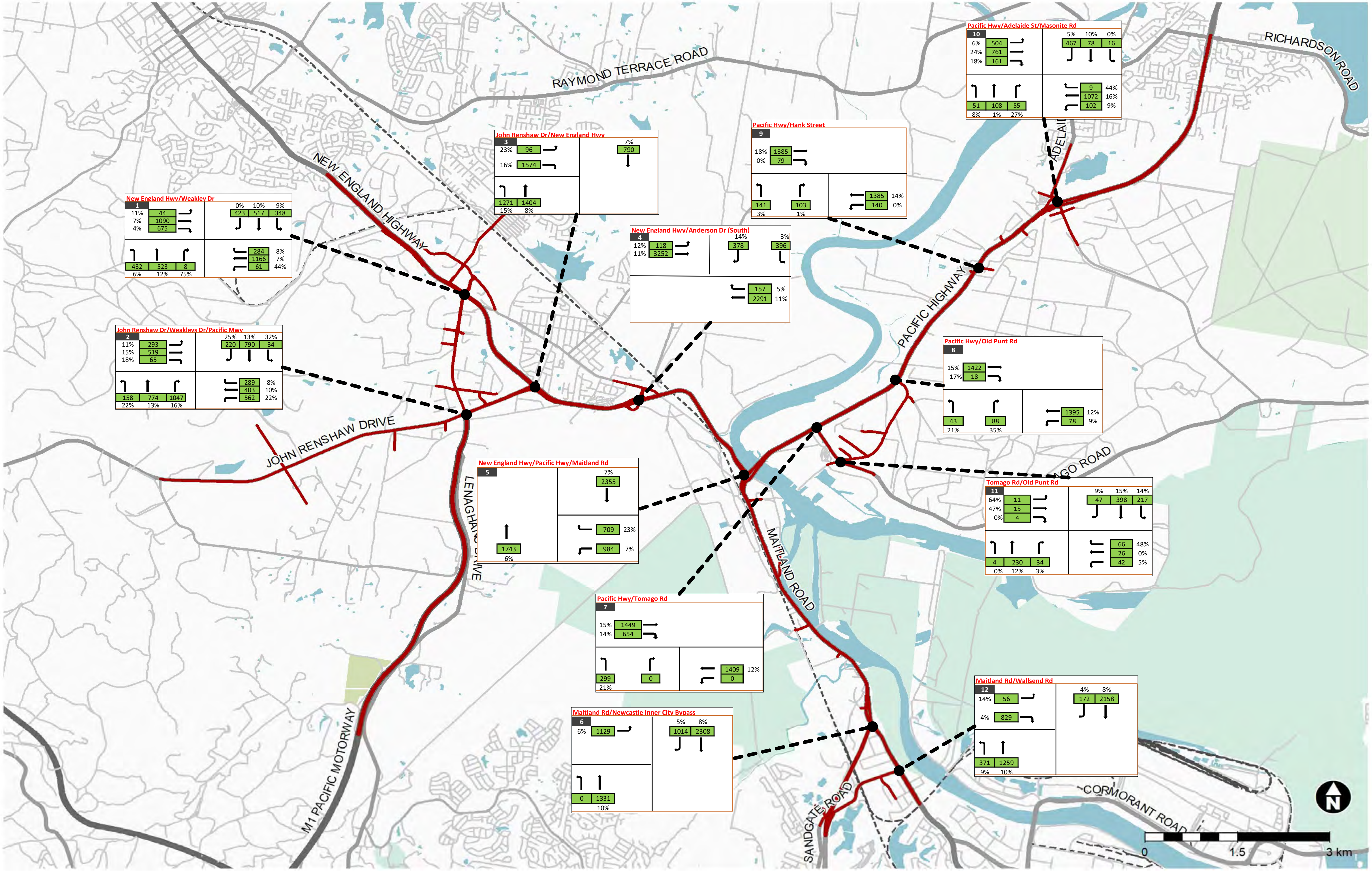
Intersection	8-9am			5-6pm		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Option 1 - Tomago - Eastbound Diverge 1	17.08	0.61	C	19.63	0.71	D
Option 1 - Raymond Terrace interchange - Eastbound Merge	7.55	0.29	B	11.45	0.44	B
Option 1 - Raymond Terrace interchange - Westbound Diverge	12.05	0.46	B	10.64	0.41	B

