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M1 Pacific Motorway extension to Raymond Terrace

Traffic and Transport Working Paper

Transport for NSW | July 2021

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Executive summary

Background

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 1999*.

Performance outcomes

This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSI 7319) relating to transport and traffic. In addition, the desired performance outcomes for the project in relation to transport and traffic as outlined in the SEARs (SSI 7319) are to:

- Manage and minimise impact to network connectivity, safety and efficiency of the transport system in the vicinity of the project
- Maintain the safety of transport system customers
- Effectively manage the impact on network capacity and the Level of Service (LoS)
- Ensure works are compatible with existing and planned infrastructure and future transport corridors.

Transport and traffic impacts

Transport has carried out extensive assessment comprising of traffic modelling and qualitative analysis for the project for the opening year (2028) and future years (2038 and 2048). The construction, operational and cumulative impacts of the project have been identified from quantitative performance indicators such as network statistics, level of service and travel time and qualitative assessment. Key findings include:

- Construction impact:
  - Minimal impacts to residential properties are expected during construction, although there are several impacts to existing commercial access arrangements in Black Hill, Tarro, Tomago and Raymond Terrace
  - Construction activities are anticipated to cause minimal disruptions to general traffic, public transport, pedestrian and cyclist, rail and maritime traffic along the existing road network. This is due to the low number of peak hour construction traffic movements, the majority of the project construction footprint being located on greenfield and due to the majority of the ancillary facilities planned to be accessed via left in/left out arrangements.
- Operational impact:
  - The project would result in improved safety outcomes across the network by providing a dual carriageway with a median, improved road alignment, wider lanes and shoulders, grade-separated interchanges. The project would also reduce traffic volumes on the existing road network. The reduced traffic volumes and design changes are expected to substantially reduce vehicle head-on crashes, rear-end crashes, vehicles turning from opposing directions, lane change crashes and run-off-road crashes
  - The project would provide positive outcomes for the performance of the road network in each of the modelled scenarios. This would result in a more efficient road network that can cater for a higher volume of vehicles, while also maintaining faster travelling speeds for motorists

- In 2028, travel times from the Pacific Highway to the New England Highway and the M1 Pacific Motorway would reduce by at least 36 per cent. The project substantially reduces travel times during both peak periods across all future modelled years. This is most pronounced for journeys between the Black Hill and Raymond Terrace for which travel times are reduced by up to 30 minutes. Travel times between other key areas such as Newcastle, Beresfield, Tomago, Hexham and Thornton would also be reduced by the project. The project would also reduce travel times for freight vehicles and improve connectivity to future development areas, such as the Beresfield and Tomago industrial areas
- Key intersections in the study area show an improved level of service as a result of the project. The redistribution of traffic to the project reduces the demand of most intersections leading to improved performance. The performance of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection improves as a result of the project, however, the intersection is expected to perform at an unsatisfactory level of service from 2038 onwards
- All interchanges would operate at LoS C or better in each of the modelled future horizon years except for the Black Hill interchange southbound merge which operates at an LoS F due to the demand for the entry ramp exceeding its capacity. Sensitivity modelling was carried out which identified the high impact on the operation of the interchange caused by the proposed developments at Black Hill. These developments are not yet approved and would be required to implement additional capacity improvements, such as alternate access, to ensure future operation through this area of the road network
- Impacts on public transport, maritime traffic and rail freight would be minimal.

- Cumulative impact:
  - The contribution of the project to the cumulative impact on transport and traffic during construction in the area is minor, considering construction would be managed through the implementation of a range of environmental management measures
  - The cumulative impacts of future land use development across the Hunter Region have been captured in the detailed traffic modelling
  - Sensitivity modelling identified the Emerging Black Hill Precinct as substantially impacting the performance of the traffic in the network. The development is not yet approved and would and would contribute substantially to the traffic demand in the study area and key intersections causing delays to traffic and negatively impacting on performance measures.

Management measures

Management measures have been developed to manage potential impacts which may arise from the construction and operation of the project, including the implementation of a Traffic Management Plan during construction to manage traffic. Haulage vehicle movements will be planned to minimise movements on the road network. A road dilapidation report will be prepared before impacts on local roads commence. A strategy to manage property, pedestrian, public transport, maritime and cycling access will be maintained at all times. Any changes to access arrangements or alternative access that are necessary during construction will be done in consultation with the landowner.

Conclusion

No major impacts are anticipated during the construction of the project with the implementation of traffic management measures. Once operational, the project would result in improved traffic performance outcomes across both the morning and evening peak periods in 2028, 2038 and 2048. This includes improvements to network-wide speeds, travel times and intersection level of service. It would deliver

improved safety across the network by providing safer roads that reduce the risk of fatal and serious injury crashes.

The project would integrate with the existing and planned transport network including rail, pedestrian, cycling and freight infrastructure. It also helps cater to the future demand generated from substantial land releases in the Black Hill, Tomago and Heatherbrae regions and ensures improved connectivity for all modes of transport. Overall, this project would contribute positively to the transport network in the Hunter region and fulfil the desired performance outcomes.

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Appendix B	Option Testing Report
Appendix C	Ancillary Facilities Access Strategy
Appendix D	Property Access Strategy

1. Introduction

1.1 Background

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* (EP&A Act) and Part 9, Division 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

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 would provide regional benefits and substantial productivity benefits on a national scale. The project location is shown in **Figure 1-1** within its regional context.

1.2 Project description

The project would include the following key features:

- 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 floodplain 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 at Purgatory Creek at Tarro and 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, temporary wharves, batching plants, soil treatment and environmental controls.

A detailed project description is provided in Chapter 5 of the environmental impact statement (EIS). The locality of the project is shown in **Figure 1-1**, while an overview of the project is shown in **Figure 1-2**.

1.3 Performance outcomes

The desired performance outcomes for the project relating to transport and traffic are to:

- Manage and minimise impact to network connectivity, safety and efficiency of the transport system in the vicinity of the project (see **Chapter 5**)
- Maintain the safety of transport system customers (see **Section 4.5** and **Section 5.2.5**)
- Effectively manage the impact on network capacity and the Level of Service (LoS) (see **Section 3.3.3**, **Section 4.4** and **Section 5.2.1**)
- Ensure works are compatible with existing and planned infrastructure and future transport corridors (see **Section 3.4**, **Chapter 4** and **Section 5.3**).

1.4 Secretary's Environmental Assessment Requirements

This assessment forms part of the EIS for the project. The EIS has been prepared under Division 5.2 of the EP&A Act. This assessment has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs) (SSI 7319) relating to transport and traffic and will assist the NSW Minister for Planning and Public Spaces to make a determination on whether or not to approve the project. It provides an assessment of the potential impact of the project on land use and property and outlines proposed management measures.

In 2019 revised SEARs were issued for the project, which included transport and traffic as a key issue. **Table 1-1** outlines the SEARs relevant to this assessment along with a reference to where these are addressed.

Table 1-1 SEARs relevant to traffic and transport

Secretary's requirement	Where addressed in this report
1. Transport and traffic	
1. The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists) impact, including, but not necessarily limited to:	
a) the identification of transport routes and scheduling of movements, particularly outside standard construction hours;	**Section 5.1.2** presents proposed working hours (including out-of-hours works) **Section 5.1.3** and **Section 5.1.4** provides information on the location of construction ancillary facilities and haulage routes. **Section 5.1.5** provides consideration of construction traffic movements
b) the indicative number, frequency and size of construction-related vehicles (passenger, commercial and heavy vehicles, including spoil management movements);	**Section 5.1.5** provides information on the number, frequency and size of construction-related vehicles
c) indicative construction worker parking;	**Section 5.1.3** presents the location of construction ancillary facilities (including indicative construction worker parking locations in **Table 5-4**)

Secretary's requirement	Where addressed in this report
d) the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times, land uses, in particular sensitive receivers, and parking arrangements);	**Section 4.4** presents the existing traffic **Section 4.3** discusses land uses surrounding the project and details existing parking arrangements. **Section 5.1.4** presents the road used for construction traffic and **Section 5.1.5** discusses the impacts of construction traffic on the road network and impacted land uses
e) access constraints and impact on public transport, pedestrians and cyclists;	**Section 5.1.7** assesses impacts on public transport, pedestrians and cyclists
f) impact to the operation of rail lines in the Lower Hunter, including the Main Northern Rail Line and rail infrastructure in Hexham;	**Section 5.1.7** assesses impact to rail lines and rail infrastructure
g) the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project; and	**Section 5.1.5** provides details of the need to close, divert or reconfigure the road network. Impacts to the cycle network are discussed in **Section 5.1.7**.
h) the cumulative traffic impact of other major development projects preparing for or commencing construction in the vicinity of the proposal.	The cumulative traffic impact of constructing this project with other projects is discussed in **Section 5.3**.
2. The Proponent must assess (and model) the operational transport impact of the project including, but not necessarily limited to:	
a) forecast travel demand and traffic volumes for the project and the surrounding road, cycle and public transport network;	**Section 4.4.1** analyses traffic growth trends in the study area and **Section 3.3.1** discusses how future traffic demand was determined. **Section 4.6** discusses the public transport network and **Section 4.8.2** discusses cyclist activity
b) travel time analysis;	A travel time analysis of the existing road network is presented in **Section 4.4.3** and the travel time impact that occurs as a result of the project are discussed in **Section 5.2.1**.
c) performance of key interchanges and intersections by undertaking a level of service analysis at key locations;	**Section 4.4.6** displays the existing Level of Service of key intersections in the network **Section 5.2.1** presents the performance outcomes of key intersections and interchanges during operation of the project.
d) wider transport interactions and modifications (local and regional roads, cycling, public and freight transport);	**Section 5.2.1** details the project's impact on regional and local roads within and surrounding the study area **Section 5.2.2** summarises the project's impact on public transport infrastructure including rail and bus services **Section 5.2.3** discusses the impact on freight **Section 5.2.4** discusses the impact on the regional connectivity road network **Section 5.2.6** discusses the impact on the cycle network.
e) access to identified and future development areas, such as the Beresfield and Tomago industrial areas;	**Section 5.2.4** discusses access to future development areas that have been identified within the study area.

Secretary's requirement	Where addressed in this report
f) transport connectivity to and from existing communities and centres (such as Newcastle, Raymond Terrace, the Lower Hunter and Port of Newcastle),	**Section 5.2.4** summarises the impact to transport connectivity for communities within and surrounding the study area.
g) impact on Newcastle Airport and Williamstown RAAF Base, maritime traffic on the Hunter River, Port of Newcastle and rail infrastructure;	Impact to the Newcastle Airport and Williamstown RAAF Base is discussed in **Section 5.2.7** Operational maritime impacts on the Hunter River and impact to the Port of Newcastle are discussed **Section 5.2.8.** Rail infrastructure impact during operation is discussed in **Section 5.2.2**.
h) impact on cyclists and pedestrian access and safety; and	**Section 5.2.5** discusses the improvements to safety as a result of the project **Section 5.2.6** discusses the impacts on cyclists and the impacts on pedestrians.
i) opportunities to integrate cycling and pedestrian elements with surrounding networks (existing and proposed) and within the project.	**Section 5.2.6** discusses the integration of the project's cycling infrastructure with existing and proposed cycling infrastructure and discusses the proposed improvements to the pedestrian network in association with the existing pedestrian network.

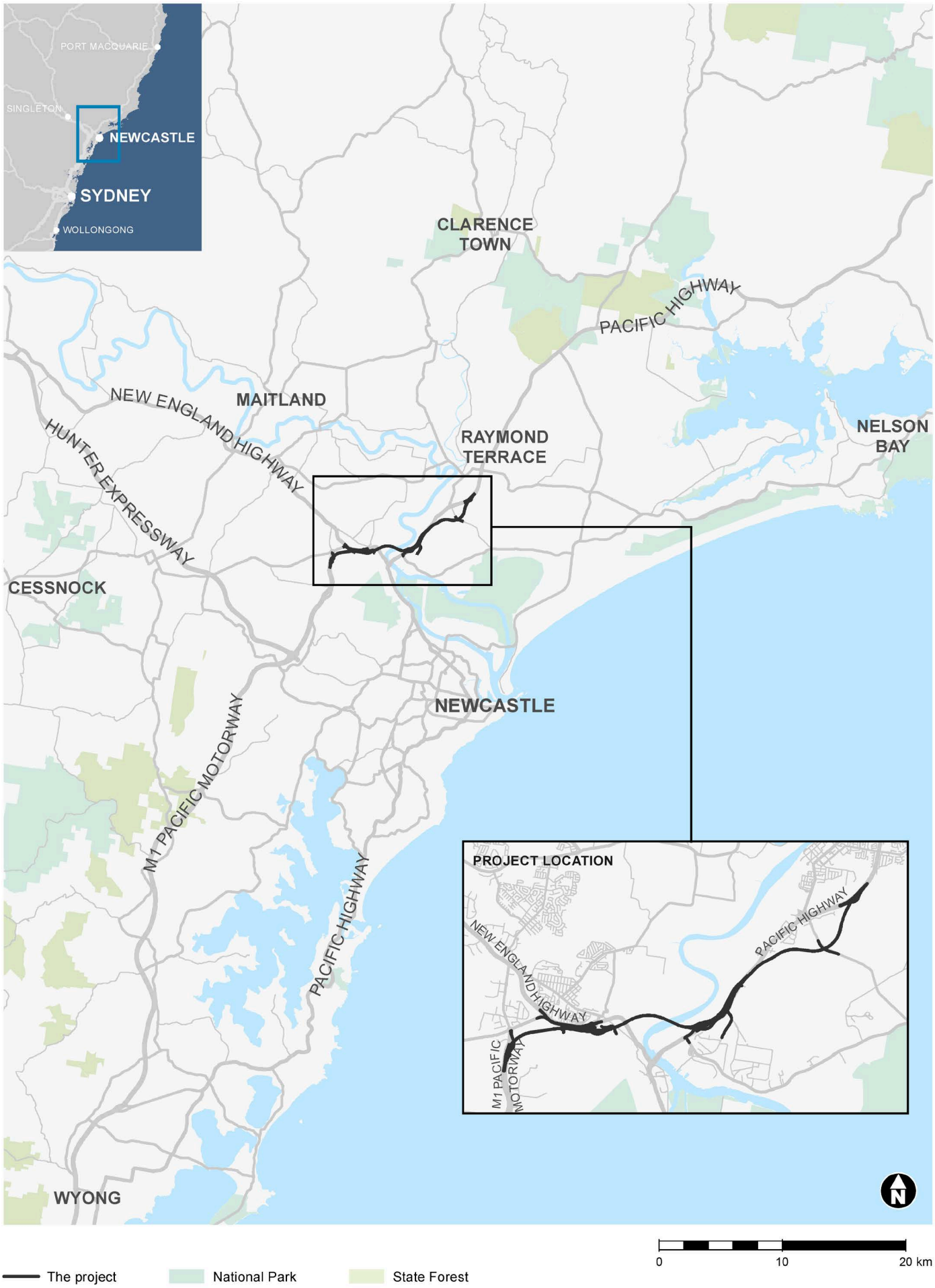

Figure 1-1 Regional context of the project

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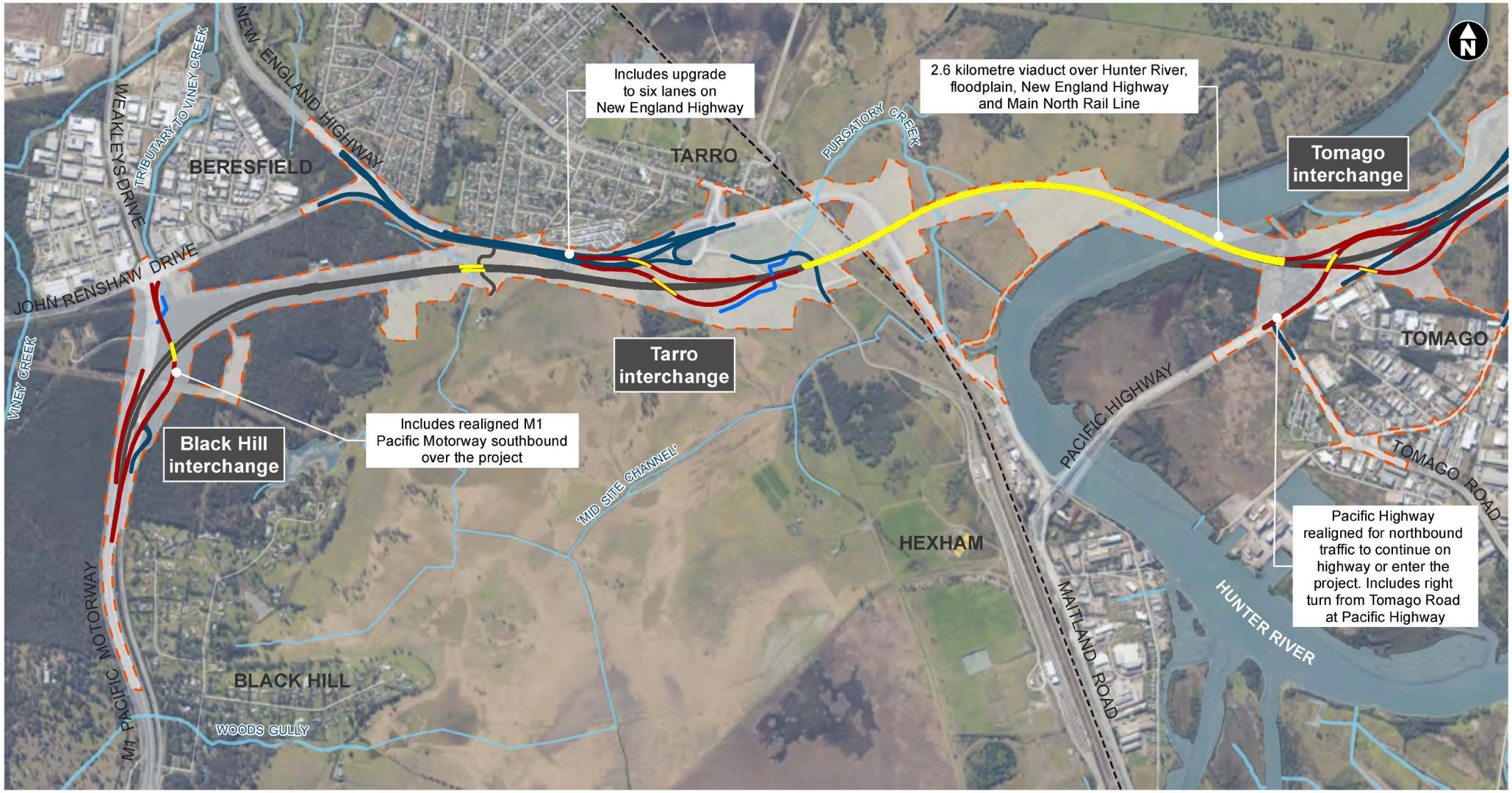

Main alignment
Adjustments to existing roads
New ramp
Creek realignment
Bridges/ Viaduct
Construction footprint
Waterways
Main North Rail Line

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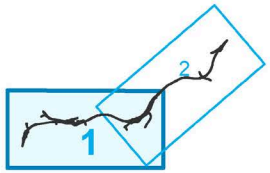

Figure 1-2 Project key features (map 1 of 2)

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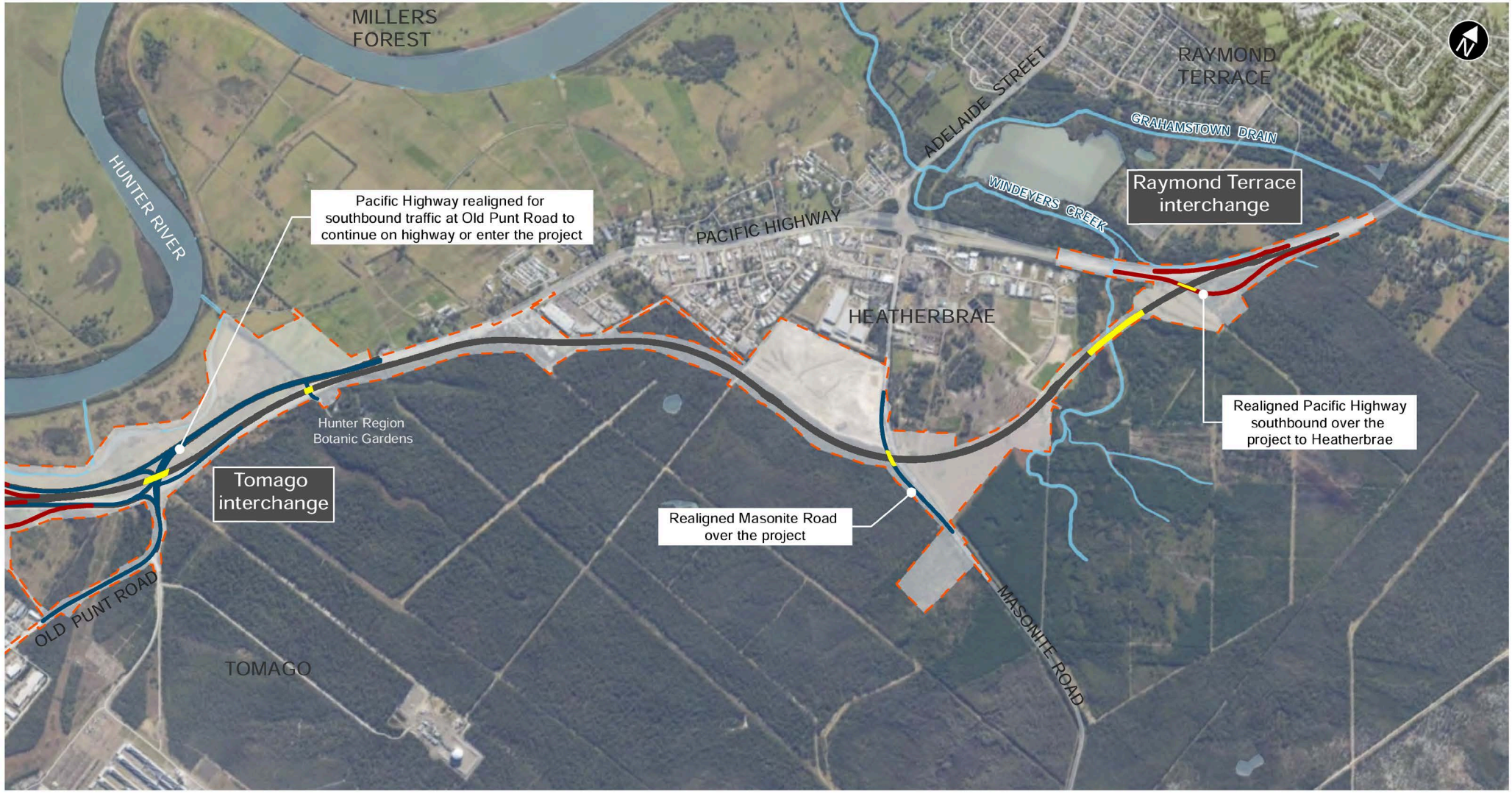

Main alignment
Adjustments to existing roads
New ramp
Bridges/ Viaduct
Construction footprint
Waterways

0 0.5 1 km

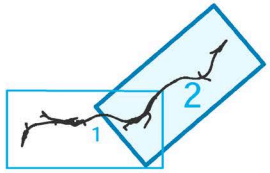

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Figure 1-2 Project key features (map 2 of 2)

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1.5 Report structure

The report is structured as follows:

- Chapter 1 – Introduces the project with a summary of the project background, project description, performance outcomes and SEARs
- Chapter 2 – Provides an overview of the policy and planning setting that relate to the project
- Chapter 3 – Provides an overview of the assessment methodology carried out for the traffic and transport assessment, including the traffic modelling and forecasting process
- Chapter 4 – Provides an overview of the existing conditions including traffic volumes, travel times and the performance of the current transport network
- Chapter 5 – Provides an assessment of the potential transport and traffic impacts of the project including during the construction and operational phase of the project. This chapter also details cumulative transport and traffic impacts associated with other approved or proposed projects in the area
- Chapter 6 – Details the mitigation measures proposed to alleviate potential negative impacts of the project
- Chapter 7 – Provides the conclusion on the outcomes of the assessment
- References
- Terms and acronyms
- Appendix A – Traffic Model Calibration and Validation Report (ONS-TA-100-REP-002)
- Appendix B – Option Testing Report
- Appendix C – Ancillary Facility Access Strategy
- Appendix D – Property Access Strategy.

2. Policy and planning setting

2.1 Alignment with transport policies and plans

The project is referred to in or supports the following strategic plans:

- Infrastructure Priority List 2020 (Infrastructure Australia, 2020)
- Future Transport Strategy 2056 (NSW Government, 2018a)
- Regional NSW Services and Infrastructure Plan (NSW Government, 2018b)
- NSW Freight and Ports Plan (Transport for NSW, 2018a)
- Moving More with Less 2018 (Transport for NSW, 2018b)
- Greater Newcastle Metropolitan Plan 2036 (DPE, 2018)
- Greater Newcastle Future Transport Plan (NSW Government, 2018c)
- Hunter Regional Plan 2036 (Transport for NSW 2016).

A review of the planning and policy framework relating to traffic and transport is documented in Chapter 2 of the EIS.

2.2 Relevant guidelines

The following guidelines were followed in completing this transport and traffic impact assessment as relevant:

- Guide to Traffic Management Part 3: Traffic Studies and Analysis (Austroads, 2017)
- Motorway design guide: Capacity and flow analysis (Roads and Maritime, 2017)
- Highway Capacity Manual 2016 (Transportation Research Board, 2016)
- Traffic Modelling Guidelines (Roads and Maritime, 2013)
- Cycling aspects of Austroads guides (Austroads, 2017)
- NSW Bicycle Guidelines v 1.2 (RTA, 2005)
- Planning Guidelines for Walking and Cycling (Department of Infrastructure, Planning and Natural Resources, 2004).

3. Assessment methodology

Assessment of the transport and traffic impacts of the project involved the following key steps to identify impacts for construction and operation:

- Review of the existing environment:
  - Assessing the existing traffic and transport network and activity in the study area through a suite of traffic survey data
  - Reviewing existing and future land uses in the study area to inform the traffic modelling, and aid in the identification of construction, operational and cumulative impacts
  - Analysing crash data for key roads relating to the project for the most recent five-year period
  - Reviewing existing public transport information.
- Traffic model development:
  - Traffic model development has previously been carried out in this area of the road network in PTV VISSIM, a traffic microsimulation software package. The model developed from the Outer Newcastle Study (ONS) has subsequently been further developed for the assessment of the project
  - Using the model to inform the assessment on the basis of model validation and calibration previously completed as part of the ONS. Further detail relating to the model calibration and validation is provided in **Appendix A**
  - Considering forecasts for population and employment growth and inter-regional traffic growth for future years 2028 (the project opening year), 2038 (10 years after opening) and 2048 (20 years after opening) to develop future trip matrices
  - Conducting a 'without project' assessment for years (2028, 2038 and 2048) using the microsimulation model to identify future projects required to maintain a functioning road network and those which are predicted to be in place upon opening of the project. This provides a 'without' project baseline against which future scenarios can be compared against to understand the project impact
  - Developing future traffic models for opening (2028) and future years (2038 and 2048), by developing a microsimulation traffic model which includes the project
  - Quantifying the impact of the Emerging Black Hill Precinct by running sensitivity scenarios using the final version of the traffic model.
- Identification of construction impact:
  - Assessing through spreadsheet analysis construction staging, compound locations and associated construction traffic impact
  - Qualitatively assessing the impact on pedestrians, cyclists, maritime traffic and local access during construction.
- Assessment of operational benefits and impact:
  - Traffic modelling to assess the broad operational traffic benefits of the project
  - Assessing impacts on transport services by mode and local access both quantitatively from the traffic modelling outputs and qualitatively.
- Assessment of cumulative impact as a result of the construction and operation activities of the project:
  - Qualitatively assessing approved and proposed projects in the vicinity of the project for cumulative impact, based on the most current and publicly available information
  - Quantitatively assessing the impacts of approved and proposed projects through the use of the traffic model.

A more detailed description of the process of traffic modelling is presented in **Appendix B**, including an overview of the steps carried out, the assumptions used, and how data is used in each stage in the traffic modelling process. **Section 3.1** presents the study area for the transport and traffic assessment. **Section 3.2, Section 3.3** and **Section 3.4** expand on the methodology used to assess the construction, operational and cumulative impacts, respectively.

3.1 Study area

The project is located within the City of Newcastle and Port Stephens Council LGAs in the Hunter Region, north of Newcastle NSW. The study area for the transport and traffic assessment of the project covers the area displayed in **Figure 3-1** and includes:

Key features within and surrounding the study area include:

- Major roads of state importance, including the M1 Pacific Motorway, the Pacific Highway, the New England Highway, John Renshaw Drive, the Hunter Expressway (via John Renshaw Drive), Tomago Road and Weakleys Drive
- Residential areas of Black Hill, Beresfield, Tarro, Heatherbrae and Raymond Terrace
- The semi-rural and urban areas of Black Hill, Tarro and Heatherbrae
- The light industrial, heavy industrial and commercial areas of Beresfield, Hexham, Tomago and Heatherbrae.

As the traffic model developed as part of the ONS has been used as a foundation of this analysis, the modelled area shown in **Figure 3-3** is larger than the study area. The assessment for the project is focussed on the Study shown in **Figure 3-1** with modelled outcomes being presented across the broader modelled area.

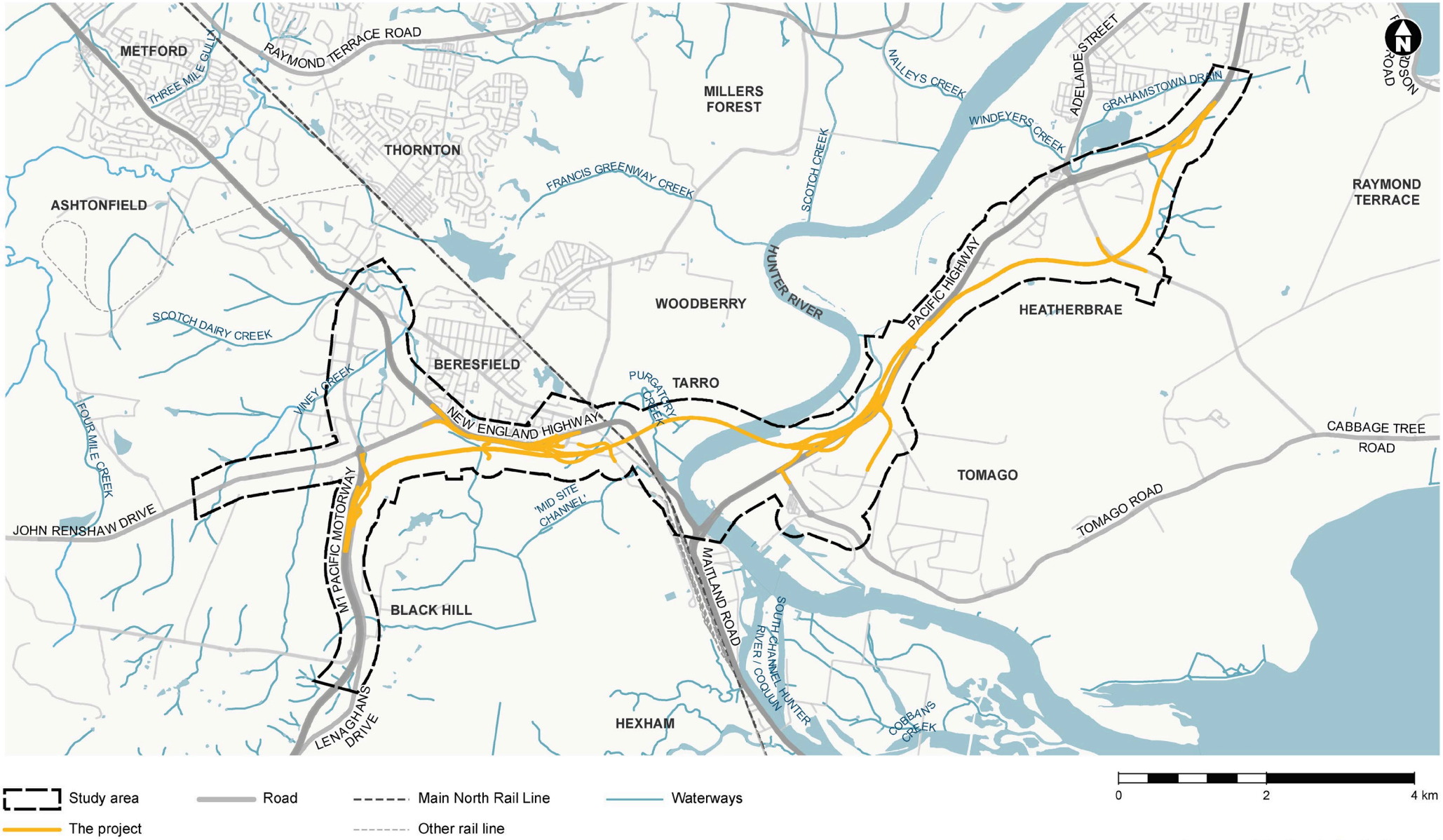

Figure 3-1 Study area boundaries

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3.2 Construction assessment methodology

The assessment of potential construction traffic impacts considered:

- Construction staging and program
- Locations of construction access routes
- Location of ancillary facilities and access
- Haulage routes and use of existing road network.

The assessment is based on potential and typical construction methodologies anticipated at this stage of the design. Further development of the above-listed aspects would occur as the project progresses through pre-construction stages.

A detailed description of the proposed construction methodology and the indicative program is provided in Chapter 5 of the EIS.

3.3 Operational assessment methodology

3.3.1 Traffic model development

The objective of the traffic modelling process is to make the best use of the available transport and traffic data, including existing transport models, to estimate the base and future conditions on the transport network surrounding the project. These transport conditions are used to assess the operational performance of the network based on scenarios with and without the project.

As the project is primarily road-based (with limited interactions with maritime), the modelling process has been focussed around traffic modelling. The following sections provide an overview of the process by which land use forecasts and network assumptions are refined and focussed to produce detailed traffic forecasts for the modelled area.

Traffic modelling has been carried out in accordance with the Traffic Modelling Guidelines (Roads and Maritime Services, NSW, 2013) and an overview of the traffic modelling process is presented in **Figure 3-2**.

Figure 3-2 Modelling process overview

Modelled area

The traffic model was used to inform the operational performance assessment. Microsimulation models are dynamic, stochastic, discrete-time modelling techniques that simulate the movement of individual vehicles based on car-following, lane changing and gap acceptance algorithms that are updated several times every second. These vehicle-to-vehicle interactions provide the basis for calculating delays.

The extent of the road network covered by the microsimulation traffic model in the context of the project is shown in **Figure 3-3**.

The project
Base model
Road
Main North Rail Line
Other rail line
Waterways

0 2 4 km

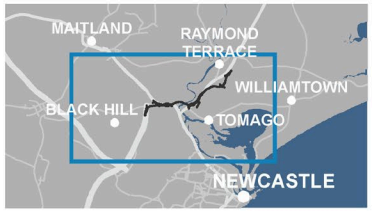

Figure 3-3 Modelled area for the traffic assessment

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Modelling assumptions

This section outlines the parameters and assumptions which influenced the traffic modelling and traffic assessment, these are outlined below:

- The year of opening of the project is assumed to be 2028
- The project would be assessed for 10 years (2038) and 20 years (2048) after opening
- The project's accepted concept design was used for the development of the 'with project' traffic models.

Modelled scenarios

In order to assess the performance of the road network with and without the project and identify the impact of the project, traffic modelling of the scenarios presented in **Table 3-1** was carried out.

Table 3-1 Summary of scenarios modelled

Scenario name	Year	With the project	Without project	Description
Base	2017	N	N	Reflects the transport network as it was in 2017 with no new projects or upgrades. The year 2017 was adopted as the existing year, as traffic counts were carried out at this time. The calibration and validation carried out on the base model also ensures the model is representative of real-world conditions.
Without project	2028	N	Y	These include the projects specified in **Table 3-2** and provides a model for comparative purposes.
Without project	2038	N	Y	
Without project	2048	N	Y	
With project	2028	Y	Y	These include the projects specified in **Table 3-2** and the project and are compared against the future year 'without project' models to determine the impact of the project.
With project	2038	Y	Y	
With project	2048	Y	Y	

Model network changes

To assess the operational impact of the project, 'with project' and 'without project' model outputs were compared. The 'without project' models represent the envisaged network and demand conditions in a scenario where the project option is not built. An assessment of the required road upgrades without the project was carried out **Table 3-2** shows the upgrades that were identified to be required as part of the 'without project' assessment and their implementation in modelled years.

The Hexham Straight project has a funding commitment to proceed, while all other projects implemented in the 'without project' model are projects without funding commitment. However, these other projects were considered to ensure robust modelling and address future traffic demand.

Further detail relating to the 'without project' model upgrades (including modelling assumptions) is provided in **Appendix B**.

Table 3-2 Summary of 'without project' project upgrades

Without project upgrade	Modelled years		
	2028	2038	2048
Maitland Road Upgrade	×	✓	✓
Weakleys Drive Upgrades	×	✓	✓
John Renshaw Drive/Weakleys Drive Intersection Upgrade	✓	✓	✓
Duplication of John Renshaw Drive	✓	✓	✓
Freeway Ramp signals on the Anderson Drive	×	✓	✓
Hexham Straight	✓	✓	✓
Removal of roundabouts at the Thornton Road/Glenwood Drive intersection and the Weakleys Drive/Glenwood Drive intersection *	×	✓	✓

*This upgrade was implemented for modelling purposes only. It is not considered a necessary project for the future road network.

Future traffic demand forecast

The Sydney Traffic Forecasting Model (STFM) was used originally to develop the future growth across the network. The STFM modelling results were analysed and found to overestimate the future growth compared to historical growth rates. As such a 1.5 per cent per annum growth rate was adopted which aligns with historic growth in the region and represents a reasonable growth rate for future horizons. **Section 4.10** displays the historic growth rate in the study area. The Emerging Black Hill Precinct was not included in the future growth of the SFTM, therefore a specific assessment and inclusion of future growth for this proposed development was included independently of the yearly growth rate.

The trip matrices for years 2028, 2038 and 2048 were developed in a two-stage process. First, the identified growth rate was applied across the network trip matrices. This was followed by adding trips generated from the Emerging Black Hill Precinct using the trip generation rates and the trip distribution pattern identified in the ONS. This process is displayed in **Figure 3-4**.

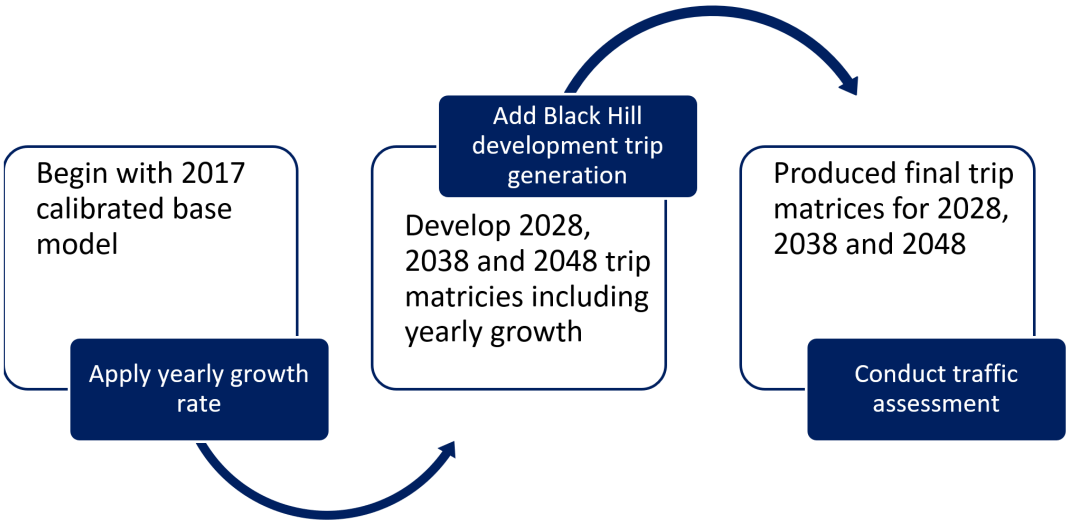


Figure 3-4 Process to develop trip matrices

3.3.2 Sensitivity modelling overview

Additional sensitivity modelling was carried out for items identified by initial modelling to have issues. This sensitivity testing was carried out using the final version of the traffic model in both peak periods for 2038. The following two scenarios were tested:

- Scenario 1 – Incorporating on and off ramps at the Black Hill Road interchange with the M1 Pacific Motorway
- Scenario 2 – No traffic generated from the Emerging Black Hill Precinct.

3.3.3 Assessment criteria

Modelling operational traffic provides an overview of the performance of the road network while indicating the impact of the project during operation. This impact can be seen either across the network or at individual locations. The performance of operational traffic is assessed in several ways, including:

- At a network level:
  - Road network performance can be assessed with network-wide statistics. These statistics are extracted from the traffic model for the morning and evening peak periods and include average speed, vehicle throughput and total time travelled within the modelled network.
- At a single point:
  - The performance of an intersection and its LoS is determined by the average delay per vehicle
  - At an interchange level, which is calculated from the density of traffic and the capacity of the entry ramp.

Further detail relating to the operational traffic assessment criteria are provided in **Appendix B**.

Level of Service performance targets

LoS D is the generally accepted target performance level at a single point. If the performance of an intersection, interchange or midblock segment falls below LoS D, investigations should be initiated to determine if suitable remediation can be provided. However, limited road capacity and high demand mean that LoS E and LoS F are regularly experienced by motorists, particularly during peak periods.

3.4 Cumulative assessment

Cumulative traffic and transport impacts may arise from the interaction of construction and operation activities of the project and other approved or proposed projects in the area. An assessment of the cumulative traffic and transport impacts was carried out based on the most current and publicly available information for the projects. The cumulative assessment is comprised of both a high-level qualitative assessment and a quantitative assessment with input from traffic modelling.

4. Existing environment

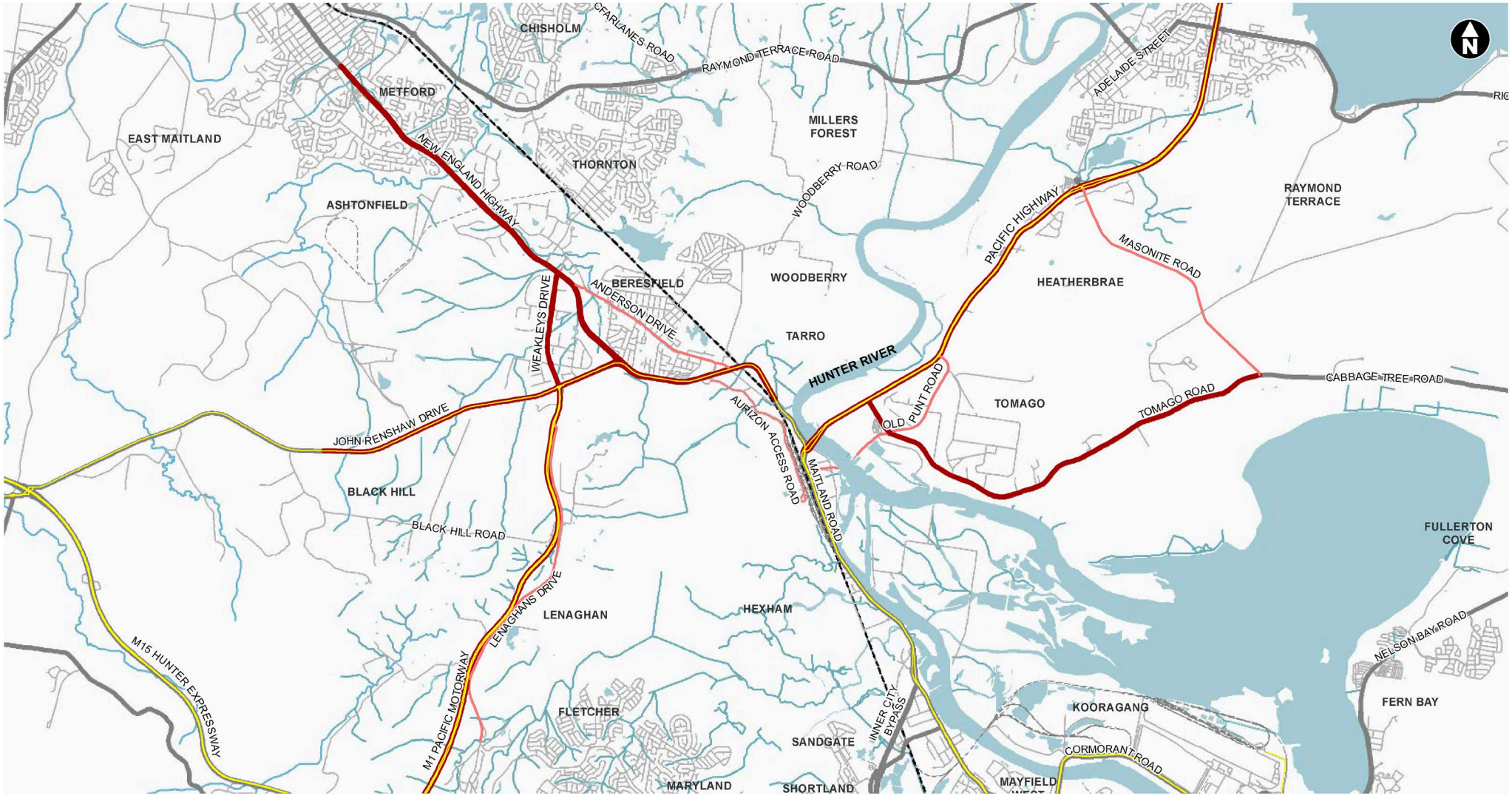
4.1 Existing road network

Transport uses a hierarchal system that designates the road network into state roads, regional roads and local roads based on the predominant function of a road. The process of classification of roads allows the function of the road to remain generally compatible with surrounding land use and the intended use of the road primarily either for movement or access. Under the NSW Road Management Arrangement between Transport and councils, three categories of roads are defined:

- **State roads**: These are the major arterial roads that carry people and goods within Sydney, Newcastle, Wollongong and the Central Coast urban areas, and also connect major regional towns, major regions of the state and interstate. Transport has responsibility for managing the primary function of these roads and state roads are maintained either by Transport or through contractual arrangements with Councils. State roads include motorways and primary arterial roads
- **Regional roads:** These are roads of secondary importance. These perform a sub-arterial function. Regional roads are the responsibility of councils to manage. Regional roads include secondary and sub-arterial roads. No regional roads were identified within the study area
- **Local roads:** These comprise the remaining council controlled roads, which provide for local circulation. Local roads are the responsibility of councils to manage. Local roads include collector roads and local roads.

The study area also includes roads which form part of the National Land Transport Network (NLTN). The NLTN is a network of nationally important road and rail infrastructure links and their intermodal connections.