Appendix C Flow diagrams

Scenario	2028 AM Peak Do Minimum	Period	8 am - 9 am

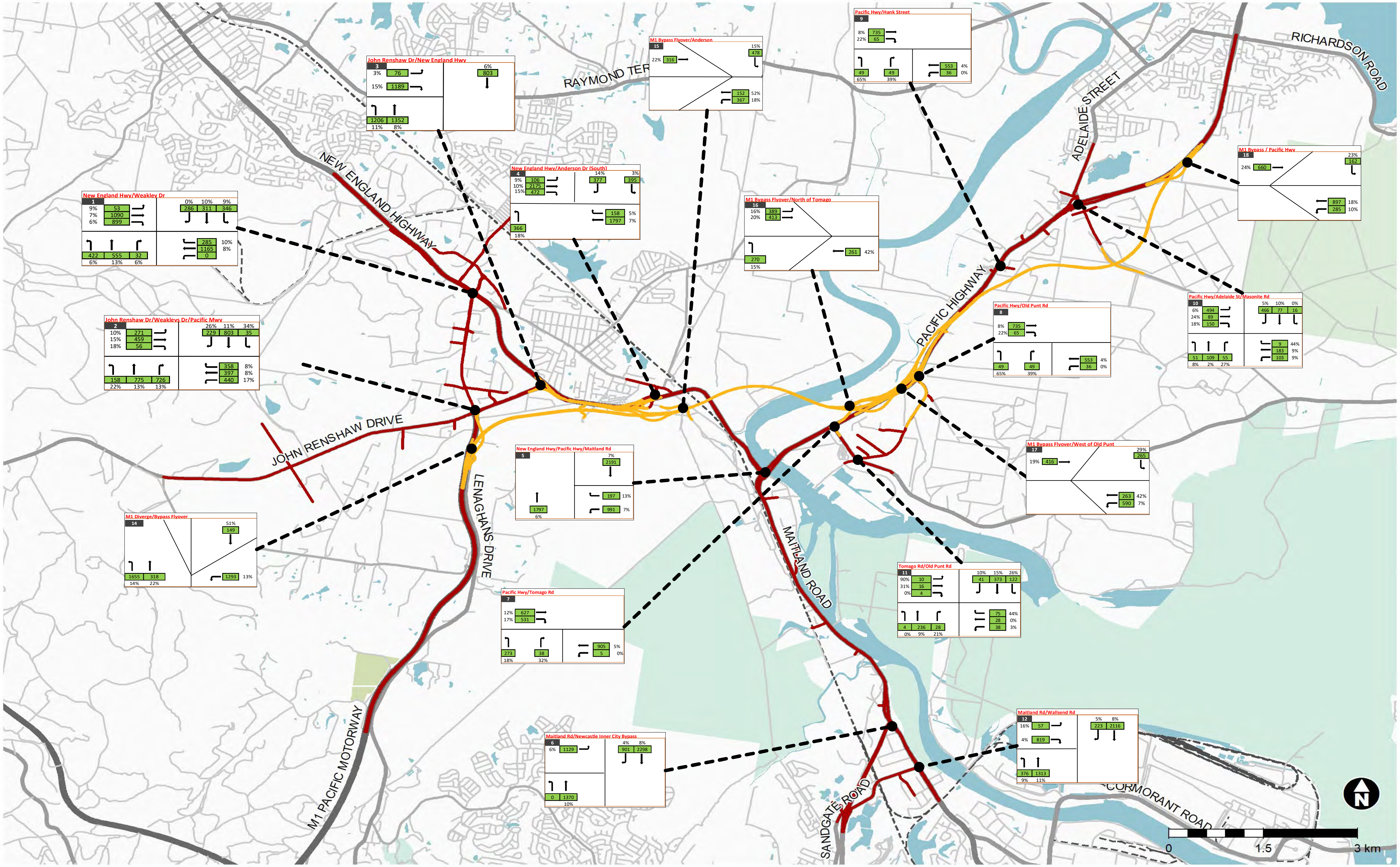
1449 Traffic Movement

48% Heavy vehicle share



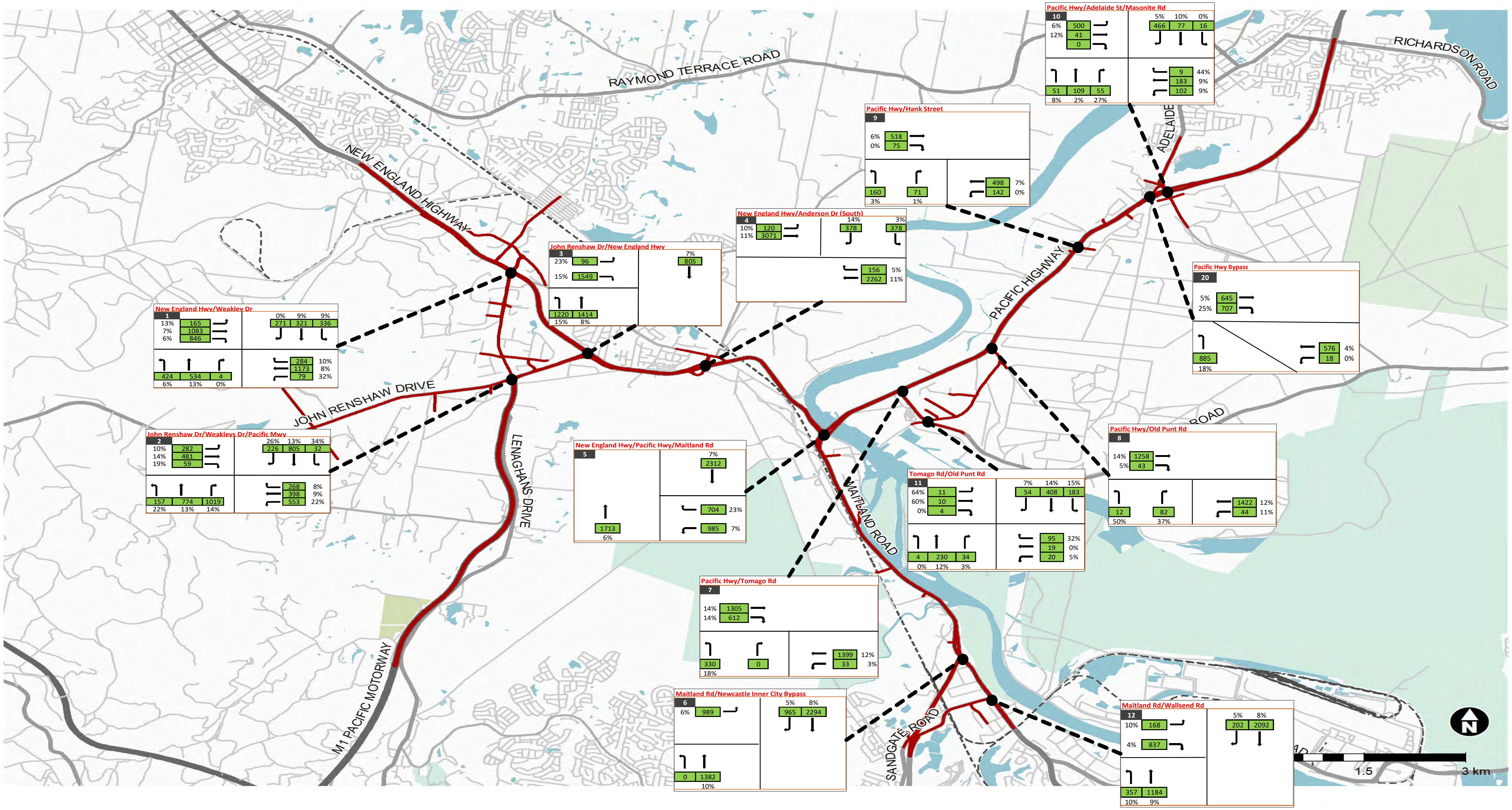
Scenario	2028 AM Peak with Project	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



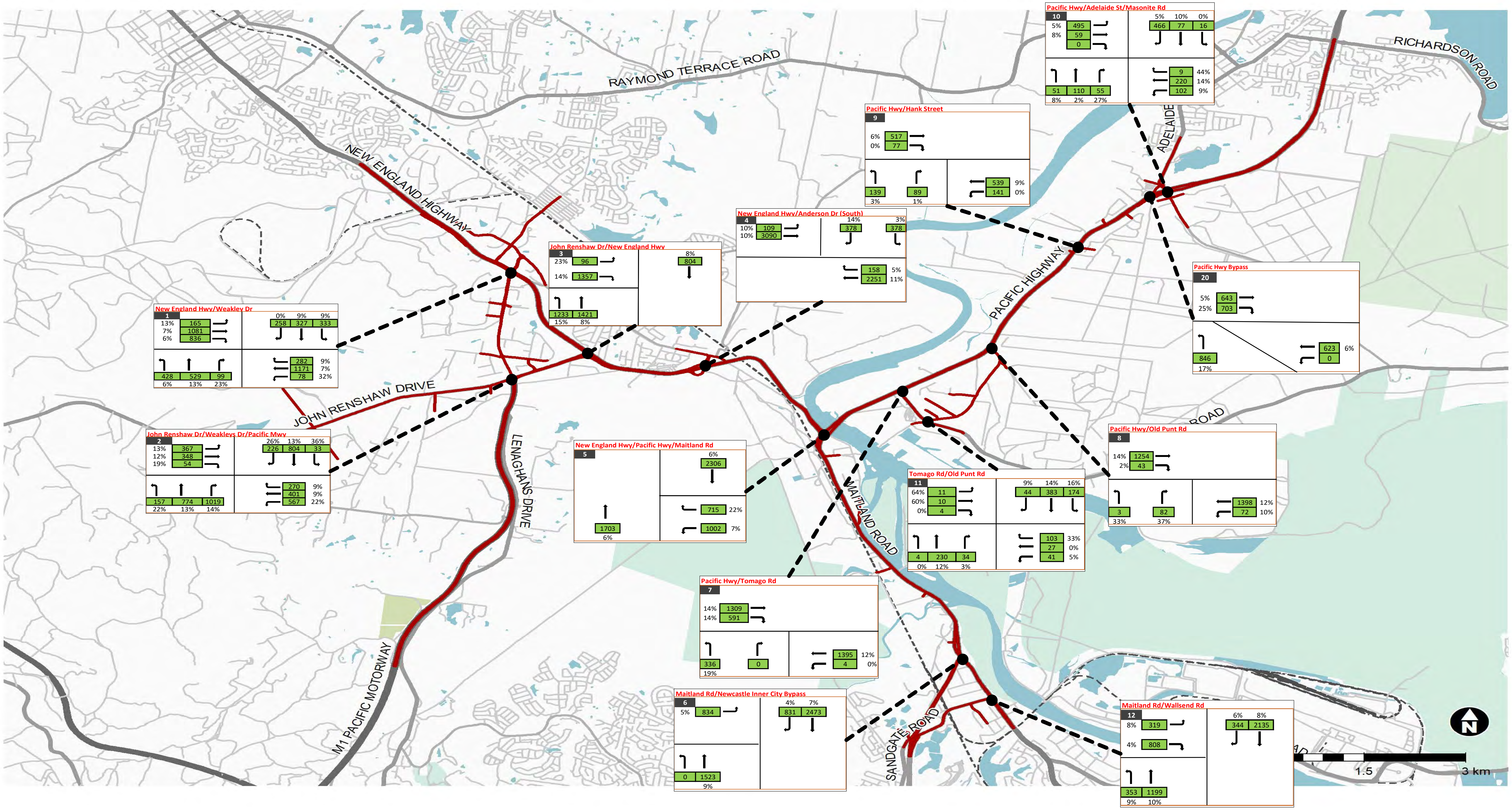
Scenario	2028 AM Peak Option 1	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