The functional hierarchy of the existing road network within and surrounding the study area is presented in **Figure 4-1**. Key roads discussed in **Section 4.1.1** and **Section 4.1.2** are also shown in **Figure 4-1**.



Roads connecting to the project

- State road
- Local road

Other roads

- State road
- Local road

- Main North Rail Line
- Other rail line
- National Land Transport Network

- Waterways

0 2 4 km

Figure 4-1 Existing road network

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4.1.1 State road network

A summary of the existing traffic conditions at key state road corridors within and surrounding the study area is provided below (shown in **Figure 4-1**):

- **M1 Pacific Motorway**: The M1 Pacific Motorway is a key north-south corridor linking Sydney to the Central Coast, Newcastle and Hunter region. It is a dual carriageway road with two lanes in each direction with a 110 kilometre per hour posted speed limit. In the study area, the M1 Pacific Motorway is split, with motorway conditions only existing south of Black Hill and north of Heatherbrae. It forms part of the NLTN, which is a defined national network of important road and rail infrastructure links and their intermodal connections. Traffic surveys carried out in 2017 recorded an average of about 40,600 vehicles (20 per cent heavy vehicles) per weekday on the M1 Pacific Motorway south of Black Hill
- **Pacific Highway**: The Pacific Highway is about seven kilometres long between the Hexham Bridge and Masonite Road. It is a dual carriageway road with generally two lanes in each direction and generally an 80 kilometre per hour speed limit. It forms part of the NLTN. The intersection of Pacific Highway and Tomago Road provides key connections to employment areas in Tomago, Newcastle Airport and the Williamtown Royal Australian Air Force (RAAF) Base. Traffic surveys carried out in 2017 on the Pacific Highway recorded an average of more than 51,800 vehicles (18 per cent heavy vehicles) per weekday north of Hexham Bridge
- **New England Highway**: The New England Highway corridor is a key east-west link between Newcastle and the Lower Hunter. In the study area, it is a dual carriageway road with generally two lanes in each direction. The speed limit is 90 kilometres per hour west of Tarro and 80 kilometres per hour east of Tarro. It forms part of the NLTN, is a key corridor into Newcastle and provides access to the Port of Newcastle. Traffic surveys carried out in 2017 indicate that the New England Highway corridor carries an average of more than 42,200 vehicles (23 per cent heavy vehicles) per weekday through Thornton and 61,000 vehicles (22 per cent heavy vehicles) per weekday north of the Pacific Highway
- **John Renshaw Drive**: John Renshaw Drive is a key east-west corridor in the study area linking the M15 Hunter Expressway and the towns of Kurri Kurri and Cessnock with the M1 Pacific Motorway and New England Highway, forming part of the NLTN. West of the M1 Pacific Motorway, the road is a single carriageway with one lane in each direction and a speed limit of 100 kilometres per hour. East of the M1 Pacific Motorway, the road has two lanes in each direction with a speed limit of 80 kilometres per hour. Traffic surveys carried out in 2017 on John Renshaw Drive recorded an average of more than 32,000 vehicles (13 per cent heavy vehicles) per weekday west of Weakleys Drive
- **Tomago Road**: Tomago Road forms part of the state road network, connecting Nelson Bay Road to the east and the Pacific Highway to the west. The intersection with the Pacific Highway is a T-intersection controlled by traffic signals, with right turns from Tomago Road onto Pacific Highway prohibited. Tomago Road provides one lane of travel in each direction along the majority of its length, with flaring at intersections to provide increased capacity. Traffic surveys carried out in 2017 on Tomago Road recorded an average of 14,200 vehicles (9 per cent heavy vehicles) per weekday east of Pacific Highway
- **Weakleys Drive**: Weakleys Drive is a single carriageway road with one to two lanes in each direction and a speed limit of 60 kilometres per hour. The road provides a north-south connection between the M1 Pacific Motorway and New England Highway and serves the adjoining light industrial land uses. Traffic surveys carried out in 2017 on Weakleys Drive recorded an average of 20,900 vehicles (19% heavy vehicles) per weekday north of John Renshaw Drive.

4.1.2 Local road network

A summary of the existing traffic conditions on local roads within and surrounding the study area is provided below (shown in **Figure 4-1**):

- **Old Punt Road**: Old Punt Road provides a single lane of travel in each direction on the northbound and southbound approach to the intersection with Tomago Road. At its northern end, Old Punt Road intersects with the Pacific Highway at a signalised T-intersection. The Pacific Highway provides a dedicated left-turn slip lane for southbound vehicles to turn into Old Punt Road and a sheltered right turn lane provided for northbound vehicles to turn into Old Punt Road
- **Masonite Road**: Masonite Road is a single carriageway road with one to two lanes in each direction and a speed limit of 70 kilometres per hour. It connects to the Pacific Highway to the north and Tomago Road to the south
- **Anderson Drive**: Anderson Drive crosses the existing New England Highway at Tarro and runs parallel to the New England Highway to the west. The local road has a speed limit of 40-50 kilometres per hour and has local area traffic management measures (signage and pedestrian crossings) near the school zone outside Tarro Public School. The road connects back to the New England Highway at Thornton
- **Lenaghans Drive**: Lenaghans Drive is a single carriageway road with one lane in each direction and a speed limit of 80 kilometres per hour. It intersects with the Pacific Highway in Black Hill and runs parallel to the M1 Pacific Motorway. The road provides access to the numerous properties and the local road network
- **Aurizon access road**: Aurizon access road is a two way, single carriageway road that can be accessed via the New England Highway in Tarro. The road provides access to the Aurizon facilities at Hexham train station.

4.2 Heavy vehicles and freight

The M1 Pacific Motorway, New England Highway and Pacific Highway provide a substantial north-south freight route. Major freight activity precincts near the study area include the Beresfield and Tomago industrial area. Other freight activity precincts include Newcastle, Port of Newcastle, Newcastle Airport and Williamtown RAAF Base. **Figure 4-2** displays the approved routes for B-Doubles within and surrounding the study area.

Heavy vehicles contribute up to 26 per cent to daily traffic volumes, with the higher percentages in the south of the project from the M1 Pacific Motorway to the Pacific Highway at Hexham. A breakdown of heavy vehicle contributions to traffic volumes is provided in **Section 4.1.1**.

The southbound Hexham Bridge is restricted from access by oversize overmass (OSOM) vehicles larger than 6.5 metres wide and/or 5.2 metres high due to the nature of the bridge design. The southbound bridge also has a load limitation which does not allow for vehicles over 68 tonnes. As a result, the southbound bridge does not provide access for higher productivity vehicles (PBS Class 2B vehicles up to 30 metres long and 90.5 tonnes in mass), as well as some OSOM vehicles from the adjacent Tomago industrial area and areas further away. A permit to travel contraflow over the northbound bridge at Hexham may be required for OSOM vehicles.

The New England Highway between Hexham Bridge and Weakleys Drive has restrictions on vehicles exceeding 3.2 metres wide or 22.0 metres long, they are not permitted to travel between 7:00am and 9:00am and 4:00pm and 6:00pm Monday to Friday. The Pacific Highway between Hexham and Raymond Terrace also has numerous restrictions on OSOM vehicles. Vehicle combinations exceeding 3.2 metres wide or 22.0 metres long must contact the Transport Pacific Highway Coordinator at least 48 hours prior to travel to gain access to the road network.

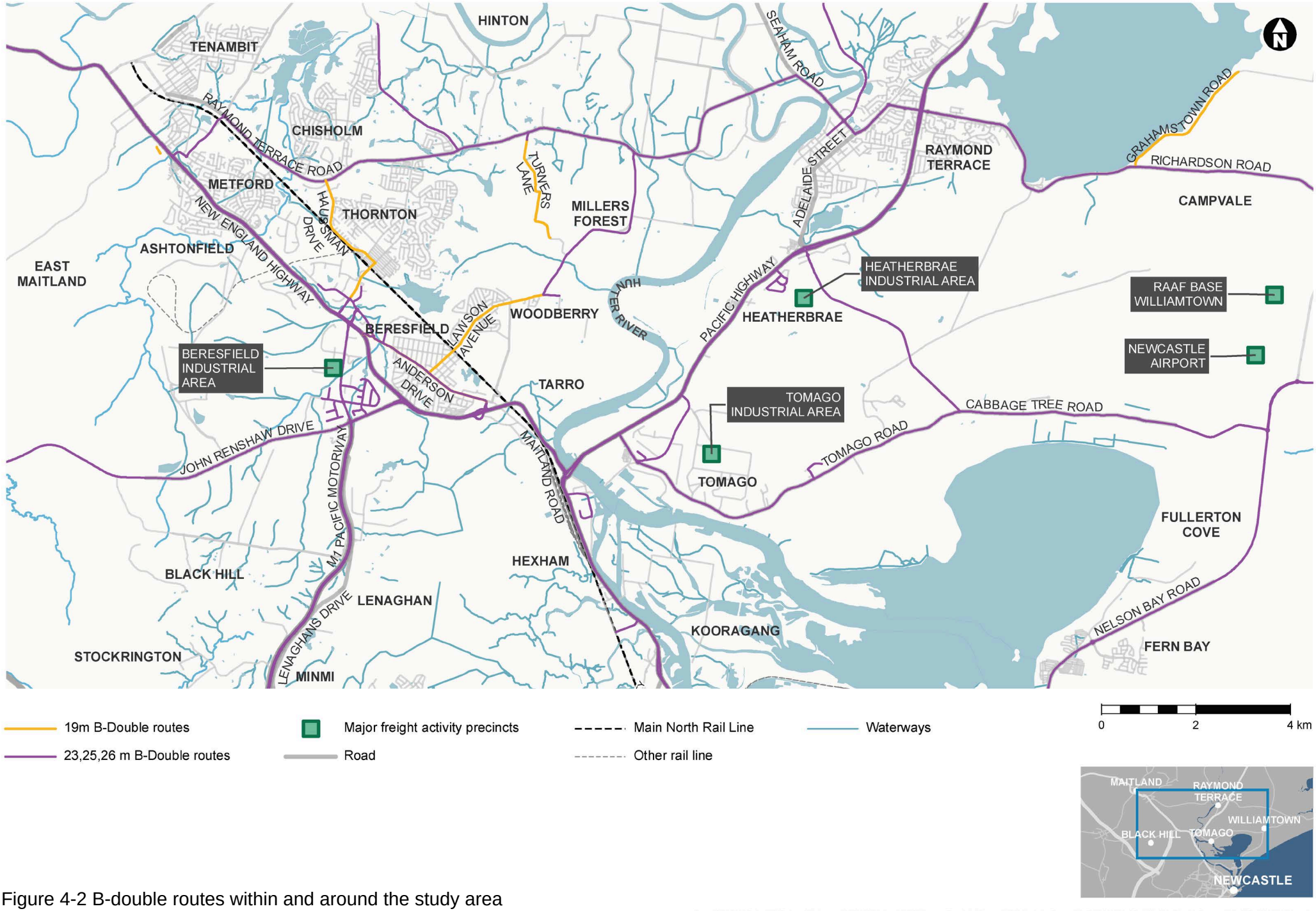

Figure 4-2 B-double routes within and around the study area

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4.3 Existing land use

The study area includes a mix of land uses, including rural and agricultural uses, environmental and water resources, manufacturing and industrial uses, services and utilities, and residential uses of varying densities. These land uses are key drivers of traffic demand in the region, contributing to high levels of local, regional and interstate traffic movements.

The City of Newcastle is located south of the study area and connected to the study area by Maitland Road. Key commercial centres within the study area include Black Hill, Tarro, Beresfield, Tomago, Heatherbrae and Raymond Terrace. Key manufacturing and industrial centres close to the project include Beresfield, Hexham, Tomago, and Heatherbrae. Heatherbrae is located south of Raymond Terrace and has been identified as an 'enterprise corridor' and destination for bulky goods retail.

The Port of Newcastle is a major Australian seaport located in the City of Newcastle and is a major driver of commercial activity in the region. The Port of Newcastle is over 15 kilometres south-east of the project.

One designated rest area is located in the study area. It is located at the Beresfield Service Centre on John Renshaw Drive and is accessed from the eastbound traffic lane. This rest area caters for both light and heavy vehicles.

Most formal parking areas are associated with businesses and industrial developments, with limited formal parking or demand on the state roads in the study area. Informal public parking within the study area is generally limited to verges and local roads.

Infrastructure associated with other modes of transport is located within the study area. Freight rail is discussed in **Section 4.7**, maritime traffic is discussed in **Section 4.9** and pedestrian and cycling facilities are discussed in **Section 4.8**.

Further detail on key regional industries is provided in the Socio-economic Working Paper (Appendix M of the EIS) while detail on land uses near the project is provided in the Land Use and Property Working Paper (Appendix N of the EIS). Future land use near the project is discussed in **Section 4.10**.

4.3.1 Regional airport and RAAF Base

Newcastle Airport is located in Williamtown around 17 kilometres by road east of the Pacific Highway/Tomago Road intersection and around 13 kilometres by road east of the Pacific Highway/Masonite Road intersection. The four main access routes to the airport are:

- From Newcastle: Via Tourle Street, Cormorant Road, Teal Street and Nelson Bay Road
- From Maitland, the M1 Pacific Motorway and west of the study area: Via New England Highway/John Renshaw Drive, Pacific Highway, Tomago Road, Cabbage Tree Road and Nelson Bay Road
- From Raymond Terrace: Via Masonite Road, Cabbage Tree Road and Nelson Bay Road, and via Richardson Road, Medowie Road and Nelson Bay Road
- From north of the study area: Via Pacific Highway, Medowie Road and Nelson Bay Road.

Cabbage Tree Road provides a connection to the airport from the study area. Tomago Road and Masonite Road provide the most direct route to and from Cabbage Tree Road and hence the airport. Tomago Road provides access from Tomago region while Masonite Road provides access from the Heatherbrae region.

Access routes from the study area to the airport are shown in **Figure 4-3** in light blue, other links to the airport are shown in dark blue.

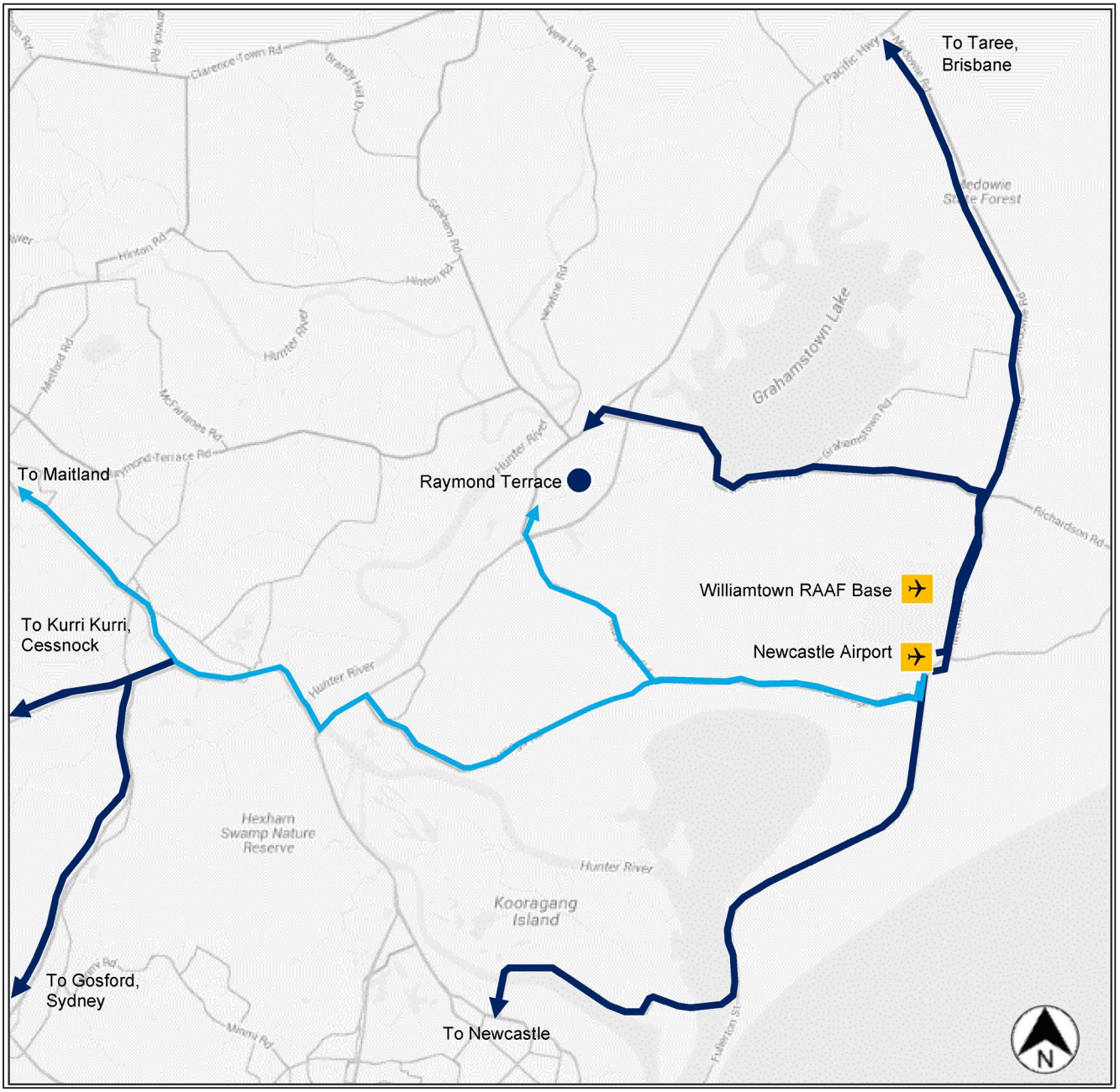

Figure 4-3 Main access routes to Newcastle Airport

The airport is owned by City of Newcastle and Port Stephens Council on land leased from the Australian Department of Defence. The airport runway is shared with Williamtown RAAF Base, which is located north of the runway and west of Medowie Road.

Newcastle Airport handled close to 1.284 million passenger movements in the 2019 calendar year. Nine destinations are served by five airlines with 252 services in total per week and include:

- Brisbane – serviced by QantasLink, Virgin Australia and Jetstar
- Gold Coast – serviced by Jetstar
- Melbourne – serviced by Virgin Australia and Jetstar
- Sydney – serviced by Rex and FlyPelican
- Taree – serviced by Rex
- Canberra, Dubbo, Coffs Harbour and Ballina (Byron Bay) – serviced by FlyPelican.

The 2036 Newcastle Airport Vision (Newcastle Airport, 2016) outlines expansion plans and proposed developments for the airport. As part of the vision, Newcastle Airport would become the airport the Hunter region deserves, offering direct international flights to key tradition destinations.

4.4 Existing road performance

4.4.1 Traffic volumes

Traffic surveys were carried between 10 October 2017 and 23 October 2017 at various locations in the study area to gain an understanding of daily traffic volumes and traffic composition. The average daily traffic volumes observed on key routes throughout the network and the proportion of heavy vehicles for each major road is presented in **Figure 4-4**.

It was originally proposed that traffic counts, as well as travel times and queue length observations, would be collected in 2020 within the study area to inform the growth analysis and future development of the VISSIM model for the project. However, on 12 March 2020, the World Health Organisation declared the coronavirus (COVID-19) as a pandemic. In response to these declarations, the Australian Government introduced a range of restrictions relating to travel, public gatherings and shut down of non-essential services. As such, the COVID-19 situation has dramatically impacted traffic volumes, making it difficult to collect more recent and representative count data for a “typical” period. Planned traffic counts were not collected in 2020, as the COVID-19 pandemic resulted in substantial changes to traffic volumes and were not considered to be representative of an average year. Therefore, existing count data, obtained from previous investigations described above, were used to inform this assessment.

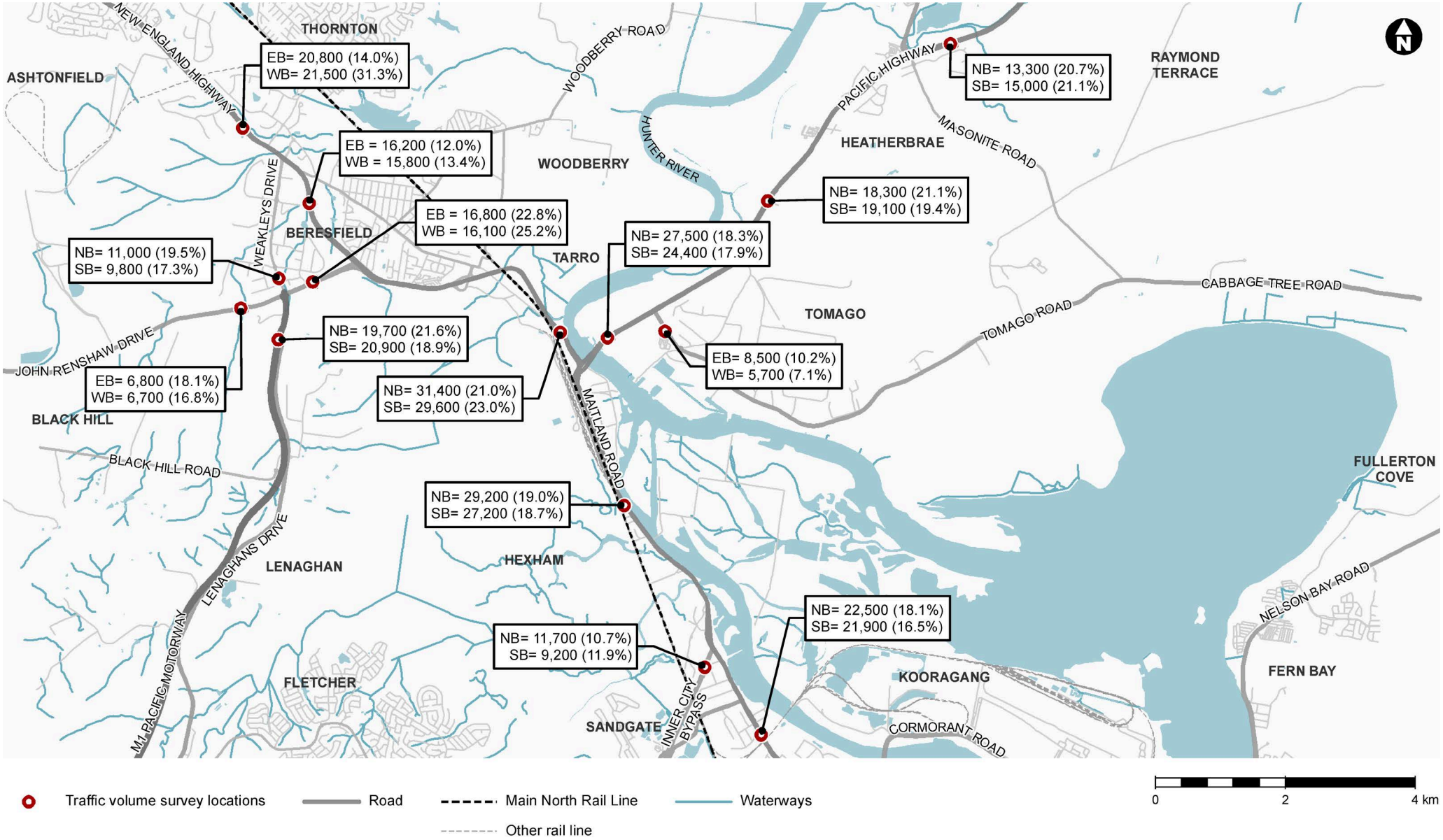

Figure 4-4 Daily traffic volumes of key routes in the network

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4.4.2 Daily and seasonal variation in traffic volumes

A Transport permanent count station (ID 05001) located on Pacific Highway, 380 metres west of Tomago Road in Tomago, was used to assess daily and seasonal variations in traffic volumes in 2019. In summary, weekday traffic volumes are higher than weekend traffic volumes, and school holiday volumes are higher than weekend volumes but less than weekday volumes. **Table 4-1** shows a comparison between the AADT and the annual average traffic volumes for weekdays, weekends and school holiday periods.

Table 4-1 Seasonal variation in traffic at traffic counter station 05001

Permanent count station	AADT	% of AADT		
		Annual average weekday	Annual average weekend	Annual average school holiday
Pacific Highway	48,564 (2017)	52,542 (110% of AADT)	36,399 (81% of AADT)	45,599 (107% of AADT)

Figure 4-5 shows the seasonal profiles of traffic at the permanent count station. The data shows seasonal fluctuations in traffic volumes with peaks that coincide with the Christmas/New Year period, Easter and the July and October school holidays. The average daily traffic volume during these periods is substantially higher than the average for the year.

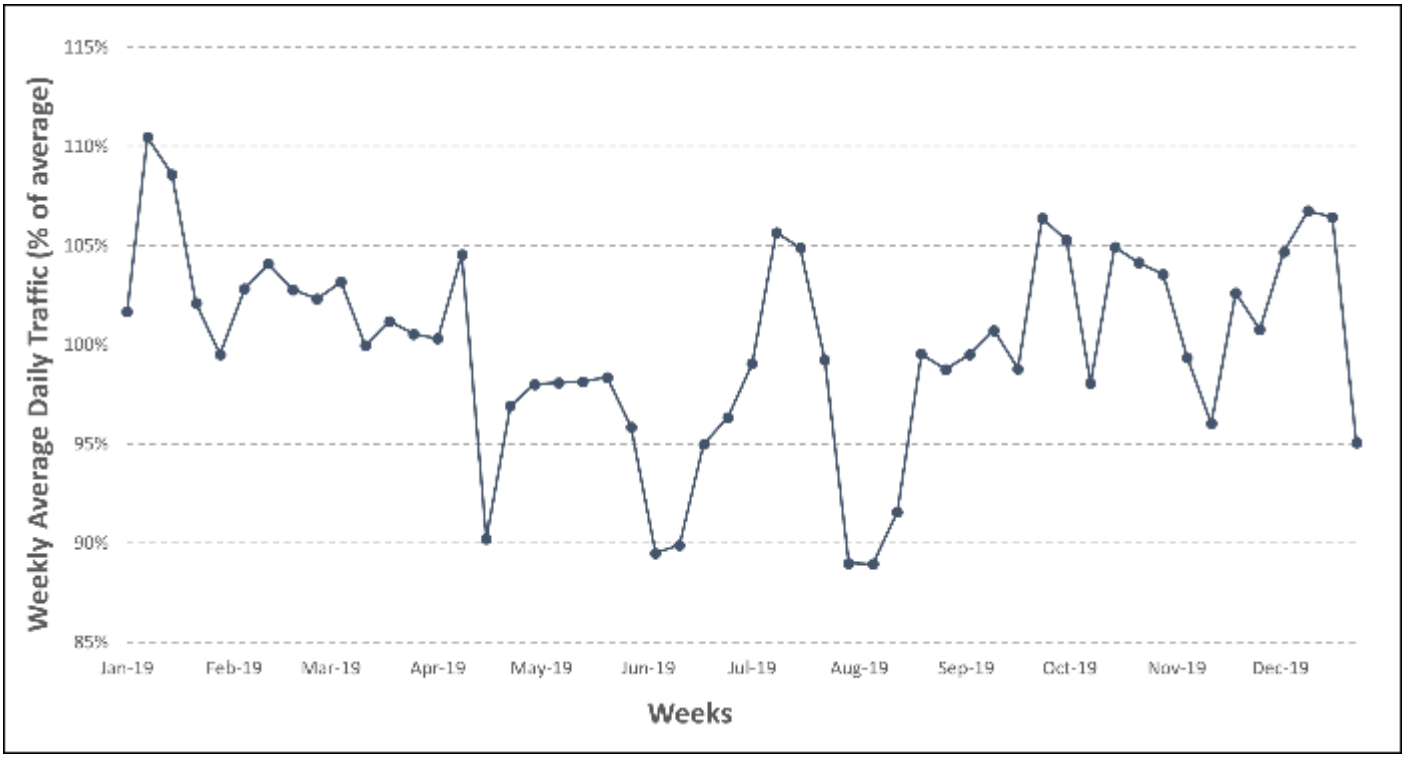

Figure 4-5 Weekly traffic volumes from traffic counter station 05001 in 2019

4.4.3 Historic traffic growth

Table 4-2 displays traffic count data collected throughout a two-week period on weekdays at the same locations in 2014 and 2017. This data shows that some roads have experienced an increase in traffic up to five per cent per year, while others have had negative growth

Traffic volumes were extracted from Transport's traffic volume viewer for four traffic counting stations within the study area to complement the count data and the average annual daily traffic (AADT) for each year.

This data is displayed in **Table 4-3**. The results indicate that historically traffic has experienced an increase of about two to three per cent each year. However, the data displays a reduction in traffic growth since 2015, with the rate of increase reducing to about one per cent AADT growth.

Table 4-2 Traffic count growth rate comparison for weekday traffic

State road and location	2014 vehicles	2017 vehicles	Growth rate per year
John Renshaw Drive, west of Weakleys Drive	11,600	13,500	5.19%
New England Highway, west of Thornton Road	43,900	42,300	-1.23%
M1 Pacific Motorway, south of John Renshaw Drive	36,000	40,600	4.09%
John Renshaw Drive, west of New England Highway	32,600	32,900	0.31%
Weakleys Drive, north of John Renshaw Drive	20,400	20,900	0.81%
New England Highway, north of Pacific Highway	65,700	61,000	-2.44%
Pacific Highway, south of Old Maitland Road	59,700	56,300	-1.94%
Pacific Highway, north of Hunter River Bridge	49,700	51,900	1.45%
Tomago Road, east of Pacific Highway	15,400	14,200	-2.67%
Pacific Highway north of Masonite Road	23,900	28,300	5.79%
Total	**358,900**	**361,900**	**0.28%**

Table 4-3 Recorded AADT at traffic counting stations within the study area

Location	AADT														Growth rate per year
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Pacific Highway, 380 m west of Tomago Road	38,094	38,276*	38,653	39,551	40,500	41,853	42,809	42,992*	42,625	47,342*	47,405*	-	48,614*	48,477	1.9%
New England Highway, 400 m east of Woodlands Close	32,321	35,114*	-	-	-	-	-	-	-	-	32,314*	-	-	-	0.0%
M1 Pacific Motorway, 280 m south of Lenaghans Drive	50,397*	53,005*	52,826	54,787	56,828	57,799*	60,167*	60,303*	64,144*	66,184	-	65,428*	68,402*	-	2.6%
John Renshaw Drive, 570 m west of Kullara Close	-	-	8,048	7,855	8,132	8,941	8,808	8,563*	9,728*	-	-	-	-	-	3.2%

*Indicates traffic data was not recorded for the majority of the year, thus the calculated AADT may be subject to seasonal variation

4.4.4 Travel time

Travel times and travel speeds provide a means of assessing the functional performance of the road network in a way that is consistent with the experience of road users through their day-to-day travel.

Travel times between the five key locations displayed in **Figure 4-6** were extracted from the 2017 base model as part of the ONS. **Table 4-4** and **Table 4-5** display the recorded travel times for the morning peak period and evening peak period respectively. More detailed travel time information is provided in **Appendix B.**

Table 4-4 Existing travel time – morning peak period 8-9am

From	To	Distance (km)	Observed travel time (min:sec)	Travel speed (km/h)
New England Highway	Maitland Road	12.5	14:55	50
	Pacific Highway	16.3	13:26	73
M1 Pacific Motorway		20.7	16:52	74
John Renshaw Drive		18.0	15:13	71
Pacific Highway	New England Highway	16.6	16:26	61
	M1 Pacific Motorway	20.9	19:31	64
	John Renshaw Drive	18.2	17:24	63
	Maitland Road	13.2	14:06	56
Maitland Road	Pacific Highway	13.3	13:25	59
	New England Highway	12.6	12:24	61

Table 4-5 Existing travel time – evening peak period 5-6pm

From	To	Distance (km)	Observed travel time (min:sec)	Travel speed (km/h)
New England Highway	Maitland Road	12.5	11:59	63
	Pacific Highway	16.3	13:26	73
M1 Pacific Motorway		20.7	16:52	74
John Renshaw Drive		18.0	15:13	71
Pacific Highway	New England Highway	16.6	16:26	61
	M1 Pacific Motorway	20.9	19:31	64
	John Renshaw Drive	18.2	17:24	63
	Maitland Road	13.2	13:46	57
Maitland Road	Pacific Highway	13.3	14:45	54
	New England Highway	12.6	13:11	57

On Pacific Highway, travel times for north-eastbound traffic are shorter than travel times for south-westbound traffic. This can be attributed to the additional delays experienced by southbound traffic at the New England Highway/Pacific Highway, Pacific Highway/Tomago Road and Pacific Highway/Old Punt Road intersections. These are described below:

- **New England Highway/Pacific Highway intersection:** The left-turn movement from the New England Highway to Pacific Highway is uncontrolled and therefore is not subject to delays from traffic signals. In contrast, the right turn movement from Pacific Highway to the New England Highway requires traffic to pass through the traffic signals
- **Pacific Highway/Tomago Road intersection**: North-eastbound traffic is delayed only when the pedestrian phase is called for the pedestrian crossing that spans Pacific Highway. Traffic signal data indicates the pedestrian phase is called infrequently. Due to the intersection configurations, southbound traffic is required to stop to allow movements to and from Tomago Road
- **Pacific Highway/Old Punt Road intersection**: Operates as a signalised seagull intersection and therefore north-eastbound traffic is not required to stop at the traffic signals. South-westbound traffic is required to stop when traffic signal phasing allows movements to and from Old Punt Road.

Average travel speeds range between 66 to 76 kilometres per hour for north-eastbound traffic and 56 to 66 kilometres per hour for south-westbound traffic.

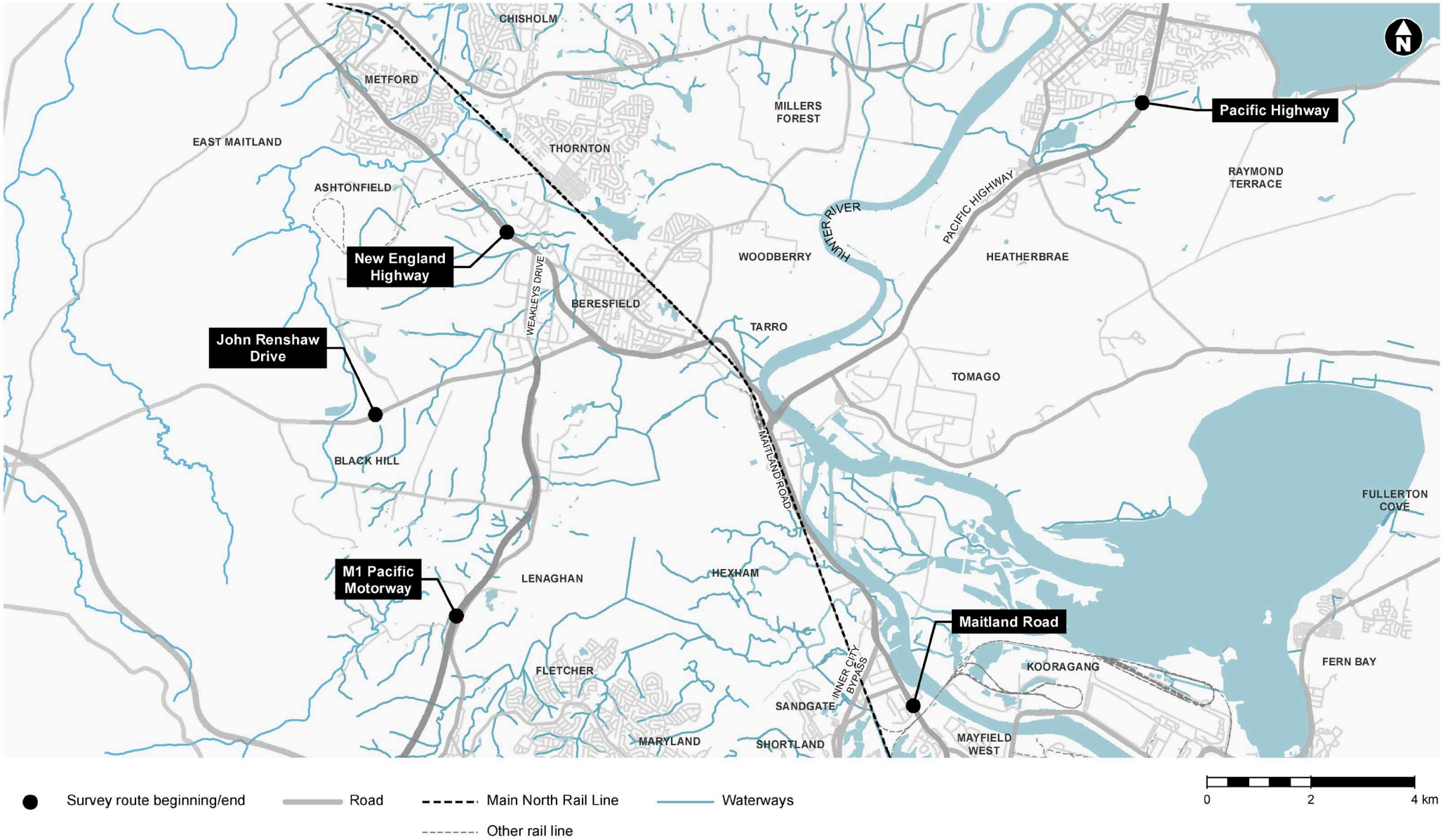

Figure 4-6 Travel time survey routes

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4.4.5 Origin-destination surveys

Origin-destination (O-D) surveys within and surrounding the study area were completed as part of the ONS in 2017 to understand traffic flows during the morning and evening peak periods. O-D surveys were conducted on Tuesday, 7 November 2017 and were carried out by placing 12 counting stations at various locations on the network. The locations of the survey stations relevant to this project are shown in **Figure 4-7**.

The following morning peak observations were made:

- For trips entering the study area at M1 Pacific Motorway, Black Hill (Station 1), Weakleys Drive, Beresfield (Station 3) was the most common destination accounting for 41 per cent of recorded vehicles. The Pacific Highway, Heatherbrae (Station 6) was the next most common destination accounting for 12 per cent of trips. Tomago Road, Tomago (Station 9) was also a common destination and attracted nine per cent of trips
- The largest movement recorded during the morning peak was the southbound movement from the New England Highway into Newcastle (Station 4 to Station 10), 47 per cent of trips entering the study area at the New England Highway travelled to the Pacific Highway in Sandgate (Station 10). Trips from the New England Highway (Station 4) to Tomago or Heatherbrae were also common, with a total of 13 per cent of trips travelling to either Station 5, 6, 7, 8 or 9
- The most frequent destination (15 per cent) for trips entering the study area from Pacific Highway, Heatherbrae (Station 6) was to M1 Pacific Motorway (Station 1)
- The largest heavy vehicle movement in the morning peak was the southbound movement from Weakleys Drive (Station 3) to the M1 Pacific Motorway (Station 1). Other common heavy vehicle routes were from Pacific Highway in Sandgate (Station 10) to both the New England Highway (Station 4) and the M1 Pacific Motorway (Station 1).

The following evening peak observations were made:

- For trips entering the study area at M1 Pacific Motorway, Black Hill (Station 1), Weakleys Drive, Beresfield (Station 3) was the most common destination accounting for 46 per cent of recorded vehicles. The Pacific Highway, Heatherbrae (Station 6) was the next most common destination accounting for 17 per cent of trips. Tomago Road, Tomago (Station 9) was also a common destination and attracted seven per cent of trips
- The largest movement recorded during the evening peak was the northbound movement from Newcastle to the New England Highway (Station 10 to Station 4)
- The most frequent destination (33 per cent) for trips entering the study area from Pacific Highway, Heatherbrae (Station 6) was to M1 Pacific Motorway (Station 1)
- The largest heavy vehicle movement in the evening peak was both southbound and northbound, between Weakleys Drive and the M1 Pacific Motorway.

A separate earlier O-D survey was carried out on 24 August 2016 between 6am and 7pm to determine travel patterns through Heatherbrae, traffic on the Pacific Highway that bypasses Heatherbrae (through trips) and trips that interact or finish within Heatherbrae (local trips). Survey station locations are presented in **Figure 4-8.**

Figure 4-7 Relevant stations for the network-wide O-D Survey

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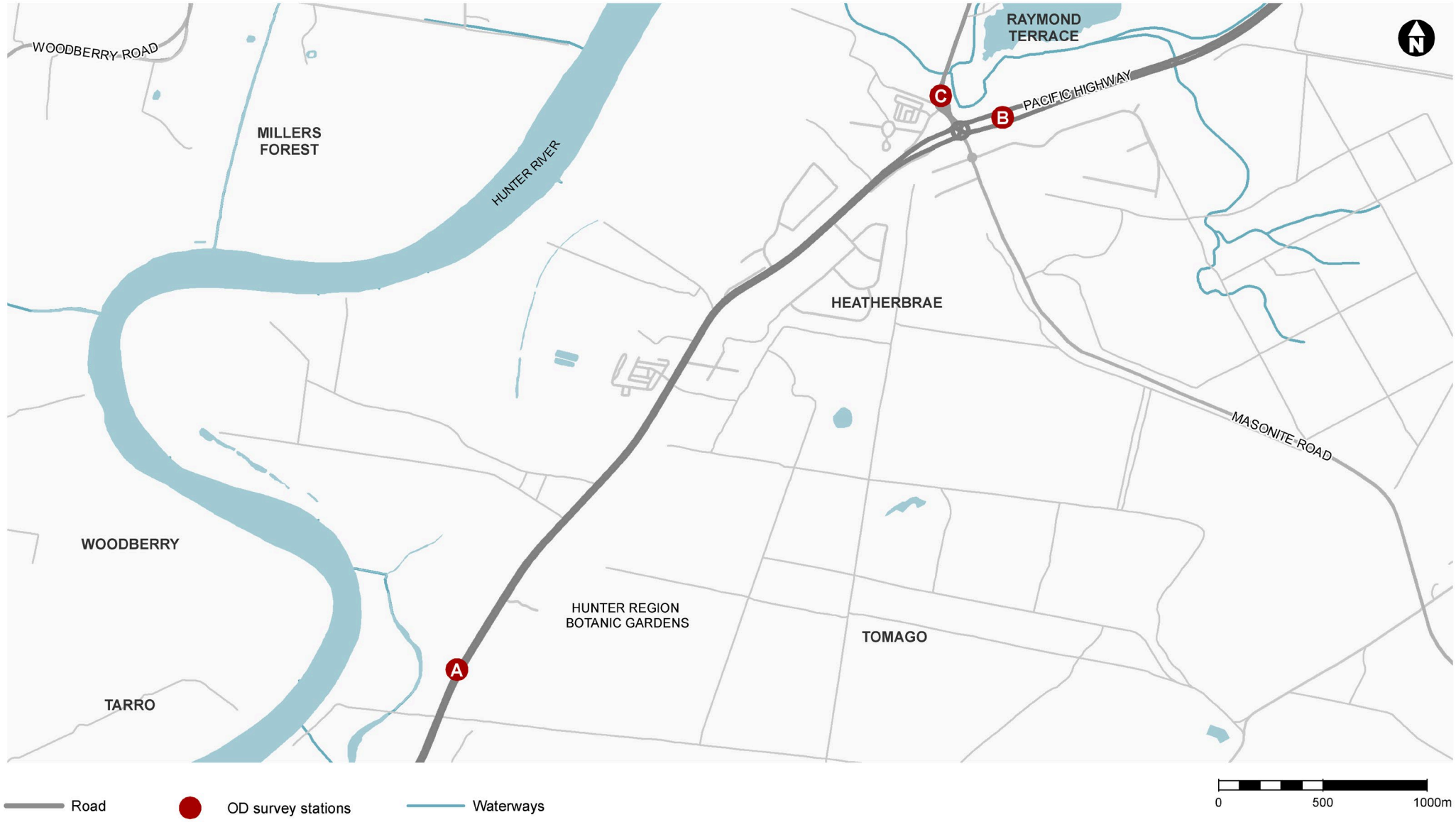

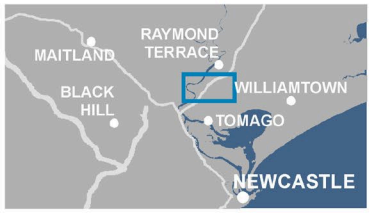

Figure 4-8 Heatherbrae O-D survey station locations

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Vehicles that were recorded travelling between Station A and Station B in either direction within a five minute period were assumed to be through trips via the Pacific Highway. Once the project is constructed, these trips would likely travel on the project road alignment, bypassing Heatherbrae. All other trips were assumed to be local trips. While vehicles may briefly stop in Heatherbrae and then continue on the Highway after a brief stop, the five minute matching period means these are captured as local trips and not through trips as they would not use the project to bypass Heatherbrae. Results from the O-D survey are presented in **Table 4-6**.

Table 4-6 O-D survey results with five-minute matching period

Trip type	Morning peak		Evening peak		Surveyed hours	
	Northbound	Southbound	Northbound	Southbound	Northbound	Southbound
Through trips	49%	20%	50%	32%	49%	31%
Local	51%	80%	50%	68%	51%	69%

The survey results indicate that in the northbound direction there was almost an even split between through trips and local trips. In the southbound direction, a greater proportion (69 per cent) of trips are local trips. From these results, it can be expected the provision of a bypass would substantially reduce traffic travelling through Heatherbrae as vehicles would have an alternative faster route.

4.4.6 Intersection performance

The traffic modelling results from the calibrated and validated 2017 base model were extracted to gain an understanding of current performance for intersections presented in **Figure 4-9**.

Intersection delays and LoS for these key intersections within and surrounding the study area for the morning and afternoon peak periods are outlined in **Table 4-7**. These results are based on modelled average delay for each hour in the traffic model.

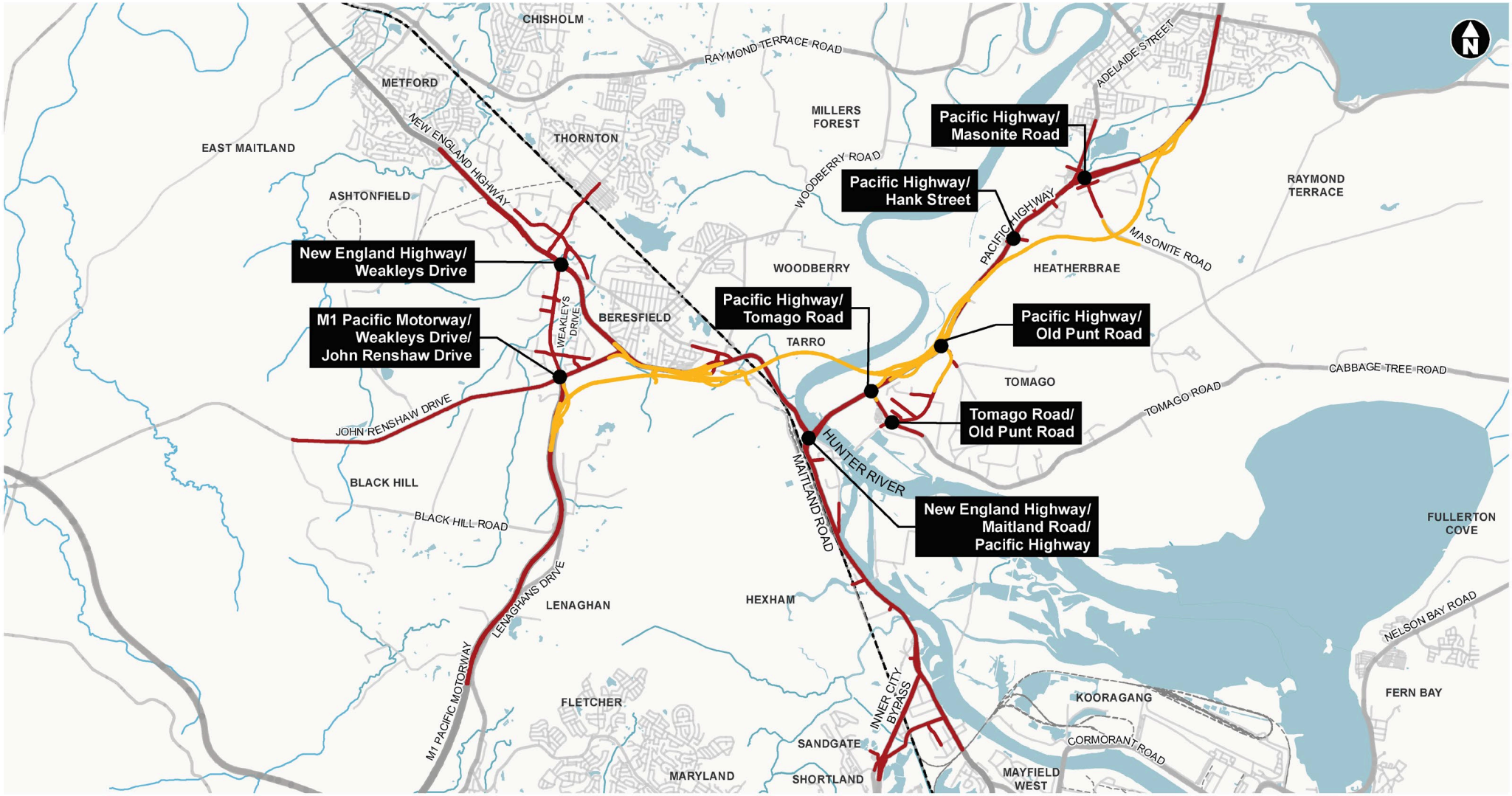

Figure 4-9 Location of intersections assessed in the traffic model

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Table 4-7 Performance of modelled intersections in 2017

Intersection	Type	Morning		Evening	
		8-9am		5-6pm	
		Avg delay (sec)	LoS	Avg delay (sec)	LoS
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Roundabout*	27	C	63	E
New England Highway/Weakleys Drive, Beresfield	Signalised	11	B	18	B
New England Highway/Maitland Road/Pacific Highway	Signalised	19	B	19	B
Pacific Highway/Tomago Road, Tomago	Signalised	15	B	11	B
Pacific Highway/Old Punt Road, Tomago	Signalised	18	B	10	B
Old Punt Road/Tomago Road, Tomago	Roundabout	4	A	1	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	11	B	10	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	10	B	10	A

* At the time of the traffic data collection exercise and the construction of the base model, the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection was a roundabout. This has since been upgraded to a signalised intersection, which has been used in the traffic modelling.
* Cells with pink shading represent intersections where performance is worse than LoS D

The M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection during the final two evening peak hours operates at a Los E. At the time of the traffic data collection exercise and the construction of the base model, this intersection was a roundabout. It has since been upgraded to a signalised intersection. However as the base model was calibrated to this intersection being a roundabout, the performance of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection is likely to have improved as a result of the intersection upgrade to traffic signals.

Overall, the model results indicate the evening peak is more congested than the morning peak as vehicles experience longer delays at the assessed intersection. However, the existing intersection delay and LoS for the majority of intersections in the study area are operating at a satisfactory LoS (D or better) in 2017.

4.5 Road safety and crash history

4.5.1 Historical crash data

A crash analysis was carried out using historical crash data provided by Transport for crashes occurring on key roads relating to the project for the five-year period from October 2014 to September 2019. This data includes fatal, serious injury, moderate injury, minor/other injury and/or non-casualty incidents.

The crash data conforms to national guidelines for reporting and classifying road vehicle crashes and are based on the following criteria:

- The crash was reported to police
- The crash occurred on a road open to the public
- The crash involved at least one moving road vehicle
- The crash involved at least one person being killed or injured, or at least one motor vehicle being towed away.

A summary of casualty crashes for a five-year period between October 2014 to September 2019 on key roads is presented in **Table 4-8** and **Table 4-9**. Key observations include:

- A total of 289 crashes were recorded in the five-year period, of which six crashes were fatal
- The most prevalent type of crash was found to be rear-end crashes (39%), followed by lane changes (9%)
- The New England Highway and Pacific Highway recorded the highest number of crashes. However, it is also the longest length of road in the assessed and carries the highest traffic volumes
- Two fatality crashes were recorded on the Pacific Highway
- One fatality crash was recorded each on John Renshaw Drive, M1 Pacific Motorway, New England Highway and Weakleys Drive
- Old Punt Road and Tomago Road recorded the lowest number of crashes over the five-year period at three and seven, respectively.

Table 4-8 Crashes by type on each road between October 2014 and September 2019

Crash type	John Renshaw Drive	M1 Pacific Motorway	New England Highway	Old Punt Road	Pacific Highway	Tomago Road	Weakleys Drive	Total
Rear end	4	9	51	-	43	4	3	114
Lane change	-	2	18	-	5	-	2	27
Off road, hit object	-	6	6		12	-	-	24
Off bend, hit object	2	4	9	-	6	-	-	21
Other same direction	1	1	12	-	2	-	1	17
Off road	-	6	3	-	3	1	1	14
Cross traffic	-	5	1	-	7	-	-	13
Sideswipe	-	5	7	1	4	-	1	18
U-turn	1	1	2	-	-	1	-	5
Head on	-	-	2	1	1	-	-	4
Object on road	-	2	2	-	-	-	-	4
Right near	-	1	1	-	2	-	-	4
Out of control on bend	-	1	-	1	1	-	-	3
Right through	-	1	1	-	1	-	-	3
Pedestrian	-	-	-	-	1	-	1	2
Right far	-	-	2	-	-	-	-	2
Right/left	-	2	-	-	-	-	-	2
Struck animal	-	1	-	-	1	-	-	2
Other	-	1	4	-	4	1	-	10
Total	**8**	**48**	**121**	**3**	**93**	**7**	**9**	**289**

Table 4-9 Total crashes on each road between October 2014 and September 2019

Road	Section	No. of fatal crashes	No. of injury crashes	No. of non-casualty (tow-away) crashes	Total
John Renshaw Drive	500 m west of M1 Pacific Motorway to New England Highway	1	3	4	8
M1 Pacific Motorway	North of Black Hill to John Renshaw Drive	1	24	23	48
New England Highway	West of Thornton Rd to Old Maitland Road	1	70	50	121
Old Punt Road	Tomago Road to Pacific Highway	0	2	1	3
Pacific Highway	New England Highway to Richardson Road	2	55	36	93
Tomago Road	500 m west of Tomago Aluminium to Pacific Highway	0	5	2	7
Weakleys Drive	John Renshaw Drive to New England Highway	1	4	4	9
Total		**6**	**163**	**120**	**289**

4.5.2 Crash rate

Crash rates are commonly expressed in terms of crashes per total travel, recognising that increased activity does not necessarily translate to increased crash risk. This is expressed as crashes per 100 million VKT. For the five years of available crash data, the crash rate has been calculated as an average over the period using the following formula:

*Crash rate per 100 million VKT = (Total number of crashes * 100,000,000) / (Number of years * 365 * Length (km) * AADT)*

Crash rates per 100 million VKT are shown in **Table 4-10** and roads which perform worse than the NSW state average have been shaded in red. The fatality crash rates for the John Renshaw Drive, Weakleys Drive and the M1 Pacific Motorway exceed to the NSW average fatality crash rate, however, they do have an injury crash rates and casualty crash rate lower than the NSW average injury crash rate. The casualty crash rates for Old Punt Road is greater than the NSW average, on this stretch of road, three crashes have occurred over the past five years, none of which have been fatal or caused a serious injury.

Table 4-10 Crash rates per 100 million VKT on each road between October 2014 to September 2019

Road	Section	Length (km)	AADT[1]	Fatalities per 100 million VKT		Serious injuries per 100 million VKT		Casualty crashes per 100 million VKT	
				Project	NSW average[2]	Project	NSW average	Project	NSW average
John Renshaw Drive	500 m west of M1 Pacific Motorway to New England Highway	1.2	30,200	1.51	0.44	0.00	6.67	6.05	16.00
M1 Pacific Motorway	North of Black Hill to John Renshaw Drive	2.8	37,900	0.52		4.13		12.91	
New England Highway	West of Thornton Road to Old Maitland Road	8.8	55,800	0.11		2.23		7.92	
Old Punt Road	Tomago Road to Pacific Highway	2.2	2,500	0.00		0.00		19.93	
Pacific Highway	New England Highway to Richardson Road	11.3	51,900	0.19		1.49		5.33	
Tomago Road	500 m west of Tomago Aluminium to Pacific Highway	1.7	11,000	0.00		0.00		14.65	
Weakleys Drive	John Renshaw Drive to New England Highway	2.2	18,800	1.32		0.00		6.62	
Average				**0.52**		**1.12**		**10.49**	

[1]*Based on most recent available survey count data from 2017*

[2]*NSW Fatality and Serious Injuries data derived from NSW Transport Road Safety Crash Stats 2018. It is the average of all roads. NSW Casualty Crashes data derived from Transport Monthly Bulletin of Preliminary Crash Data (April 2020).*

4.6 Public transport

4.6.1 Bus services

The bus network operating within and surrounding the study area consists of local buses and regional coach services. These are described below.

Local buses

Ten local buses operate in the study area providing connections to Newcastle, Raymond Terrace, Newcastle Airport, Nelson Bay and Maitland. Most bus routes in the study area use the lower order road network, with the exception of:

- Route 140 that operates on Pacific Highway and Maitland Road
- Routes 145, 181 and 182 that operate on the New England Highway west of Weakleys Drive.

Most routes operate at 30 to 60 minute frequencies on weekdays, 60 minute frequencies on Saturdays and 120 minute frequencies on Sundays. **Figure 4-10** displays the bus routes within and surrounding the study area.

Long-distance coach services

Long-distance coach services pass through the study area to provide inter-regional connections. Long-distance coaches operated by Greyhound and Premier Motor Service via the Pacific Highway services Port Macquarie, Kempsey, Coffs Harbour, Grafton Ballina, Byron Bay, Gold Coast and Brisbane. Long-distance coaches operated by Greyhound via the New England Highway service Tamworth, Armidale, Glen Innes, Tenterfield, Stanthorpe, Warwick and Brisbane. There are a total of four services in each direction per day.

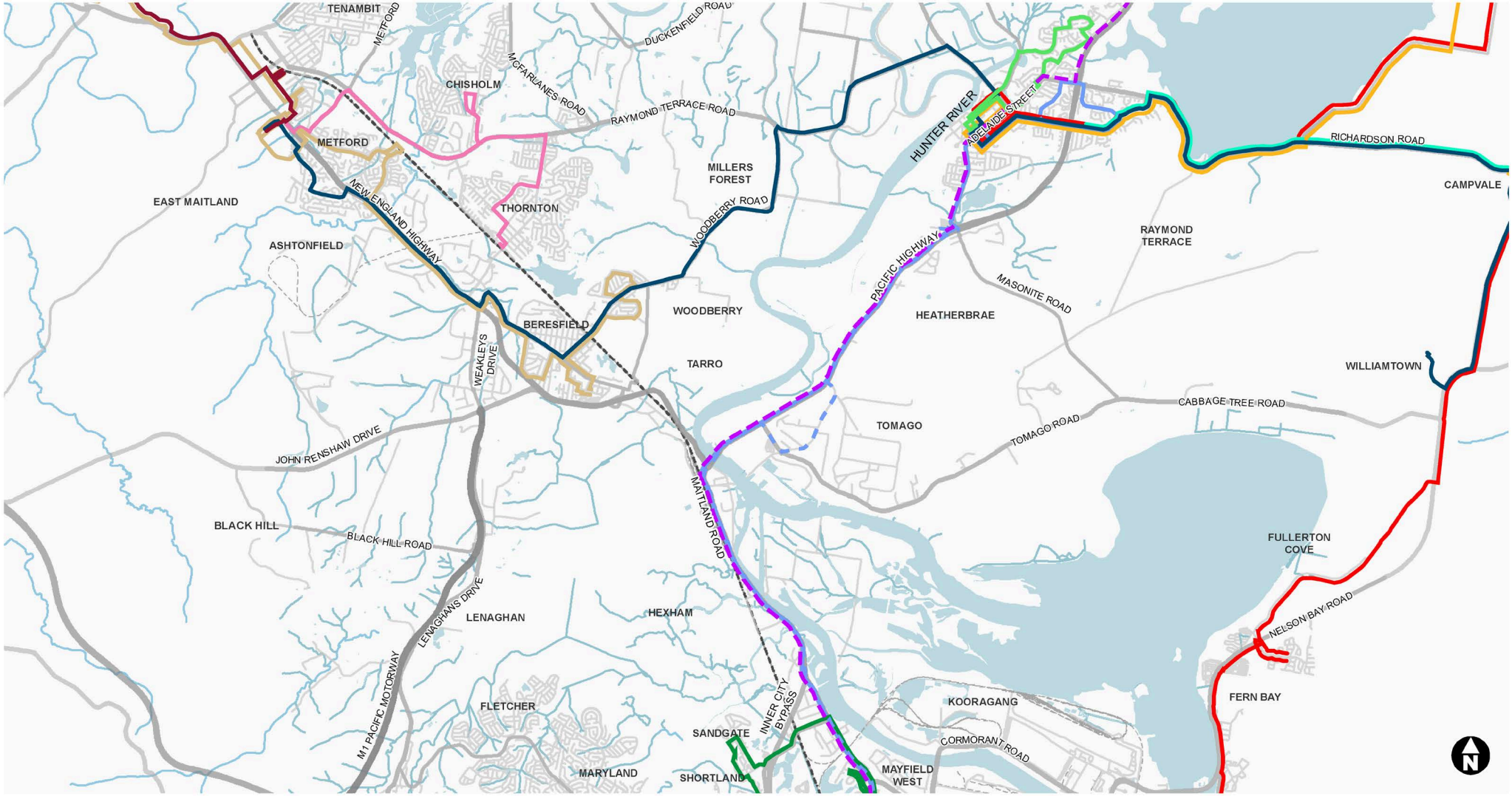
4.6.2 Passenger rail network

The rail network in the study area consists of the Main North Rail Line, with four tracks that broadly run parallel to the New England Highway and Pacific Highway. The Main North Rail Line primarily serves freight traffic from the Hunter Valley mining industry, with some passenger rail. Railway stations close to the project are located at Thornton, Beresfield, Tarro, Hexham and Sandgate as shown in **Figure 4-11.** These stations are serviced by the Hunter Line, an intercity line operated by NSW TrainLink connecting Hamilton (Newcastle) with Maitland, Scone and Dungog.

Thornton Station and Beresfield Station receive the most train services in the region with 98 weekday services and 57 weekend services. Tarro Station, Hexham Station and Sandgate Station receive fewer services per day with only 49 on weekdays and 43 on weekends.

The average morning peak hour service frequency at Thornton and Beresfield towards Hamilton (Newcastle) is 10 to 20 minutes, compared to 60 minutes at Tarro, Hexham and Sandgate. Similarly, in the evening peak hour, the average service frequency at Thornton and Beresfield towards Scone/Dungog is 10 to 20 minutes, compared to 30 to 60 minutes at Tarro, Hexham and Sandgate.

The Main North Rail Line is also used by NSW TrainLink regional services between Sydney and Moree, Armidale, Grafton, Casino and Brisbane. However, TrainLink regional services do not stop at stations close to the project. The nearest stations serviced by these trains are Broadmeadow and Maitland. Two NSW TrainLink regional services pass through the region daily.



Bus routes

- 47
- 135
- 136
- 137
- 140
- 140 (peak hours)
- 141
- 145
- 181
- 182
- 189
- Regional coaches network
- Road
- Waterways

0 2 4 km

Figure 4-10 Operating bus services

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Railway station
Main North Rail Line
Other rail line
Road
Waterways

0 2 4 km

Figure 4-11 Rail network

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4.7 Freight rail

The Main North Rail Line supports the haulage of coal between 35 coal mines located in the Hunter Valley and the Port of Newcastle for export. Known as the Hunter Valley Coal Chain, the railway infrastructure is owned by RailCorp and managed by the Australian Rail Track Corporation (ARTC) under a 60-year lease that commenced in 2004. Four rail haulage providers service the Hunter Valley Coal Chain:

- Pacific National
- Aurizon
- One Rail
- Southern Short-haul Railroad.

Collectively the Hunter Valley Coal Chain facilitates about 22,000 train movements per year, which equates to 60 train movements per day. In the study area, freight trains run on two dedicated tracks (one towards and one away from the Port of Newcastle). Coal trains are separated from passenger trains, while general cargo/container trains share tracks with passenger trains.

A Hexham Train Support Facility for Aurizon coal trains is located to the west of the Main North Rail Line close to the project (refer to **Figure 4-12**). Aurizon access road as a key connection to the facility from the New England Highway, Tarro. The facility consists of seven tracks with a total length of 10.5 kilometres and has the following functions:

- Operational management of Aurizon coal trains
- Statutory and routine maintenance inspections
- Attachment/detachment of locomotives and wagons
- Provision of fuel, water and other supplies to locomotives
- Servicing and storage of locomotives and wagons.

The Hexham Train Support Facility is consistent with the ARTC strategy of continuous improvement associated within the Hunter Valley Corridor Capacity Strategy which would reduce reliance on the existing and future road network.

Figure 4-12 Hexham train support facility (Aurizon, 2015)

4.8 Pedestrian and cycling facilities

4.8.1 Pedestrian network

Overall in the study area, particularly along the NLTN and State roads, there are limited pedestrian facilities provided due to the relatively low demand. There are various footpaths and associated facilities within the study are in the key residential catchment areas (e.g. Tarro and Beresfield) and limited footpaths and facilities within industrial and employment areas at Beresfield, Tomago and Heatherbrae. Signalised pedestrian crossings are provided at the following intersections:

- Pacific Highway and Tomago Road – across the eastern leg of the intersection to access the bus stop on the Pacific Highway servicing the Tomago industrial area
- Pacific Highway and Hank Street – across all approaches to the intersection due to the adjacent commercial and retail developments in Heatherbrae.

4.8.2 Cycle network

There are no existing dedicated cycle paths within the study area, therefore cyclists use the shoulders of the existing road network.

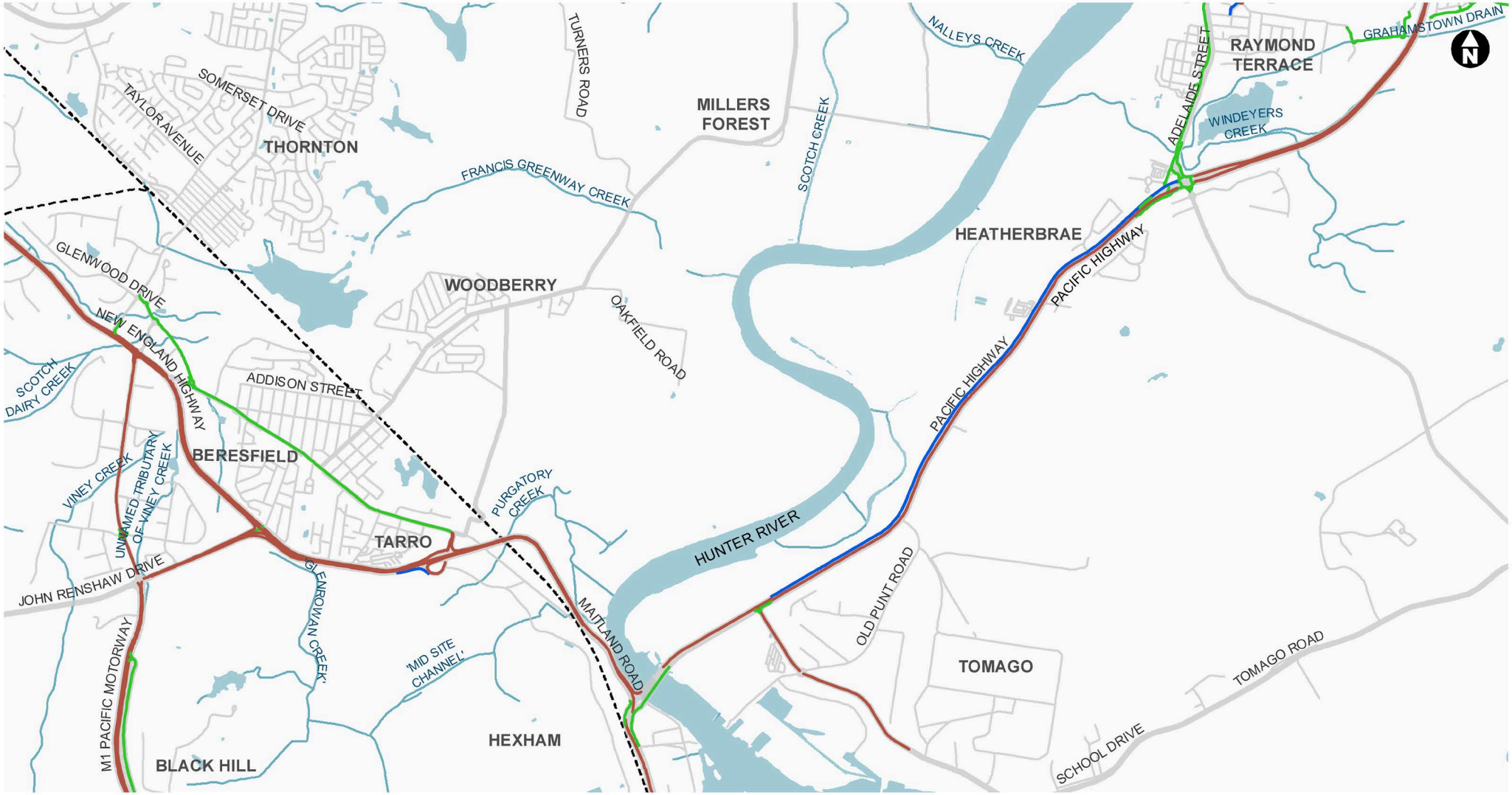
Inter-regional cycle movement is facilitated by on road shoulders on the M1 Pacific Motorway, New England Highway/Maitland Road and Pacific Highway and are classified by the Cycleway Finder V3 (TfNSW, 2020) as high difficulty routes. Weakleys Drive, John Renshaw Drive and Tomago Road are also designated as high difficulty on-road routes. Anderson Drive through Beresfield and Tarro is designated as a low difficulty on-road route.

Dedicated shared paths are provided at the following locations:

- From north of the existing Hexham Bridge (eastern side), Tomago to the intersection of Maitland Road/Old Maitland Road, Hexham (840 metres continuous length)
- From Anderson Drive west of Byron Street, Beresfield to Glenwood Drive east of Thornton Road, Thornton (1.4 kilometres continuous length)
- From Pacific Highway north of Motto Lane, Heatherbrae to Swan Street south of Sturgeon Street, Raymond Terrace (2.5 kilometres continuous length).

A marked cycle lane is provided on New England Highway in the southbound direction between the exit-ramp to the existing Hexham Bridge and the intersection with Pacific Highway. The recent upgrade to the M1 Pacific Motorway and Weakleys Drive intersection provides painted shoulders for cyclists and designates crossing locations. The M1 Pacific Motorway and Weakleys Drive intersection would need to be permanently modified to allow cyclists to cross and continue their journey along the project.

The current cycle network in the study area is predominantly on high difficulty on-road routes, shown in **Figure 4-13**.



Cycle infrastructure

- Hard difficulty
- Moderate difficulty
- Low difficulty
- Main North Rail Line
- Waterways

Figure 4-13 Existing cycling infrastructure

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4.9 Maritime traffic

The Hunter River is a major river in NSW running between Newcastle and Liverpool Range in NSW. Within the study area is a navigable channel used by both commercial and recreational users.

The Hexham Bridges pass over the Hunter River in the study area. The old Hexham Bridge carries southbound traffic and is a steel truss bridge with a central lifting span. While down it has a clearance height of 4.7 metres. The newer northbound bridge which carries northbound traffic has a fixed 10 metre clearance height. About eight trawlers regularly use the area, larger vessels can be booked for the bridge to be lifted providing greater clearance. The bridge is raised about 120 times per year and is also closed for bi-annual maintenance. When the bridge is raised, westbound traffic over the bridge is temporary stopped for approximately five minutes.

4.10 Traffic growth and future land use

4.10.1 Future land use

The study area is covered by the Hunter Regional Plan 2036 (DPE, 2016) and Greater Newcastle Metropolitan Plan 2036 (DPE, 2018), which outlines the future land use vision for the Hunter and Greater Newcastle areas and provide frameworks for land use planning priorities and decisions. Raymond Terrace will be the focus of population and employment growth over the next 20 years. Tomago, Heatherbrae and the convergence of the national road network around Thornton, Beresfield and Black Hill are identified as significant employment precincts. The Greater Newcastle Metropolitan Plan (DPE, 2018) also identifies Beresfield, Black Hill and Tomago as major employment precincts and trading hubs within Greater Newcastle. West Wallsend, Cameron Park and Edgeworth south of the study area are identified as urban release areas and will be a focus of future housing and urban renewal opportunities.

Beresfield and Black Hill are proposed to be a freight and logistics hub, with complementary manufacturing and light industrial activity. Three precincts are identified within this location, including:

- Beresfield Precinct, which will support freight and logistics, manufacturing and other light industrial uses
- Emerging Black Hill Precinct, located west of the M1 Pacific Motorway, which is proposed to be the subject of a master plan that considers freight and logistic uses, the adjoining mine site and road access to John Renshaw Drive
- Thornton Precinct, which is proposed to support expanded business and light industrial uses.

Tomago is proposed to be an advanced manufacturing and industrial area. Local planning for the Tomago Industrial Precinct would look to enable the efficient movement of goods by protecting freight routes connecting Tomago to Newcastle Airport and Port of Newcastle. The Tomago Shipbuilding Precinct located next to the Hunter River is identified as a location to promote the development of shipbuilding industries that maximise opportunities to secure defence contracts.

Emerging Black Hill Precinct traffic generation

The Emerging Black Hill Precinct is a proposed major development within the study area and would be located south of John Renshaw Drive and west of M1 Pacific Motorway. The development would constitute about 300 hectares of net development area, which is expected to generate substantial traffic volumes onto the adjacent road network.

The Emerging Black Hill Precinct is included in the traffic modelling for future horizon years and it has been assumed that 25 per cent of the development would be complete by 2028, 75 per cent by 2038 and 100 per cent by 2048. The development would be a key generator of traffic in the region for future horizon and accounts for about 11 per cent of all trips in the study area by 2038 and 12 per cent by 2048.

4.10.2 Traffic growth forecast

With consideration of the historic traffic growth rate and the traffic generated from the Emerging Black Hill Precinct. **Table 4-11** displays the growth rate assumptions and trips generated from the Emerging Black Hill Precinct used to develop the traffic demand matrices for the modelled years.

The growth rates used for the morning and evening peak periods were used to adjust the 2028, 2038 and 2048 'without project' models from the ONS 2017 model's base trip matrices.

Table 4-11 Traffic growth rate assumptions

Modelled year	Background growth (both peak periods)	Emerging Black Hill Precinct	Morning peak Black Hill trips	Evening peak Black Hill trips
2017 (base)	N/A	0% of development complete	0	0
2028 (opening year)	1.5%	25% of development complete	1,882	2,159
2038 (future horizon)	1.5%	75% of development complete	5,646	6,476
2048 (future horizon)	1.5%	100% of development complete	7,528	8,635

5. Assessment of potential impact

5.1 Construction impact

5.1.1 Construction activities and indicative program

The timing and sequence of the project has considered the requirement to minimise the impact on existing traffic, enable safe construction access and minimise the duration of construction. Construction of the project is expected to begin in 2023 and end in 2028, with work occurring across the full length of the construction footprint during this period. An overview of the construction program is shown in **Table 5-1**.

Table 5-1 Construction program

Construction component	Year 1				Year 2				Year 3				Year 4				Year 5			
Enabling works	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■				
Construction of ancillary facilities	■	■	■	■	■	■	■													
Operation of ancillary facilities			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Drainage and water quality control									■	■	■	■	■	■	■					
Clearing, grubbing and demolition					■	■	■	■	■	■	■	■	■	■	■					
Bulk earthwork					■	■	■	■	■	■	■	■	■	■	■	■	■	■		
Pavements								■	■	■	■	■	■	■	■	■	■	■	■	
Bridges and viaducts					■	■	■	■	■	■	■	■	■	■	■	■	■			
Roadside furniture and finishing work											■	■	■	■	■	■	■	■	■	■
Traffic management and control			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	
Landscaping														■	■	■	■	■	■	

5.1.2 Workforce and construction work hours

Workforce

The size and composition of the construction workforce would vary over the duration of construction depending on the activities carried out and the construction program and staging. The workforce is expected to peak at about 1050 workers per year, including construction workers and professional and administrative staff. Multiple work crews may construct the project at any one time.

Construction work hours

The recommended standard hours for construction as noted in the Interim Construction Noise Guideline (DECC, 2009) are shown in **Table 5-2**. In the event that the Environmental Planning and Assessment (COVID-19 Development – Construction Work Days) Order 2020 is still in force at the time of construction, or if standard construction work hours are further altered, the standard construction hours for the workforce would be adopted.

Table 5-2 Standard working hours

Day	Start time	Finish time
Monday to Friday	7am	6pm
Saturday	8am	1pm
Sunday and public holidays	No work	

Extended working hours

The Interim Construction Noise Guidelines (DECC, 2009a) recognises there are some situations where construction may need to be carried out outside of the recommended standard construction hours. This includes public infrastructure work that shortens the construction period of the project.

As the majority of work would be away from residences and sensitive receivers (particularly north of Tarro), Transport is seeking approval for standard construction hours plus:

- An extra hour at the start and end of each day Monday to Friday
- An extra five hours on a Saturday
- Work on Sunday and public holiday from 7am to 5pm.

This is referred to as 'extended construction hours', outlined in **Table 5-3**, and would apply across the project. Transport would carry out targeted consultation with affected residents before work starts.

Table 5-3 Extended working hours

Day	Start time	Finish time
Monday to Friday	6am	7pm
Saturday	7am	5pm
Sunday and public holidays	7am	5pm

Transport aims to achieve a balance between amenity and more efficient delivery of major infrastructure upgrades. As a result, Transport is investigating opportunities for ensuring delivery of the benefits of the project as soon as possible. Early completion of construction would provide considerable benefits to the community and road users. In particular, extended working hours would:

- Reduce the volume of traffic on roads during peak hours due to construction staff and construction vehicles travelling to and from the construction site outside of peak traffic periods
- Time benefits, including potentially bringing forward the opening date for the project by increasing the allowable construction hours
- Cause less disruption to sensitive receivers, the community, local business, motorists, pedestrians and cyclists as work would be completed earlier than compared to adopting standard work hours
- Enable greater flexibility in project scheduling. This would enable the contractor to make allowances for adverse weather and potential flooding events.

The proposed extended construction hours would only apply to normal construction activities. If required, blasting would only be carried out Monday to Friday between 9am and 5pm and Saturday between 9am and 1pm.

Out-of-hours work

The Interim Construction Noise Guidelines (DECC, 2009a) also recognises there are some situations where specific construction work may need to be carried out outside the recommended standard hours.

In addition to standard working hours and extended construction hours, some construction activities would need to be carried out during evening and night time periods (referred to as ‘out-of-hours work’). The activities that may need to be carried out out-of-hours include:

- Delivery of plant and materials that is required outside construction work hours as requested by police or other authorities for safety reasons (e.g. oversized deliveries)
- Installation of traffic controls, such as concrete barriers
- Traffic switches between each construction phase
- Operation of concrete and asphalt batching plants within ancillary facilities
- Resurfacing of asphalt pavement on existing roads and concrete and asphalt pouring
- Construction work interfacing with the M1 Pacific Motorway, New England Highway and the Pacific Highway, including construction of overbridge piers for the M1 Pacific Motorway entry and exit ramps and ramp tie-ins with the M1 Pacific Motorway, cross drainage below existing roads, pavement, surfacing, line markings, kerbs and traffic islands, traffic signs and signals
- Short-term traffic diversions along the existing road network (M1 Pacific Motorway, New England Highway, John Renshaw Drive, Masonite Road, and the Pacific Highway)
- Bridge construction work over the Main North Rail Line and existing roads including the New England Highway, Pacific Highway and Old Punt Road traffic along existing road networks (including establishing temporary protection work, installation of girders, sealing of joints, establishing temporary screens to enable construction to continue on the deck, and removal of temporary work)
- Utility modifications, relocations or protection measures work
- Removal of existing static signage and installation of new signs
- Removal of existing traffic barriers and installation of temporary and permanent traffic barriers
- Removal of existing lane marking and application of new lane marking on existing roads
- Any work that does not cause noise emissions to be audible at any sensitive receiver
- Emergency work to avoid the loss of lives, property and/or to prevent environmental harm.

Out-of-hours construction activities would be supported by out-of-hours operation of temporary ancillary facilities.

The exact timing of out-of-hours work would depend on construction activities, construction techniques and constraints imposed by the affected communities or the relevant authorities (utility authorities or road/motorway operators) and would be subject to the requirements of the construction contractor.

The potential construction noise and vibration impacts are presented in **Chapter 8**. Extended and out-of-hours work would be managed through the implementation of a Construction Noise and Vibration Management Plan which would include feasible and reasonable mitigation measures to minimise the potential for adverse impact on the local community.

5.1.3 Location of construction ancillary facilities and access

Twenty-one ancillary facilities have been identified along the length of the project (**Figure 5-1**) and potential functions (including indicative construction worker parking locations) have been indicated in **Table 5-4**. For the purposes of this assessment, it is assumed that all ancillary facilities would be used for construction purposes. This assessment is expected to be conservative as not all sites would necessarily be used for construction, and not all sites would be functioning at all times over the construction period. It is expected that all construction workers would park within the construction footprint and therefore not impact on existing parking arrangements within the study area.

Access to ancillary facilities for delivery vehicles and staff are summarised in **Table 5-5**. 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. The project ancillary facility access strategy is provided in **Appendix C.**

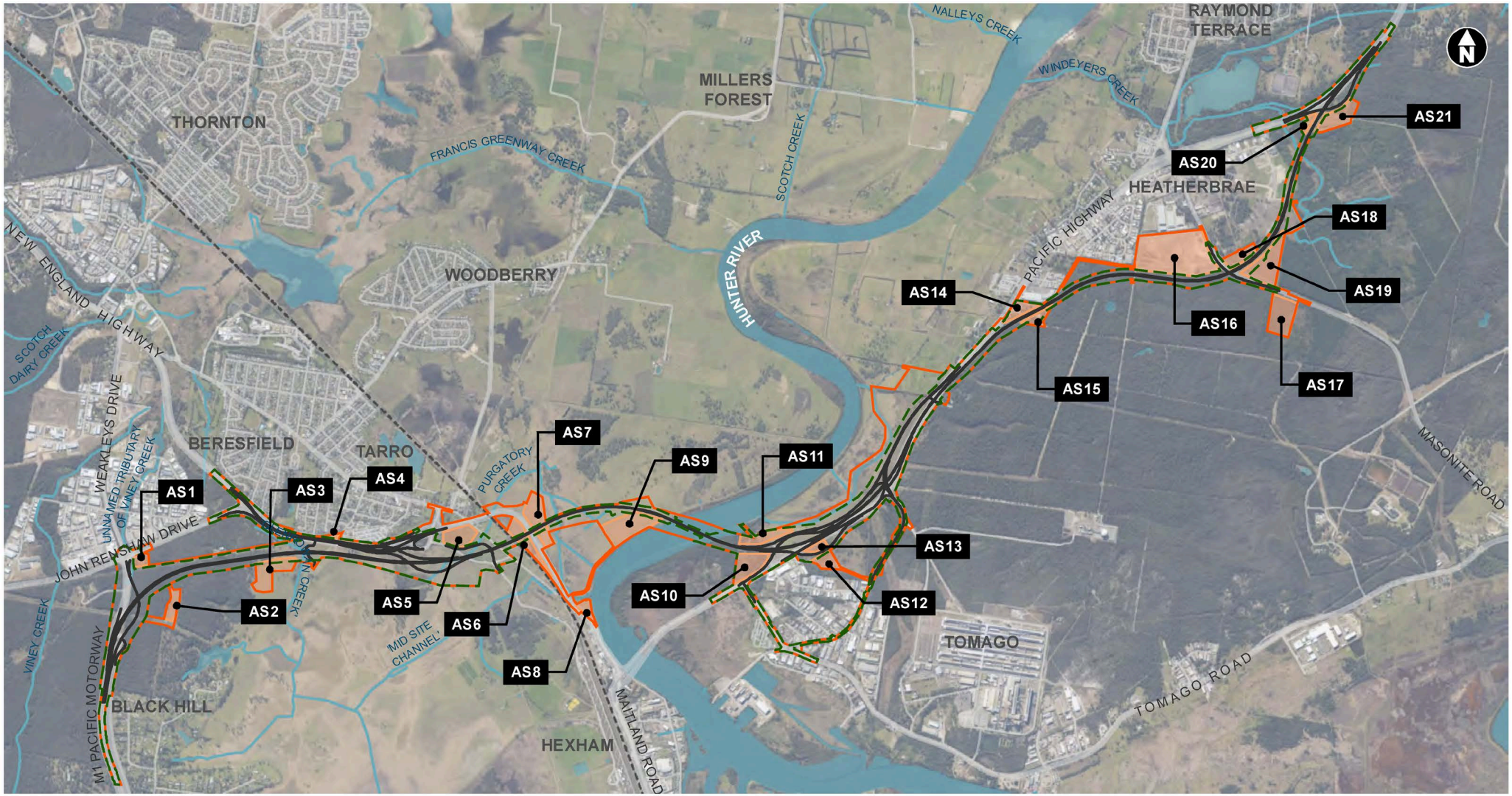

Figure 5-1 Ancillary facility locations

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Table 5-4 Ancillary facility functions and activities

Ancillary facility reference	Location	Potential function											Construction activities			
		Laydown	Stockpiles (incl. mulch)	Crushing and materials	Concrete batch plant	Concrete precast yard	Asphalt batch plant	Acid sulphate soil treatment	Wharf facilities	Main compound (incl. parking)	Satellite compound	Parking	Established for early works	Interchange	Main viaduct	Bridge
AS1	Black Hill: supports the construction of the Black Hill interchange and main alignment	✓	✓								✓		✓	✓		✓
AS2	Black Hill: supports the construction of the Black Hill interchange, main alignment, and areas of the New England Highway widening	✓	✓								✓			✓		✓
AS3	Black Hill: supports the construction of the main alignment, bridge, areas of the New England Highway widening, and being the largest of the ancillary facilities outside of a flood prone area provides an area for a main construction compound south of the Hunter River	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	✓
AS4	Tarro: supports the construction of the Tarro interchange, main alignment, John Renshaw Drive and areas of the New England Highway widening.	✓	✓									✓		✓		
AS5	Tarro: supports the construction of the Tarro interchange, main alignment, and main viaduct construction	✓	✓					✓			✓		✓	✓	✓	✓
AS6	Tarro: supports the main viaduct construction between the rail corridor and the New England Highway	✓	✓					✓			✓		✓		✓	
AS7	Tarro: supports the main viaduct construction between the New England Highway and Hunter River	✓	✓	✓	✓	✓	✓	✓		✓					✓	
AS8	Hexham: supports viaduct construction	✓	✓								✓				✓	
AS9	Hexham: supports viaduct construction, particularly over the Hunter River	✓							✓		✓				✓	
AS10	Tomago: supports the construction of the Tomago interchange, main viaduct construction and main alignment	✓	✓		✓	✓	✓	✓		✓	✓		✓	✓	✓	✓
AS11	Tomago: supports the construction of the Tomago interchange, main viaduct construction, and main alignment	✓	✓		✓	✓	✓	✓			✓			✓	✓	✓

Ancillary facility reference	Location	Potential function											Construction activities			
		Laydown	Stockpiles (incl. mulch)	Crushing and materials	Concrete batch plant	Concrete precast yard	Asphalt batch plant	Acid sulphate soil treatment	Wharf facilities	Main compound (incl. parking)	Satellite compound	Parking	Established for early works	Interchange	Main viaduct	Bridge
AS12	Tomago: supports the construction of the Tomago interchange, and the main alignment	✓	✓	✓	✓						✓		✓	✓		✓
AS13	Tomago: supports the construction of the Tomago interchange, and the main alignment	✓	✓								✓		✓	✓		✓
AS14	Heatherbrae: supports the construction of the main alignment, and local roads including Botanic Gardens access, Old Punt Road	✓	✓					✓			✓		✓			✓
AS15	Heatherbrae: supports the construction of the main alignment, and local roads including Botanic Gardens access, Old Punt Road	✓	✓					✓				✓				✓
AS16	Heatherbrae: supports the construction of the main alignment, Masonite road, and being the largest of the ancillary facilities provides an area for the main construction compound north of the Hunter River	✓	✓		✓	✓	✓	✓		✓			✓			✓
AS17	Heatherbrae: supports construction of Masonite Road and the main alignment	✓	✓		✓	✓	✓			✓	✓		✓			✓
AS18	Heatherbrae: supports construction of Masonite Road and the main alignment	✓	✓									✓				✓
AS19	Heatherbrae: supports construction of Masonite Road and the main alignment	✓	✓		✓	✓	✓	✓		✓	✓		✓			✓
AS20	Raymond Terrace: supports construction of the Raymond Terrace interchange, the main alignment, and bridge over Windeyers Creek	✓	✓									✓		✓		✓
AS21	Raymond Terrace: supports construction of the Raymond Terrace interchange, the main alignment, and bridge over Windeyers Creek	✓	✓					✓			✓			✓		✓

Table 5-5 Ancillary facility access details

Ancillary facility reference	Direct entry access	Direct exit access
AS1	Left in John Renshaw Drive	Left out to John Renshaw Drive
AS2, AS3	Left in from Lenaghans Drive	Left out to Lenaghans Drive
AS1, AS2, AS3 (alternative using utility easement)	Left in from westbound New England Highway	Left out to westbound New England Highway
AS4	Left in from Quarter Sessions Road	Right out to Quarter Sessions Road
AS5	Left in from Aurizon access	Right out to Aurizon access
AS6	Left in from westbound New England Highway	Left out to westbound New England Highway
AS7	Left in from eastbound New England Highway	Left out to eastbound New England Highway
AS8	Left in from eastbound New England Highway/Right in from westbound New England Highway	Left out to eastbound New England Highway
AS9	Left in from eastbound New England Highway	Left out to eastbound New England Highway
AS10, AS11	Left in from northbound Pacific Highway	Left out to northbound Pacific Highway
AS12, AS13	Left in from southbound Pacific Highway	Left out to southbound Pacific Highway
AS12, AS13 (alternate access via Old Punt Road)	Left in from northbound Old Punt Road	Left out to northbound Old Punt Road
AS14, A15	Left in from southbound Pacific Highway	Left out to southbound Pacific Highway
AS16	Left/right in from Masonite Road	Left out to northbound Masonite Road
AS17	Left in from northbound Masonite Road	Left out to northbound Masonite Road
AS18, AS19	Left in from southbound Masonite Road	Left out to southbound Masonite Road
AS20, S21	Left in from southbound Pacific Highway	Left out to southbound Pacific Highway

Construction workforce travel

Construction staff would have parking available at the main compound with 200 spaces and satellite compounds with 40 spaces (compound locations are detailed in **Table 5-4**). Personnel would be advised of suitable parking arrangements as part of the compulsory project induction and would be encouraged to carpool.

5.1.4 Haulage routes and use of the existing road network

As the majority of the new work would be constructed off the existing road network, many of the construction traffic movements are not anticipated to impact traffic on existing roads, except at access points. However, where continuous access along the main alignment is not possible, the existing road network would be used. As the work south of the Hunter River has a cut/fill balance and north of the Hunter River is expected to be located on fill, carting of excess material from site is generally not anticipated, leading to minimal spoil management movements.

Imported fill destined for the project north of Hunter River is likely to be transported from quarries to the north as they appear to have greater capacity to support the project. Using quarries to the north would also provide a more efficient haul route. The quarries to the north of the project have good access to the Pacific Highway and would therefore approach the site either via Heatherbrae (for the majority of work) or Medowie Road (to access the ancillary facilities off Masonite Road).

Other substantial construction movements would result from the delivery of concrete and asphalt which would come from both local suppliers and if required on-site batch plants located with ancillary sites identified in **Table 5-4**. These vehicles could originate from either north or south of the construction footprint and therefore could approach using the M1 Pacific Motorway, New England Highway, Pacific Highway and/or Tomago Road.

Vehicles delivering pre-cast concrete elements for the main viaduct, interchanges and bridges could be oversize, overmass, or both. Oversize and overmass vehicles are likely to be escorted and travel at slower speeds than other vehicles on the existing road network. Precast facilities may be required to produce the precast concrete products to build bridge deck segments and girders ready for assembly. Potential locations for precast facilities are identified in **Table 5-4**.

Some vehicle movements may be required to truck contaminated material and/or dewatering discharge offsite if unable to be treated onsite. The need for and quantity of this material would be confirmed in detailed design.

Access diagrams in **Appendix C** outline the haulage routes proposed to access various areas within the construction footprint.