Scenario	2028 AM Peak Option 2	Period	8 am - 9 am

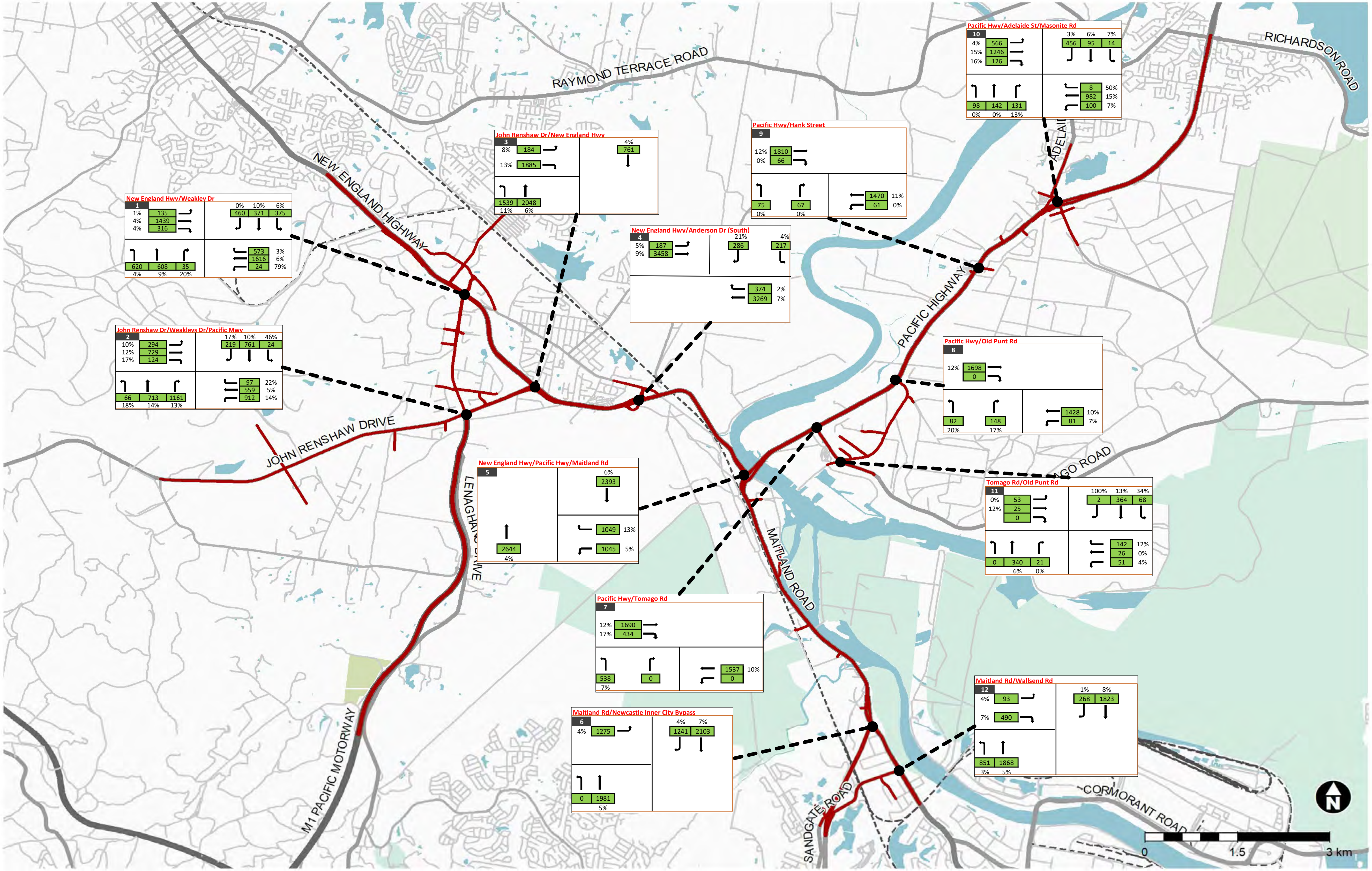
1449 Traffic Movement
48% Heavy vehicle share