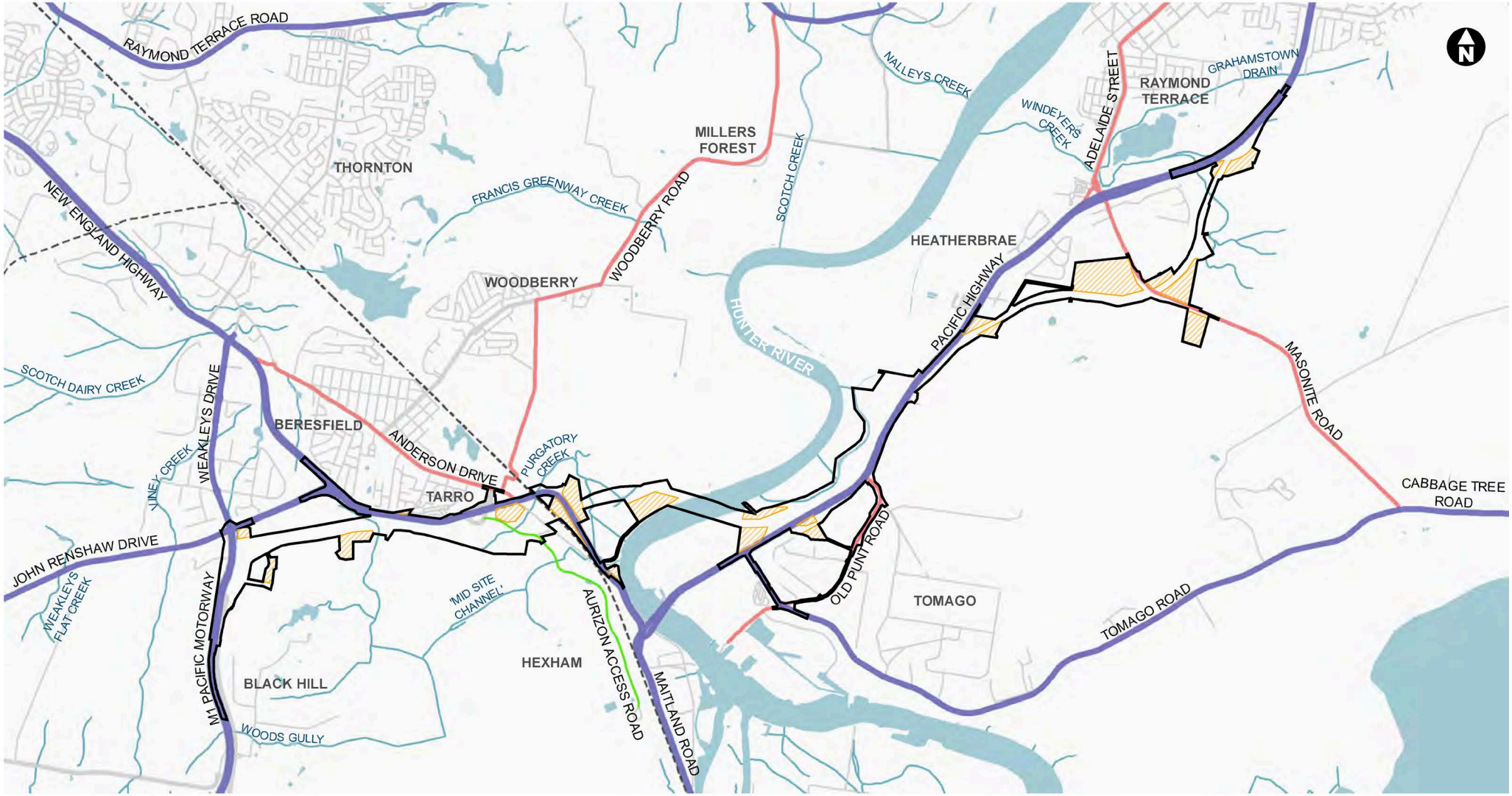
Where construction traffic movements are unable to be confined to the construction footprint, the existing road network would need to be used. Where possible, heavy vehicle movements would primarily use state roads, however local may need to be used. Roads that could be used by the project include:

- State classified roads such as M1 Pacific Motorway, New England Highway, Pacific Highway, Cabbage Tree Road, Tomago Road, Weakleys Drive, Raymond Terrace Road and Richardson Road
- Local classified roads such as Medowie Road, Masonite Road, Anderson Drive, Old Punt Road, and Woodlands Drive
- The private access road to the Aurizon facility.

Table 5-6 describes local roads which may be used for project construction and their access requirements. These roads are shown on **Figure 5-2**.

Table 5-6 Local roads which may be used during construction

Road	Access required	Comments
Medowie Road	Occasional haulage of quarry materials from the north	The majority of materials to be hauled to site and expected to be along the main road corridor comprising the Pacific Highway. However, depending on access requirements, there may be the occasional need to use Medowie Road as an alternate haul route for quarries to the north of the project.
Masonite Road	Construction (heavy and light) vehicle access Haulage of quarry materials	As Masonite Road would be adjusted as part of the project, construction vehicles would need to access this road. The largest of the ancillary facilities (AS16) is also located on Masonite Road.
Old Punt Road	Construction (heavy and light) vehicle access Haulage of quarry materials Haulage of plant and equipment	As Old Punt Road would be adjusted as part of the project, construction vehicles would need to access this road. Old Punt Road and Tomago Road 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).
Anderson Drive	Construction (heavy and light) vehicle access Haulage of quarry materials Haulage of plant and equipment	Anderson Drive provides access to the Tarro interchange works and ancillary facility AS5. It is also the link from the New England Highway entry/exit ramps to Tarro. The entire length of Anderson Drive could be used by construction vehicles from the connection to the New England Highway at Tarro through to Thornton. The Anderson Drive overpass of the New England Highway could also be temporarily configured to provide a turn-around facility for construction vehicles.
Woodlands Close	Construction (heavy and light) vehicle access	The main access to ancillary facilities AS5 is located at the corner of Woodlands Close and the Aurizon Access Road. AS5 would be serviced by the Aurizon Access Road, with infrequent access provided from Woodlands Close.
Woodbury Road	Construction (heavy and light) vehicle access Haulage of quarry materials Haulage of plant and equipment	Woodbury Road connects to Anderson Drive at Tarro and provides a means by which plant and equipment can access the project from suppliers to the north of the project.
Adelaide Street	Haulage of quarry materials Haulage of plant and equipment	Adelaide Street provides a means by which quarry materials, plant and equipment can travel to site from the north-west.
Seaham Road	Haulage of quarry materials Haulage of plant and equipment	Seaham Road connects to Adelaide Street at Raymond Terrace and provides a means by which quarry materials, plant and equipment can travel to site from the north-west.



Construction footprint
Ancillary facility
State road
Local road
Private road
Main North Rail Line
Waterways

0 1 2 km

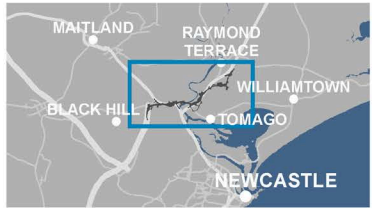


Figure 5-2 Roads which may be used during construction

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5.1.5 Impact on traffic

Construction traffic movements

The most substantial contribution to additional vehicle movements on the existing road network would occur at access points to the ancillary facilities and at roads being used for haulage. Based on **Table 5-7**, the daily traffic movements anticipated at each of the ancillary facilities show that there are almost 2,800 daily vehicle in and out movements expected to support construction. This includes about 1,300 daily heavy vehicle movements and 1,500 construction workforce (light vehicle) movements.

On average there are about 132 heavy vehicle movements and 147 construction workforce (light vehicle) in and out movements during the peak hour across the 21 ancillary facilities. While no construction vehicle movements have been estimated for out-of-hours work, they are anticipated to be below the peak hour movement numbers listed in **Table 5-7**.

Construction traffic on the existing road network

To provide an indication of the worse-case impacts of construction traffic on the existing network, it is assumed that estimated peak hour construction volumes shown in **Table 5-7** has been spread across the 21 ancillary facilities and compared against traffic volumes on access roads. This assessment is considered conservative, as it could be assumed that the construction workforce (light vehicle) movements would occur prior to the morning peak (before 7am) and outside the evening peak (before or after the 3pm to 6pm period). This is because the likely construction hours between Monday and Friday would be across 7am to 6pm. These movements would take up about 50 per cent of the daily vehicle movements and are likely to occur outside commuter peak hours.

As shown in **Table 5-5**, the majority of the access points at each of the ancillary facilities are left in/left out arrangements with dedicated deceleration and acceleration lanes. The site that does allow for right in for construction traffic uses an existing dedicated U-turn lane (AS8), therefore not impacting on any through traffic. Two other sites allow for right out movements (AS4 and AS5) however these connect to a low volume local road (Quarter Sessions Road) and access road (Aurizon access) respectively.

Of all the sites, AS3 is expected to experience the largest number of daily construction vehicle movements with 364 vehicles per day and 36 peak hour movements per hour. Access to AS3 would be left in from Lenaghans Drive, or alternatively left in from New England Highway (westbound) using the utility easement. Exiting AS3 can facilitate a left out to Lenaghans Drive, or a left out from New England Highway (westbound) using the utility easement. Some delays may be experienced by road users due to the nature of vehicles being used to deliver these components.

While the majority of construction traffic movements would occur within the construction footprint, away from existing roads, construction traffic on the existing road network is expected from transport of imported fill and construction materials (as discussed in **Section 5.1.4**). Where possible, heavy vehicles would primarily use state roads. This would contain the impact of haulage by heavy vehicles to state roads which already cater for a percentage of heavy vehicles as detailed in **Section 4.1.1**.

Overall, **Table 5-7** shows construction traffic volumes are low in comparison to volumes on the existing road network, based on the low number of peak hour construction traffic movements (on average 132 heavy vehicles and 147 light vehicles during peak hour), and that the majority of the ancillary facilities are accessed via dedicated left in/left out arrangements, minimal delays and queuing to the surrounding network are anticipated as a result of accessing ancillary facilities. Note, some ancillary sites have potential alternate access points to the existing road network (**Table 5-5**).

Table 5-7 Daily construction traffic movements

Ancillary facilities	Heavy vehicles		Light vehicles		Total		Main entry and exit access road	Existing Road daily volume (One way)	Existing Road peak hour volume (One way)
	Daily (in and out)	Peak hour (in and out)	Daily (in and out)	Peak hour (in and out)	Daily vehicles (in and out)	Peak hour vehicles (in and out)			
AS1	26	3	46	4	72	7	John Renshaw Drive - Westbound	20,190	960
AS2	64	6	46	5	110	11	Lenaghans Drive - Southbound	Low	Low
AS3	210	21	154	15	364	36	Lenaghans Drive - Southbound	Low	Low
AS4	42	4	10	1	52	5	Quarter Sessions Road	Low volume local road	Low volume local road
AS5	54	5	46	5	100	10	Aurizon access road	Low volume local road	Low volume local road
AS6	0	0	46	5	46	5	New England Highway - Westbound	37,970	1,900
AS7	128	13	154	15	282	28	New England Highway - Eastbound	36,390	1,730
AS8	0	0	46	5	46	5	New England Highway - Eastbound	36,390	1,730
AS9	90	9	46	5	136	14	New England Highway - Eastbound	36,390	1,730
AS10	108	11	154	15	262	26	Pacific Highway (Tomago) - Northbound	32,530	1,720
AS11	50	5	46	5	96	10	Pacific Highway (Tomago) - Northbound	32,530	1,720

Ancillary facilities	Heavy vehicles		Light vehicles		Total		Main entry and exit access road	Existing Road daily volume (One way)	Existing Road peak hour volume (One way)
	Daily (in and out)	Peak hour (in and out)	Daily (in and out)	Peak hour (in and out)	Daily vehicles (in and out)	Peak hour vehicles (in and out)			
AS12	70	7	46	5	116	12	Pacific Highway (Tomago) - Southbound	28,730	1,450
AS13	156	16	46	4	202	20	Pacific Highway (Tomago) - Southbound	28,730	1,450
AS14	24	2	46	5	70	7	Pacific Highway (south of Heatherbrae) - Southbound	22,820	1,100
AS15	38	4	10	1	48	5	Pacific Highway (south of Heatherbrae) - Southbound	22,820	1,100
AS16	128	13	154	15	282	28	Masonite Road - Northbound	5,470	240
AS17	12	1	154	16	166	17	Masonite Road - Northbound	5,470	240
AS18	34	3	10	1	44	4	Masonite Road - Southbound	4,400	190
AS19	18	2	154	15	172	17	Masonite Road - Southbound	4,400	190
AS20	40	4	10	1	50	5	Pacific Highway (north of Heatherbrae) - Southbound	18,120	760
AS21	26	3	46	4	72	7	Pacific Highway (north of Heatherbrae) - Southbound	18,120	760
Total	**1,318**	**132**	**1,470**	**147**	**2,788**	**279**			

Temporary traffic intersections

To accommodate construction activities and delivery of materials to various sites across the project, the following temporary traffic intersections are proposed:

- New England Highway eastbound exit ramp at Tarro – modification of the existing intersection to allow right turn movements onto Anderson Drive
- Aurizon access road at Tarro – modification of the existing intersection to allow right turn movements onto Anderson Drive
- Anderson Drive at Tarro – modification to allow vehicles to exit to eastbound New England Highway
- Tomago Road intersection with the Pacific Highway at Tomago – modification of the signalised intersection to allow construction vehicles to exit and enter the ancillary facilities (AS10 and AS11) to the north of Pacific Highway
- Old Punt Road intersection with the Pacific Highway at Tomago – temporary modification of the signalised intersection to facilitate construction work of the realignment to the Pacific Highway
- Masonite Road – channelised intersection to allow right turn movements into ancillary facility AS16 (if a roundabout as part of a previously approved development application is not constructed prior to commencement of the project), Masonite Road would also be realigned to maintain access during construction
- Temporary turn provisions (possibly including acceleration and deceleration lanes) for entry and exit to ancillary facilities across the entire project.

As indicated above, the exit ramp from New England Highway to Anderson Drive would require modification to allow construction traffic to turn right onto Anderson Drive through the following treatment:

- A temporary signalised intersection to allow vehicles to turn right from the eastbound New England Highway exit ramp right onto Anderson Drive
- Modifications to allow vehicles to turn right from the Aurizon access road to northbound Anderson Drive (either a roundabout or more likely temporary signals).

The temporary intersections would improve direct access and connectivity for construction activities while reducing delays to general traffic by removing unnecessary heavy vehicle movements. These temporary traffic intersections would be subject to final design, construction staging and contractor usage of ancillary facilities.

Temporary pavement construction and use

Where temporary pavement is required to be constructed close to existing traffic lanes, construction is likely to impact existing traffic including speed limit reductions, lane closures, traffic switches and temporary lane configurations. To minimise disruptions, some sections of temporary pavement could be constructed out-of-hours as detailed in **Section 5.1.2**. Where possible, shoulders would be temporarily narrowed to provide adequate working width for the work, which may result in a reduction in speed limits.

Key impacts associated with the use of temporary pavements are expected to be associated with the tie ins with the existing road network. Depending on sight distance, clearances and pavement geometry, speed limits may need to be reduced in the vicinity of the temporary pavement. These speed limit reductions may result in temporary and localised traffic delays.

Temporary changes to roads

Generally, traffic switches would occur within adjacent carriageways between each stage. However, construction also involves changes to traffic conditions such as contraflows which may pose a risk to motorists if appropriate controls such as temporary signage and line markings are not properly implemented.

Temporary short-term diversions, road closures and temporary traffic intersections may be required to support construction.

5.1.6 Impact on property access

During construction, access to properties near to construction works would be maintained although temporary changes may be required for some properties at Black Hill, Hexham, Tarro, Tomago, Heatherbrae and Raymond Terrace.

Thirty-six lots would have the existing access affected by construction of the project, including:

- Aurizon access road, serving multiple properties
- Access to TransGrid easement in Black Hill and Tomago
- Access to Hunter Water utilities and property at Tarro and Heatherbrae
- Private property at Tarro, west of the new Tarro interchange
- Access across the future Newcastle Power Station proposed by AGL at Tomago
- Access to the Hunter Region Botanic Gardens
- Access to the existing forestry plantation north of Masonite Road.

The above changes to access would be managed throughout construction and become permanent changes once the project is completed.

The project would also require adjustments to existing tracks and trails, including access and easement tracks to utility infrastructure and associated easements and driveways to private properties. One residential property access would be impacted during construction.

These properties may require alternate access during construction. Where the project severs existing access tracks, (including fire trails) turnaround facilities would be provided on access tracks to allow vehicles to turn around or alternate access to the road network would be provided. Access tracks and driveway adjustments would be confirmed during detailed design and consultation with property owners.

Access to all existing and proposed infrastructure for maintenance purposes would be provided by maintaining existing access and easement arrangements where possible or developing alternative maintenance access arrangements where required. The property access strategy is provided in **Appendix D.**

5.1.7 Impact on other transport modes

Public transport

The project would not impact on any current bus routes travelling in and around the construction footprint. Three bus stops on Pacific Highway would be temporarily relocated during construction. The three relocated bus stops include:

- The existing bus stop on Pacific Highway, just north of the Tomago Road intersection

- The existing northbound bus stop on the Pacific Highway, near the Hunter Region Botanic Gardens intersection
- The existing southbound bus stop on the Pacific Highway, near the Hunter Region Botanic Gardens intersection.

Pedestrians

Given the lack of pedestrian infrastructure within the construction footprint, pedestrian volumes are anticipated to be very low (as discussed in **Section 4.8.1**), therefore inconvenience to pedestrians as a result of construction activities are considered minor. No separated shared paths discussed in **Section 4.8.2** are impacted.

Cyclists

Where practical, minimum two metre shoulders have been adopted during construction. However, shoulders would be reduced for areas with limited clearance widths. Locations where cyclist access may be impacted during construction include:

- Tarro interchange (John Renshaw Drive westbound)
- Tarro interchange (New England Highway westbound)
- Tarro interchange (New England Highway eastbound).

Where the cycling network is affected, alternative cycling routes would be developed and detours established as required during the construction period.

Rail

The viaduct for the project would be constructed over the Main North Rail Line. Track possessions would be used to establish temporary protection works and to install the precast bridge girders over the rail line. Pre-defined periods of track work would be used for such activities to minimise the impact on the rail network. There would be minimal impact to rail infrastructure at Hexham as the construction contractor would likely work in and around ARTC shutdowns to construct over the rail. Impact to rail operations from project construction are expected to be negligible.

Maritime traffic

The viaduct over Hunter River is about 310 metres long and comprised of multiple sets of piers, three main spans and two back spans. The river spans consist of two independent bridge structures for each carriageway. This has been done to allow the piers to be staggered between the carriageways, so they are parallel to each other in the direction of the river, which maximises the navigational area for maritime traffic, reduces hazards and minimises the losses from the flood flows down the river.

To support the construction of the viaduct, the following methodology is proposed:

- The piers in the centre of the river are proposed to be constructed using piling rigs, cranes and concrete pumps placed on barges, with secondary barges supplying the materials to the piers and removing spoil
- The piers adjacent to the banks of the river are proposed to be constructed from temporary earth platforms, as the water is likely to be too shallow for the barge to access. Geofabric on the river bed with rock fill would be considered to create the platform without unduly compromising navigation or flood flows on the river

- A temporary wharf would be constructed on both sides of the river to service barges for construction of the river crossing. The wharves are likely to be constructed in a similar manner to the temporary platforms described above. Alternatively, the wharf(s) could be constructed as a temporary bridge structure. On completion of construction, the platforms and wharf(s) would be removed.

While it is not anticipated that large scale dredging of the river would be required, localised dredging may be necessary within the construction footprint at the wharf locations, to support viaduct construction and/or to provide sufficient draft for the barges at localised low areas of the river.

The construction contractor would manage barge movements to ensure that the impacts on inbound and outbound marine traffic are minimised. In addition, a navigational channel would be kept open during construction. As such, impacts on maritime traffic during construction are anticipated to be low and manageable.

Given the Port of Newcastle is over 15 kilometres south-east of the project, there would also be no impact on the functionality of the port during construction.

5.2 Operational impact

This section provides an assessment of the operational performance of the project and the impact on the traffic and transport network.

5.2.1 Road network performance

Traffic volumes

Modelled peak hour and daily traffic volumes for the various scenarios are presented in **Figure 5-3** and **Figure 5-4** (2028, 2038 and 2048 scenarios 'with project'). Daily traffic volumes have been calculated using an expansion factor.

Analysis of the modelled traffic flows in 2028 in the 'with project' scenario shows the following key impacts throughout the network:

- The New England Highway to the west and the Pacific Highway to the east of the existing Hexham Bridge are likely to see substantially reduced traffic flow as a result of the project. These locations are expected to experience a reduction in traffic flow between 20 to 45 per cent, which would occur as vehicles use the project as an alternative east-west route
- Substantial reductions in traffic flows are likely on John Renshaw Drive east of Weakleys Drive, with a reduction of up to 13 per cent in the morning peak (8-9am) and 19 per cent in the evening peak (5-6pm). This reduction occurs as the project provides an alternative route which vehicles use to travel west-east
- The largest reduction in traffic in 2028 is expected to occur on Pacific Highway west of Masonite Road, which is likely to experience about a 50 per cent reduction in traffic flow in both peak periods. The project would result in a shift in traffic flow from the Pacific Highway to the project, reducing traffic through Heatherbrae

- In 2028, the volume of traffic travelling on Old Punt Road would substantially increase in the evening peak period (109 per cent increase) as a result of the project. This outcome is expected to occur due to the improved connectivity to the project. This increase in traffic on Old Punt Road correlates with a decrease in traffic travelling on Tomago Road, as the improved connectivity from Old Punt Road provides an alternative route for vehicles.

Analysis of the 2038 and 2048 volumes show a similar pattern with a reduction in daily traffic on John Renshaw Drive, New England Highway and Pacific Highway. The future horizons also display an increase in traffic on the existing M1 Pacific Motorway, south of Weakleys Drive. This increase is expected as the project provides greater capacity for north and southbound traffic which reduces the unreleased trips that occur in the ‘without project’ traffic model.

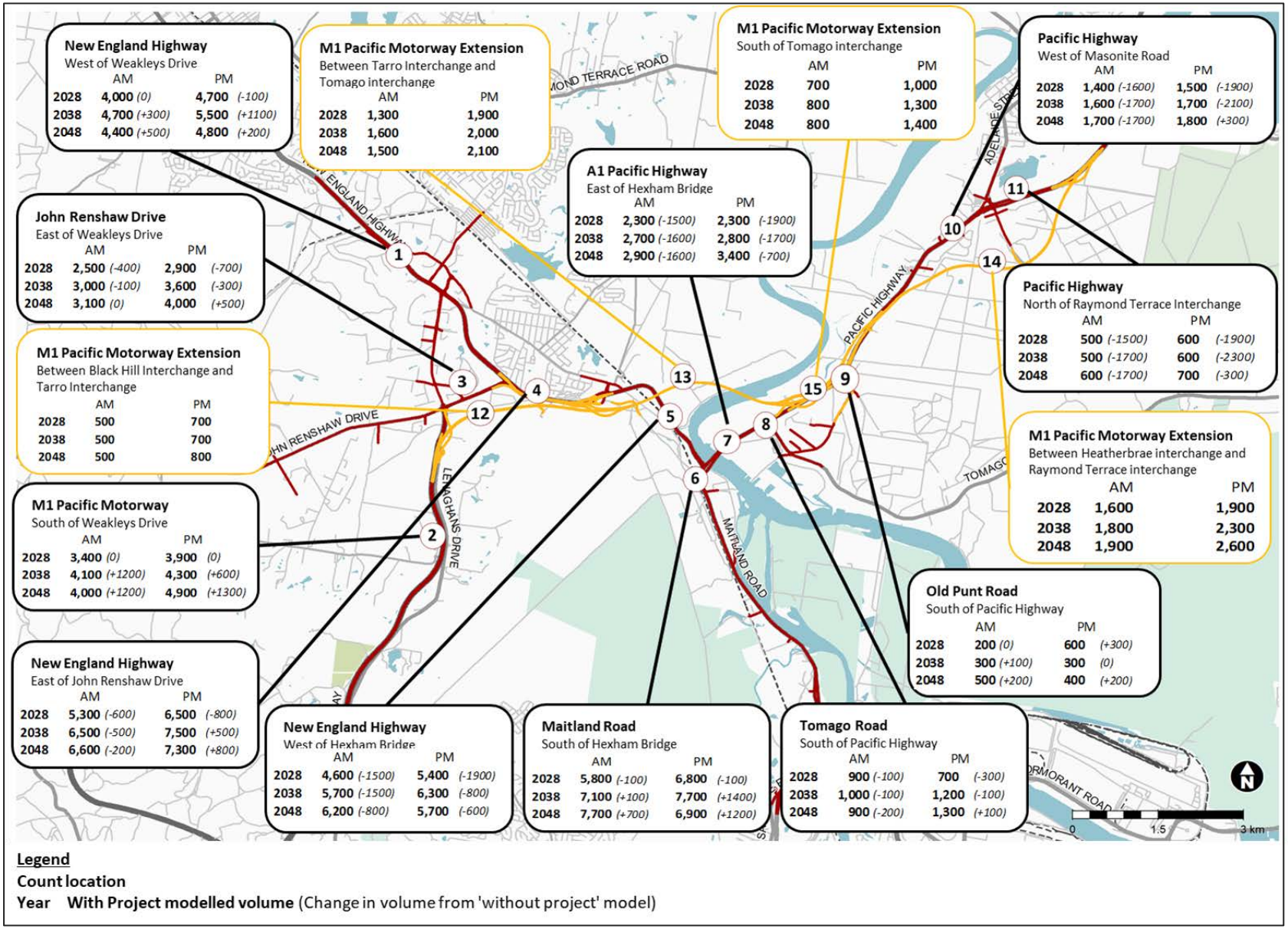

Figure 5-3 Peak period traffic volumes (8am to 9am and 5pm to 6pm)

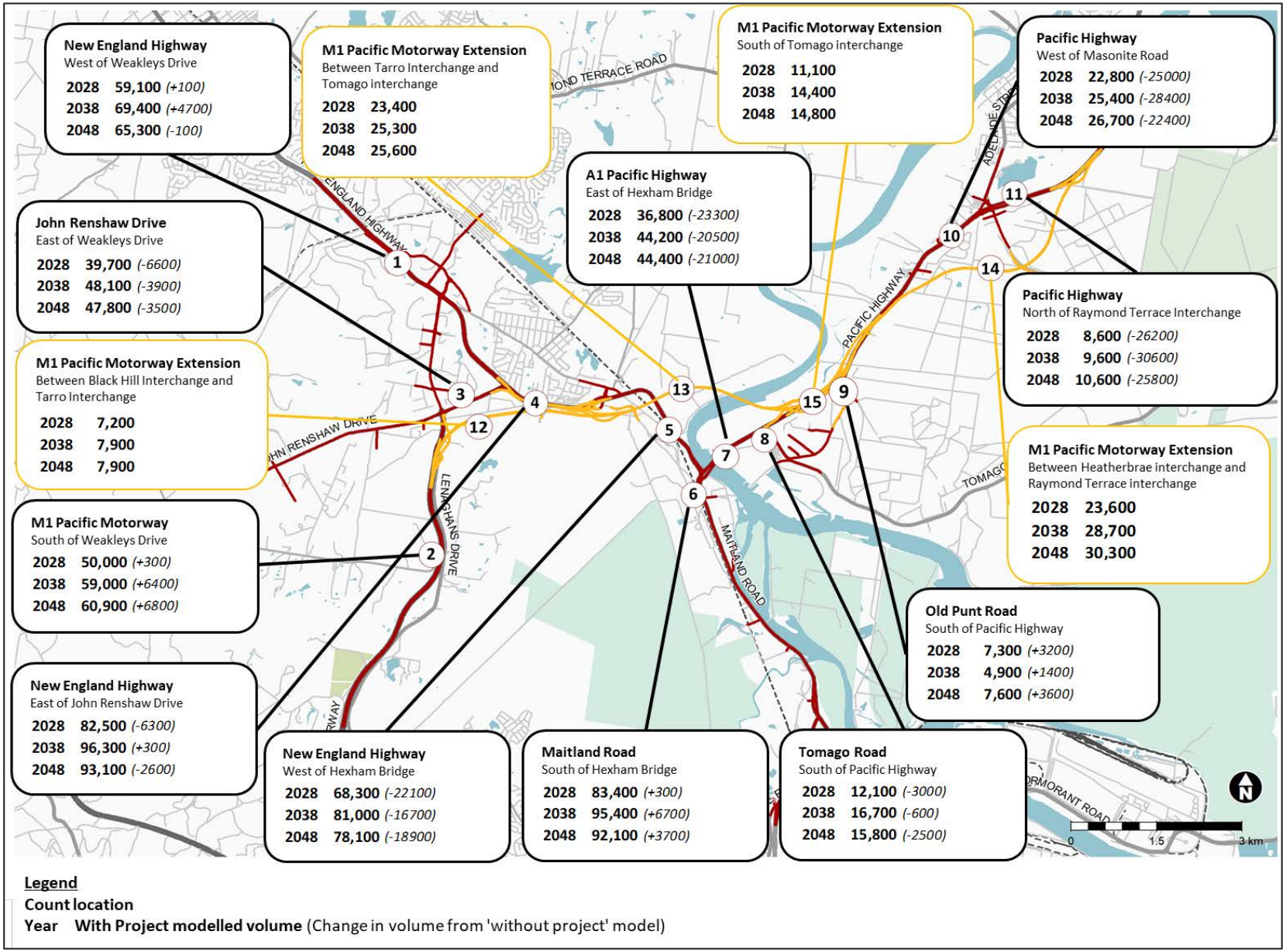

Figure 5-4 Forecast daily traffic volumes

Travel time performance

A comparison between the travel times from 'without project' and 'with project' scenarios is provided in **Figure 5-6** and **Figure 5-7**, with travel time improvements on key routes shown in **Table 5-8** and **Table 5-9**. These figures display the travel times in the most congested hour during the morning and evening peak, which are 8am to 9am for the morning and 5pm to 6pm for the evening peak in 2028 and 2048. The figure displays the origin of vehicles at the bottom x-axis value and the destination as the top x-axis value. **Figure 5-5** displays the locations from where travel times were measured.

The morning peak hour results indicate travel times for most origin and destination combinations are likely to decrease as a result of the project when compare with the 'without project' scenarios. This is consistent for all the future years modelled. Key morning peak hour outcomes include:

- Travel times along the road corridor between Black Hill and Raymond Terrace would reduce by 39 to 74 per cent. In 2048, this improvement in travel time equates to a saving of about 30 minutes per vehicle
- The project would result in a 35 to 60 per cent reduction in travel times from the New England Highway at the western edge of the study area to Pacific Highway at the eastern edge of the study area. These improvements equate to a travel time saving of about 15 minutes per vehicle in 2048
- Travel times from the Pacific Highway to the New England Highway and the M1 Pacific Motorway would reduce by at least 36 per cent in 2028 and by 2048 about 60 per cent. In 2048, this improvement in travel time equates to a saving of 15-20 minutes per vehicle
- Improved travel times to and from Maitland Road, as travel times from and to key locations would be reduced by greater than 22 per cent in each of the future horizon years.

The evening peak hour results indicate travel times for most origin and destination combinations are likely to decrease as a result of the project when compared with the 'without project' scenarios. This is consistent for all the future years modelled. Key evening peak hour outcomes include:

- Travel times along the road corridor between Black Hill and Raymond Terrace would reduce by 46 to 72 per cent. In 2048, this improvement in travel time equates to a saving of about 35 minutes per vehicle
- The project would result in a 28 to 64 per cent reduction in travel times from the New England Highway at the western edge of the study area to Pacific Highway at the eastern edge of the network. These improvements equate to a travel time saving of about 15 minutes per vehicle in 2048
- Travel times from the Pacific Highway to the New England Highway and the M1 Pacific Motorway would reduce by at least 45 per cent in 2028 and about 42 per cent in 2048. In 2048, this improvement in travel time equates to a saving of 30 minutes per vehicle
- The project also improves travel times between Maitland and key locations with a reduction by greater than 12 per cent in each of the future horizon years.

In both peak periods, the project results in a reduction in travel time from trips originating from John Renshaw Drive, however in future horizons with the project travel times are still lengthy. As discussed in **Section 3.3.1** the Emerging Black Hill Precinct would be a key generator of traffic in future years with access and egress points located on John Renshaw Drive. High levels of traffic from the development are distributed onto the network via John Renshaw Drive, which results in substantial delays and queues for vehicles at the western approach of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. These delays are reflected in the poor travel time performance for vehicles originating from John Renshaw Drive. For each of the sensitivity scenarios tested, delays across the network were reduced, which would correlate to improved travel times across the network. Refer to **Appendix B** for more detailed sensitivity analysis.

Table 5-8 Travel time improvements for key routes across the project (morning peak)

Origin	Destination	2028			2048		
		Travel time without project	Travel time with project	Time saved	Travel time without project	Travel time with project	Time saved
M1 Pacific Motorway	Pacific Highway	20:35	11:32	9:03	55:53	17:41	38:12
	Maitland Road	21:11	16:34	4:37	59:07	33:24	25:43
Pacific Highway	M1 Pacific Motorway	19:05	11:34	7:31	31:13	11:40	19:33
	New England Highway	15:52	10:10	5:42	24:03	10:20	13:43
	Maitland Road	17:24	14:00	3:24	24:35	19:55	4:40
Maitland Road	Pacific Highway	16:37	13:55	2:42	18:03	15:00	3:03

Table 5-9 Travel time improvements for key routes across the project (evening peak)

Origin	Destination	2028			2048		
		Travel time without project	Travel time with project	Time saved	Travel time without project	Travel time with project	Time saved
M1 Pacific Motorway	Pacific Highway	21:17	11:32	9:45	37:53	19:50	18:03
	Maitland Road	20:26	16:49	3:37	44:23	29:22	15:01
Pacific Highway	M1 Pacific Motorway	21:04	11:29	9:35	1:08:50	30:21	38:29
	New England Highway	17:58	10:16	7:42	1:07:05	38:09	28:56
	Maitland Road	16:07	13:37	2:30	1:06:21	30:11	36:10
Maitland Road	Pacific Highway	16:21	14:27	1:54	47:20	26:43	29:37

Overall, when comparing travel times for journeys through the network between the ‘without project’ and the ‘with project’ scenarios, the project substantially reduces travel times for both the morning and evening peak periods across all future modelled years.

These improvements would substantially reduce travel times between Newcastle, Raymond Terrace, Maitland and other regional industrial areas. Furthermore, the project would provide key infrastructure for movements along the eastern coast of Australia, improving travel time and travel time reliability between Brisbane in the north and Melbourne and Sydney. While the model covers the morning and evening peak periods, it is expected travel times in off peak periods and holiday periods between Maitland and Raymond Terrace, and Black Hill and Raymond Terrace would also markedly improve as vehicles can travel less distance at consistently higher speeds without the traffic signals interrupting traffic flow.

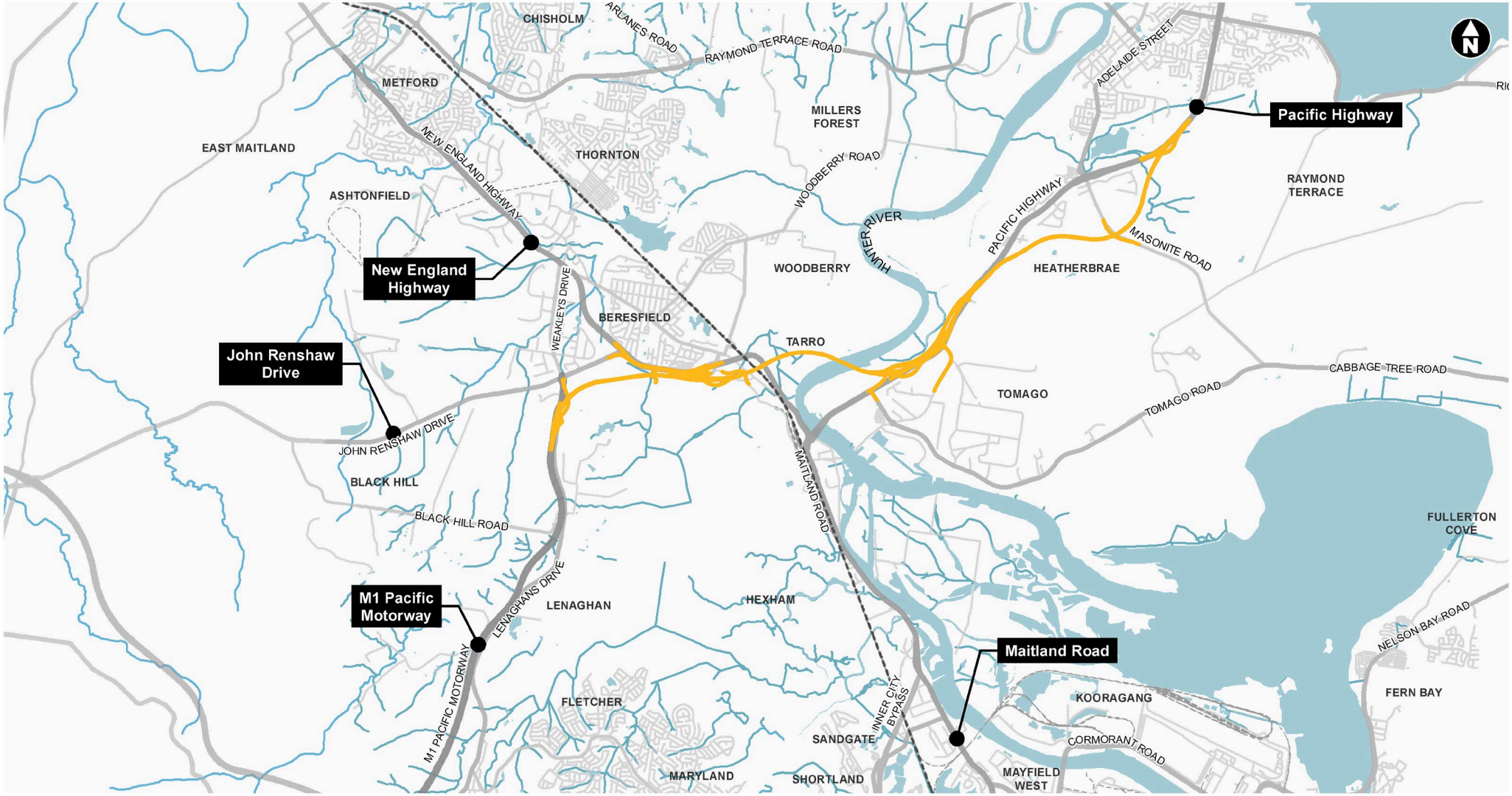

Figure 5-5 Travel time survey routes

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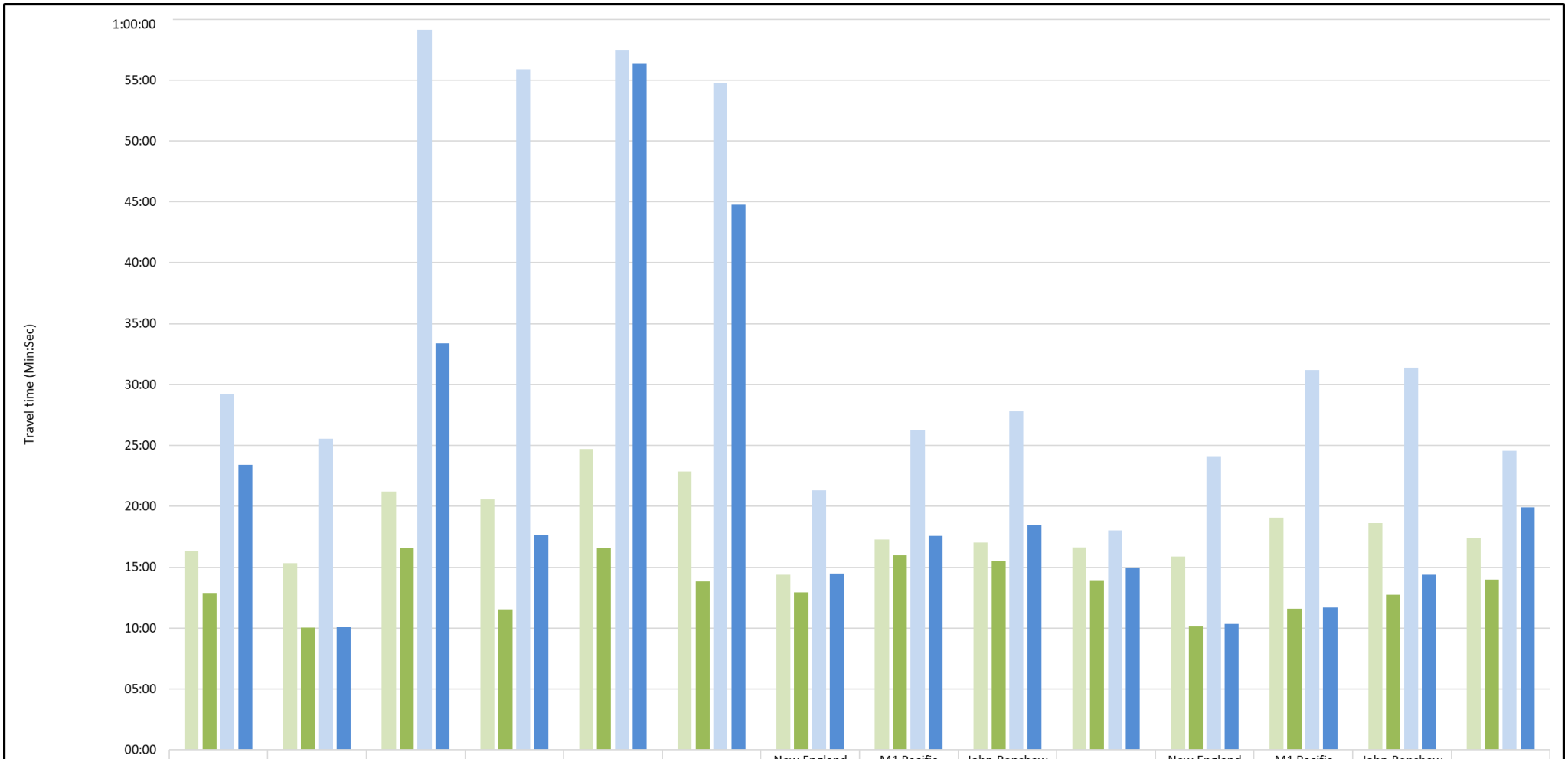
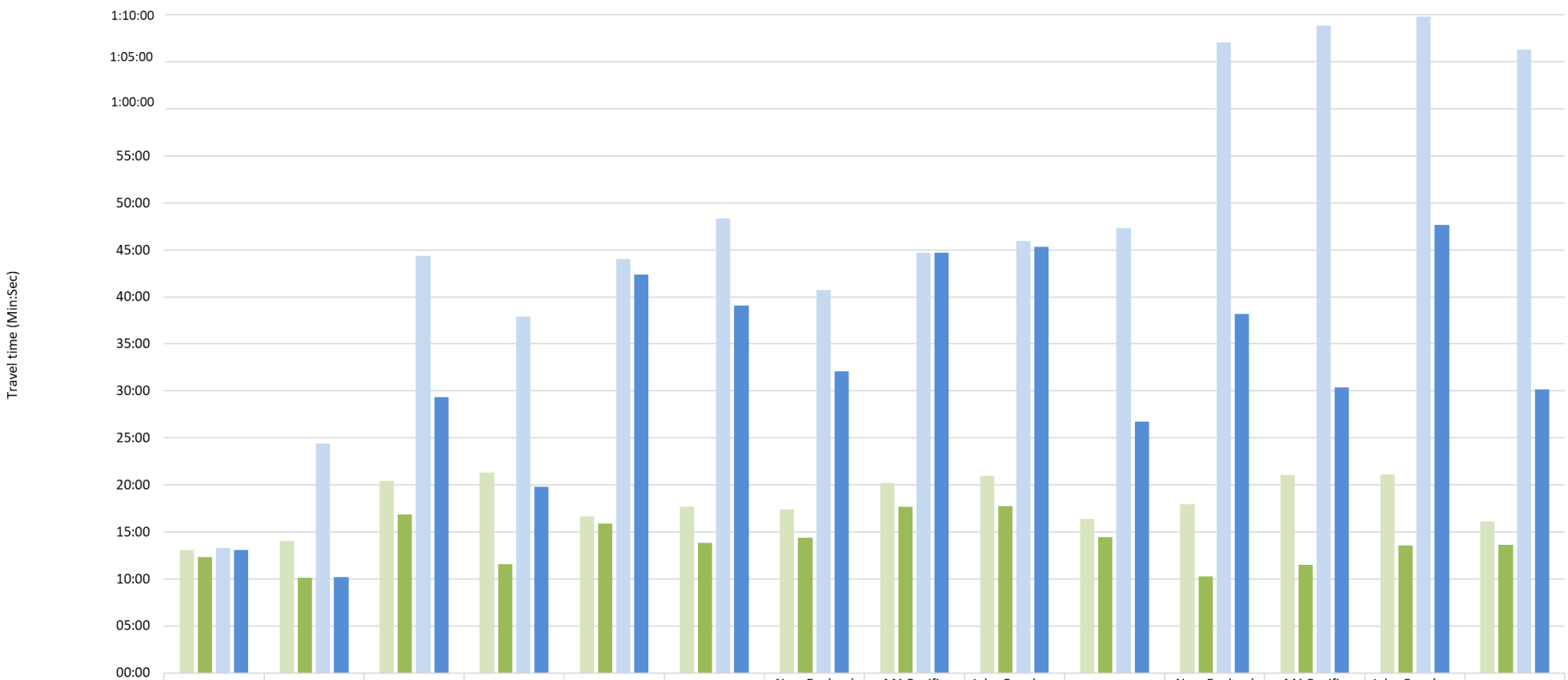


Destination	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	Maitland Road	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Pacific Highway	New England Highway	M1 Pacific Motorway	John Renshaw Drive	Maitland Road
Origin	New England Highway		M1 Pacific Motorway		John Renshaw Drive		Maitland Road				Pacific Highway			
2028 Do Min Scenario	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 Project Scenario	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
2048 Do Min Scenario	29:14	25:35	59:07	55:53	57:28	54:43	21:18	26:15	27:46	18:03	24:03	31:13	31:23	24:35
2048 Project Scenario	23:25	10:07	33:24	17:41	56:24	44:47	14:30	17:36	18:28	15:00	10:20	11:40	14:22	19:55

Figure 5-6 Morning peak (8-9am) travel times across the network



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 Do Min Scenario	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 Project Scenario	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
2048 Do Min Scenario	13:19	24:23	44:23	37:53	44:00	48:19	40:42	44:41	45:58	47:20	1:07:05	1:08:50	1:09:48	1:06:21
2048 Project Scenario	13:04	10:13	29:22	19:50	42:22	39:06	32:04	44:43	45:18	26:43	38:09	30:21	47:39	30:11

Figure 5-7 Evening peak (5-6pm) travel times across the network

Network statistics

A comparison of key network statistics between the 'without project' and 'with project' scenarios is provided in **Table 5-10** for 2028, 2038 and 2048.

Comparison of the 'without project' and 'with project' scenarios for the 2028 horizon year indicates that:

- In 2028, there is a substantial increase in average network speed, particularly during the evening peak period with the forecast average network speed is likely to increase by 10 per cent. This is accompanied by a slight increase in vehicle throughput
- In 2038, there is a substantial improvement in the operational performance of the road network is likely. Up to an additional nine per cent of vehicles can complete their trips within the modelled period. The forecasted average network speed is likely to increase by 17 per cent in the morning peak and 31 per cent in the evening peak
- In 2048, Substantial improvement in the operational performance of the road network is likely, particularly during the evening peak period. Forecast average network speed is likely to increase by 22 per cent in each of the peak periods.