Scenario	2028 PM Peak Do Minimum	Period	5 pm - 6 pm

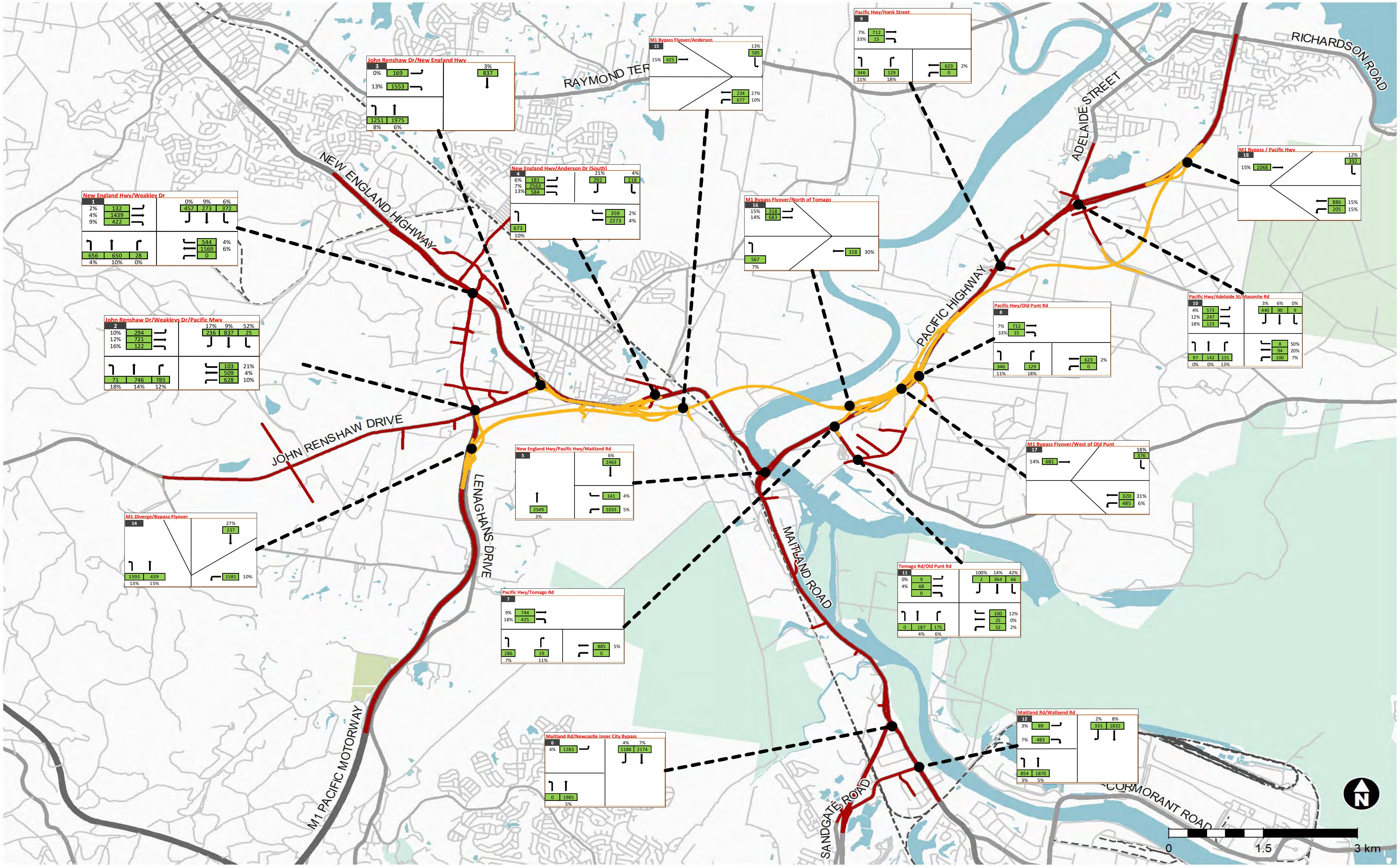
1449 Traffic Movement

48% Heavy vehicle share



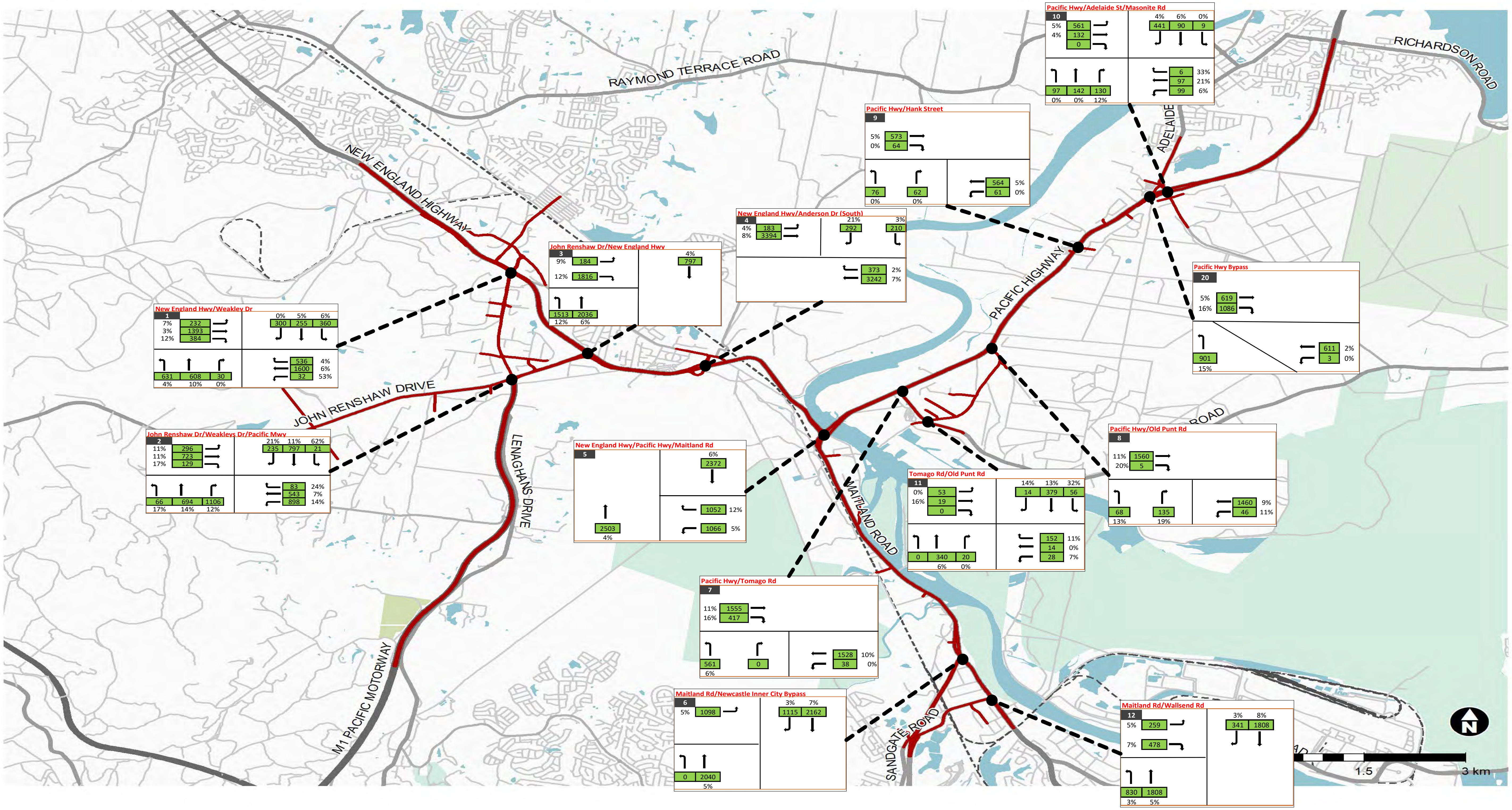
Scenario	2028 PM Peak with Project	Period	5 pm - 6 pm

1449 Traffic Movement
48% Heavy vehicle share



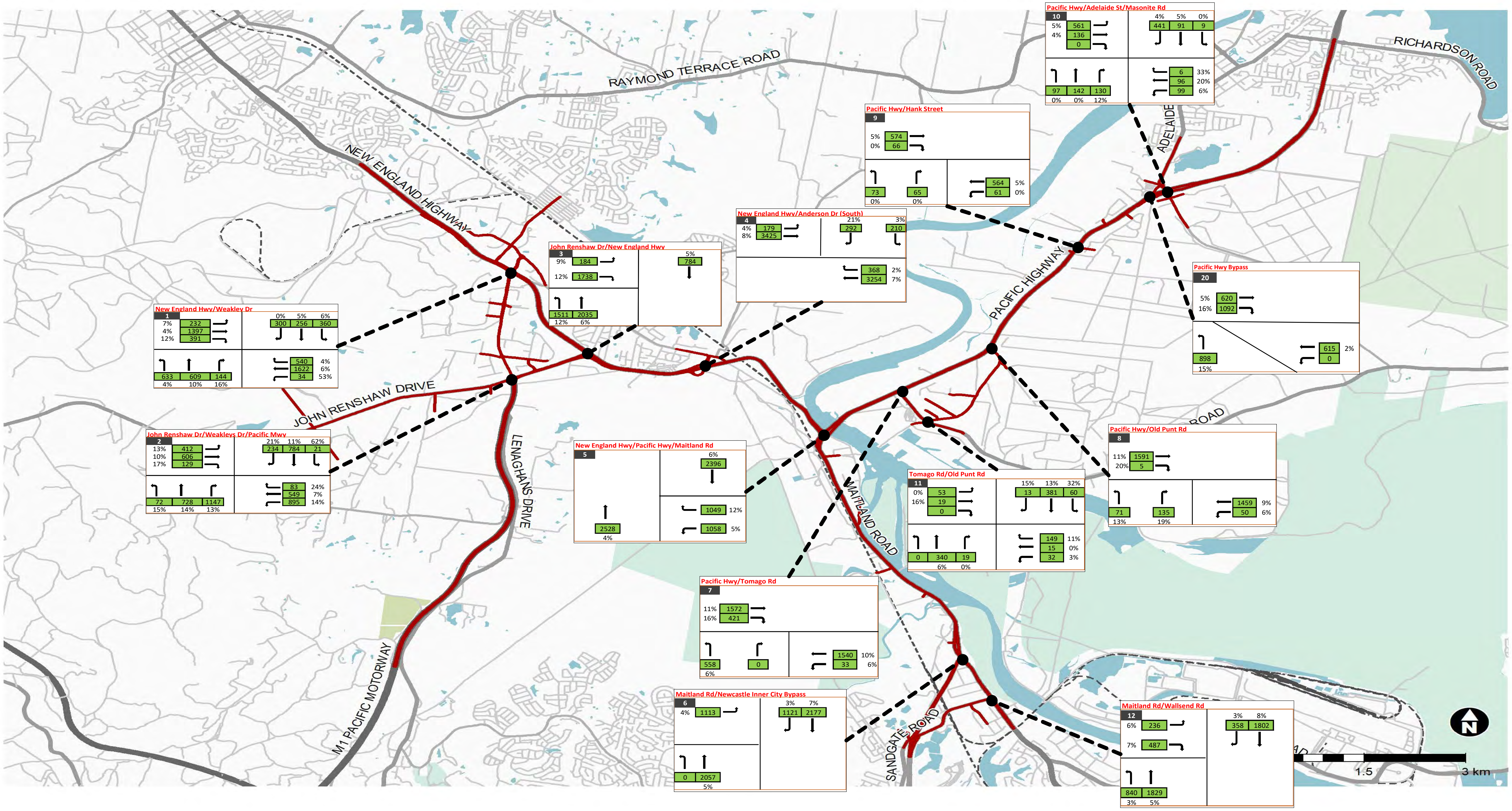
Scenario	2028 PM Peak Option 1	Period	5 pm - 6 pm