Overall, the key network statistics demonstrate the project would provide positive outcomes for the performance of the road network in each of the modelled scenarios. The project results in a more efficient road network, that can cater to a higher volume of vehicles, while also maintaining faster travelling speeds for motorists. More detailed network statistic outputs are provided in **Appendix B.**

Table 5-10 Network statistics

Year	Network statistic	Morning peak		Evening peak	
		Without project	With project	Without project	With project
2028	Total throughput	42,801	42,927	47,787	48,048
	Network speed (km/h)	59	64	55	61
2038	Total throughput	48,673	50,362	50,993	55,620
	Network speed (km/h)	45	53	37	49
2048	Total throughput	50,361	53,037	51,081	56,924
	Network speed (km/h)	35	43	29	37

Intersection performance

The operational performance at key intersections within the network is presented in **Table 5-11** to **Table 5-13**. As outlined in **Section 3.3.3**, 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:

- New England Highway/ Pacific Highway/Maitland Road: The project would substantially improve the performance of this intersection during the evening period as vehicles travelling on the New England Highway between Tarro and Tomago would reroute to the project. This is most evident in the 2038 evening model, under 'without project' conditions, as the intersection operates at a LoS E. When modelled with the project, the intersection operates as a satisfactory LoS D. The project markedly reduces the traffic demand for the right turn movement from the Pacific Highway to the New England Highway. This substantially reduces the overall demand at the intersection and would enable the

reallocation of green time to other movements at the intersection, ultimately improving the performance of the intersection

- Pacific Highway/Masonite Road: The project provides a bypass of Heatherbrae, which substantially reduces the traffic demand and throughput at the Pacific Highway/Masonite Road roundabout. The reduction in demand is evidenced in the evening peak in both 2038 and 2048, as the intersection improves from operating at LoS E (in 2038) and LoS F (in 2048) to LoS A in both years as a result of the project
- M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection: The project would improve the performance of this intersection, as traffic travelling to or from the east of the model extent would reroute to use the project in 2028. However, the intersection is expected to perform at LoS E from 2038 onwards
- Intersections along the Pacific Highway between Maitland Road and Masonite Road would improve in performance. This is particularly noticeable in the 2038 and 2048 horizon years when flows on the Pacific Highway are forecast to exceed the capacity of these intersections. Removal of the east-west movements along this section of the Pacific Highway improves the performance of the Maitland Road and Masonite Road intersections with Pacific Highway and reduces volumes to within the road's capacity.

The intersection of the Hunter Region Botanical Gardens (HRBG) and Pacific Highway in Tomago would be signalised. Signals for vehicles entering and exiting the HRBG would be triggered by vehicle detectors. The intersection is expected to have low volumes of traffic entering and exiting the HRBG. A qualitative assessment has been carried out and this intersection is expected to have minimal impact on traffic.

Ultimately, the high volume of vehicles generated from the Emerging Black Hill Precinct contributes substantially to the poor performance of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill in future horizon years. The sensitivity modelling results where the Emerging Black Hill Precinct is not developed show the operation of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection to be substantially improved. Vehicle delays at the intersection were almost halved and the intersection operating LoS improved from LoS F in both peak periods to a LoS D in the morning peak and LoS E in the evening peak. Please refer to **Appendix B** for more detailed analysis.

Table 5-11 Performance of modelled intersections in 2028

Intersection	Type	2028 'without project'				2028 'with project'			
		8-9am		5-6pm		8-9am		5-6pm	
		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
New England Highway/Weakleys Drive, Beresfield	Signalised	18	B	20	B	28	C	33	C
New England Highway/Maitland Road/Pacific Highway	Signalised	18	B	48	D	23	C	30	C
Pacific Highway/Tomago Road, Tomago	Signalised	18	B	18	B	17	B	15	B
Pacific Highway/Old Punt Road, Tomago	Signalised	10	A	9	A	5	A	5	A
Old Punt Road/Tomago Road, Tomago	Roundabout	4	A	3	A	3	A	5	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	12	B	10	B	11	B	9	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	17	B	3	A	4	A

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

Table 5-12 Performance of modelled intersections in 2038

Intersection	Type	2038 'without project'				2038 'with project'			
		8-9am		5-6pm		8-9am		5-6pm	
		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	180	F	120	F	124	F	151	F
New England Highway/Weakleys Drive, Beresfield	Signalised	58	E	104	F	28	C	41	D
New England Highway/Maitland Road/Pacific Highway	Signalised	25	C	83	F	36	D	38	D
Pacific Highway/Tomago Road, Tomago	Signalised	19	B	101	F	18	B	15	B
Pacific Highway/Old Punt Road, Tomago	Signalised	10	A	86	F	5	A	5	A
Old Punt Road/Tomago Road, Tomago	Roundabout	4	A	114	F	4	A	10	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	14	B	49	D	12	B	9	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	9	A	62	E	4	A	5	A

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

Table 5-13 Performance of modelled intersections in 2048

Intersection	Type	2048 'without project'				2048 'with project'			
		8-9am		5-6pm		8-9am		5-6pm	
		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	181	F	131	F	142	F	136	F
New England Highway/Weakleys Drive, Beresfield	Signalised	91	F	91	F	62	E	96	F
New England Highway/Maitland Road/Pacific Highway	Signalised	76	E	83	F	38	D	70	E
Pacific Highway/Tomago Road, Tomago	Signalised	41	D	89	F	31	C	120	F
Pacific Highway/Old Punt Road, Tomago	Signalised	22	C	143	F	6	A	48	D
Old Punt Road/Tomago Road, Tomago	Roundabout	4	A	153	F	6	A	139	F
Pacific Highway/Hank Street, Heatherbrae	Signalised	15	B	73	E	13	B	10	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	15	B	>200	F	4	A	5	A

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

Interchange analysis

A merge and diverge analysis was carried out at each motorway entry and exit ramp to determine the performance of the ramp-motorway junction (merge/diverge influence area). This 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). **Figure 5-9** to **Figure 5-12** outline the volumes of on and off ramps at the interchanges. **Table 5-14** to **Table 5-16** present the analysis results for merge and diverge segments in the modelled future horizon years for the interchanges displayed in **Figure 5-8**:

- Black Hill interchange
- Tarro interchange
- Tomago interchange
- Raymond Terrace interchange.

The volume of vehicles on each of the above ramps are shown in **Figure 5-9** to **Figure 5-12**.

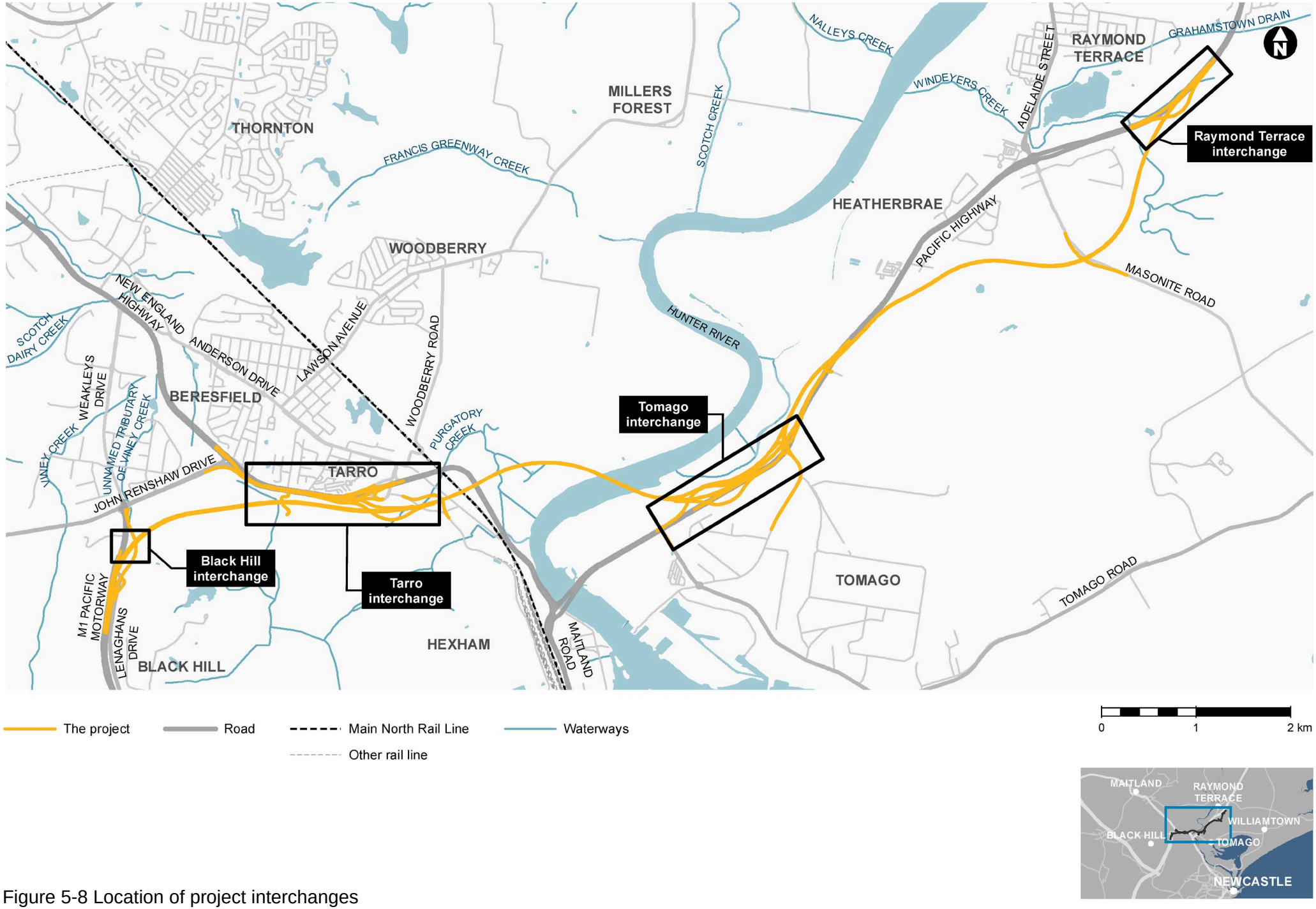


Figure 5-8 Location of project interchanges

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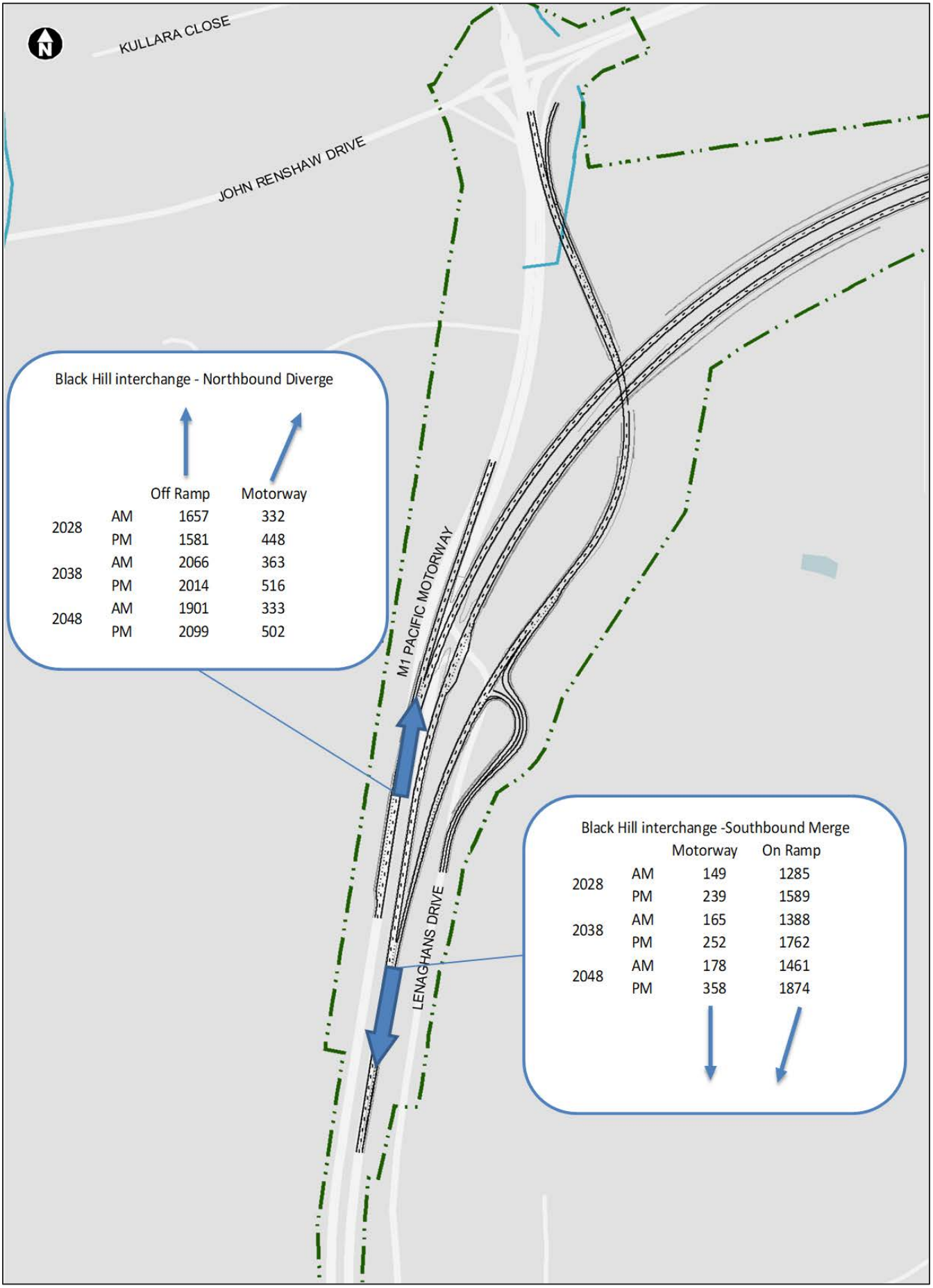
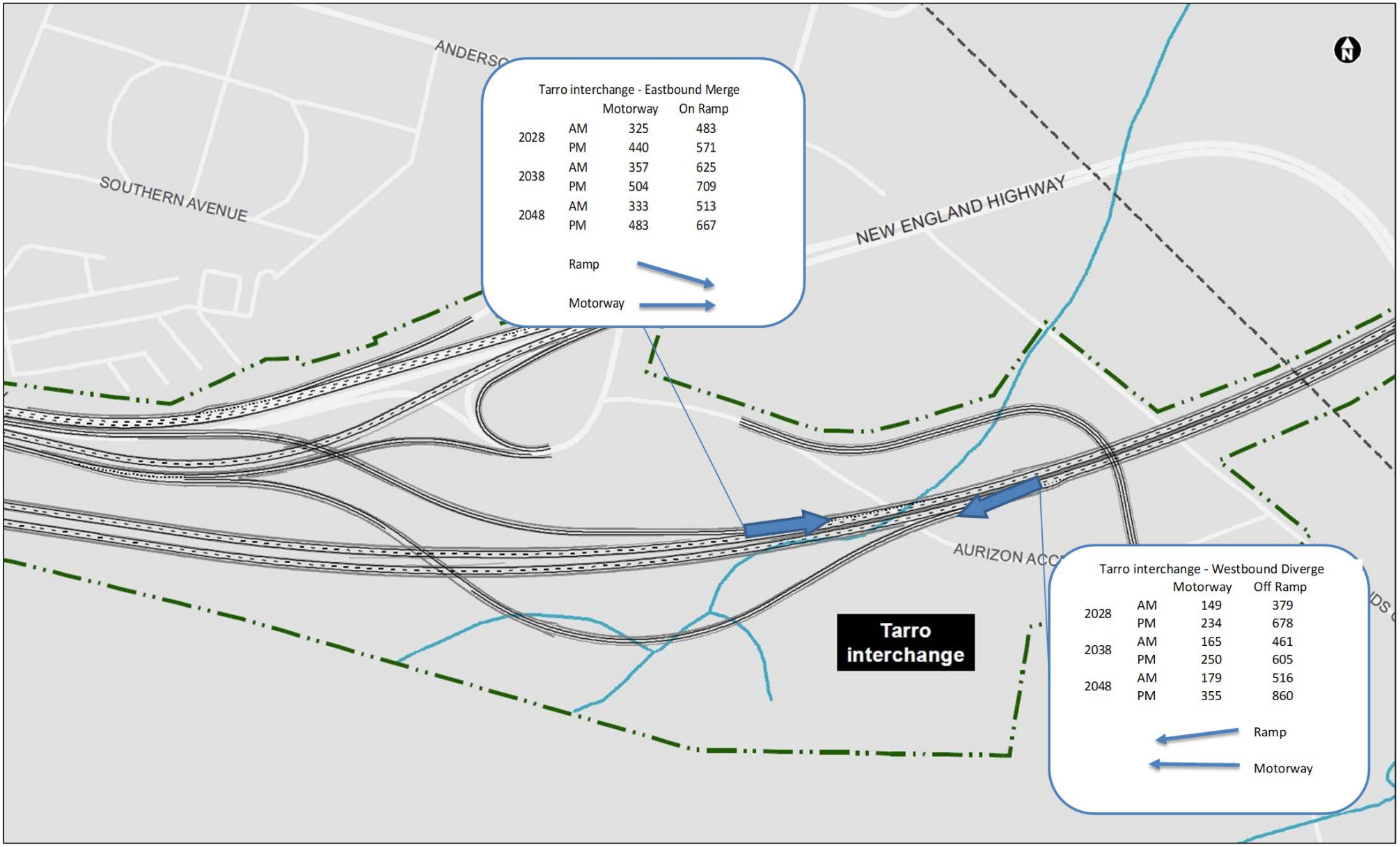


Figure 5-9 Black Hill interchange volume



Tarro interchange - Eastbound Merge

		Motorway	On Ramp
2028	AM	325	483
	PM	440	571
2038	AM	357	625
	PM	504	709
2048	AM	333	513
	PM	483	667

Tarro interchange - Westbound Diverge

		Motorway	Off Ramp
2028	AM	149	379
	PM	234	678
2038	AM	165	461
	PM	250	605
2048	AM	179	516
	PM	355	860

Figure 5-10 Tarro interchange volume

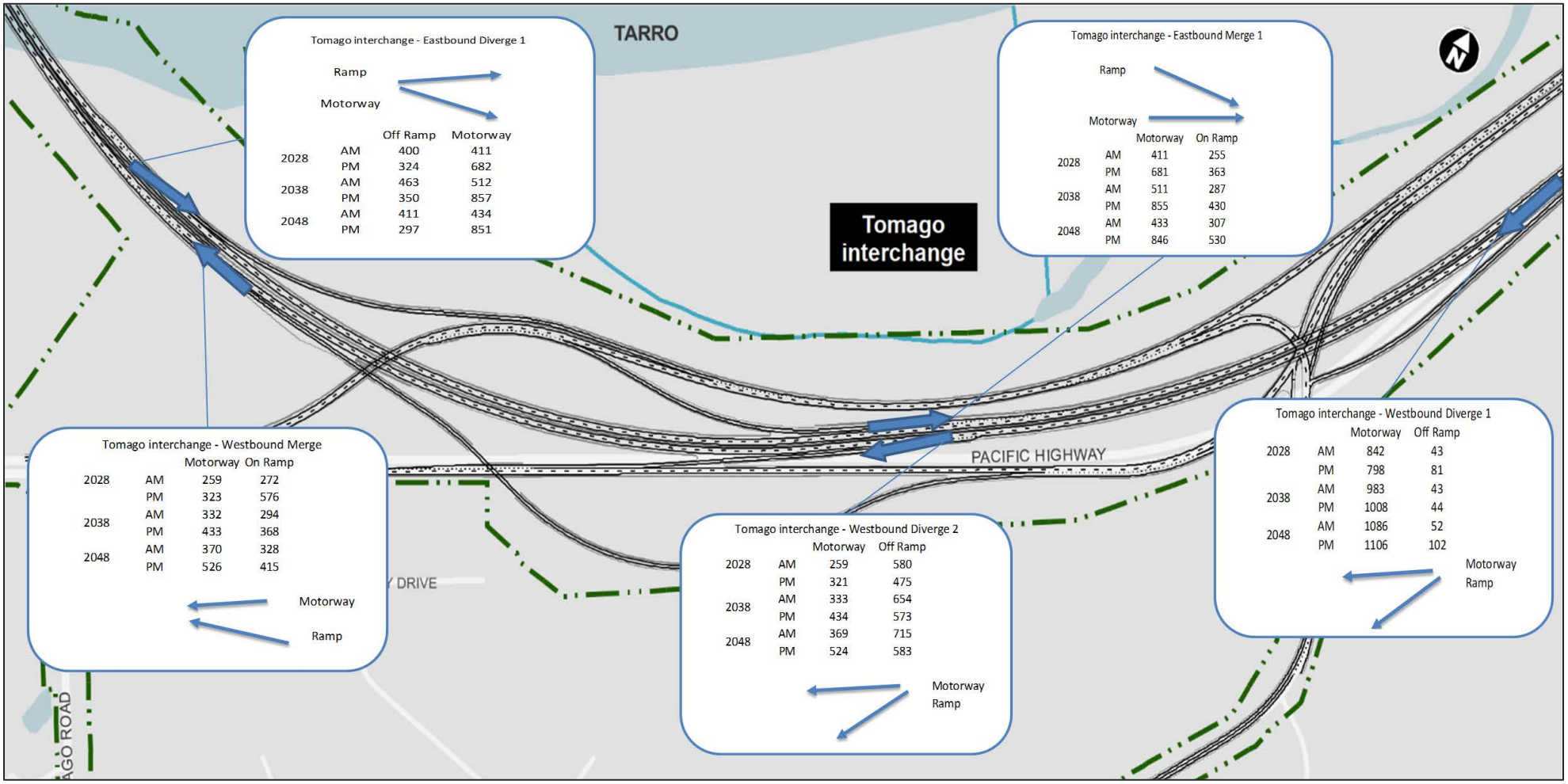


Figure 5-11 Tomago interchange volume

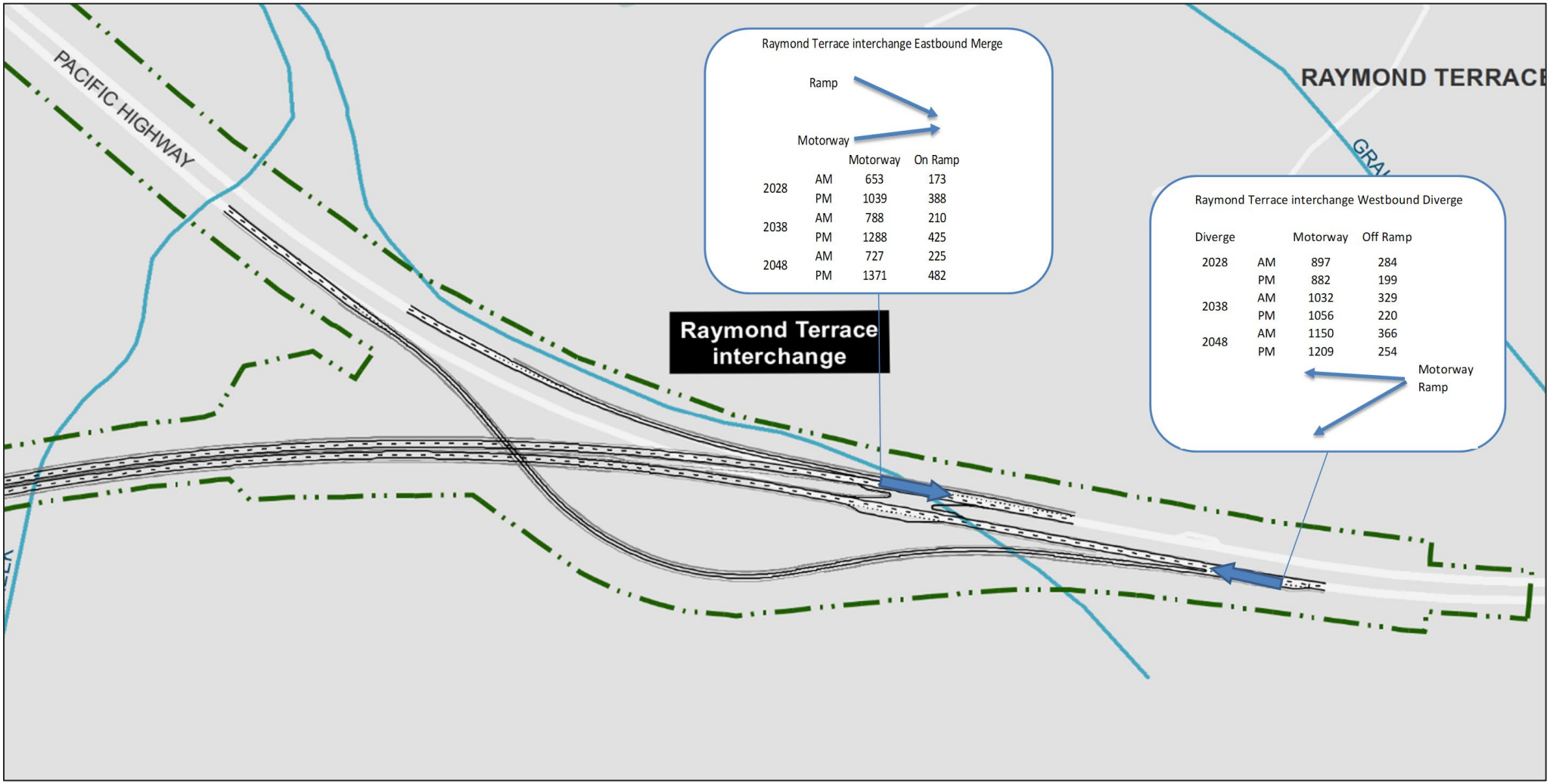


Figure 5-12 Raymond Terrace interchange volume

Table 5-14 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
Black Hill interchange - Northbound Diverge*	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.8	0.9	B	11.9	1.1	F
Tarro interchange - Eastbound Merge	6.5	0.3	B	7.5	0.4	B
Tarro interchange - Westbound Diverge	1.9	0.3	A	2.5	0.4	A
Tomago interchange - Eastbound Merge	5.7	0.2	A	7.3	0.3	B
Tomago interchange - Westbound Diverge 1	2.2	0.4	A	2.7	0.3	A
Tomago interchange - Westbound Diverge 2	6.4	0.3	B	6.0	0.2	A
Tomago interchange - Eastbound Diverge 1	2.4	0.3	A	4.3	0.2	A
Tomago Interchange - Westbound Merge	5.0	0.2	A	7.0	0.4	B
Raymond Terrace interchange - Eastbound Merge	5.6	0.3	A	8.4	0.4	B
Raymond Terrace interchange - Westbound Diverge	8.6	0.3	B	8.4	0.3	B

* Due to a nearby signalised intersection an interchange assessment could not be conducted at the Black Hill interchange - Northbound Diverge.
* Cells with pink shading represent intersections where performance is worse than LoS D

Table 5-15 Performance of modelled interchanges for 2038

Intersection	8-9am			5-6pm		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange - Northbound Diverge*	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.2	0.8	B	11.5	1.0	F
Tarro interchange - Eastbound Merge	7.6	0.4	B	8.7	0.5	B
Tarro interchange - Westbound Diverge	2.0	0.3	A	2.6	0.4	A
Tomago interchange - Eastbound Merge 1	6.3	0.2	B	8.5	0.4	B
Tomago interchange - Westbound Diverge 1	2.8	0.4	A	3.5	0.4	A
Tomago interchange - Westbound Diverge 2	7.4	0.3	B	7.6	0.3	B
Tomago interchange - Eastbound Diverge 1	3.1	0.3	A	5.7	0.3	A
Tomago Interchange - Westbound Merge	5.4	0.2	A	6.2	0.3	A
Raymond Terrace interchange Eastbound Merge	6.4	0.3	B	9.7	0.5	B
Raymond Terrace interchange Westbound Diverge	9.5	0.3	B	9.7	0.3	B

* Due to a nearby signalised intersection an interchange assessment could not be conducted at the Black Hill interchange - Northbound Diverge.
* Cells with pink shading represent intersections where performance is worse than LoS D

Table 5-16 Performance of modelled interchanges for 2048

Intersection	8-9am			5-6pm		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange - Northbound Diverge*	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.8	0.9	B	12.6	1.1	F
Tarro interchange - Eastbound Merge	6.7	0.3	B	8.3	0.5	B
Tarro interchange - Westbound Diverge*	2.2	0.3	A	N/A	N/A	N/A
Tomago interchange - Eastbound Merge 1	6.1	0.2	A	9.1	0.4	B
Tomago interchange - Westbound Diverge 1	3.1	0.5	A	4.3	0.4	A
Tomago interchange - Westbound Diverge 2	8.2	0.3	B	8.4	0.3	B
Tomago interchange - Eastbound Diverge 1	2.5	0.3	A	5.7	0.3	A
Tomago Interchange - Westbound Merge	5.8	0.2	A	6.9	0.3	B
Raymond Terrace interchange Eastbound Merge	6.3	0.3	B	10.4	0.6	B
Raymond Terrace interchange Westbound Diverge	10.4	0.3	B	10.9	0.4	B

* Due to a nearby signalised intersection or queueing upstream an interchange assessment could not be conducted at the Black Hill interchange - Northbound Diverge and Tarro interchange – Westbound Diverge
* Cells with pink shading represent intersections where performance is worse than LoS D

The Black Hill interchange southbound merge between Weakleys Drive and the M1 Pacific Motorway operates at LoS F during each of the assessed evening peak periods. This is due to the demand on the entry ramp exceeding its capacity during the assessed 15-minute peak period. The excess demand results in queueing on Weakleys Drive which extends to the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. This queueing impacts all southbound movements at the intersection and results in extensive queuing in 2038 onwards for the northern, eastern and western approaches. In 2048, the extensive queueing from the eastern approach increases in the evening peak to reach as far as the Tarro Interchange – Westbound Diverge.

Queuing from the south approach of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection does not create problems on the M1 Pacific Motorway which operates at LoS C. The M1 Pacific Motorway would continue to operate without major disruptions as the demand on the motorway is within the capacity and it is the entry ramp from the intersection that is constrained. A ramp metering assessment was carried out for the southbound entry ramp. However, it will not provide any benefit due to high demands in 2038 and 2048 exceeding the ramps capacity.

All other merges assessed across the project operate at an acceptable LoS C or better in each of the modelled scenarios, indicating that it would experience a minimal decrease in performance due to merge points.

All diverge points assessed operate at a LoS C or better in each of the modelled future horizon years. However, the Weakleys Drive northbound diverge cannot be assessed due to the influence of the downstream M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. Queueing at the southern approach to this intersection extends to the northbound Weakleys Drive diverge point, causing a negative impact on the operation of the junction.

Overall, the interchange assessment shows the project would operate at a LoS C or better across the modelled merge and diverge points for each of the scenarios.

Sensitivity testing

As detailed in **Section 3.3.2**, additional sensitivity modelling was carried out for the two sensitivity scenarios tested to quantify the impact of the Emerging Black Hill Precinct on the road network. The development located south-west of the John Renshaw/Weakleys Drive intersection was found to be a major driver of traffic demand in the traffic model accounting for about 11 per cent of all traffic demand in 2038. The sensitivity modelling results for the two scenarios are summarised below, with more detail provided in **Appendix B**.

Scenario 1 - Black Hill Road interchange

The provision of south-facing ramps connecting Black Hill Road to the M1 Pacific Motorway was found to improve the performance of the road network, particularly during the evening peak. Improvements were evident at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive and Black Hill interchange southbound merge. These improvements are a result of more direct access to the Emerging Black Hill Precinct site from the south, which reduces the distance travelled by vehicles accessing and departing the site. This consequently reduces the number of vehicles travelling the network surrounding the Emerging Black Hill Precinct.

Scenario 2 - Sensitivity results

The sensitivity testing shows the removal of all Black Hill traffic from the 2038 road network would improve performance outcomes. There would be substantial improvements to the key network statistics along with intersection and interchange LoS improvements. The improved outcomes are a result of less traffic demand which limits the build-up of queues and delays.

5.2.2 Impact on public transport

Interaction with rail infrastructure

There would be no impact to the function of the Main North Rail Line and Hexham train support facility during project operation. Access to Thornton, Beresfield, Tarro and Hexham railway stations, and ARTC assets via Tarro interchange, would remain as existing.

Bus services

The project would not affect any current bus routes. It is expected that local routes would continue to service the local community and operate on the existing road network as this would provide the greatest number of potential customers. The project would improve bus travel time reliability as a result of reduced traffic volumes on the existing road network. Decreased congestion and improved intersection performance would also benefit bus travel times.

As discussed in **Section 5.1.7**, three bus stops would be relocated during construction for the project. The relocated bus stops would be located as close as possible to the original bus stop locations, and pathways would be provided to maintain access with relocated bus stops. Consultation would be carried out with the affected bus operators during detailed design.

5.2.3 Impact on freight

As stated in **Section 4.2**, the current network has constraints for OSOM vehicles at both the southbound Hexham Bridge and at the New England Highway crossing of the Main North Rail Line. The project would provide an alternative route offering improved freight connectivity and allow free movement at these locations without the requirement for a permit.

Future land releases surrounding the study area are expected to substantially increase the generation of new freight movements in future years. This would be driven predominately by the Emerging Black Hill Precinct and developments around Tomago and Heatherbrae. 'Without project' modelling results indicate there would be substantial congestion in the network, lengthy delays and increased travel times apply for all vehicles including freight.

Routes from the Pacific Highway (Sandgate) to both the New England Highway (Beresfield) and the M1 Pacific Motorway (Black Hill) carry a large volume of heavy vehicles. Although vehicles travelling on these routes would not use the project, the redistribution of other traffic to the project would reduce congestion on other roads within the study area resulting in a reduction in travel times for all vehicles, including freight traffic by greater than 22 per cent during the peak hours.

Other routes between industrial areas such as Tomago, Black Hill, Beresfield and Raymond Terrace that carry a substantial volume of heavy vehicles would experience substantial reductions in delays and travel times as a result of the project. Further, the project would also result in freer flowing traffic and greater efficiency of heavy vehicle operations.

The project would provide a free flowing high standard, access-controlled motorway that integrates with the NLTN. The project would contribute towards connecting Melbourne, Sydney and Brisbane via a high standard duplicated motorway and improve connectivity for state and national freight. The cumulative impact of projects on freight is discussed in **Table 5-17**.

5.2.4 Impact to regional and local community connectivity

Regional connectivity

The M1 Pacific Motorway, New England Highway, Pacific Highway and John Renshaw Drive form part of the NLTN and are a key component of the Sydney to Brisbane road link. In addition to facilitating substantial interstate freight movements between Victoria, NSW and Queensland, these roads provide the primary access to the City of Newcastle, Port of Newcastle, Newcastle Airport, Upper Hunter Valley mining developments, Maitland and other major employment and commercial centres in the Hunter Region. The reduction in delays, reduction in travel time and improved travel time reliability that occur as a result of the project, would provide enhanced connectivity to communities and activity centres in the Lower Hunter and Newcastle regions, including Newcastle, Raymond Terrace, the Port of Newcastle and Newcastle Airport. The additional capacity provided by the project would also ensure the long term reliability and functionality of the NLTN, state roads and local roads.

These benefits would enable the project to support future land use and development within the study area and the surrounding region, improving access and connectivity to current and future employment and growth areas to and from the M1 Pacific Motorway and Pacific Highway. The project would support:

- Future employment and population growth at Raymond Terrace, which is identified as a strategic centre within the Hunter Region
- Growth and development of employment precincts at Tomago and Thornton, Beresfield and Black Hill.

The project would provide enhanced access to the Beresfield and Tomago industrial areas by providing new entry and exit points, delivered through the Tarro and Tomago interchange. The project would also provide more efficient access to facilitate economic growth for the Lower Hunter and key regional employment areas such as the Port of Newcastle, Newcastle Airport, Raymond Terrace and Black Hill.

Impact on property access

The project would be constructed to full motorway standard with no direct access to properties from the main alignment. Twenty-three lots would have the existing property access affected by the project. As discussed in the Land Use and Property Working Paper (Appendix N of the EIS) suitable access

arrangements to these properties would be maintained during construction for these properties. Some properties may require alternate access strategies, which would consider movements along the length of the project and interactions with the local road network. In locations where an alternate route is required due to construction, complex movements have been avoided where possible.

With the application of these changes via an alternate access strategy, access to commercial properties will be maintained. Transport will continue to liaise with landowners during detailed design to confirm access arrangements. Full details on permanent changes to property accesses are detailed in **Appendix D**.

5.2.5 Impact on road safety

As stated in **Section 1.3**, one of the key objectives of the project is to improve road safety. As stated in **Section 4.5**, the current crash rate is 10.78 crashes per 100 metres VKT and 0.54 casualty crashes per kilometre.

The project would have a positive impact on road safety in the study area by addressing the following issues:

- Rear end, multi-vehicle crashes are the most common type of crash occurring within the study area. Many of these crashes occur on the New England Highway and Pacific Highway and are caused by traffic congestion. The project would reduce congestion on the New England Highway and Pacific Highway and is anticipated to result in a substantial reduction in rear-end type crashes
- Lane changes are the second most frequent type of crash in the study area with 66 per cent of these crashes occurring on the New England Highway. The project would reduce the number of vehicles travelling on the New England Highway which would reduce the risk of lane change crashes
- Access to and from the project is to be provided via grade-separated interchanges. This would reduce potential points of conflict between vehicles. Providing grade-separated interchanges would also result in free-flow conditions along the project, minimising the risk of congestion-related incidents
- Off road and off bend crashes are a common cause of fatal and serious injury crashes in the study area. The project provides improved road alignment, wider lanes and shoulders with barriers, and would minimise the risk and impact of any off-road crashes.

5.2.6 Impact on the pedestrian and cycle network

Pedestrians

The study area is predominantly comprised of industrial land uses which leads to very low volumes of pedestrians. The project would result in fewer traffic movements on the existing road network as traffic reroutes to the M1 Pacific Motorway.

The project would provide a shared path about 900 metres long along the southbound lane of the realigned Masonite Road in order to provide safer pedestrian access and to accommodate future development in the surrounding area. No shared path would be provided along the main alignment.

The proposed signalised intersection at the HRBG would provide a signalised pedestrian crossing which would provide access to the bus stop located on the eastern side of the Pacific Highway. It would also offer improved pedestrian access to the HRBG.

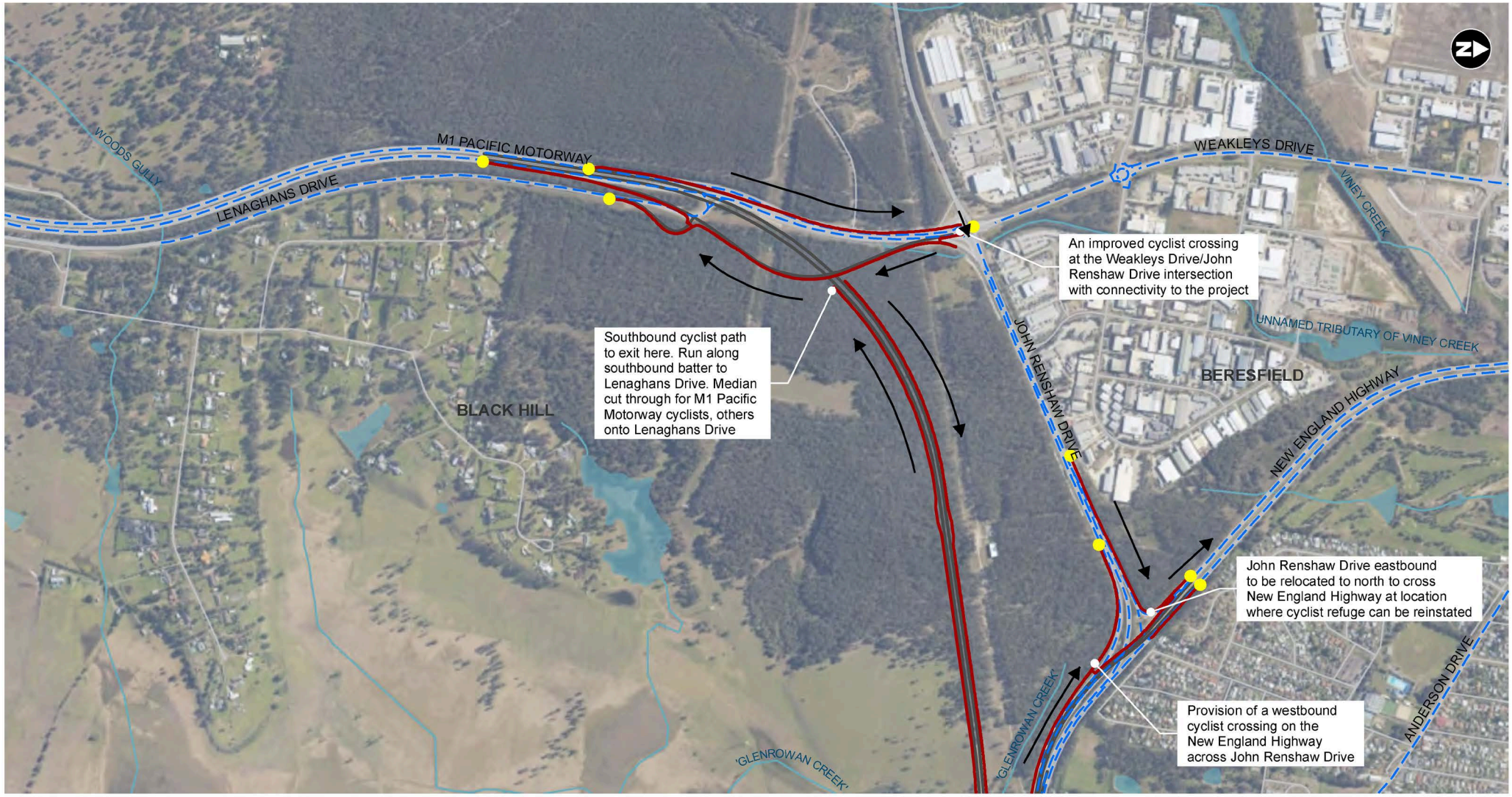
Cyclist

The existing cycling network, the new cycle routes provided by the project and other cycle routes proposed are shown in **Figure 5-13**. Cyclists would be able to use the 2.5 metre to three metre wide shoulders provided on the motorway and two metre to 2.5 metre wide sealed shoulders provided on ramps. This would improve cycle connectivity through the study area. Changes to the existing cycle network include:

- A signalised crossing at the M1 Pacific Motorway/John Renshaw Drive intersection with connectivity to the project to provide a safe crossing location for cyclists
- Relocating the existing cyclist crossing on the New England Highway, just east of John Renshaw Drive further west before the northbound entry ramp at the Tarro interchange
- Provision of a westbound cyclist crossing on the New England Highway across John Renshaw Drive
- Replacing the existing gore crossings at the Tarro interchange with new ramps which would create a link between the main alignment in both directions and the future Richmond Vale Rail Trail from Tarro to Shortland
- Provision for northbound cyclists on the Pacific Highway crossing to access Old Punt Road and for crossing from Old Punt to access the northbound Pacific Highway Carriageway
- Provision for northbound cyclists on Pacific Highway to access the main alignment at Tomago interchange and to connect to the traffic signals at Tomago Road
- Provision for northbound cyclists on Pacific Highway to access the HRBG
- Provision for a shared path over the realigned Masonite Road.

Overall, the project would provide additional cycling routes and enhances safety for cyclists.

A dedicated off-road cycleway is proposed by the city of Newcastle for a distance of about 900 metres between Tarro and Shortland. This future route would intersect with the project with a diversion nominated along the realigned Aurizon access road (see **Figure 5-14**).