1449 Traffic Movement
48% Heavy vehicle share



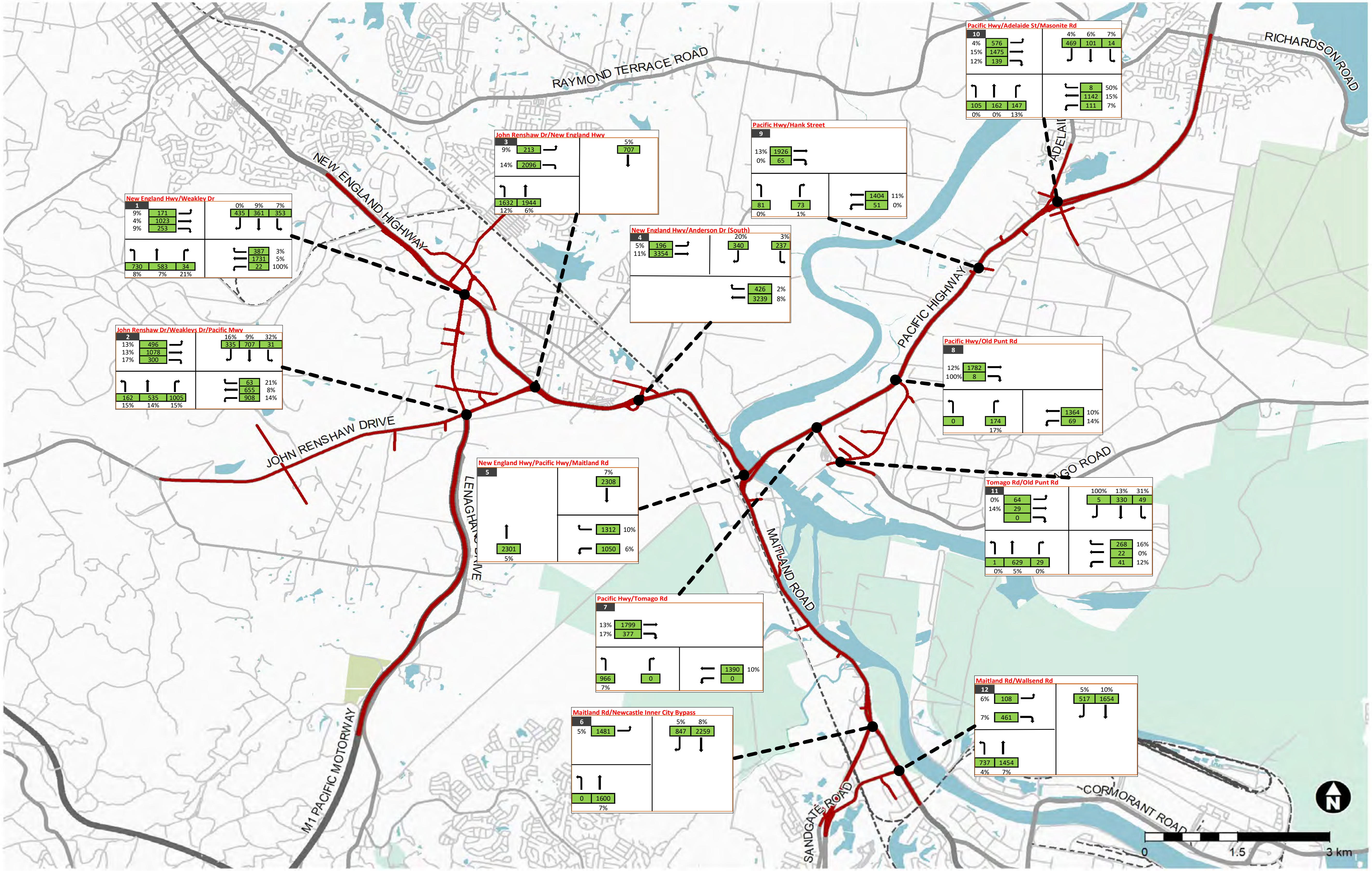
Scenario	2028 PM Peak Option 2	Period	5 pm - 6 pm

1449 Traffic Movement
48% Heavy vehicle share



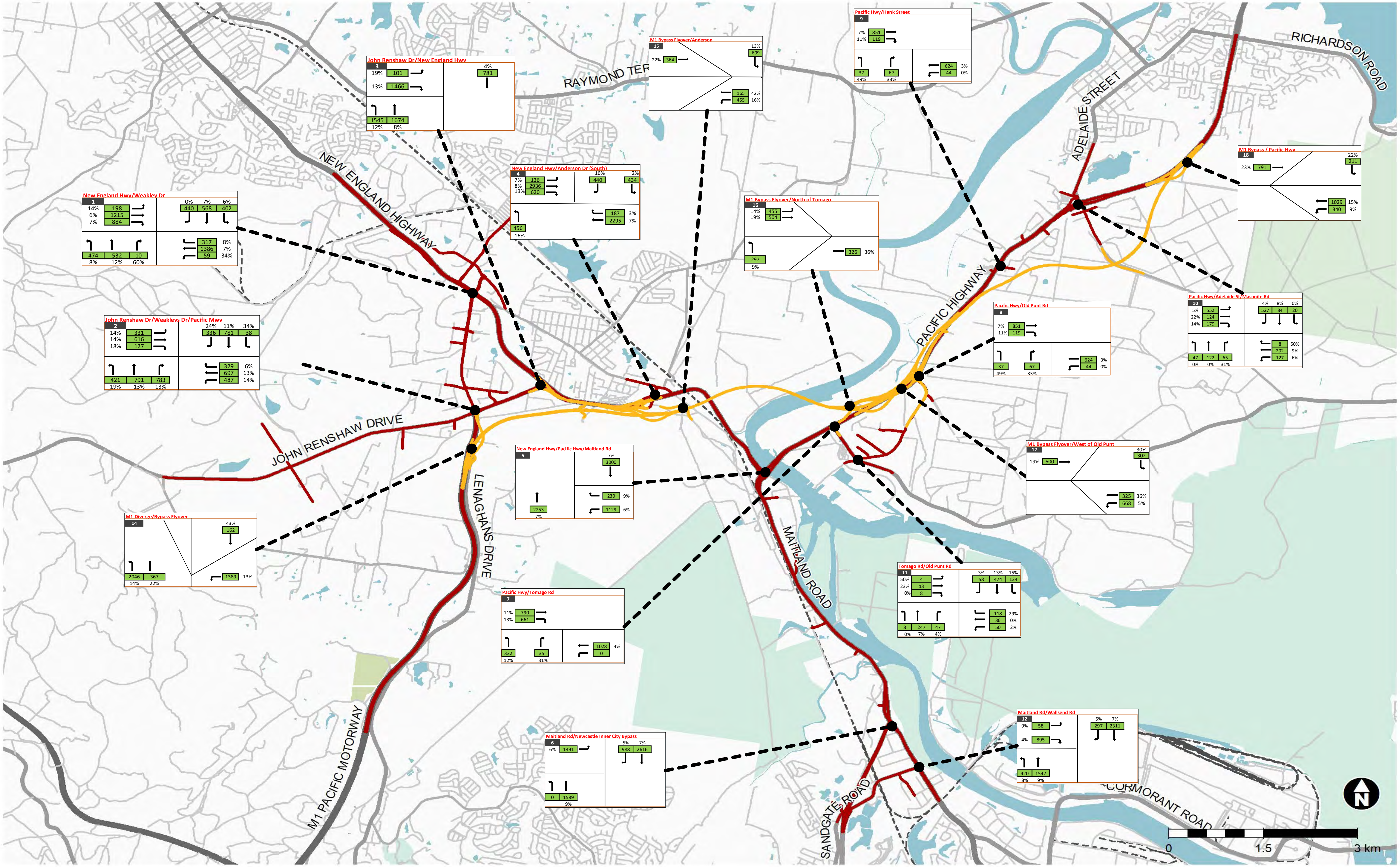
Scenario	2038 AM Peak Do Minimum	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



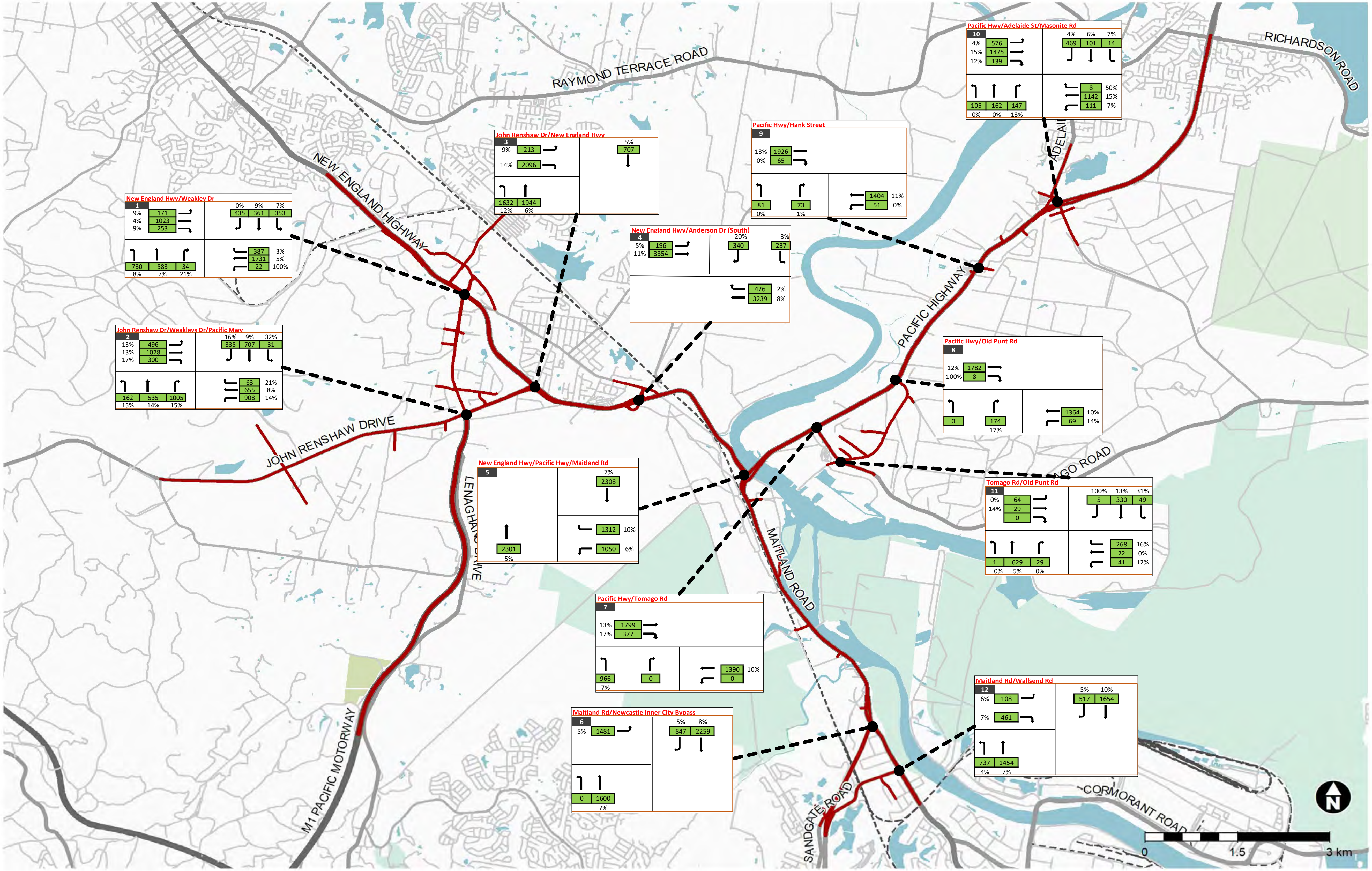
Scenario	2038 AM Peak with Project	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



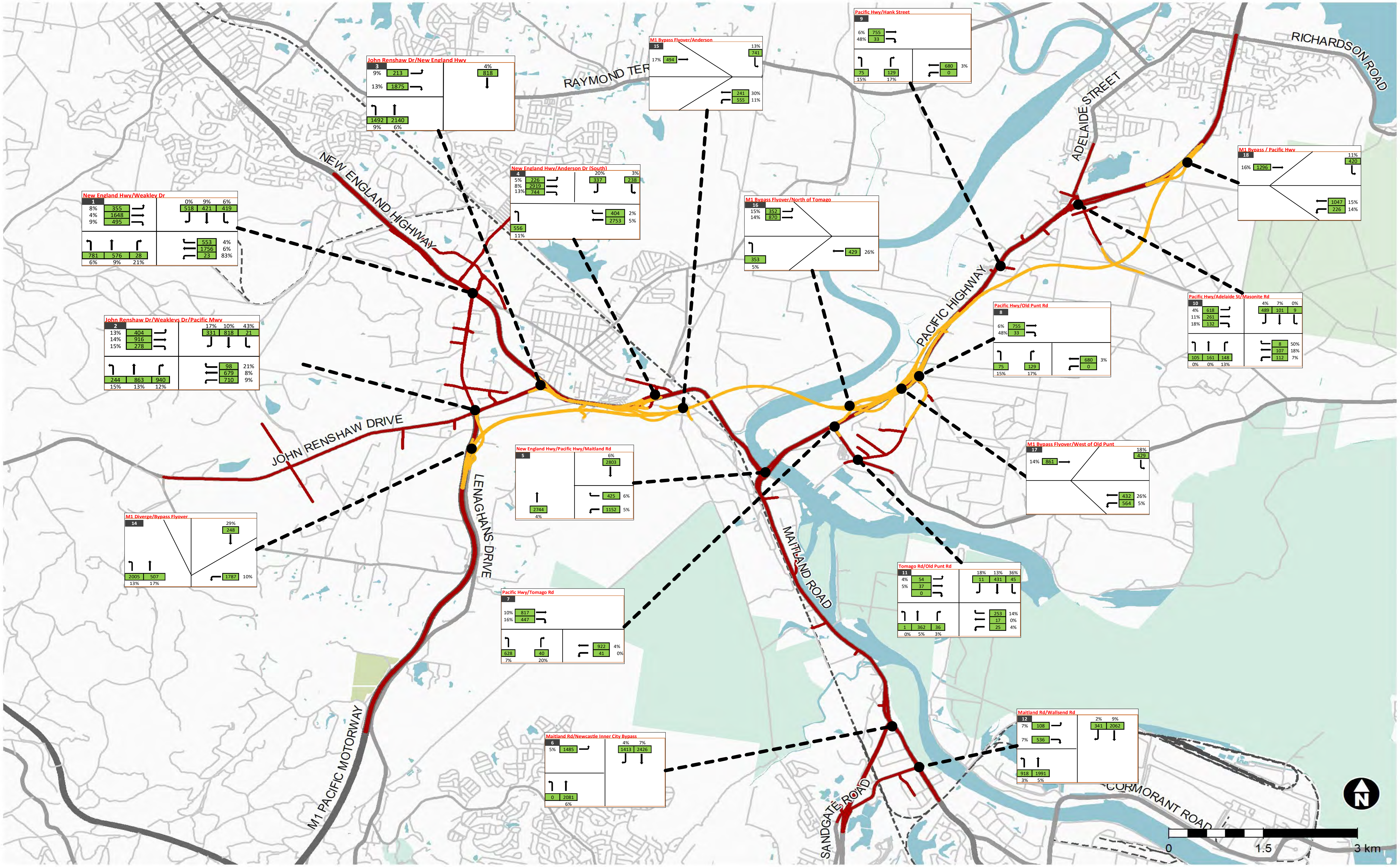
Scenario	2038 PM Peak Do Minimum	Period	5 pm - 6 pm