The project
Cycle route (the project)
Cycle tie in point to the existing network
Existing cycle network
Road
Waterways

0 0.5 1 km

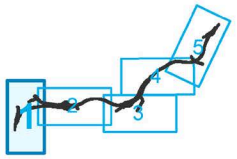


Figure 5-13 Existing and proposed cycle route (map 1 of 5)

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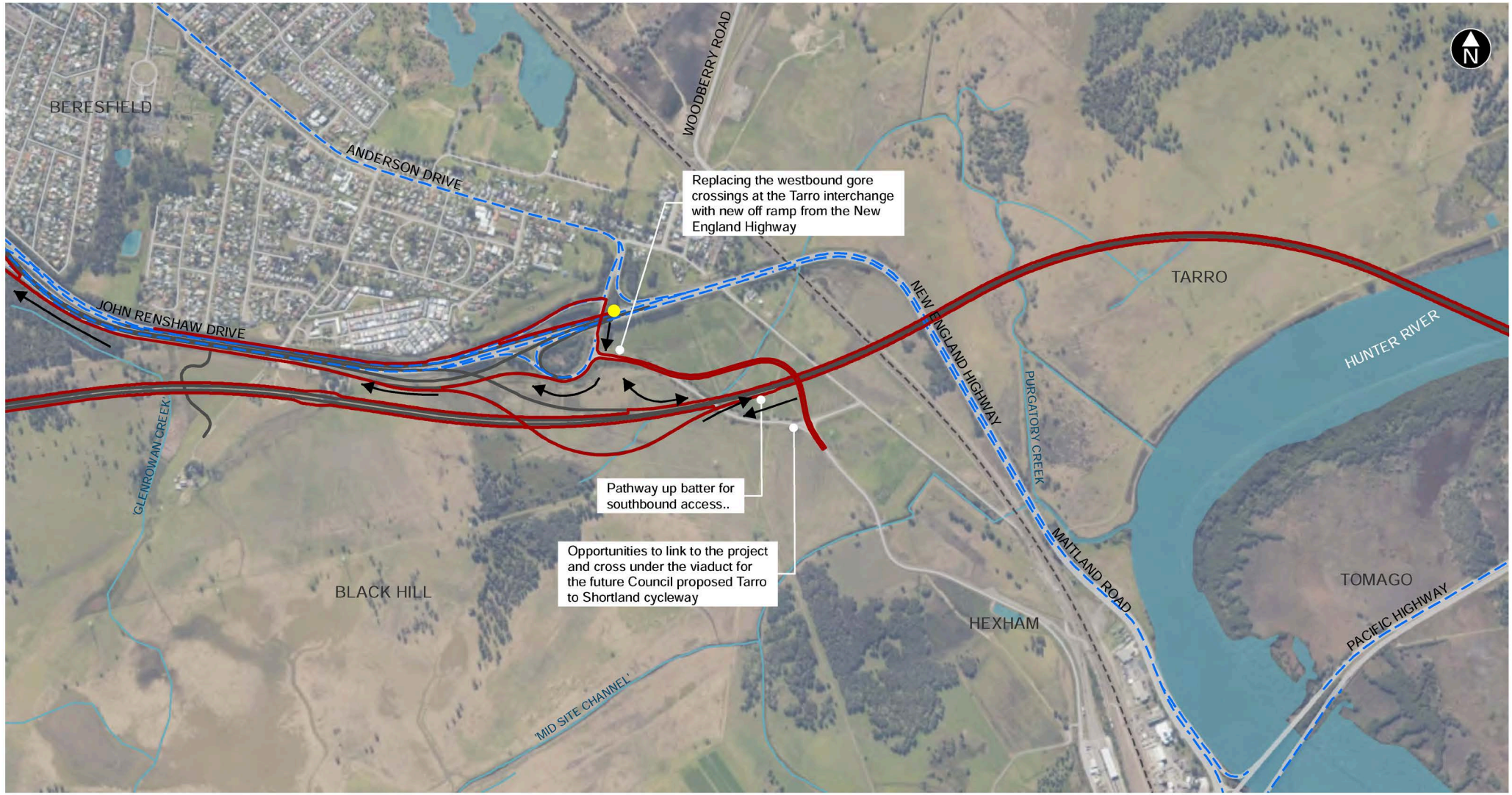

The project
Cycle route (the project)
Cycle tie in point to the existing network
Existing cycle network
Road
Main North Rail Line
Waterways

0 0.5 1 km

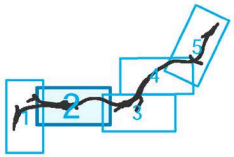

Figure 5-13 Existing and proposed cycle route (map 2 of 5)

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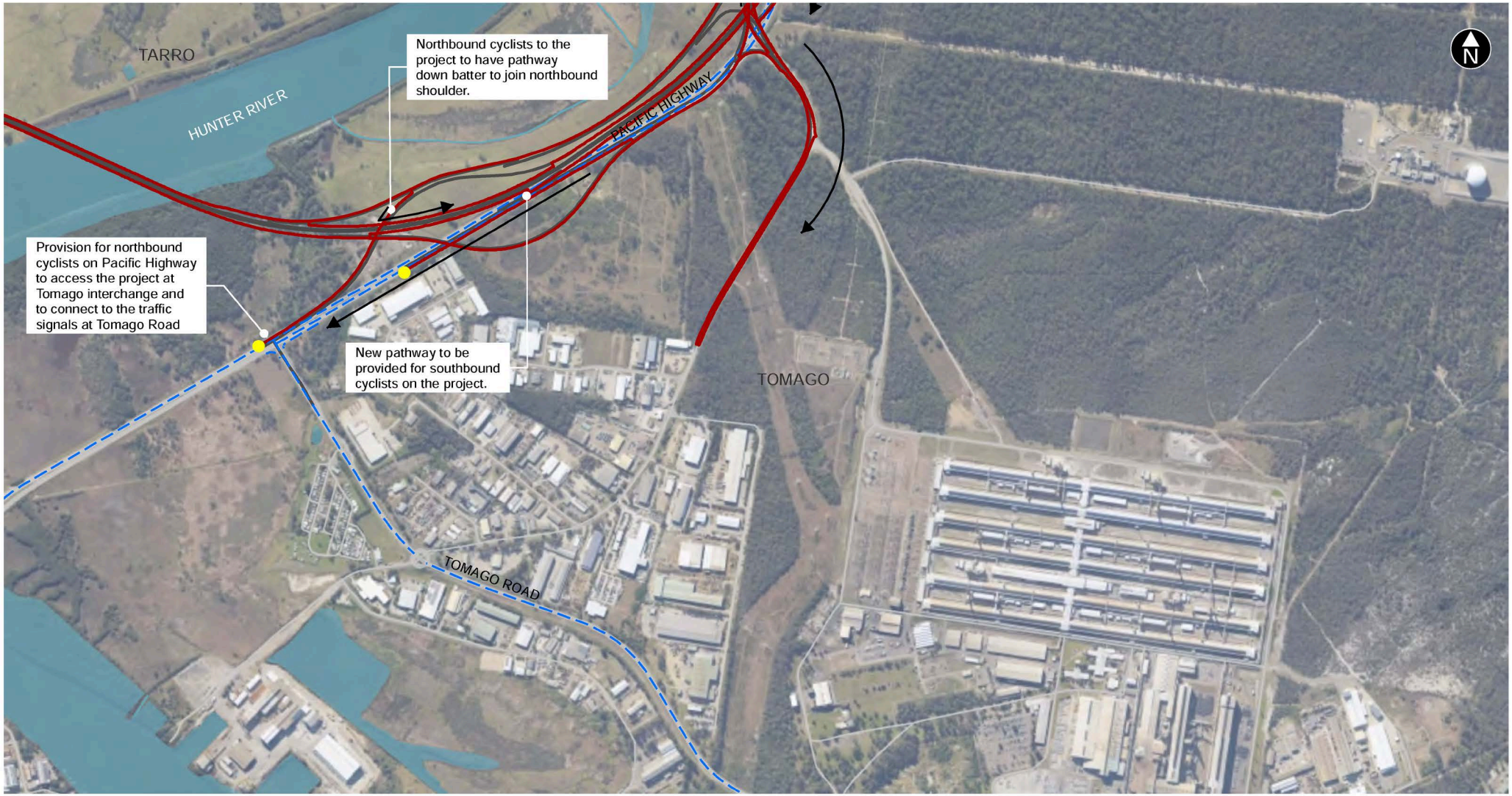

The project
Cycle route (the project)
Cycle tie in point to the existing network
Existing cycle network
Road
Waterways

0 0.5 1 km

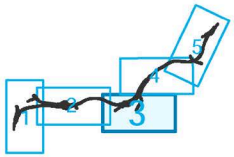

Figure 5-13 Existing and proposed cycle route (map 3 of 5)

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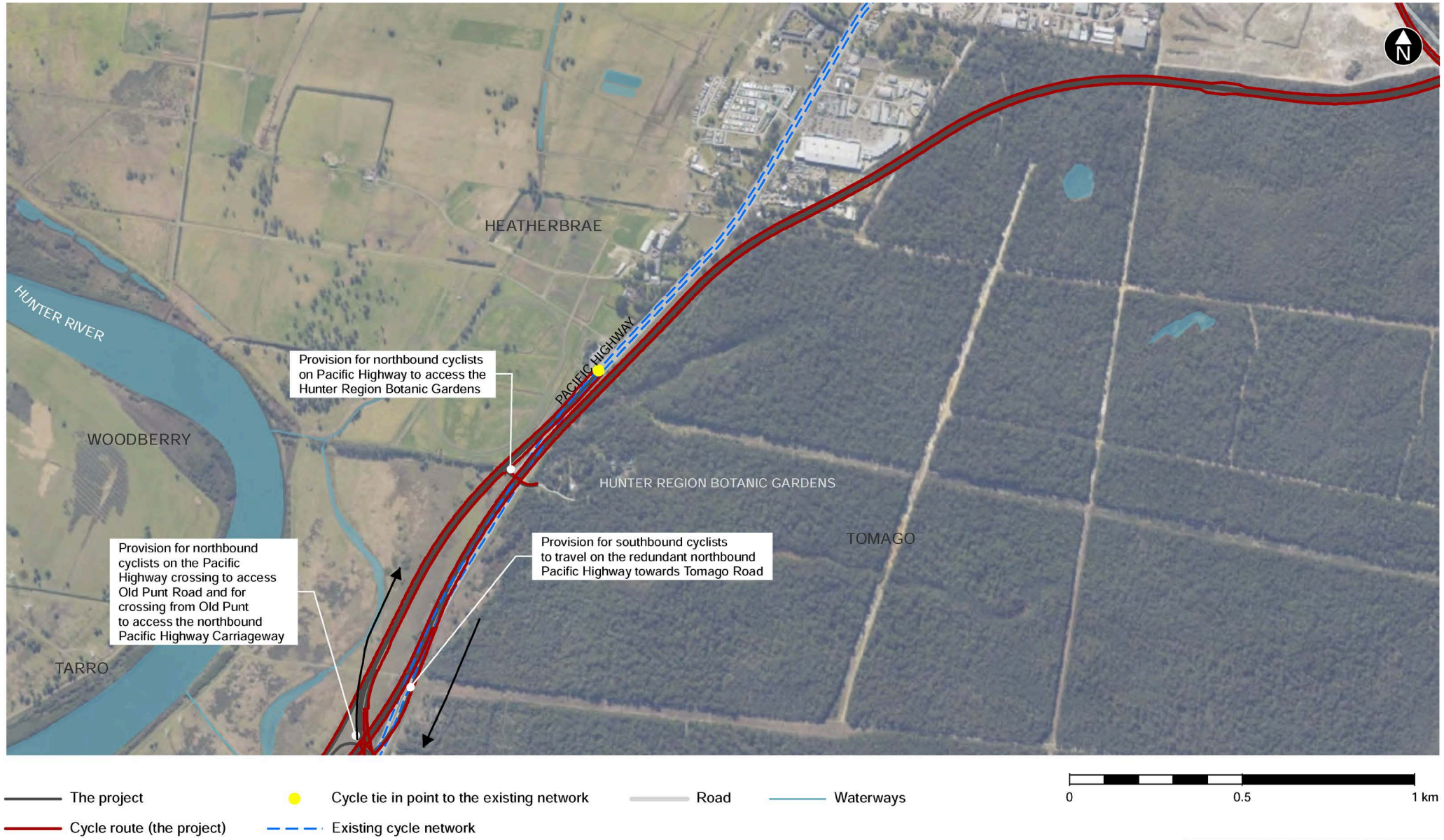

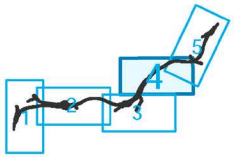

Figure 5-13 Existing and proposed cycle route (map 4 of 5)

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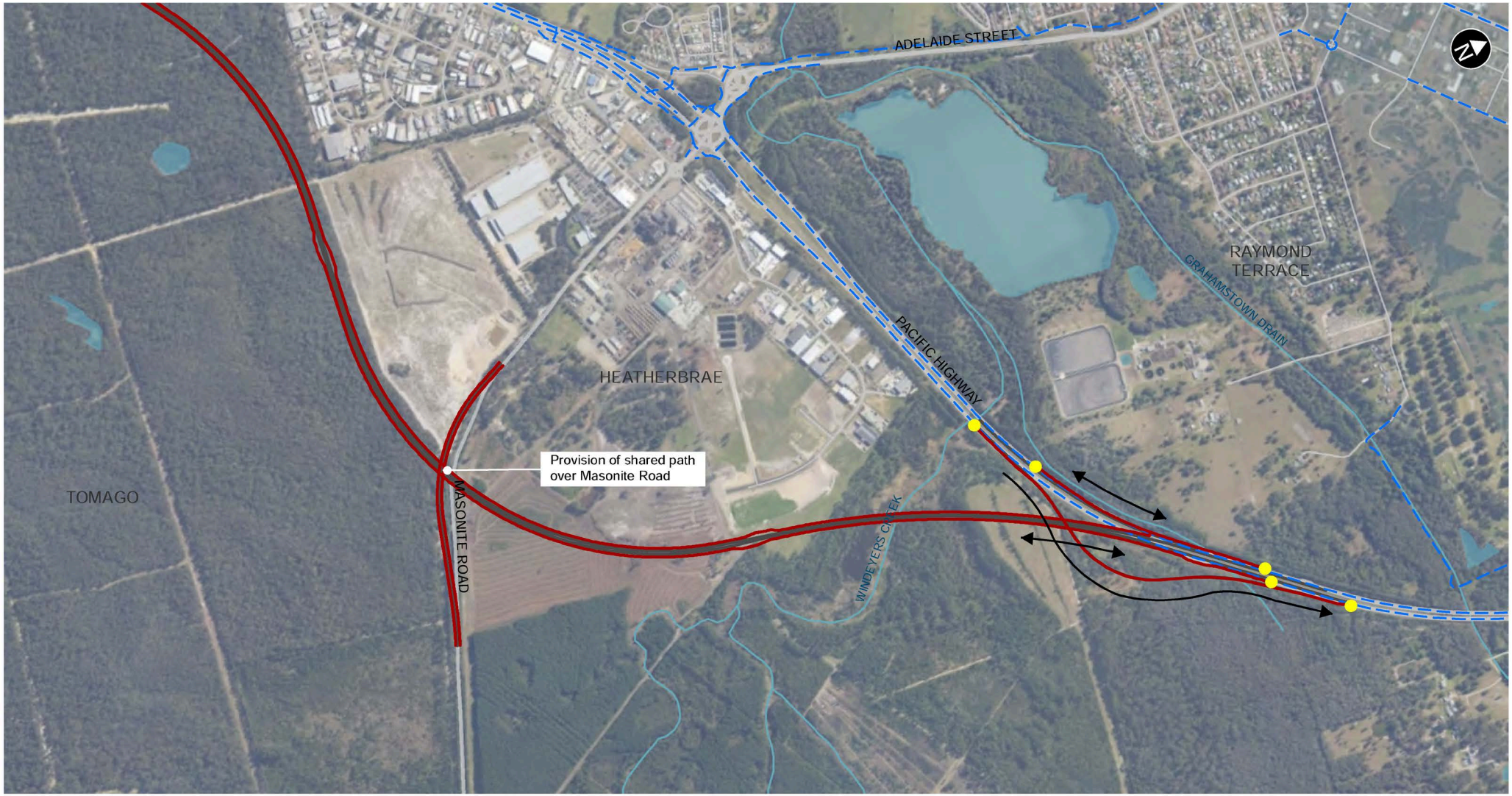

The project
Cycle route (the project)
Cycle tie in point to the existing network
Existing cycle network
Road
Waterways

0 0.5 1 km

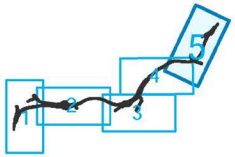

Figure 5-13 Existing and proposed cycle route (map 5 of 5)

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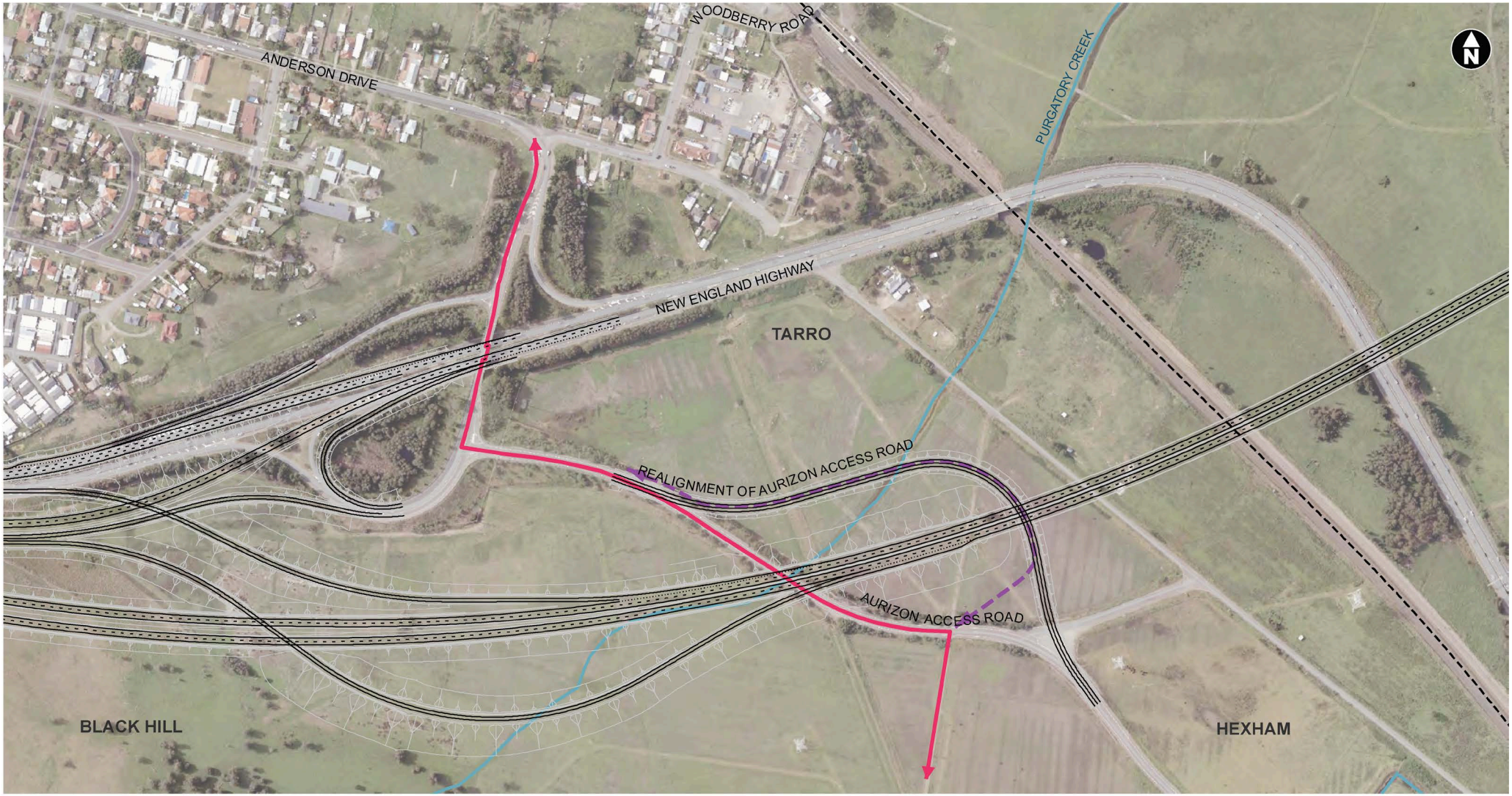

The project

Proposed off-road cycleway

Proposed diversion for Shortland to Tarro cycleway

Main North Rail Line

Waterways

0 100 200m

Figure 5-14 Shortland to Tarro Map (Source: City of Newcastle)

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5.2.7 Impact on regional airport

The project would have a positive impact on Newcastle Airport and Williamtown RAAF Base function once operational. It would reduce travel times and improve travel time reliability for trips to Newcastle Airport and Williamtown RAAF Base for traffic from Maitland, the M1 Pacific Motorway and areas west of the study area. The project would therefore result in improved access to the Newcastle Airport and Williamtown RAAF Base.

5.2.8 Impact on maritime traffic

The new bridge structures associated with the project would have a clearance of about 11 metres and would be supported by six sets of piers within the river. This is greater than the existing Hexham Bridge downstream which was a fixed clearance height of 10 metres. The bridge design over the Hunter River would allow for the continued use of the river by maritime traffic once built.

The project would result in impact to prawn trawling areas due to the design and location of the bridge over the Hunter River. The project would be designed to allow the passage of commercial fishing vessels along the Hunter River, although the placement of piers would limit the ability to trawl along the shoreline near the bridge. The project would require changes to trawling practices near to the bridge, with trawling nets required to be pulled in to pass under the bridge.

No other impacts to maritime traffic are expected and there would also be no impact on the functionality of the Port of Newcastle when the project is operational.

5.3 Cumulative impact

Cumulative traffic and transport impacts may arise from the interaction of construction and operation activities of the project, and other approved or proposed projects in the area. When considered in isolation, specific project impacts may be considered minor. These minor impacts may, however, be more substantial when the impact of multiple projects on the same receivers is considered.

The projects detailed in **Table 5-17** are in varying stages of delivery and planning. This section provides an assessment of cumulative traffic and transport impact based on the most current and publicly available information for these projects. In many instances, this is a high-level qualitative assessment, but the cumulative impacts from other projects, particularly development projects, have also been captured in the in the traffic modelling as part of the future traffic growth across the Hunter Region as detailed in **Section 3.4** and **Section 4.10**.

The contribution of the project to the cumulative impact on traffic and transport in the area is minor, considering construction would be managed through the implementation of a range of environmental management measures.

Table 5-17 Assessment of potential cumulative impact for relevant identified projects

Project (approval status)	Relevance in consideration of cumulative impact	Potential cumulative impact
Emerging Black Hill Precinct, which includes: • Black Hill Employment Lands (In planning) • Black Hill Hunter Business Park (In planning)	• Located south of John Renshaw Drive and west of M1 Pacific Motorway. • Likely to be some overlap in the construction program, meaning the likelihood of concurrent (simultaneous) construction and operation • Likely to be concurrent (simultaneous) operation.	The Emerging Black Hill Precinct is included in the traffic modelling for future horizon years. It has been assumed that 25 per cent of the development would be complete by 2028, 75 per cent by 2038 and 100 per cent by 2048. The development will be a key generator of traffic in the region for future scenarios and accounts for about 12 per cent of all trips in the study area by 2048. There is likely to be some overlap in construction, as it is located within the project's construction footprint, to the south of John Renshaw Drive and west of M1 Pacific Motorway. However, there is a low likelihood for disruptions, with construction access likely to come from John Renshaw Drive west of the Weakleys Drive intersection which is outside the construction footprint. It is possible construction traffic would use the M1 Pacific Motorway and New England Highway to access the Emerging Black Hill Precinct, which may result in construction vehicles additional to what the project would contribute. These construction vehicle volumes are not expected to exceed capacity (including heavy vehicle capacity) of these state roads. The impact of the Emerging Black Hill Precinct during project operation is captured throughout this report. Sensitivity testing of the development has been carried out and can be viewed in detail in **Appendix B**. In summary, the development substantially impacts the performance of the network in future horizon years due to the magnitude of traffic generated out of the development.
Kinross Industrial / Weathertex, Heatherbrae (Approved)	• Located within the project's construction footprint to the north of the project in Heatherbrae. • Potential to be consecutive (back to back) construction and concurrent (simultaneous) operation.	The timing for the Weathertex industrial development has not yet been announced, although some land has been cleared for the development to the north of the project. The industrial development is proposed on land identified for AS16. If the Weathertex industrial development is developed prior to or during construction this ancillary facilities would be unavailable to the project for use. Construction of the project and Weathertex industrial development have the potential to extend potential disruptions relating to amenity and traffic (including access and travel times). The Weathertex industrial development operational traffic impact is captured as part of the future traffic demand growth within the study area.
Newcastle Power Station (In planning)	• Located within the project's construction footprint at Tomago near Old Punt Road. • Potential to be consecutive (back to back) construction and concurrent (simultaneous) operation.	AGL propose to construct a 250 Mega Watt (MW) gas fired power station at Tomago, with gas pipelines and electricity transmission lines. Construction of the power station is due to commence in 2021 with the power station expected to be operational in 2022. The site for the proposed power station is located between the Pacific Highway and Old Punt Road, north of the Tomago industrial area (AGL, 2019). The power station would be located next to AS12 and AS13. The project has considered the AGL power station in its design. Cumulative traffic operational impacts are minimal, as the station would not generate large amounts of traffic as it would employ approximately 23 operational and maintenance people.

Project (approval status)	Relevance in consideration of cumulative impact	Potential cumulative impact
Hexham Straight (In planning)	• Located about one kilometre south of the project at Hexham • Potential to be consecutive (back to back) construction and concurrent (simultaneous) operation.	The Hexham Straight project has a funding commitment to proceed and the concept design and environmental assessment is currently being carried out. Transport plan to upgrade the Hexham Straight (Maitland Road) between Sandgate and the existing Hexham Bridge. The proposed scope of the Hexham Straight project involves the addition of an extra lane in both directions, replacement of the bridges at Ironbark Creek, adjustments to connecting roads as well as substantial utility relocation. The concept design and environmental assessment are currently being carried out for the Hexham Straight project. The construction of the project has the potential to overlap with the construction of Hexham Straight which would result in additional impact on traffic and road access within the study area. The Hexham Straight project has been captured in the traffic modelling as part of the 'without project' upgrades. The upgrades include an extra lane in each direction between Sandgate and the existing Hexham Bridge. For the 'without project' model, the lane configuration at the existing Hexham bridge maintains the existing layout to ensure adequate operation. The operational impact of the existing Hexham Bridge is captured in the 'without project' and project traffic model. A comparison between the two modelling scenarios has identified the benefits originating from the project.
Lower Hunter Freight Corridor (in planning)	• The investigation area includes Hexham at the south east of the project and south west of the project at M1 Pacific Motorway and Lenaghans Drive	The Transport Lower Hunter Freight Corridor (LHFC) forms a part of the NSW Freight and Ports Strategy (Transport for NSW, 2018a) and in 2018 preliminary investigations were being carried out to assess options for a dedicated freight rail line between Fassifern and Hexham. No options were available on the website to review. An investigation areas figure between Fassifern and Hexham was available. The construction of a rail freight corridor would reduce the demand for road freight in the study area. However, as the scale and alignment of the LHFC are undetermined, the cumulative operational impact of this project is unknown. The design of the project allows for the LHFC.
Richmond Vale Rail Trail to Shortland, including Shortland to Tarro cycleway (In planning)	• Intersects the project at Tarro	This project is not expected to result in cumulative impact with the project. The Richmond Vale Rail Trail to Shortland would encourage additional pedestrian and cyclist use within the study area. The Shortland to Tarro Bike Trail would intersect with the project and provide an additional pedestrian and cyclist routes within the study area. Overall, it would have minimal impact on the traffic within the study area.

6. Environmental management measures

The management measures presented in **Table 6-1** have been developed to specifically manage potential impact which have been predicted as a result of the proposed works. Where possible, the project has planned to avoid and minimise traffic and transport impact during the construction and operational phases. Despite this, the project would result in impact on the road network during construction and operation. Management measures will be implemented to avoid, minimise and/or manage these impacts on the road network. These measures should be incorporated into relevant Environmental Management Plans (EMPs) during construction and operations.

Table 6-1 Environmental management measures

Impact	Reference	Management measure	Responsibility	Timing
Management of traffic during construction	TT01	A Traffic Management Plan (TMP) will be prepared and implemented in accordance with the Traffic Control at Work Sites Manual (RTA, 2018) and QA Specification G10 Control of Traffic. The TMP will include: • Confirmation of haulage routes, including minimisation of haulage movements during peak periods on routes where feasible. • Access management plan to ensure access to properties can be maintained where it is safe and feasible during construction • Site specific traffic control measures (including signage) to manage and regulate traffic movement • Measures to manage temporary changes to the road network including use of barriers, lane occupancies or temporary road closures • Measures to maintain pedestrian and cyclist access (including communication, signage and alternative routes) • Requirements and methods to consult and inform the local community of impacts on the local road network (including for out of hours work) • Access to ancillary and construction sites including entry and exit locations and measures to prevent construction vehicles queuing on public roads • A response plan for any construction traffic incident • Consideration of other developments that may be under construction to minimise traffic conflict and congestion.	Contractor	Prior to construction/ construction

Impact	Reference	Management measure	Responsibility	Timing
Property access	TT02	Existing accesses to properties and businesses will be maintained during construction. Where this is not feasible or reasonable, temporary alternative access arrangements will be provided following consultation with the affected property and business owners.	Transport / Contractor	Detailed design/ prior to construction/ during construction
	TT03	Access will be maintained to rail infrastructure facilities along Aurizon access road. Transport will liaise with Aurizon and ARTC during detail design and construction.	Transport / Contractor	Detailed design/ prior to construction/ during construction
Impacts to bus services	TT04	Any changes to bus stops will be implemented in consultation with Transport, relevant councils, and relevant bus operators.	Contractor	Prior to construction/ construction
Emergency vehicle access	TT05	Where possible, access for emergency vehicles will be maintained at all times during construction. Any site-specific requirements will be determined in consultation with the relevant emergency services agency.	Contractor	Construction
Maritime impacts	TT06	A navigational channel would be provided during construction within the Hunter River.	Contractor	Construction
Damage or impacts on local road infrastructure	TT07	A road dilapidation report will be prepared before impacts on local roads commence. The report will document the existing conditions of local roads. This report will be issued to councils and stakeholders as relevant.	Contractor	Prior to construction

7. Conclusion

This report has provided an assessment of the potential traffic and transport impacts of the project on its own and as part of the broader planned traffic network during construction and operation.

The assessment of potential construction traffic impacts considers the construction program, location of construction access routes, location of ancillary facilities, haulage routes and use of the existing road network. Construction staging, compound locations and associated construction traffic impact from the project were assessed through a spreadsheet analysis. Impact on pedestrians, cyclists, maritime traffic and local access during construction were assessed qualitatively.

Key outcomes of the construction impact assessment are:

- There is not anticipated to be major impacts to traffic and transport access and operation that cannot be managed with robust traffic management and communication with affected residents, business operators and road users
- Minimal impacts to residential properties were identified. There are several impacts to existing commercial access arrangements in Black Hill, Tarro, Tomago and Raymond Terrace. Mitigation strategies and detour routes have been considered and outlined
- Minimal delays and queuing on the surrounding network is anticipated as a result of accessing ancillary facilities. This is due to the low number of peak hour construction traffic movements along with dedicated left in/left out arrangements for the majority of the ancillary facilities
- Cyclist and pedestrian access would be maintained via communication, signage and alternative routes as part of the Traffic Management Plan
- Bus routes would not be affected during construction. However, three bus stops on Pacific Highway would be relocated during construction. Impact to rail operations from project construction are expected to be negligible. Impacts on maritime traffic are expected to be minimal as work on the Hunter River would be completed during low maritime navigation times.

Within the study area, the road network current carries large volumes of local and interregional traffic which comprises a large percentage of heavy vehicles. The future land releases in the study area are expected to substantially increase the generation of new freight movements in future years. This would result in traffic demand exceeding the capacity of the existing road network and substantial increases to congestion leading to delays as displayed in the 2038 and 2048 without project model results. The traffic modelling results with the project show substantial improvements to the network performance.

Key outcomes of the traffic operational modelling are that:

- The project maintains the safety of the transport system through the provision of a dual carriageway with a median, improved road alignment, wider lanes and shoulders, grade-separated interchanges, and reduced traffic volumes on the existing road network. This is expected to substantially reduce vehicle head-on crashes, rear-end crashes, vehicles turning from opposing directions, lane change crashes and run-off-road crashes
- The efficiency of the road network would improve as a result of the project. In 2028, the project results in improved network performance outcomes in each of the peak periods. From 2038 onwards, the study area with the project begins to show a reduction in network performance outcomes due to increased traffic volume which is driven by development of employment precincts at Tomago and Thornton,

Beresfield and Black Hill. Overall, the project results in a more efficient road network that can cater to a higher volume of vehicles, while also maintaining faster travelling speeds for motorists

- Key intersections along the Pacific Highway between Maitland Road and Masonite Road show an improved level of service. Removal of the main east-west movements along the Pacific Highway improves the performance of these intersections and reduces volumes to within capacity
- Despite some improvements that occur at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection as a result of the project, the intersection is expected to perform at an unsatisfactory Level of Service from 2038 onwards, primarily due to proposed major employment development adjacent to the intersection
- The project would improve connectivity between Newcastle, Raymond Terrace, Maitland and other regional industrial areas during both peak and off peak periods by substantially reducing travel times. This is most pronounced for journeys that currently use the New England Highway between Tarro and Raymond Terrace. Travel times along the M1 Pacific Motorway corridor between Black Hill and Raymond Terrace would also substantially reduce with a reduction in travel times by up to 74 per cent
- All interchanges would operate at Level of Service C or better in each of the modelled future horizon years except for the Black Hill interchange. The northbound Black Hill interchange diverge is impacted by the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection as queueing at the southern approach to this intersection extends to the northbound Weakleys Drive diverge point. Traffic demand for the entry ramp to the southbound diverge exceeds the ramp's capacity resulting in a LoS F
- Two sensitivity modelling scenarios carried out for the Emerging Black Hill Precinct resulted in satisfactory performance for the southbound Black Hill interchange merge and other substantial improvements to the traffic outcomes. Road upgrades would need to be considered including additional access points to the Emerging Black Hill Precinct
- The project would either maintain or improve outcomes for the wider transport network including cycling, public transport, freight, rail and maritime traffic. It would also provide an opportunity to integrate the project design with future planned cycling and shared user path routes.

The key outcomes of the traffic cumulative impact assessment are that:

- The Emerging Black Hill Precinct was found to most substantially impact the project due to its overlapping construction timeline and high trip generation rate. The Emerging Black Hill Precinct would negatively impact the performance of the road network
- Potential impacts from the Hexham Straight project may arise due to the overlapping construction timeframes with the project. This would result in additional impact on traffic and road access within and surrounding the study area. The lower Hunter Freight corridor and Richmond Vale Rail Trail to Shortland are both in planning but have been considered in the design of the project. These projects would have minimal impact on the project.

The following key management measures have been developed to specifically manage potential construction impacts from the project:

- A Traffic Management Plan will be prepared and implemented with haulage vehicle movements will be planned to minimise movements on the road network

- Property, pedestrian and cycling access will be maintained at all times. Any changes to access arrangements or alternative access that are necessary during construction will be done in consultation with the landowner
- The construction contractor will liaise with Transport, council (where relevant), emergency services and public transport authorities regarding any road closures, diversions or reconfigurations of the road and cycle network during construction. A road dilapidation report will be prepared before impacts on local roads commence.

Once operational, the project is expected to improve the performance of the road network, resulting in improved traffic performance outcomes across both peak periods in future years. The project would deliver improved safety across the network, improve network connectivity and is compatible with existing and planned future projects. With the implementation of recommended environmental management measures, no adverse residual impacts are anticipated during construction. These outcomes are consistent with the desired performance outcome for traffic and transport aspect of the project.

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Terms and acronyms

Term/ Acronym	Description
ARTC	Australian Rail Track Corporation
AADT	Average Annual Daily Traffic
EIS	environmental impact statement
LoS	Level of Service
LGAs	local government areas
the project	M1 Pacific Motorway extension to Raymond Terrace
NLTN	National Land Transport Network
OSOM	Oversize overmass
ONS	Outer Newcastle Study
PCU	passenger car units
PTV	A traffic software development company that develops VISSIM
SEARs	Secretary's Environmental Assessment Requirements
STFM	Sydney Traffic Forecasting Mode
TMP	Traffic Management Plan
Transport	Transport for New South Wales
VKT	vehicle kilometres travelled

Appendix A

Traffic Model Calibration and Validation Report ONS-TA-100-REP-002

Outer Newcastle Study

Traffic Model Calibration and Validation Report Rev02

ONS-TA-100-REP-002

Prepared for: Roads and Maritime Services
Date: 9 June 2018

This report is confidential and is provided solely for the purposes of traffic modelling for the Outer Newcastle Study (ONS). This report is provided pursuant to a Consultancy Agreement between SMEC Australia Pty Limited ("SMEC") and Roads and Maritime Services under which SMEC undertook to perform a specific and limited task for Roads and Maritime Services. This report is strictly limited to the matters stated in it and subject to the various assumptions, qualifications and limitations in it and does not apply by implication to other matters. SMEC makes no representation that the scope, assumptions, qualifications and exclusions set out in this report will be suitable or sufficient for other purposes nor that the content of the report covers all matters which you may regard as material for your purposes.

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Appendices

Appendix A **RMS review comment**

Appendix B **Turn Counts**

Appendix C **Travel Time Results**

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1. Introduction

1.1. Overview

SMEC has been engaged by Roads and Maritime Services (Roads and Maritime) on the Outer Newcastle Study (ONS), which will inform the strategic design, economic analysis and prioritisation of future state road upgrades in the study area.

The ONS study area (see section 1.5) comprises nationally significant freight routes, which converge at several key intersections. These routes and intersections currently experience significant congestion, constrain freight productivity and illustrate a low level of reliability.

Roads and Maritime has previously undertaken planning for both the M1 Pacific Motorway to Raymond Terrace project (currently at 80% concept design), and also the previous the Preliminary Outer Newcastle Study.

Roads and Maritime has made available to SMEC all previous studies and traffic models relevant for this study. As part of the engagement, SMEC has expanded, recalibrated and validated the previous MWH VISSIM model, using 2017 survey data. This updated model will be used to inform the strategic design and economic analysis of various road and intersection upgrades proposed within the study area. This model will also be used for any required modelling in the later stages of concept and detailed design.

1.2. Purpose of this report

The purpose of this *Traffic Model Calibration and Validation Report* is to demonstrate that the AM and PM 2017 base year models are calibrated to an acceptable standard, as outlined in the Roads and Maritime *Traffic Modelling Guideline,* Version 1, February 2013.

This *Traffic Model Calibration and Validation Report* contains but it is not limited to the following information:

- Definition of the modelled study area
- Available recorded data used in the calibration and validation process
- Any assumptions made during model development, including the OD matrix estimation process
- Assessment of model stability
- Assessment of calibration criteria
- Assessment of model validity

1.3. Modelling objective

The *Traffic Model Calibration and Validation Report* is aimed at supporting the following project objectives.

- Transfer the original MWH model from VISSIM 8.0-13 to 10.6.
- Extension of the traffic models to include three additional signalised intersections, Old Maitland Rd/Pacific Hwy, Inner City Bypass/Pacific Hwy, and Wallsend Rd/Pacific Hwy.
- Update, calibrate and validate the traffic models using new 2017 survey data. This includes revisions of the original demand matrices produced by MWH.
- Application of detailed VISSIM microsimulation model to assess the performance of various projects' and project combinations.

- Inform the *Traffic and Transport Assessment Report*, which in turn informs the options designprocess, as well as providing inputs for the economic analysis of various projects and project combinations.

1.4. Scope of work

SMEC has developed a comprehensive approach to meet the modelling objectives of this study. It involves analysis of background information, traffic data analysis, development of a road based VISSIM traffic model, and application of the model to assess the future network performance of future upgrade scenarios. The overall traffic modelling process is shown graphically in Figure 1-1.

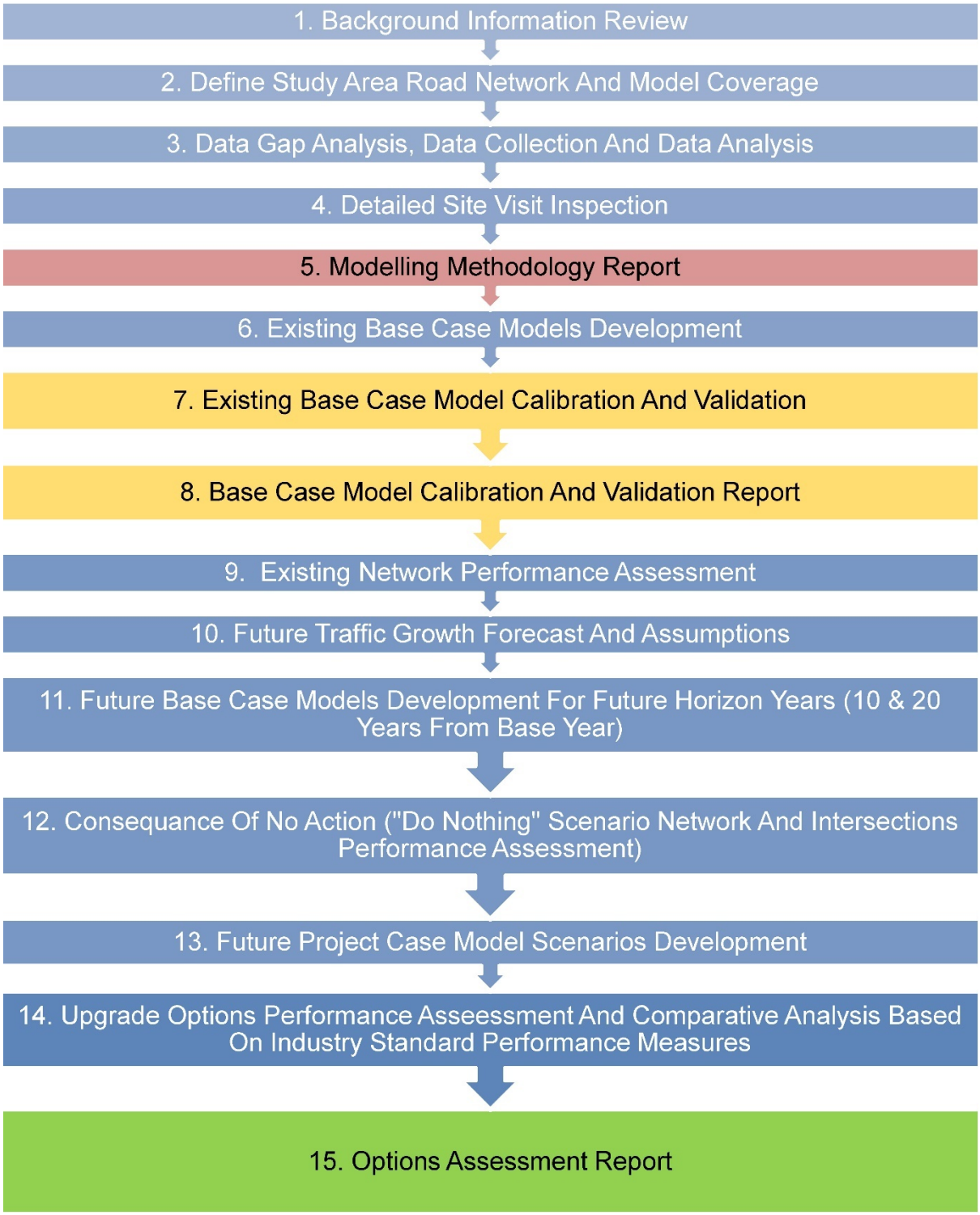


Figure 1-1 Project methodology

1.5. Study area

Figure 1-2 illustrates the VISSIM model network coverage, adopted for this project, as well as the locations of all intersections and roads included in the model.

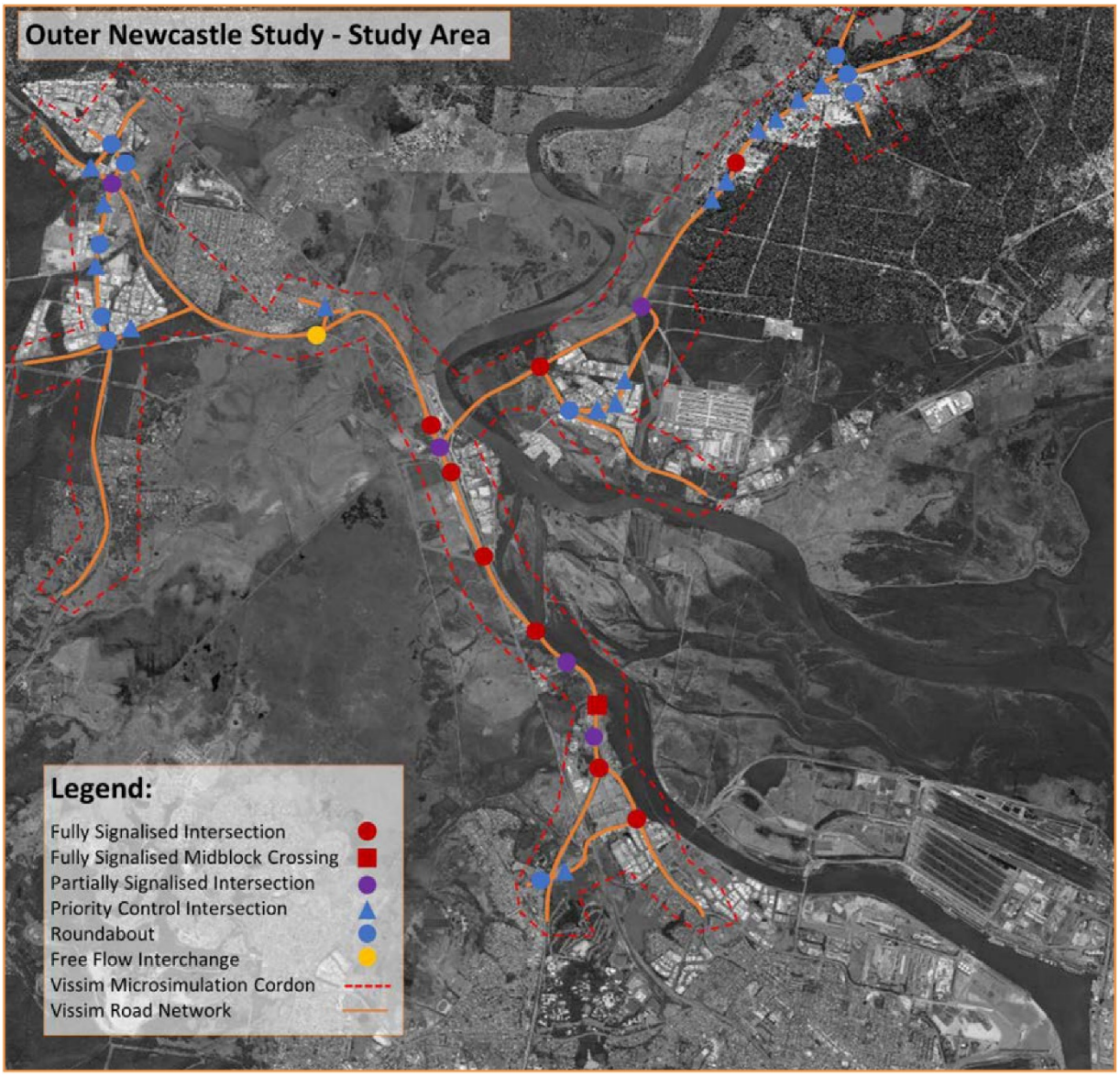


Figure 1-2 Study area

1.6. Report outline

In general, this report is structured with the following key sections

- Existing conditions
- Model assumptions
- Model stability
- Model calibration and validation
- Conclusion.

2. Existing conditions

2.1. Traffic surveys

There were six main sources of traffic data were used for this project. These include:

- Classified vehicle turn counts survey data performed on the 18/10/17.
- Classified vehicle midblock counts traffic survey data performed between 10/10/17 and 24/10/17.
- Queue length surveys performed on the 18/10/17.
- Travel time surveys performed on the 18/10/17 and 19/10/17.
- Origin-destination survey performed on the 7/11/17.
- SCATS detector volume, and phase timing data collected on the 18/10/17.

The traffic data was supported by the provision of signalised intersection plans provided by RMS, as well as the original VISSIM OD demand matrices developed by MWH.

Figure 2-1 and Table 2-1 below show the locations of traffic surveys.