1449	Traffic Movement
48%	Heavy vehicle share



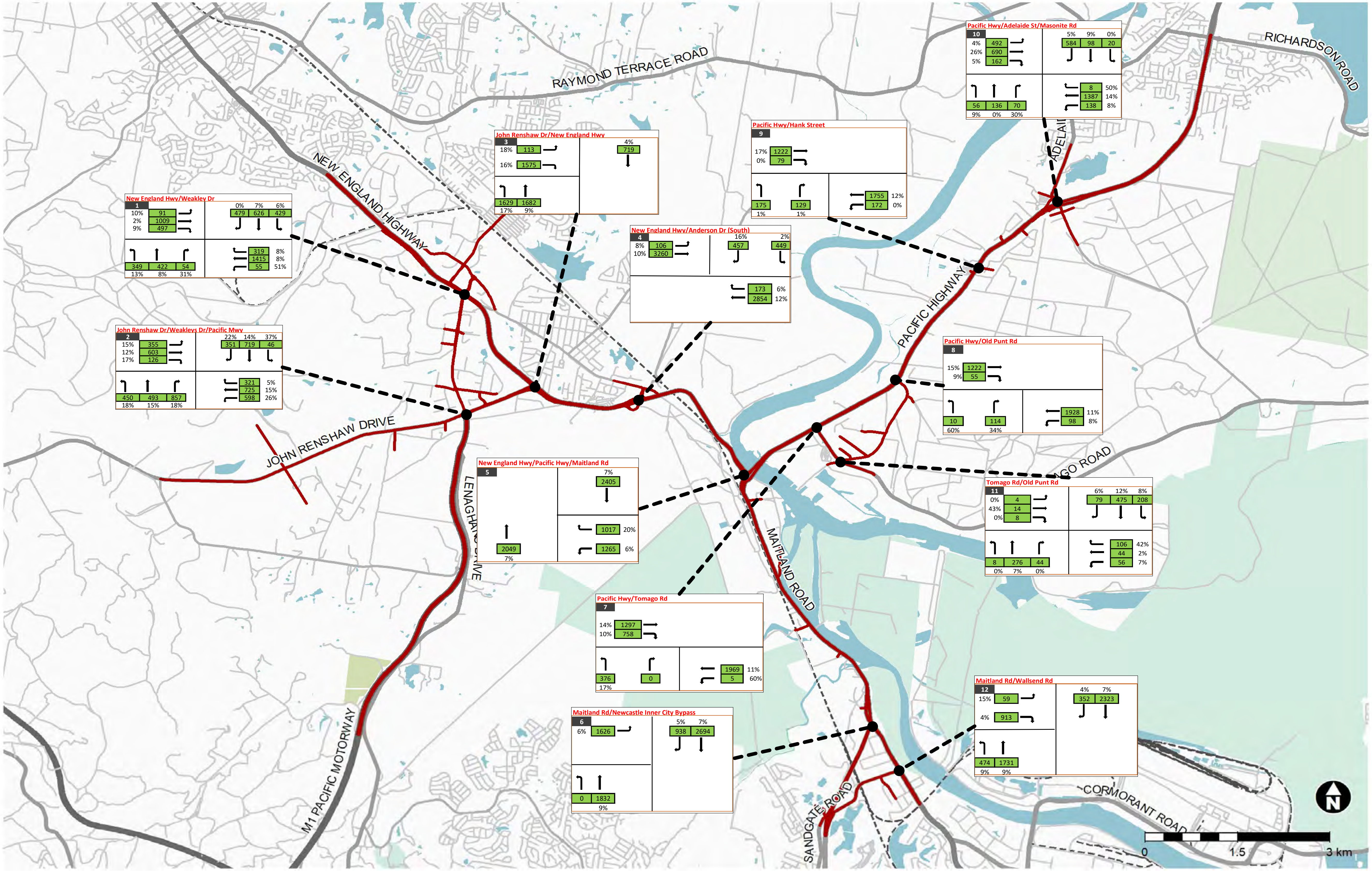
Scenario	2038 PM Peak with Project	Period	5 pm - 6 pm

1449 Traffic Movement
48% Heavy vehicle share



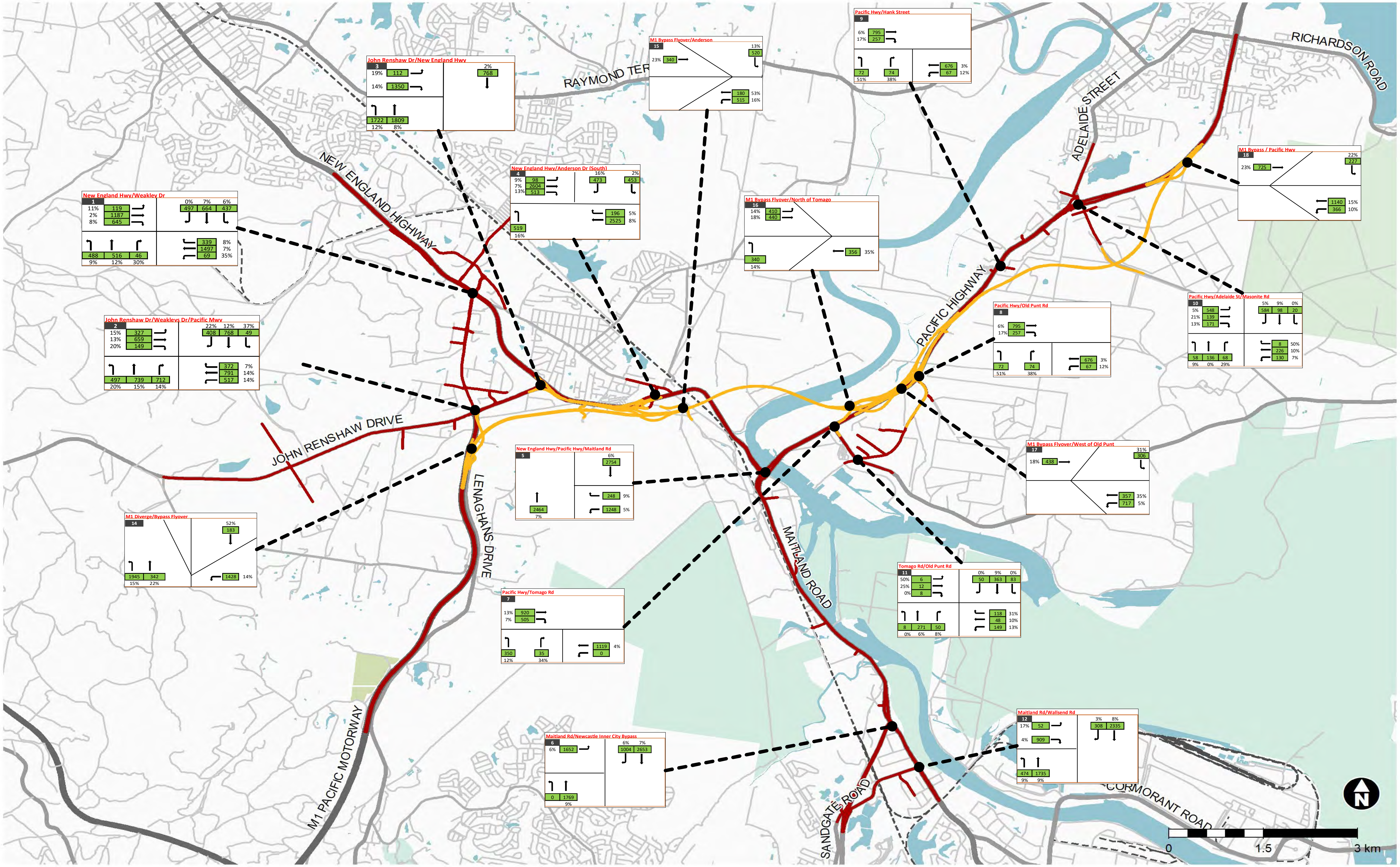
Scenario	2048 AM Peak Do Minimum	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