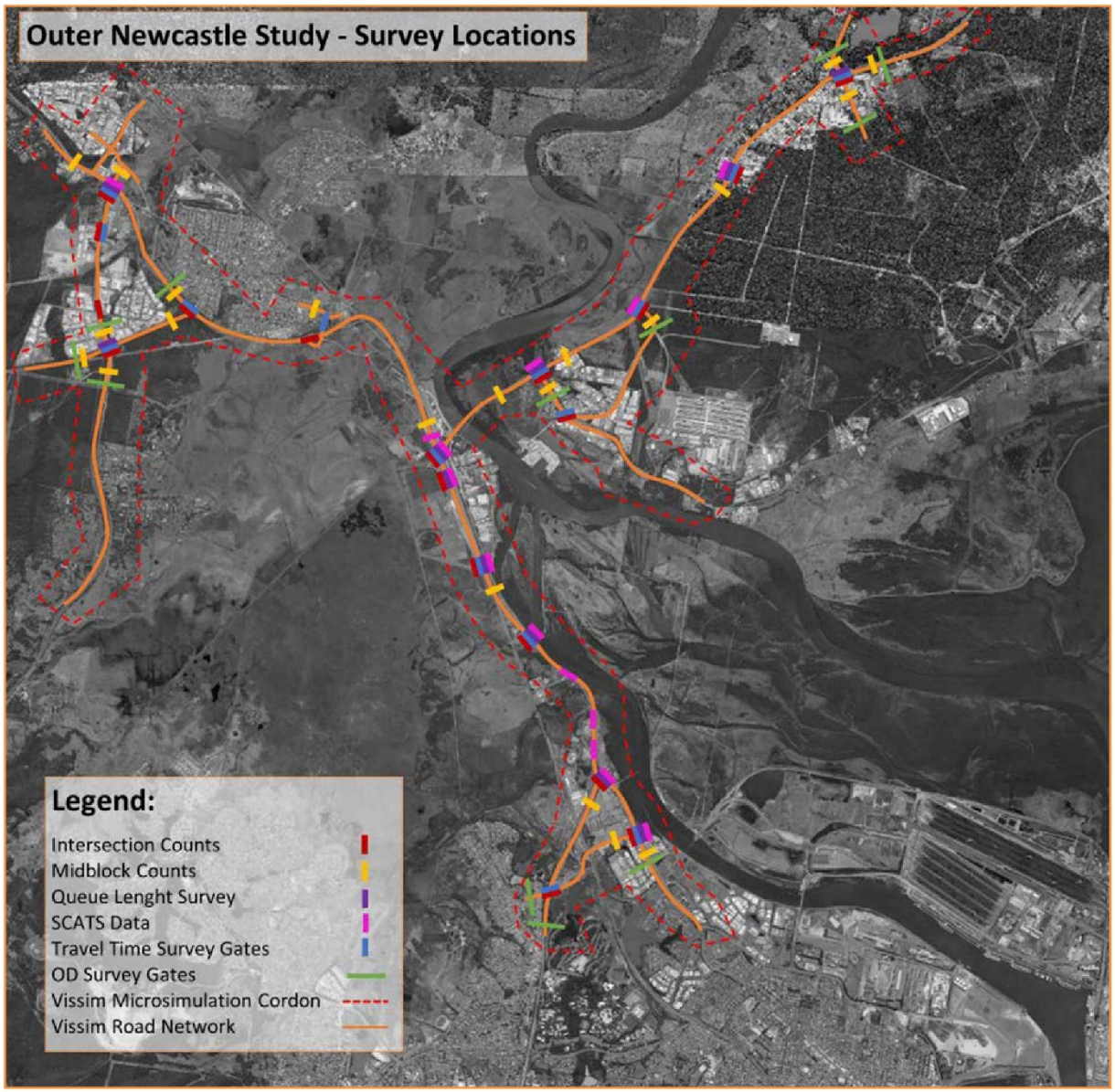


Figure 2-1 Traffic Survey Locations

Table 2-1 Traffic Survey Locations

Survey Type	ID	Location	Date
Classified Intersection Turning Volumes	1	John Renshaw Dr/ Weakleys Dr	18/10/2017
	2	Yangan Dr/ Weakleys Dr	
	3	Canavan Dr/ Weakleys Dr	
	4	New England Hwy/ Weakleys Dr	
	5	New England Hwy/ John Renshaw Dr	
	6	New England Hwy/ Anderson Dr	
	7	Pacific Hwy/ Maitland Rd	
	8	Pacific Hwy/ Tomago Rd	
	9	Old Punt Rd/ Tomago Rd	

Survey Type	ID	Location	Date
Travel Time Survey	10	Old Punt Rd/ Pacific Hwy	
	11	Hank St/ Pacific Hwy	
	12	Masonite Rd/ Pacific Hwy	
	13	Old Maitland Rd/ Maitland Rd (North End)	
	14	Old Maitland Rd/ Maitland Rd (South End)	
	15	Shamrock St/ Maitland Rd	
	16	Inner City Bypass/ Maitland Rd	
	17	Wallsend Rd/ Maitland Rd	
	1	New England Hwy/Weakleys Dr	
	2	Weakleys Dr/Canavan Dr	
	3	New England Hwy/John Renshaw Dr	
	4	Weakleys Dr/John Renshaw Dr	
	5	New England Hwy/Anderson Dr	
	6	Maitland Rd/Pacific Hwy	
	7	Pacific Hwy/Tomago Rd	
	8	Tomago Rd/Old Punt Rd	
	9	Maitland Rd/Old Maitland Rd (South)	
	10	Pacific Hwy/Old Punt Rd	
	11	Maitland Rd/Shamrock St	
	12	Pacific Hwy/Hank St	
	13	Pacific Hwy/Masonite Rd	
	14	Pacific Hwy/Inner City Bypass	
	15	Sandgate Rd/Wetlands Pl	
	16	Maitland Rd/Wallsend Rd	
Classified Midblock Speed andVolume Survey	1	M1, South of John Renshaw Dr.	10/10/17-24/10/17 24hr
	2	John Renhaw Dr, West of Weakleys Dr.	10/10/17-24/10/17 24hr
	3	Weakleys Dr, North of John Renshaw Dr.	10/10/17-24/10/17 24hr
	4	New England Hwy, West of Thornton Rd.	11/10/17 - 23/10/17 24hr
	5	Weakleys Dr, North of New England Hwy.	10/10/17 - 23/10/17 24hr
	6	New England Hwy, West of John Renshaw Dr.	10/10/17 - 23/10/17 24hr
	7	John Renshaw Dr, West of New England Hwy.	11/10/17 - 23/10/17 24hr
	8	Anderson Dr, West of New England Hwy.	11/10/17 - 23/10/17 24hr
	9	New England Hwy, North of Pacific Hwy.	11/10/17 - 24/10/17 24hr

Survey Type	ID	Location	Date
Classified Midblock Speed and Volume Survey (cont.)	10	Pacific Hwy, 1km North of the Hunter River Bridge	11/10/17 - 23/10/17 24hr
	11	Tomago Rd, East of Pacific Hwy.	12/10/17 - 22/10/17 24hr
	12	Pacific Hwy, North of Tomago Rd.	11/10/17 - 23/10/17 24hr
	13	Old Punt Rd, South of Pacific Hwy.	10/10/17 - 22/10/17 24hr
	14	Pacific Hwy, South of Hank St.	11/10/17 - 23/10/17 24hr
	15	Adelaide St, West of Pacific Hwy.	10/10/17 - 23/10/17 24hr
	16	Masonite Rd, East of Pacific Hwy.	10/10/17 - 23/10/17 24hr
	17	Pacific Hwy, North of Masonite Rd.	11/10/17 - 23/10/17 24hr
	18	Maitland Rd, South of Old Maitland Rd (Hexham)	11/10/17 - 23/10/17 24hr
	19	Newcastle Inner City Bypass, South of Maitland Rd.	12/10/17 - 22/10/17 24hr
	20	Sandgate Rd, South of Maitland Rd.	10/10/17 - 22/10/17 24hr
	21	Maitland Rd, South of Sandgate Rd.	11/10/17 - 22/10/17 24hr
Queue Length Survey	1	John Renshaw Dr/ Weakleys Dr	18/10/2017
	4	New England Hwy/ Weakleys Dr	
	7	Pacific Hwy/ Maitland Rd	
	8	Pacific Hwy/ Tomago Rd	
	11	Hank St/ Pacific Hwy	
	12	Masonite Rd/ Pacific Hwy	
	13	Old Maitland Rd/ Maitland Rd (North End)	
	14	Old Maitland Rd/ Maitland Rd (South End)	
	15	Shamrock St/ Maitland Rd	
	16	Inner City Bypass/ Maitland Rd	
	17	Wallsend Rd/ Maitland Rd	
OD Survey Gates	1	M1 Pacific Mwy, south of Lenaghans Dr, Black Hill	7/11/2017
	2	John Renshaw Dr, west of M1 Mwy, Black Hill	
	3	Weakleys Dr, north of John Renshaw Dr, Beresfield	
	4	New England Hwy, west of John Renshaw Dr, Tarro	
	5	Adelaide St, west of Pacific Hwy, Heatherbrae	
	6	Pacific Hwy, north of Masonite Rd, Raymond Terrace	
	7	Masonite Rd, east of Pacific Hwy, Heatherbrae	
	8	Old Punt Rd, east of Pacific Hwy, Tomago	
	9	Tomago Rd, east of Pacific Hwy, Tomago	
	10	Maitland Rd, east of Wallsend Rd, Shortland	

Survey Type	ID	Location	Date
OD Survey Gates (cont.)	11	Newcastle Inner City Bypass, south of Shortland Interchange	
	12	Sandgate Rd, south of Inner City Bypass	

2.2. SCATS Traffic Signal data

SMEC received SCATS traffic signal data to assist in the development of the VISSIM traffic models. These included:

- Signal Historical Operation Data - 18/10/17
- Recorded Detector Volumes - 18/10/17
- Site Specific notes detailing operational anomalies
- TCS Plans

SCATS data has been made available for the following sites:

Table 2-2 Available SCATS Data

TCS ID	Intersection
TCS: 3289	New England Hwy/ Weakleys Dr
TCS: 722	Pacific Hwy/ Maitland Rd
TCS: 2557	Oak Resturant/New England Hwy
TCS: 4063	Pacific Hwy/ Tomago Rd
TCS: 4064	Old Punt Rd/ Pacific Hwy
TCS: 4328	Hank St/ Pacific Hwy
TCS: 4332	Old Maitland Rd/ Maitland Rd (North End)
TCS: 4018	Old Maitland Rd/ Maitland Rd (South End)
TCS: 3470	Shamrock St/ Maitland Rd
TCS: 4393	Inner City Bypass/ Maitland Rd
TCS: 876	Wallsend Rd/ Maitland Rd
TCS: 3946	Maitland Rd/ Sparke St
TCS: 4019	Maitland Rd & U turn bay
TCS: 4080	Maitland Rd & Old Maitland Rd West

3. Model assumptions

3.1. Modelling platform

VISSIM Version 10.00-06 was used for the model development. As requested by Roads and Maritime, VISVAP was also applied for traffic signal coding.

3.2. Time period

The base case model represents existing 2017 traffic conditions for:

- Three hours in the morning (AM) peak period between 6:00 am and 9:00 am for an averageweekday condition
- Three hours in the afternoon (PM) peak period between 3:00 pm and 6:00 pm for an averageweekday condition

As recommended by the modelling guidelines, each model was also built with a 45-minute warm-up period to ensure a good representation of traffic conditions at the beginning of the modelling period. In addition, a 30-minute cool down period was also included to replicate the reduced traffic demand after the peak period.

3.3. Assignment type

Vehicle Dynamic assignment has been used in the model.

3.4. Vehicle types

The demand matrices were estimated separately for each modelled hour and for the following vehicle types:

- Cars/ Light vehicles
- Heavy vehicles.

3.5. Traffic zones/input

The model has been coded with 47 zones, as shown in the below in Figure 3-1.

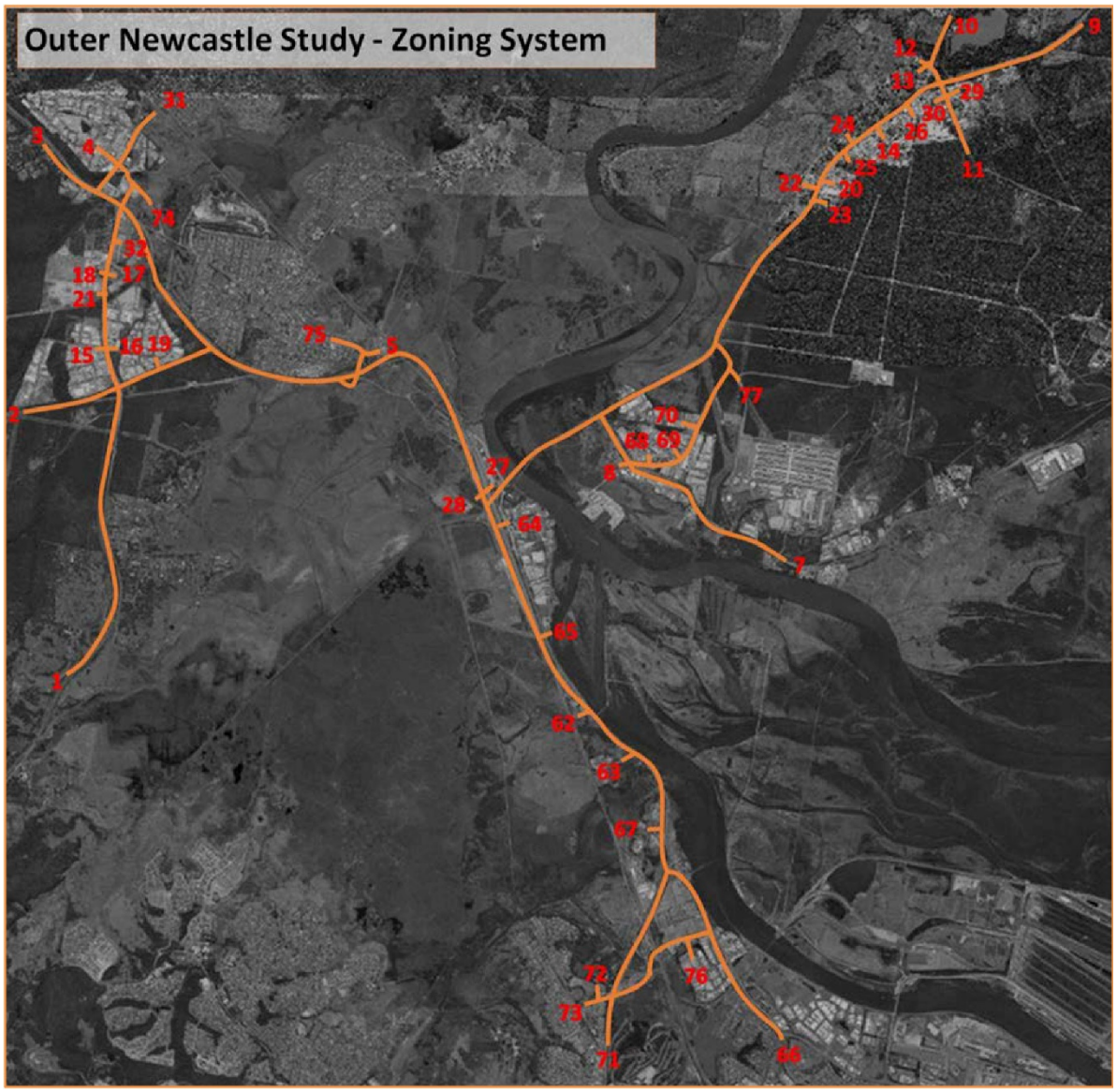


Figure 3-1 Zone layout

3.6. Speed profiles

Speed profiles have been coded as per the received MWH model. Further review of speed limits have been also completed to match them to the posted speed limits.

3.7. School zones

A School Zone has been identified on the southern end of Anderson Dr, outside Tarro Public School. This school zone is operational between 8:00-9:30am and 2:30-4:00pm, and has been included in the model. The exact location is shown in Figure 3-2.

Figure 3-2 School zones

3.8. Traffic signals

As part of the modelling process, SMEC completed signals coding with actuation algorithm using VISVAP. The coded traffic signals run on a fixed cycle time with demand actuated phase timing. These parameters were calibrated against signal data as well as site specific notes, provided by the RMS.

Fixed offset times, updating every hour as the cycle time changes, are used to achieve coordination between signals where necessary. Based on the received SCATS setting and site specific notes, offsets are in place between:

- Maitland Rd & Old Maitland Rd West (TCS 4080)
- New England Highway & Pacific Highway (TCS 722)
- New England Highway & Oak Access (TCS 2557)

Information provided also states that Maitland Rd & Shamrock St (TCS 3470) and Maitland Rd & Old Maitland Rd East (TCS 4332) are coordinated off peak, however during the peak hours they are divorced to take into account the long and unmatched cycle times.

3.9. Public transport

Existing bus routes and bus frequencies were included in the model based on the available public transport information sourced from *http://www.transportnsw.info/.* Figure 3-3 shows the public transport network identified within the study area.

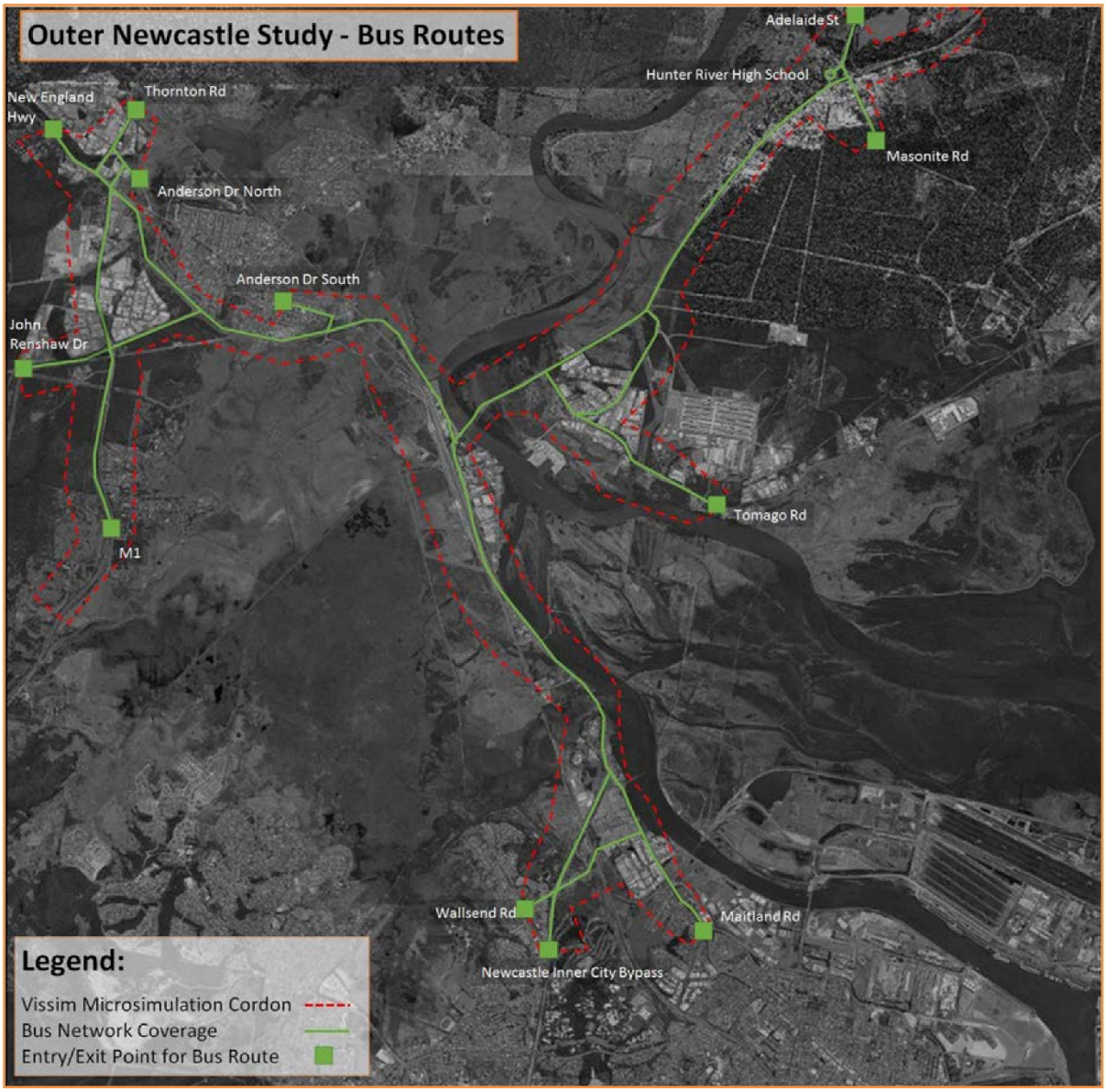


Figure 3-3 Bus Network Coverage within Study Area

Table 3-1 summarises bus services identified within the study area, the routes that they traverse, as well as the total number of services entering the model within the 3-hour peak periods. A total of 64 services operate within the area, travelling along 27 unique routes.

Table 3-1 Bus frequencies and routes

Route Description.	Route #	3hr Volume			
		AM		PM	
		NB/WB	SB/EB	NB/WB	SB/EB
Between Maitland Rd & Adelaide St via Tomago Rd	140	6	0	0	6
	1292				
Between Wallsend Rd & Maitland Rd	47	3	4	4	3
	739				
	6277				
	6242				
Between Maitland Rd & Adelaide St	1304	0	9	8	0
	1272				
	1323				
	140				
	1291				
	1311				
	1481				
Between Maitland Rd & Anderson Dr South	1223	0	3	1	0
	2371				
	1501				
	2381				
Between Maitland Rd & Thornton Rd Via New England Hwy and Weakleys Dr	2373	0	0	1	0
Between Wallsend Rd & Anderson Dr South	2522	0	1	1	0
	2471				
Between Wallsend Rd & Adelaide St	1492	0	0	1	0
Between Newcastle Inner City Bypass & Anderson Dr South	2821	1	0	0	0
Between Newcastle Inner City Bypass & Adelaide St	1221	1	1	0	0
Between Newcastle Inner City Bypass & John Renshaw Dr	160	1	1	0	0
Between Masonite Rd & Adelaide St	135	5	1	0	2
	1321				
	1231				
	135				
	1211				
	1342				
	1314				
Adelaide St Loop via Hunter River High School	1271	0	4	0	1
	0072				
	1201				
	1381				
	1631				
Between Adelaide St & Anderson Dr South	1261	0	1	0	0
Between Adelaide St & Tomago Rd South via Old Punt Rd	1262	0	0	0	1
Between Anderson Dr North & New England Hwy via Weakleys Dr	181	0	9	0	8
	145				
	2402				
	1261				
	1223				
	1501				
	2381				
	2223				

Route Description.	Route #	3hr Volume			
		AM		PM	
		NB/WB	SB/EB	NB/WB	SB/EB
Between Anderson Dr North & Thornton Rd	2202	1	0	3	0
	2622				
	2522				
	1378				
Between Anderson Dr North & M1 via Weakleys Dr	2652	0	0	0	1
Between John Renshaw Dr & Anderson Dr North via Weakleys Dr	2392	1	0	0	0
Between M1 & New England Hwy via John Renshaw Dr	1511	1	0	0	0
Between M1 & Anderson Dr South	2611	0	2	0	1
	1151				
	1378				
Between New England Hwy & Anderson Dr North via Thornton Rd	145	5	0	6	0
	181				
Between New England Hwy & Thornton Rd	182	2	0	3	0
Between New England Hwy & Maitland Rd	2611	0	1	0	0
Between New England Hwy & M1 via Weakleys Dr	1513	0	0	0	2
	6635				
Between New England Hwy & Adelaide St	1294	0	0	0	1
Between New England Hwy & Thornton Rd via Weakleys Dr	182	0	5	0	6
	2601				
	1441				
	1293				
	2416				
	2514				
Between Thornton Rd & Anderson Dr North	2371	0	10	0	1
	2201				
	2511				
	2471				
	2281				
	2551				
	2401				
	1151				
	2622				
	2372				
	2634				

3.10. Trip Table Matrix Estimation

To develop the trip matrix, the original matrices from the MWH model were furnessed against the counts taken as part of the 2017 traffic surveys. The matrices were then further refined as part of the calibration process.

3.11. Pedestrians and cyclists

Based on provided SCATS phasing data, pedestrian specific phases are rarely called within the AM and PM peaks. It was deemed that pedestrian traffic would have little impact on signal operation, and hence pedestrians have been omitted from this model to aid simplicity, and reduce variability in results.

3.12. Traffic profile

Traffic profiles were developed for the outbound volumes across both the AM and PM peak periods, for each zone, reflecting the volumes observed in the traffic counts the 2017 survey data. Profiles for the overall study area have been divided into three sectors (see Figure 3-4) and are shown in Figure 3-5 AM traffic profile and Figure 3-6 PM traffic profile.

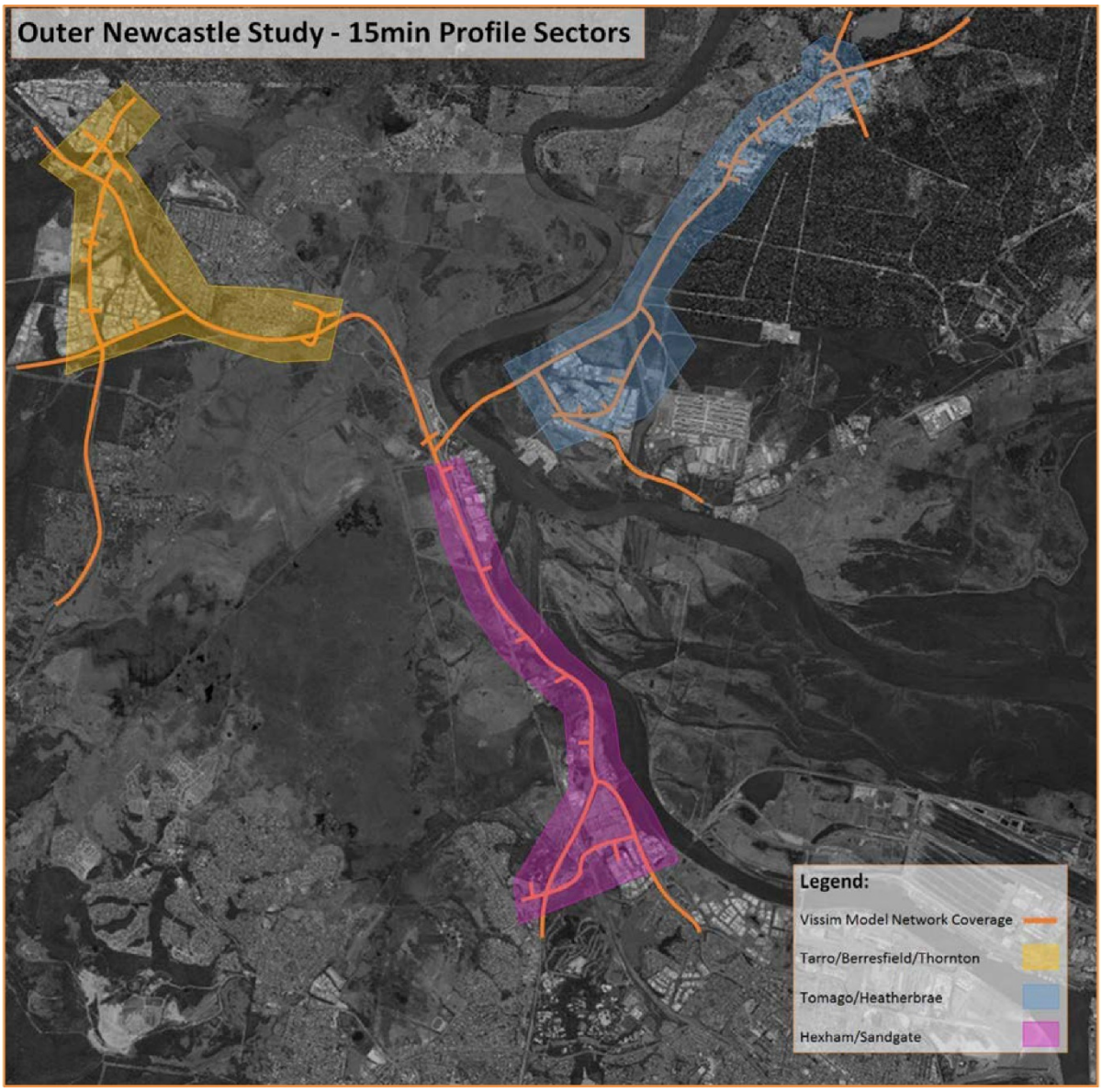


Figure 3-4. Traffic profile sectors

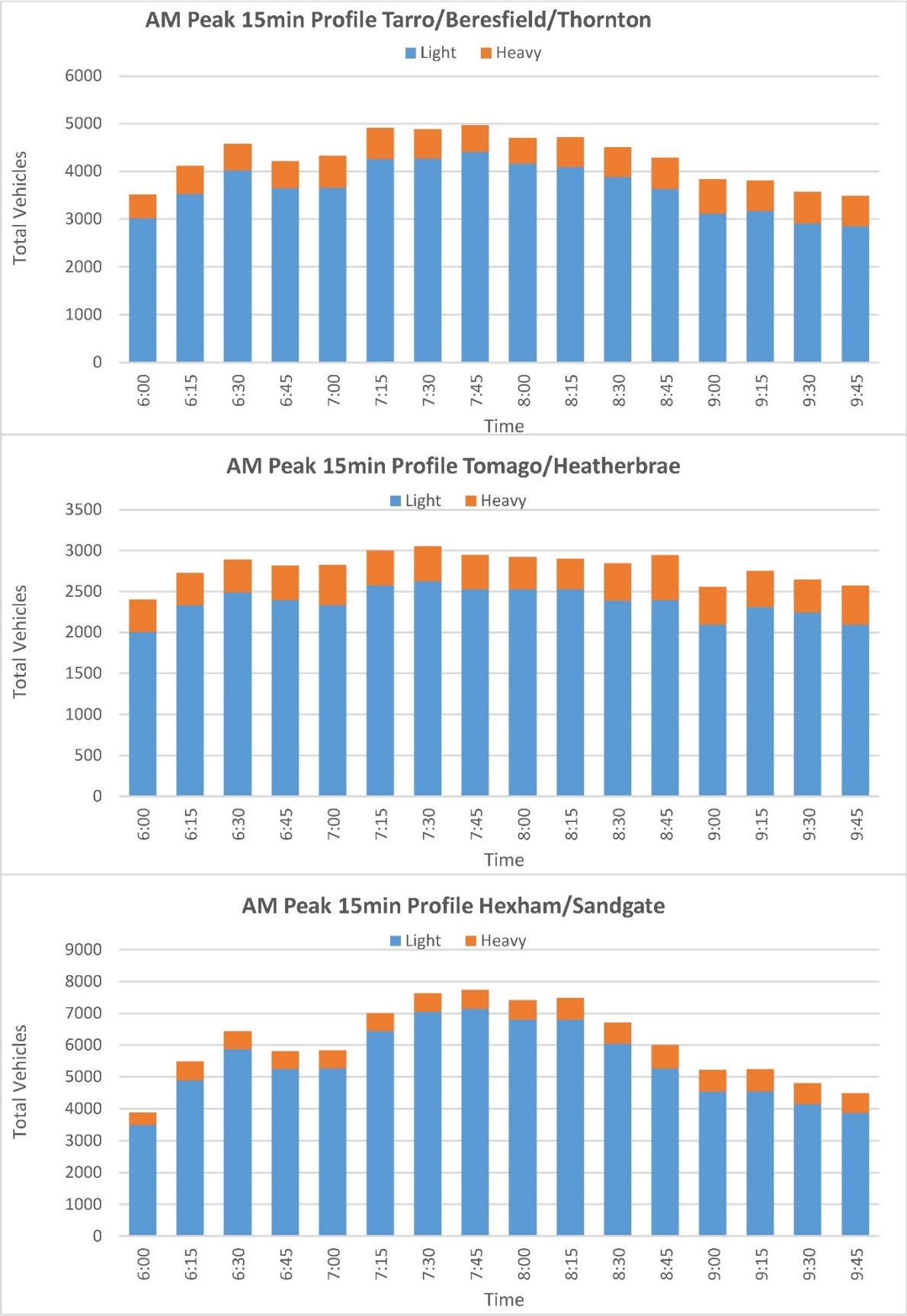
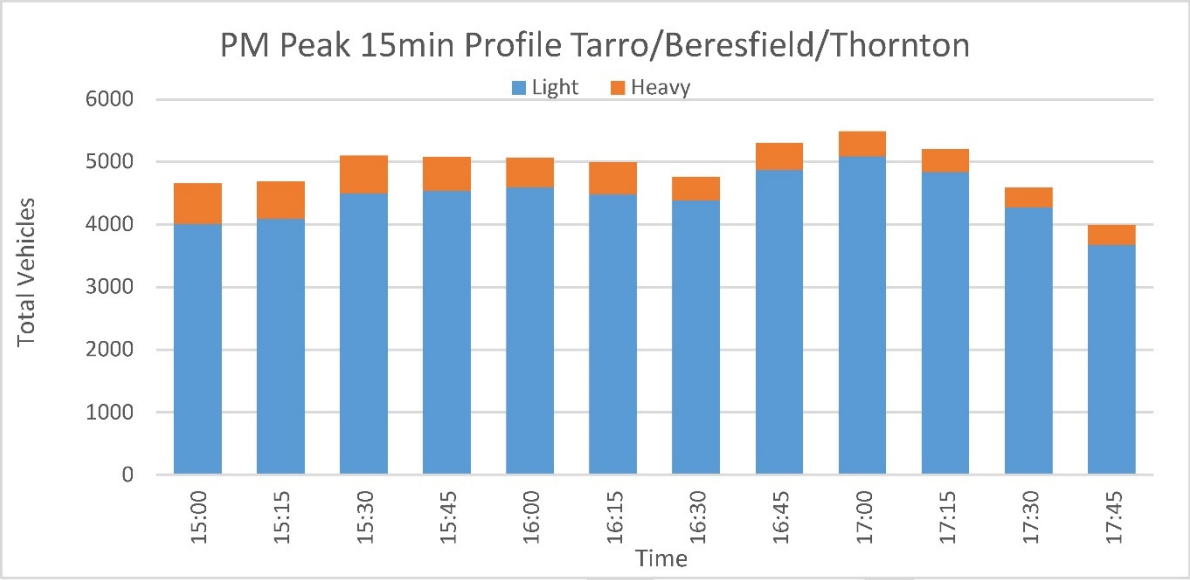
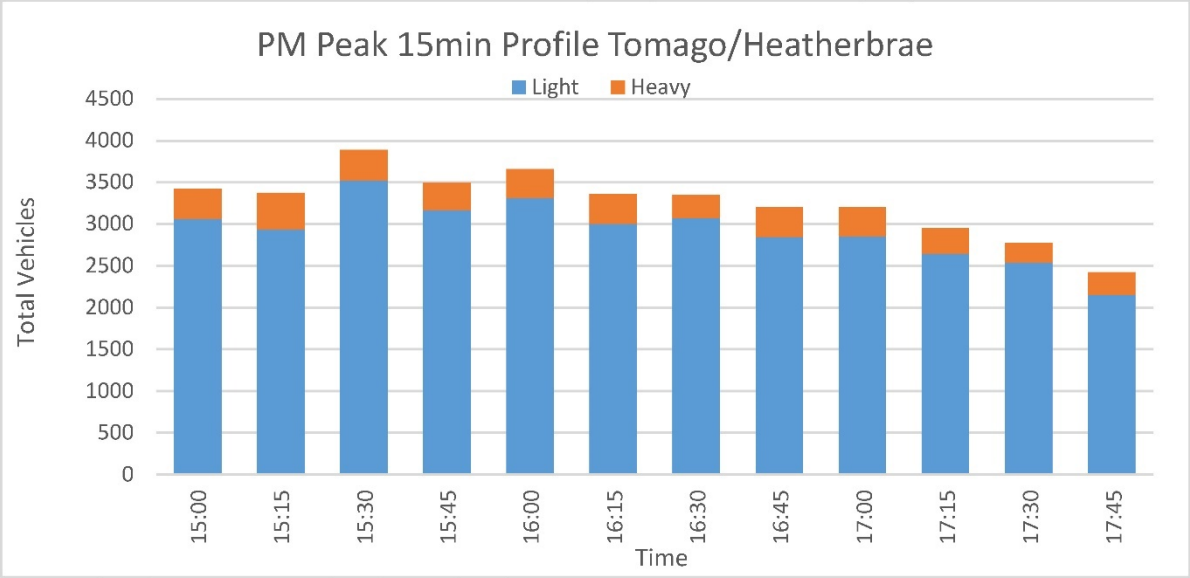


Figure 3-5 AM traffic profile





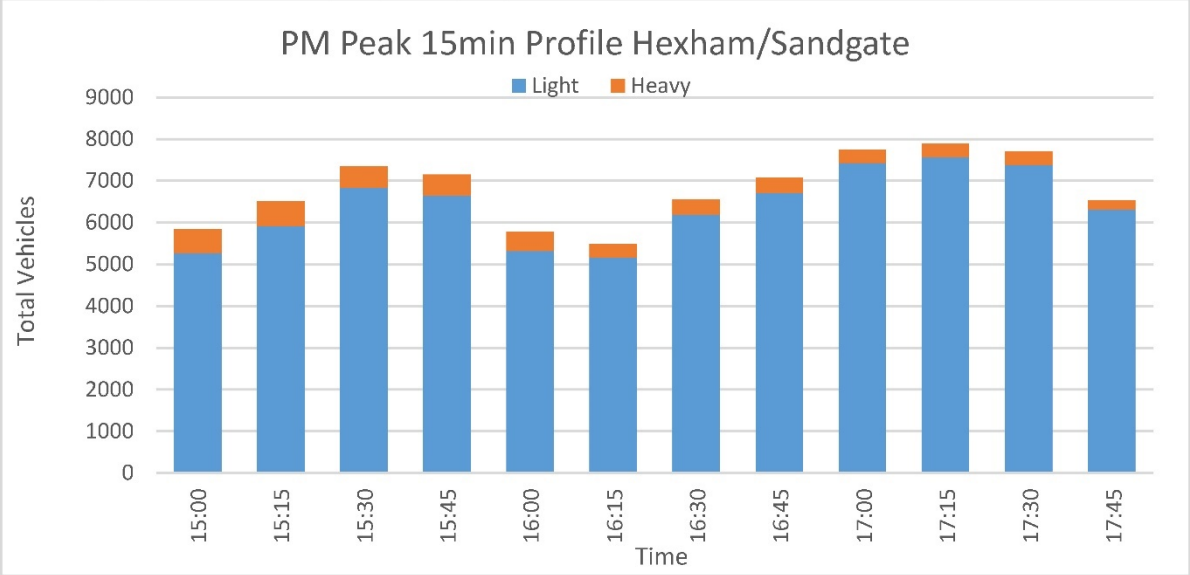


Figure 3-6 PM traffic profile

3.13. Behaviour parameters

In general, and in order to calibrate the traffic model network for the observed traffic conditions, default VISSIM criteria were applied, however where necessary, defaults values were adjusted to reflect the observed area specific behaviours. Such values include:

- *Next lanes:* Forcing vehicles into the correct lanes and avoiding the attractive but incorrect lanes, which the vehicles should not move into
- *Emergency Stop distance* and *Lane Change distance:* Adjusting visibility distance to improvelane change behaviour and reduce unrealistic congestion
- *Zone Release Speed:* this value is mainly adjusted to ensure vehicles commence their trip at the posted speed limit and at the expected travel speed
- *Additive* and *Multiplic part of safety distance:*
- reaction times and headways to adjust the capacity of links in the models and reflect observed driver behaviour
- *Waiting time before diffusion:* waiting time before diffusion was increased to 150 seconds inorder to match the max cycle times
- *Min. Headway* and *Min. Gap Time*: these values allow vehicles to judge whether there is asufficient gap at priority intersections
- *Cooperative lane change:* Adjusts whether or not vehicles will brake to allow other vehiclesto enter into their lane.

4. Model stability

Similar to other main stream microsimulation packages, VISSIM micro-simulation models use random number sequences to produce a small level of variability within each simulation to reflect the range of behaviours that are exhibited in the real world.

The VISSIM software package allows the modeller to provide an initial seed value for each model run. The seed value affects the generation of the random numbers that influence the model operation and variability. Therefore, each time the model runs with a different seed value some slightly different set of outputs is generated. It is generally expected that these outputs would be very similar, but not identical, and it is an analysis of the variability between these results that indicates the stability of the model.

According to the Roads and Maritime modelling guidelines, there are a number of ways in which the stability of a model across a number of seed runs can be demonstrated. Roads and Maritime suggests that at least one of the following techniques to be graphically presented within the basemodel reporting:

- Total kilometres in network or Vehicle Kilometre Travel (VKT) results
- Total travel time in network or Vehicle Hour Travel (VHT) results.

In order to analyse the model stability for each peak period models, SMEC assessed model stability across five seed values. The results from different seed values were produced for number of vehicles in the network for regular intervals throughout the simulation.

Figure 4-1 and Figure 4-2 show the AM and PM peak variation in VKT and VHT values in the network with five different seeds[1]. The model was run for five 'seed' values as per the modelling guidelines. The five seeds values were 560, 28, 7771, 86524, and 2849.

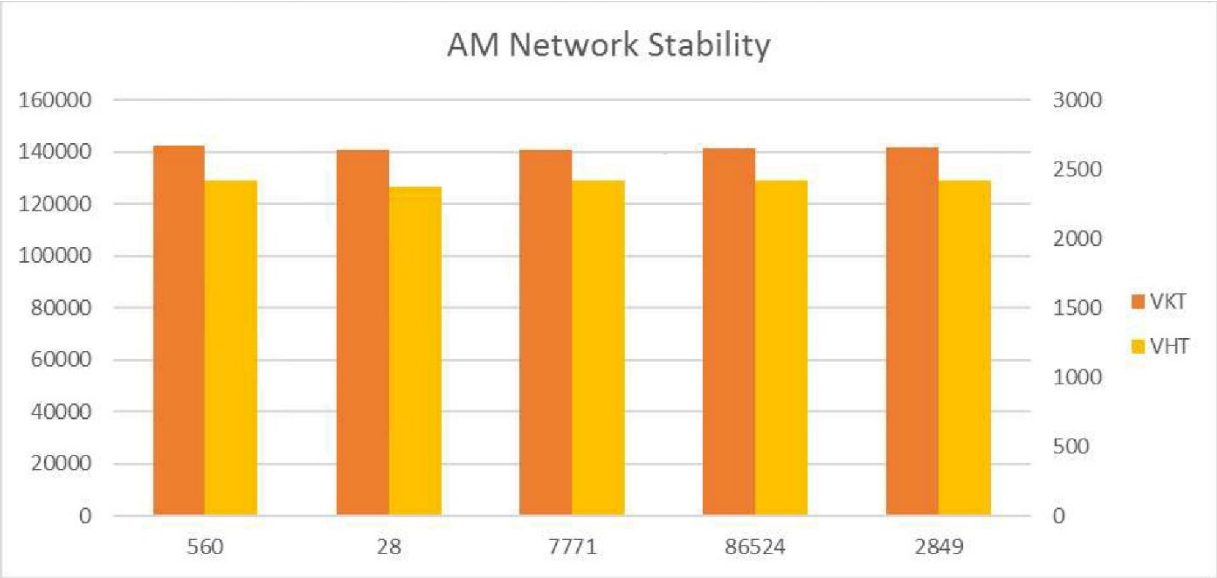


Figure 4-1 AM Network Stability

[1] Seed value specifies the value used by the random number generator. Identical networks simulated using the same processor will return the same results using the same seed value.

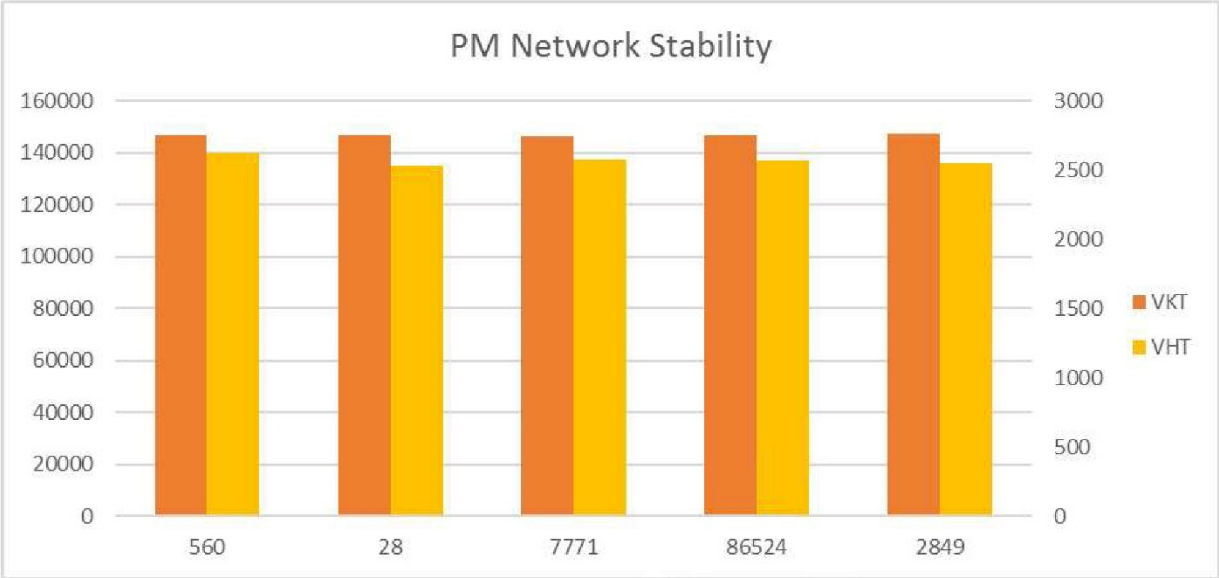


Figure 4-2 PM Network Stability

5. Model calibration and validation

5.1. Traffic Models Calibration

5.1.1 Overview

Model calibration involves matching observed traffic volumes with the modelled traffic flows to ensure that the base model is representative of the existing traffic conditions.

Throughout this project, model calibration criteria given in the Roads and Maritime *Traffic Modelling Guideline,* Version 1, February 2013, were used for the base case model calibration and validation purpose.

To further ensure the models are a good fit for the network, the base models were audited by the RMS with comments received on 28 May 2018. A list of comments and responses are provided in Appendix A.

5.1.2 Network calibration

The traffic models were calibrated to the observed vehicle movements and behaviours within the traffic network. During network calibration process, the Vissim default time step value of ten was adopted.

In general, to calibrate the traffic model network for the observed traffic conditions, default VISSIM criteria were applied, however where necessary, defaults values were adjusted to reflect the observed area specific behaviours.

5.1.3 Calibration criteria

Model calibration criteria given in the Roads and Maritime *Traffic Modelling Guideline, Version 1, and February 2013* were used for the base case model calibration and validation purpose.

Considering the nature and the size of the project and the agreed model network coverage included in the micro-simulation model, the entire model was treated under Core area calibration targets which tends to more conservative targets to meet.

Road and Maritime's calibration criteria for this project is shown below in Table 5-1.

Table 5-1 Calibration criteria (standard-network wide)

Network Criteria	Target
Link and turn volumes: GEH < 5	≥85%
Link and turn volumes: 5 < GEH < 10	≤15%
Link and turn volumes: GEH ≥ 10	0%
Link and turn volumes: R^2	>0.95
Core Criteria	**Target**
Flows less than 100 vehicle per hour	to be within 10 vehicles of observed value
Flows between 100 and 1000 vehicle per hour	to be within 10 per cent of observed value
Flows between 1000 and 2000 vehicle per hour	to be within 100 vehicles of observed value
Flows larger than 2000 vehiles per hour	to be within 5 per cent of observed value

Source: RMS Modelling guideline 2013

5.1.4 Core area definition

It was agreed with the RMS that the following intersections were considered part of the core area:

- Maitland Road/Pacific Highway
- Pacific Highway/John Renshaw Drive/Weakleys Drive
- New England Highway/Weakleys Drive
- Pacific Highway/Tomago Road
- Pacific Highway/Masonite Road.