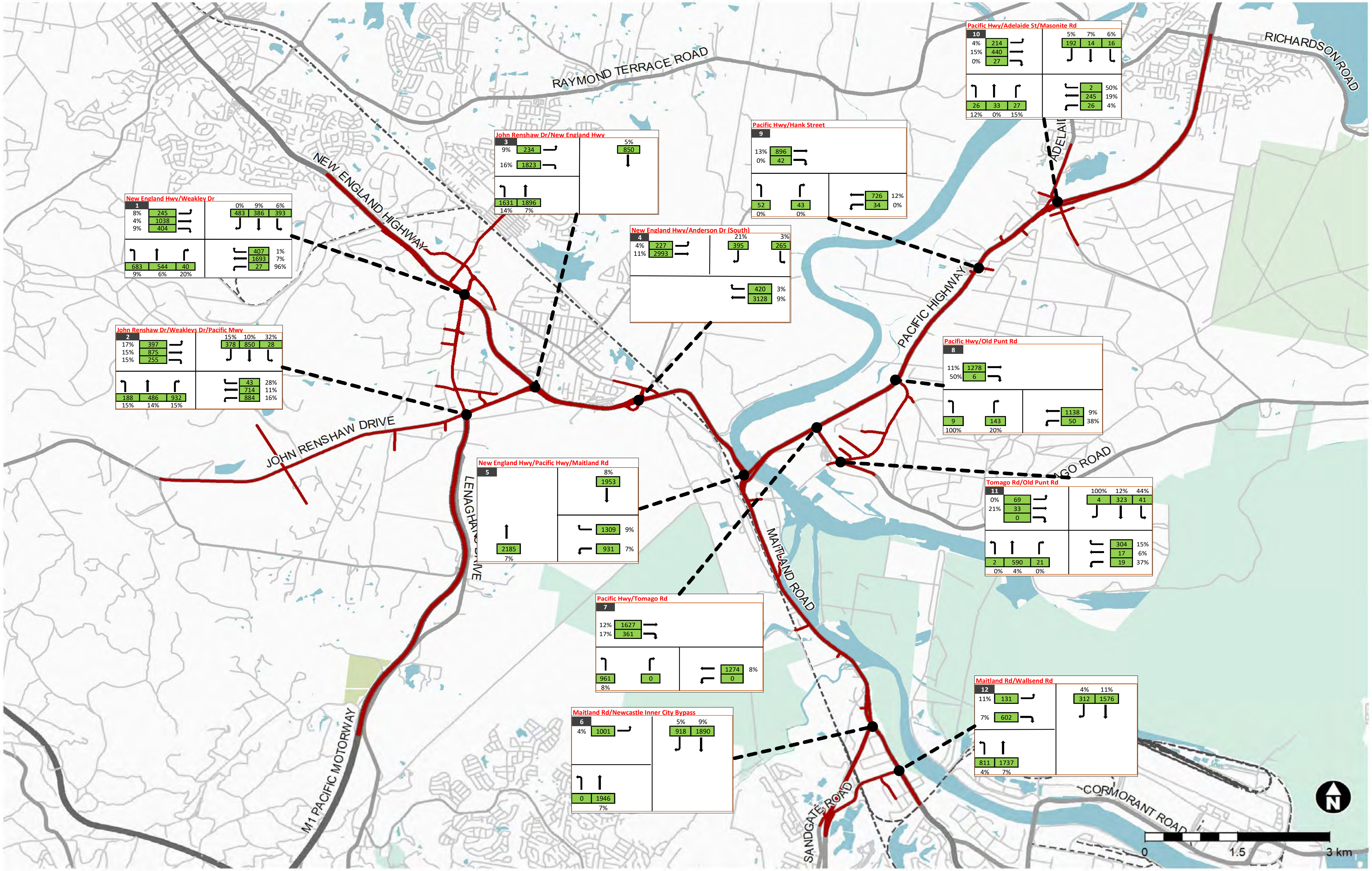
Scenario	2048 AM Peak with Project	Period	8 am - 9 am

1449 Traffic Movement
48% Heavy vehicle share



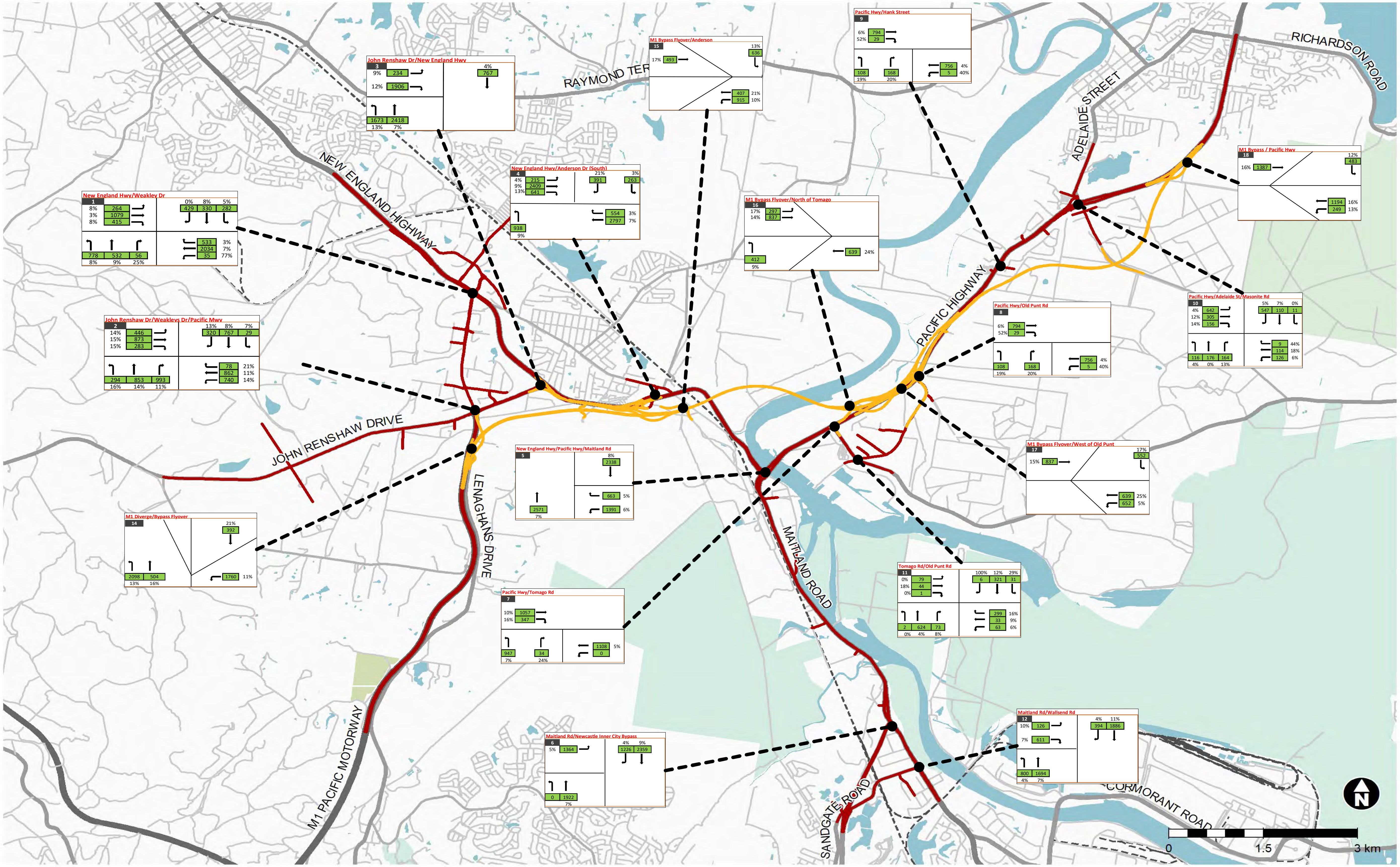
Scenario	2048 PM Peak Do Minimum	Period	5 pm - 6 pm

1449	Traffic Movement
48%	Heavy vehicle share



Scenario	2048 PM Peak with Project	Period	5 pm - 6 pm

1449 Traffic Movement
48% Heavy vehicle share



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