5.1.5 Intersection turn flow calibration results

Table 5-2 AM Peak Calibration results (median seed 2849)**Error! Reference source not found.**and Table 5-3 PM Peak Calibration results (median seed 28) summarise network wide model calibration results for each modelled hour for the median seed in AM and PM peak periods respectively.

Table 5-2 AM Peak Calibration results (median seed 2849)

GEH value/criteria	Target	Achieved AM peak (6:00am-7:00am)		Achieved AM peak (7:00am-8:00am)		Achieved AM peak (8:00am-9:00am)	
		Number of turns	(%)	Number of turns	(%)	Number of turns	(%)
GEH < 5	≥ 15%	133	100%	133	100%	133	100%
5 ≤ GEH ≤ 10	< 15%	0	0%	0	0%	0	0%
GEH > 10	0%	0	0%	0	0%	0	0%
R^2	>0.95	1.00		1.00		1.00	
Flows < 99	to be within 10 vehicles	16	100%	15	100%	16	100%
99 ≤ Flows <1000	to be within 10 per cent	26	100%	28	100%	28	100%
1000 ≤ Flows <2000	to be within 100 vehicles	6	100%	4	100%	4	100%
Flows >2000	to be within 5per cent	0	100%	1	100%	0	100%

Table 5-3 PM Peak Calibration results (median seed 28)

GEH value/criteria	Target	Achieved AM peak (6:00am-7:00am)		Achieved AM peak (7:00am-8:00am)		Achieved AM peak (8:00am-9:00am)	
		Number of turns	(%)	Number of turns	(%)	Number of turns	(%)
GEH < 5	≥ 85%	133	96%	132	99%	131	99%
5 ≤ GEH ≤ 10	< 15%	4	4%	1	1%	1	1%
GEH > 10	0%	0	0%		0%	0	0%
R^2	>0.95	1.00		1.00		1.00	
Flows < 99	to be within 10 vehicles	13	100%	14	100%	16	100%
99 ≤ Flows <1000	to be within 10 per cent	29	100%	28	100%	27	100%
1000 ≤ Flows <2000	to be within 100 vehicles	6	100%	6	100%	4	100%
Flows >2000	to be within 5per cent	0	100%	0	100%	1	100%

Detailed model calibration results for AM and PM Peak are reported in **Appendix B**.

5.1.6 R^2 plots (observed vs modelled intersection turn flows)

R^2 is a statistical measure which indicates how well a regression line approximates observed data points. R^2 is a descriptive measure between zero and one (zero for worst and 1 for the best match). R^2 plots are based on 50 turning movements (observed vs modelled) for each modelled hour in AM and PM peak period for the entire modelled road network.

Figure 5-1 to Figure 5-6 show the R^2 plots for each modelled hour in AM and PM peak period for the area network.

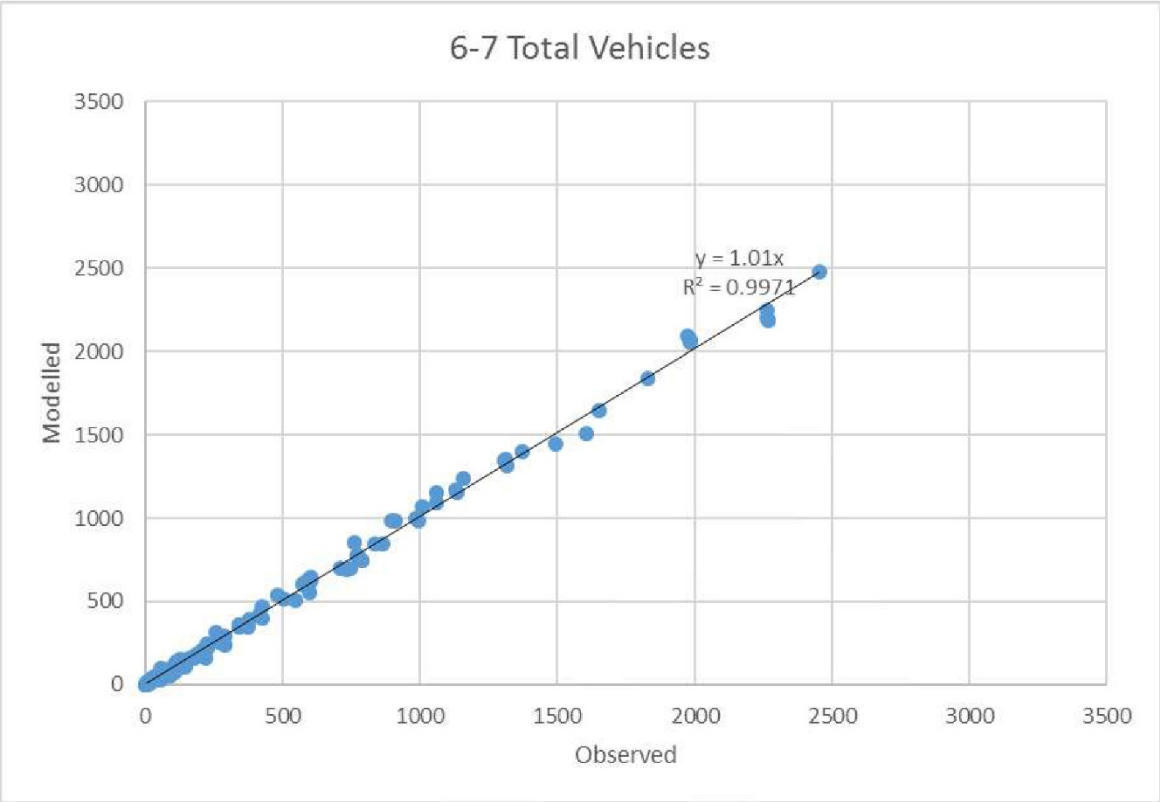


Figure 5-1 Turn Calibration 6-7 AM (median seed: 7771)

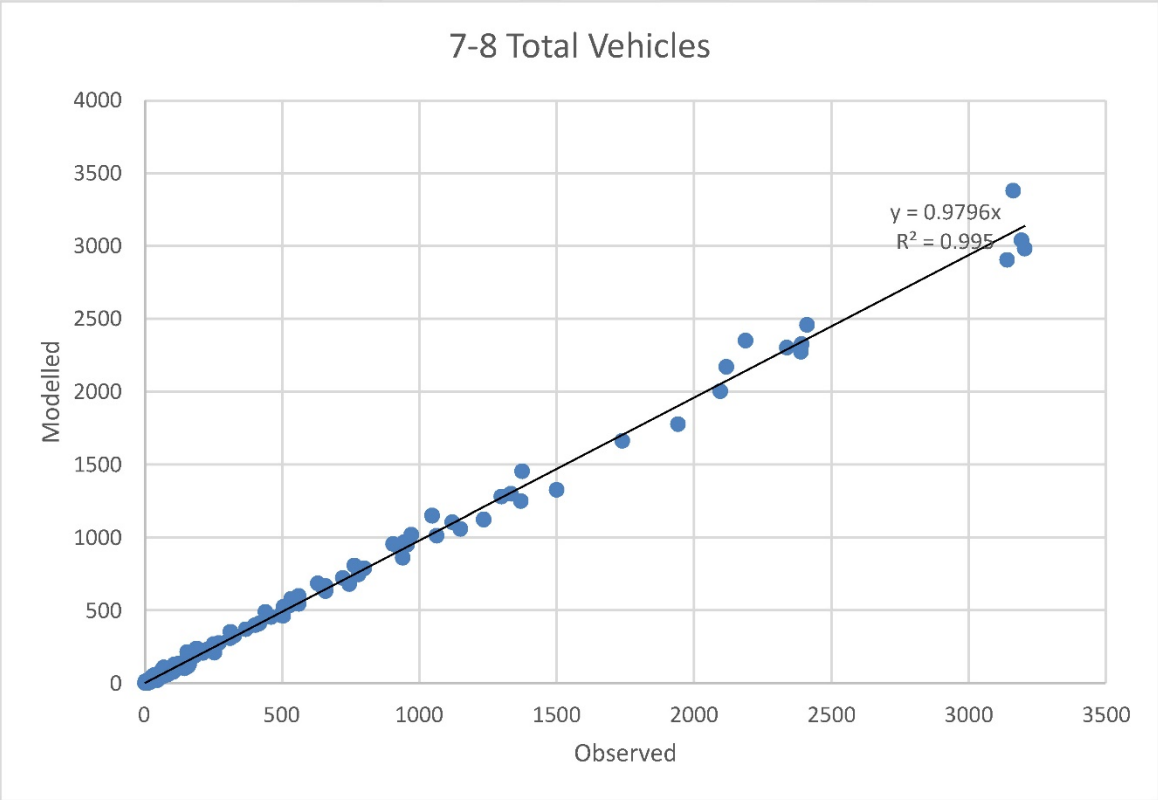


Figure 5-2 Turn Calibration 7-8 AM (median seed: 7771)

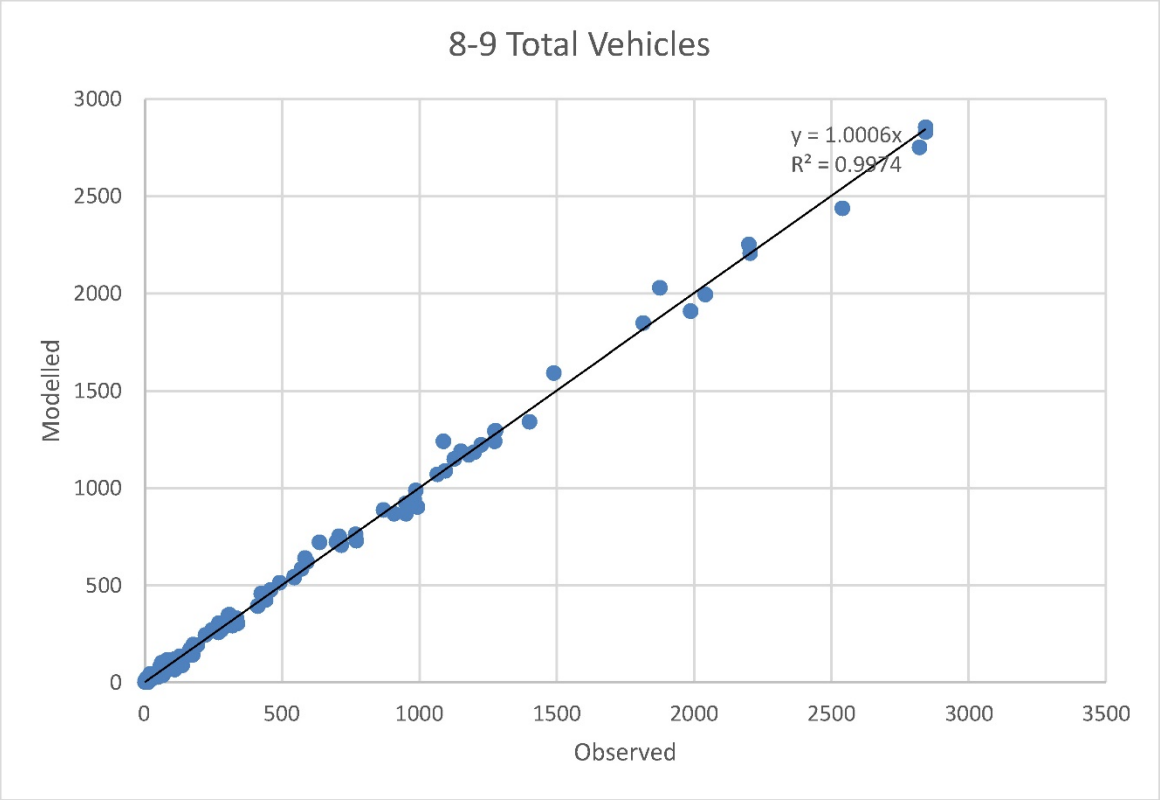


Figure 5-3 Turn Calibration 8-9 AM (median seed: 7771)

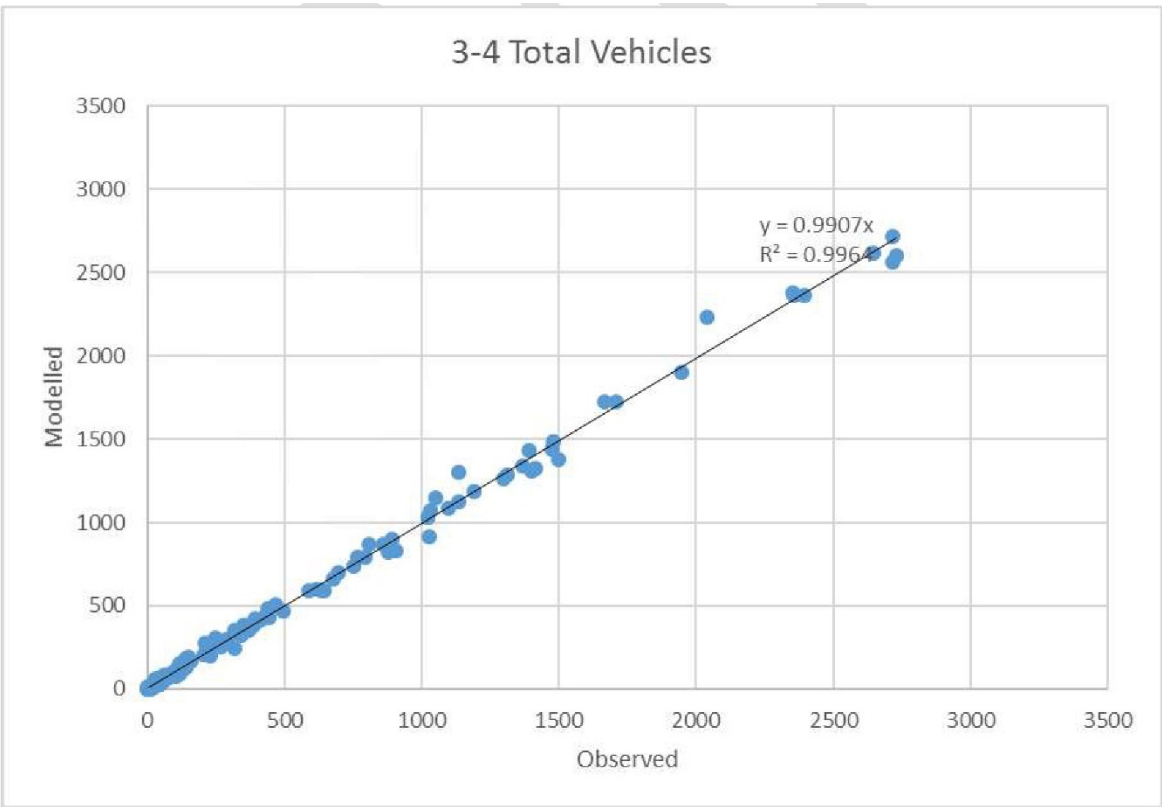


Figure 5-4 Turn Calibration 3-4 PM (median seed: 86524)

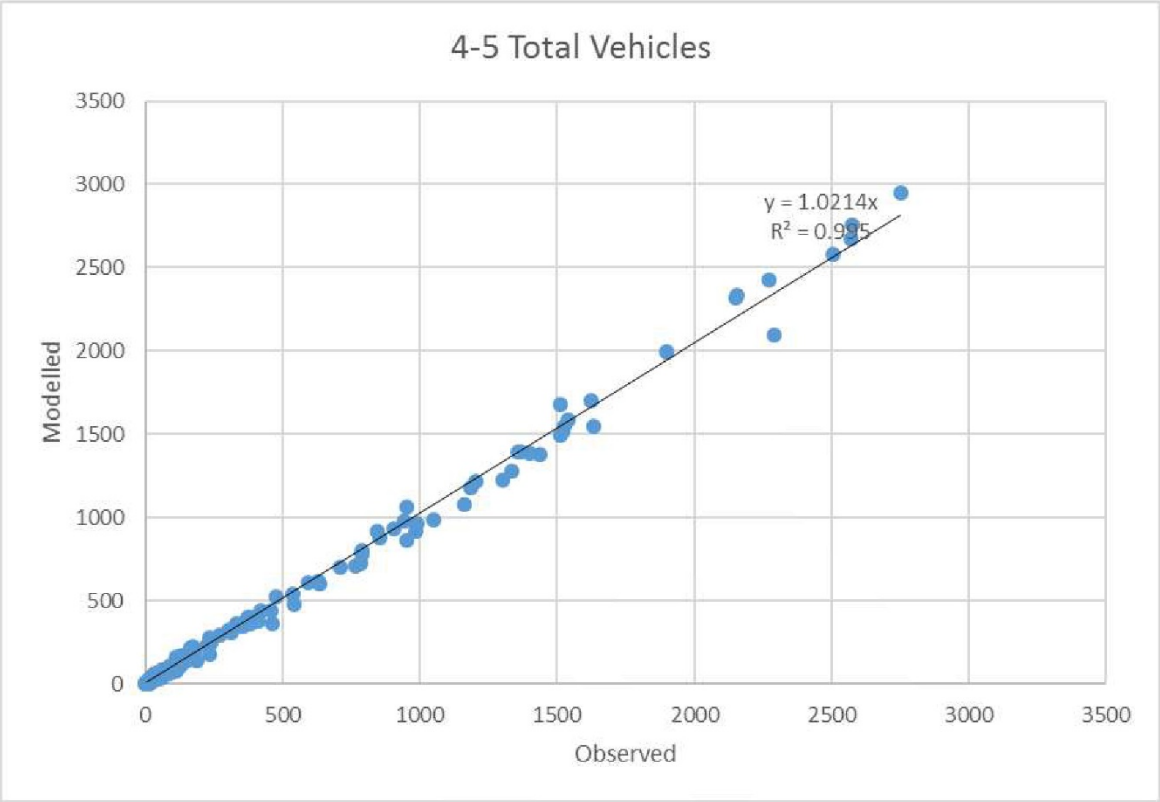


Figure 5-5 Turn Calibration 4-5 PM (median seed: 86524)

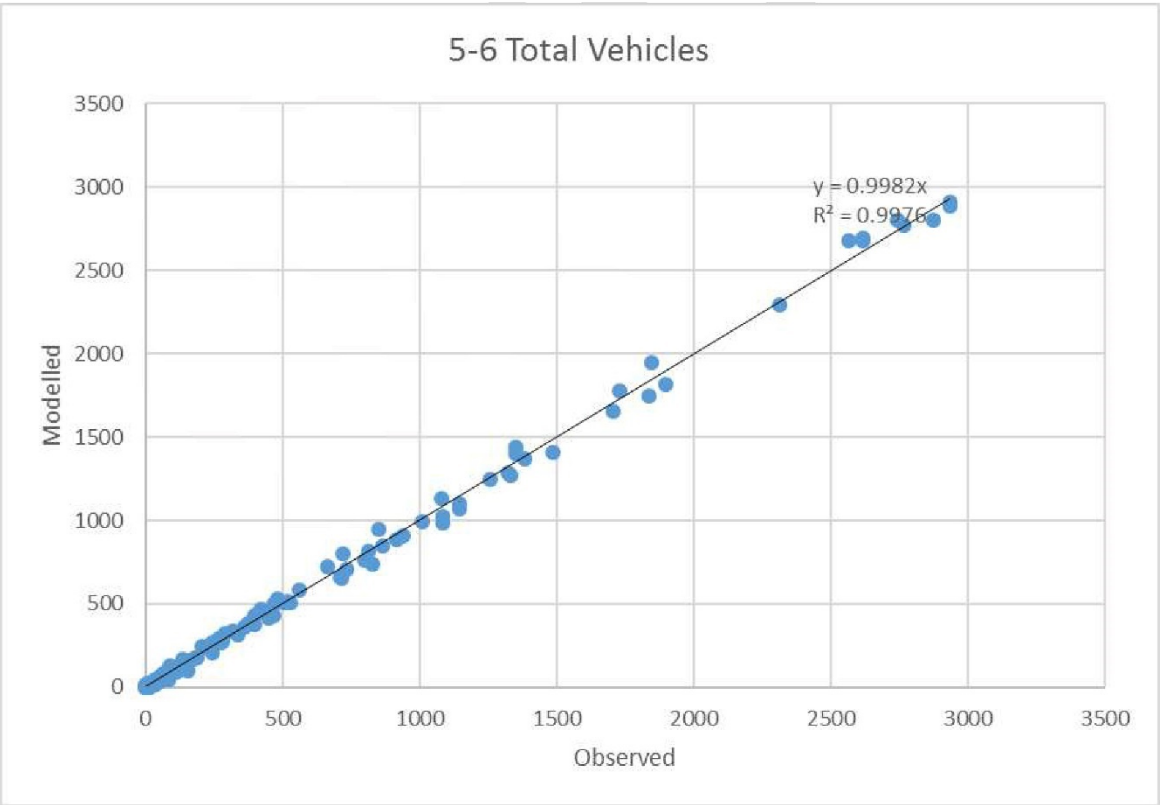


Figure 5-6 Turn Calibration 5-6 PM (median seed: 86524)

As figures 5-1 to 5-6 show, the R^2 values for all modelled periods are above 0.99, and the slope achieved also is approximately equal to one. This shows a good match between modelled turning volumes, and observed intersection counts data, indicating that a good level of calibration has been achieved.

5.1.7 Queue Calibration

Modelled queue lengths have been compared with surveyed queue lengths. The RMS Modelling Guidelines 2013 state Counting or calculating queue lengths is a subjective exercise since queued vehicles will often still be moving slowly and it will not always be clear what criteria should be used to constitute a queue. Also, since data is likely to be collected by a number of surveyors it is unlikely that consistent and accurate reporting will be possible across the study area. Additionally, software packages will each calculate queue lengths using different criteria and methodologies which add a further level of complexity. It is for this reason that the queues have been calibrated visually. The following sections show maximum queues length observed in the model.

AM Queues

John Renshaw Drive and Weakleys Drive

In the AM peak, the John Renshwaw Drive and Weakleys Drive intersection was shown to have queues up to 25 vehicles northbound, 18 vehicles southbound and 20 vehicles eastbound. These have been replicate in the model. Northbound queues are shown in Figure 5-7

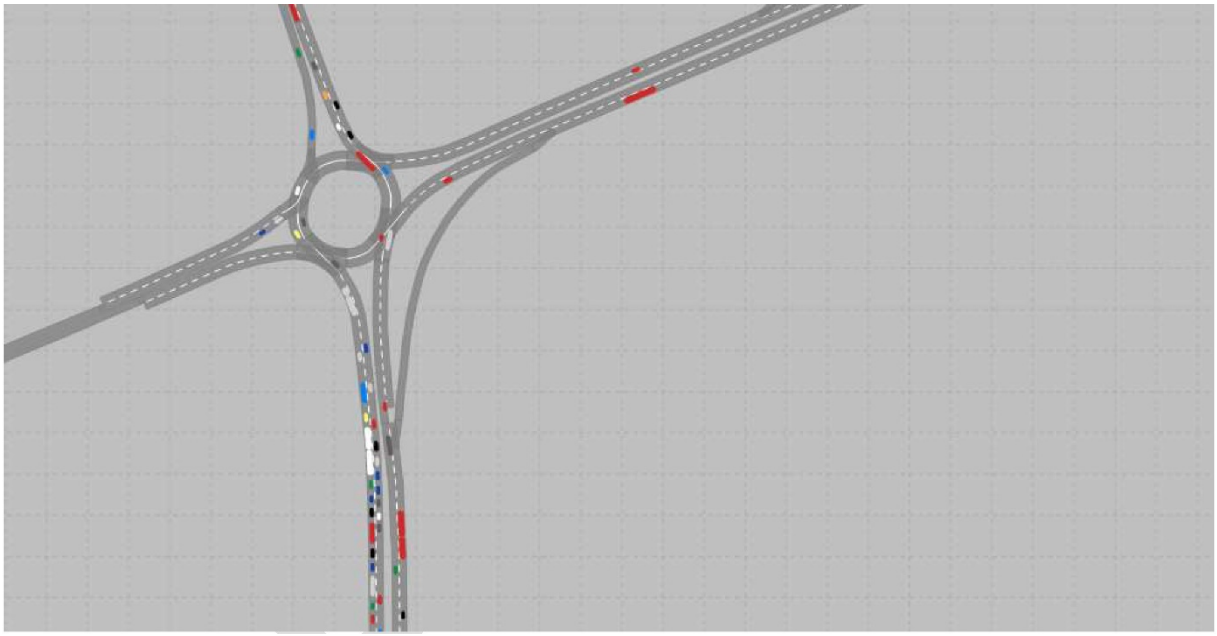


Figure 5-7 Northbound queues at John Renshaw Drive/Weakleys Drive roundabout

New England Highway and Pacific Highway

At the New England Highway and Pacific Highway intersection during the AM peak, queues were observed to be over 30 vehicles in the southbound, over 25 vehicles in the westbound and over 25 vehicles in the northbound. This is shown below in Figure 5-8

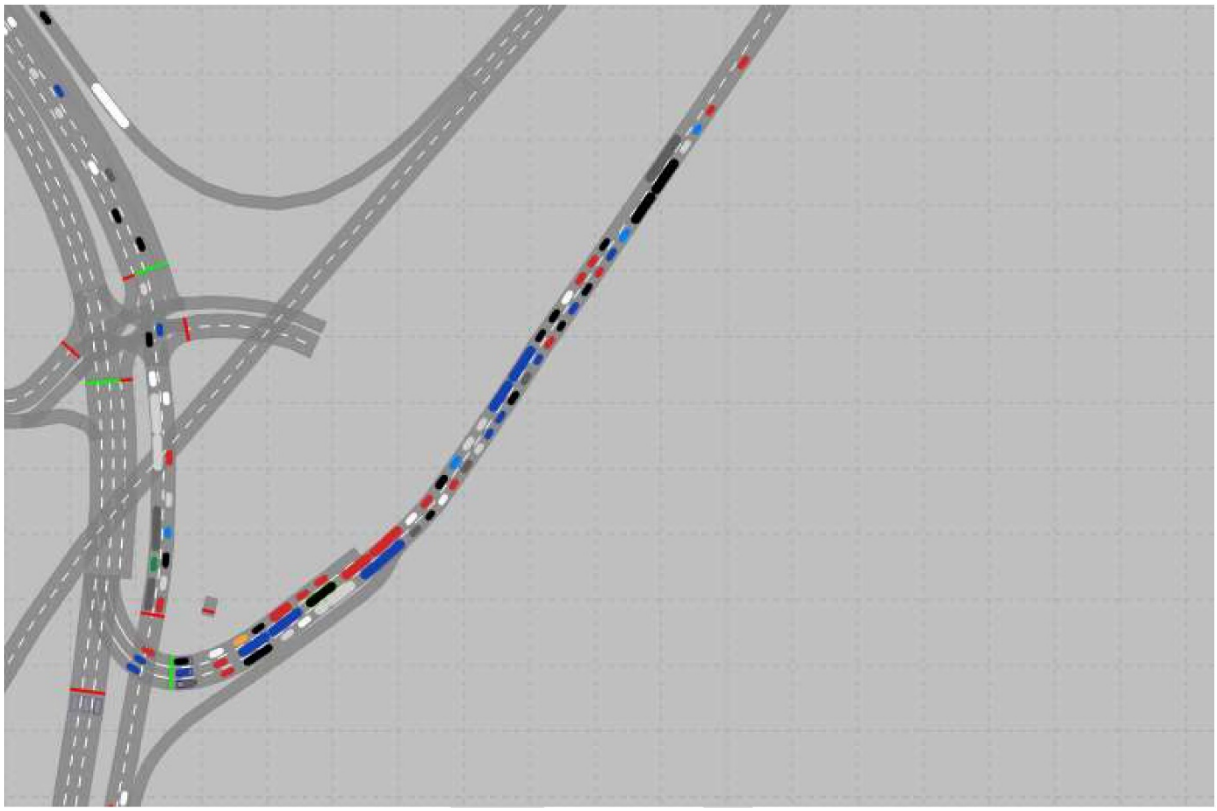


Figure 5-8 Westbound queues at New England Highway and Pacific Highway intersection

Maitland Road and Inner City bypass

At the Maitland Road and Inner City bypass intersection, the queues were measured to be over 25 vehicles northbound, over 35 vehicles eastbound and over 25 vehicles southbound. These are shown below in Figure 5-9 and Figure 5-10

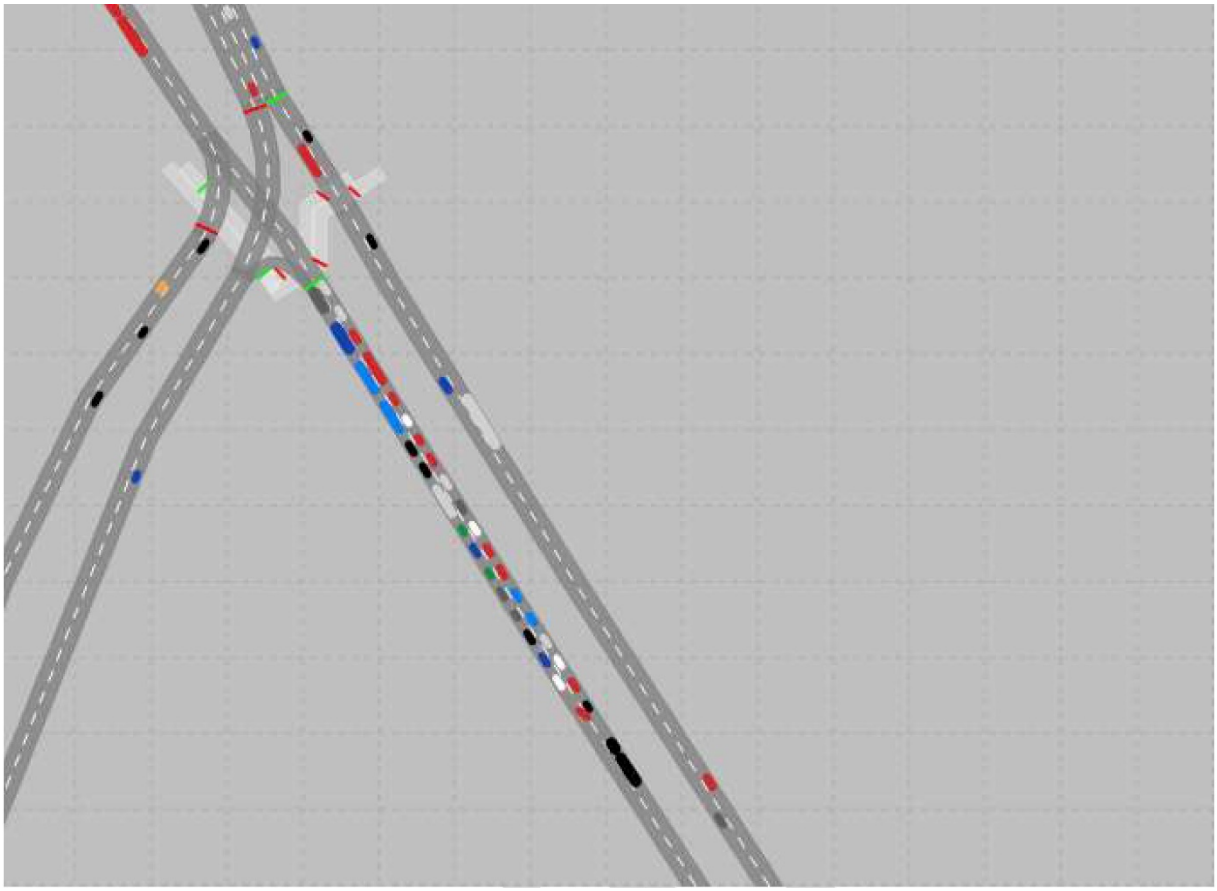


Figure 5-9 Northbound queues at Maitland Road and Inner City bypass

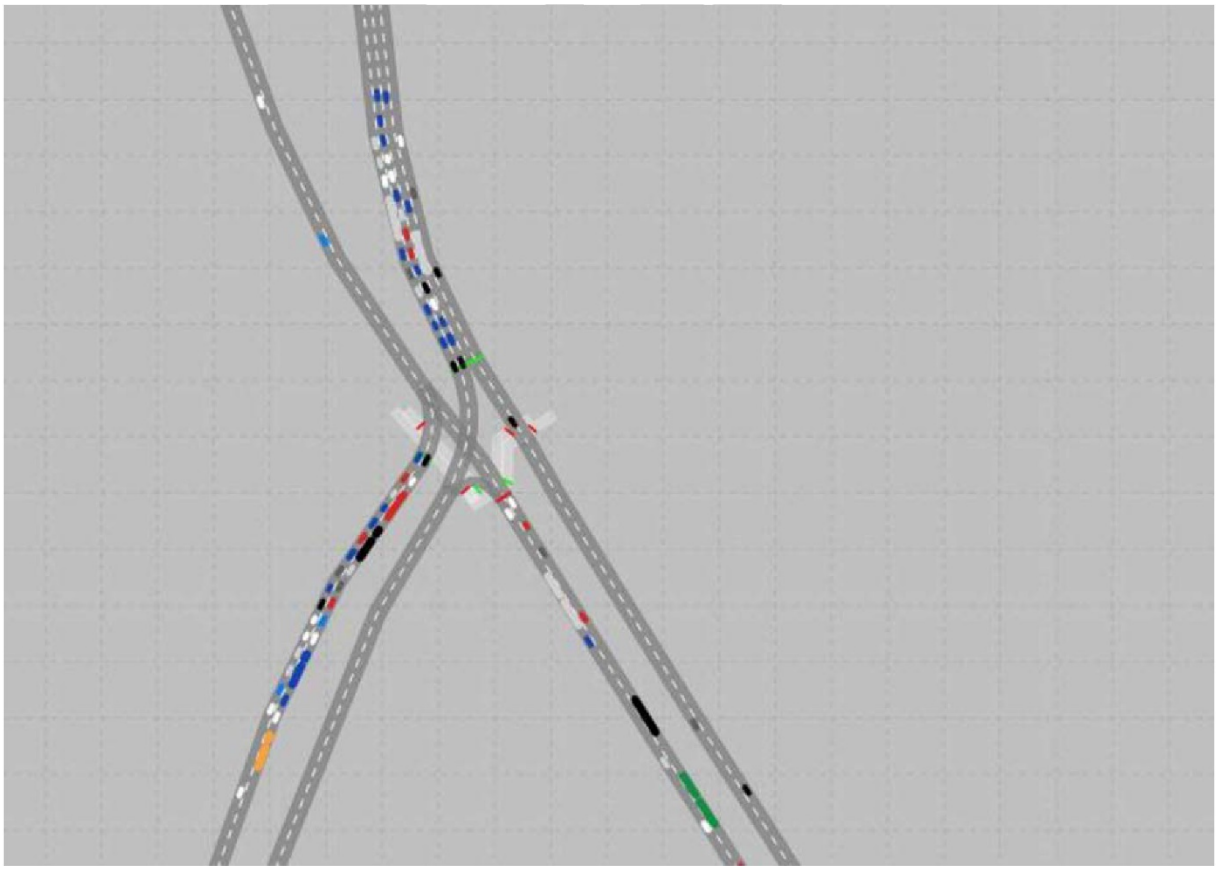


Figure 5-10 Eastbound queues at Maitland Road and Inner City bypass

PM Queues

John Renshaw Drive and Weakleys Drive

In the AM peak, the John Renshwaw Drive and Weakleys Drive intersection was shown to have queues up to 20 vehicles northbound, 19 vehicles southbound and 18 vehicles eastbound. These have been replicate in the model. Northbound queues are shown in Figure 5-11

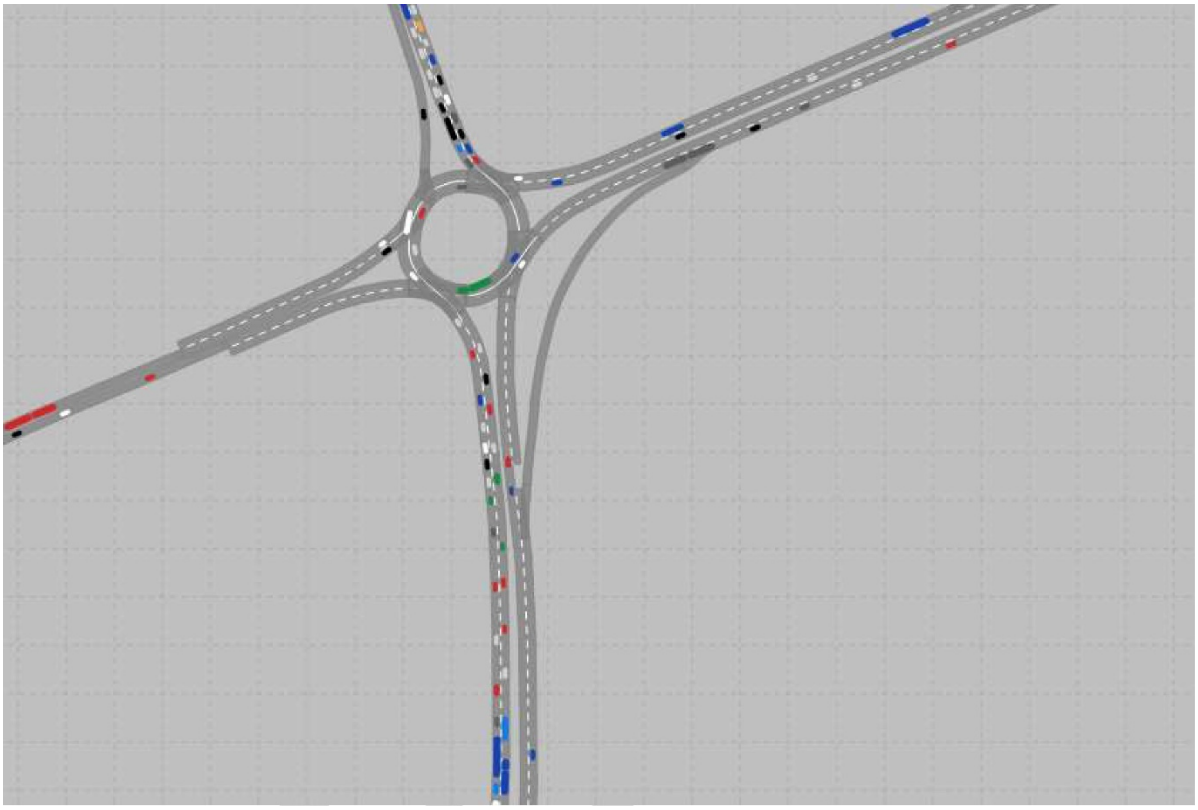


Figure 5-11 Northbound queues at John Renshaw Drive/Weakleys Drive roundabout

New England Highway and Pacific Highway

At the New England Highway and Pacific Highway intersection during the AM peak, queues were observed to be over 25 vehicles in the southbound, over 30 vehicles in the westbound and up to 35 vehicles in the northbound. This is shown below in Figure 5-12

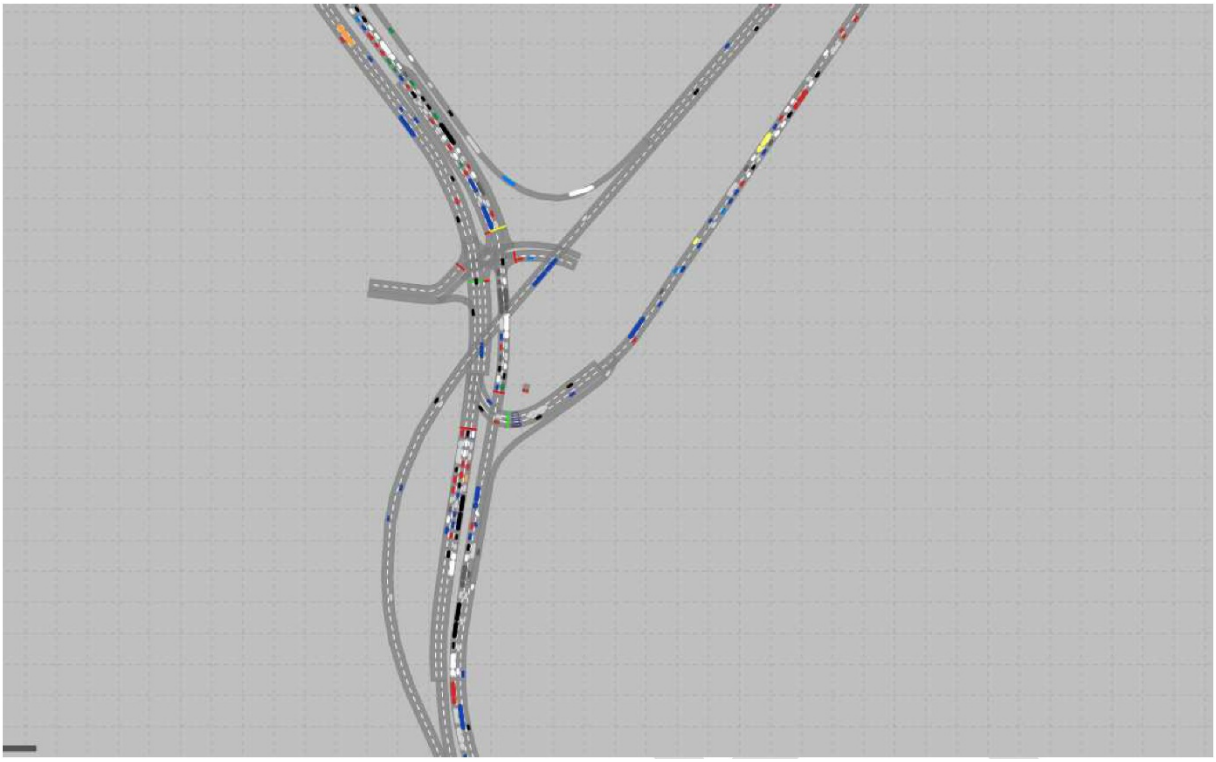


Figure 5-12 Westbound queues at New England Highway and Pacific Highway intersection

Maitland Road and Inner City bypass

At the Maitland Road and Inner City bypass intersection, the queues were measured to be over 40 vehicles northbound, over 50 vehicles eastbound and over 35 vehicles southbound. These are shown below in Figure 5-13

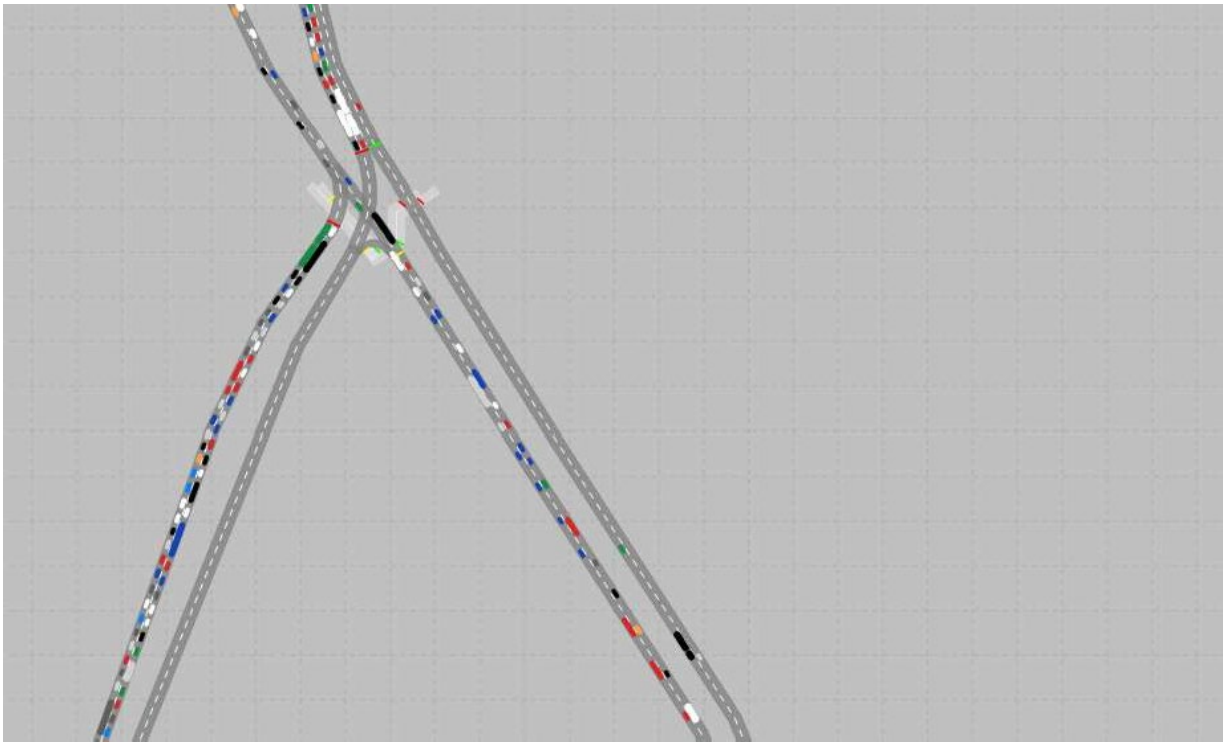


Figure 5-13 Eastbound queues at Maitland Road and Inner City bypass

5.2. Traffic Models Validation

5.2.1. Overview

Model validation is the term used to describe the independent verification process used to demonstrate that a model has been calibrated to a sufficient extent to accurately reproduce on-street conditions.

A common technique used to assess the accuracy of a model is to compare surveyed and modelled travel times along key routes in the study area. To validate the base case VISSIM models, available observed travel time data along two routes in the study area were used.

The modelling guideline recommends the following criteria for the travel time model validation:

- Average modelled journey time to be within +/-15 per cent or one minute (whichever is greater) of average observed journey time for full length of route. Each route should be cumulatively graphed by section.
- Qualitative queue length analysis has also been performed at identified key intersections

5.2.2. Travel time validation

Travel time comparison provides a good indication that the calibrated model accurately reflects delay conditions on major routes in the study area. Observed and modelled travel times, as cumulative values, were compared in the southbound and northbound direction for a travel time routes shown in Figure 5-14.

Figure 5-14 Travel time routes

Figure 5-15 to Figure 5-26 show AM and PM peak travel time comparisons between modelled and average survey travel time data for each route and direction of travel, respectively. This comparison indicated that the most modelled travel time (orange line) is within the upper (+15 per cent) and lower (-15 per cent) boundaries of observed average travel times (Based on Google Travel time and Travel Time Surveys).

As a common modelling practice, where observed travel time show high levels of fluctuations (which indicates less stable real-time operation), proving overall traffic conditions are replicated adequately (e.g. volumes, delay, queuing conditions), it is acceptable to have some variations above the criteria in the modelled travel times.

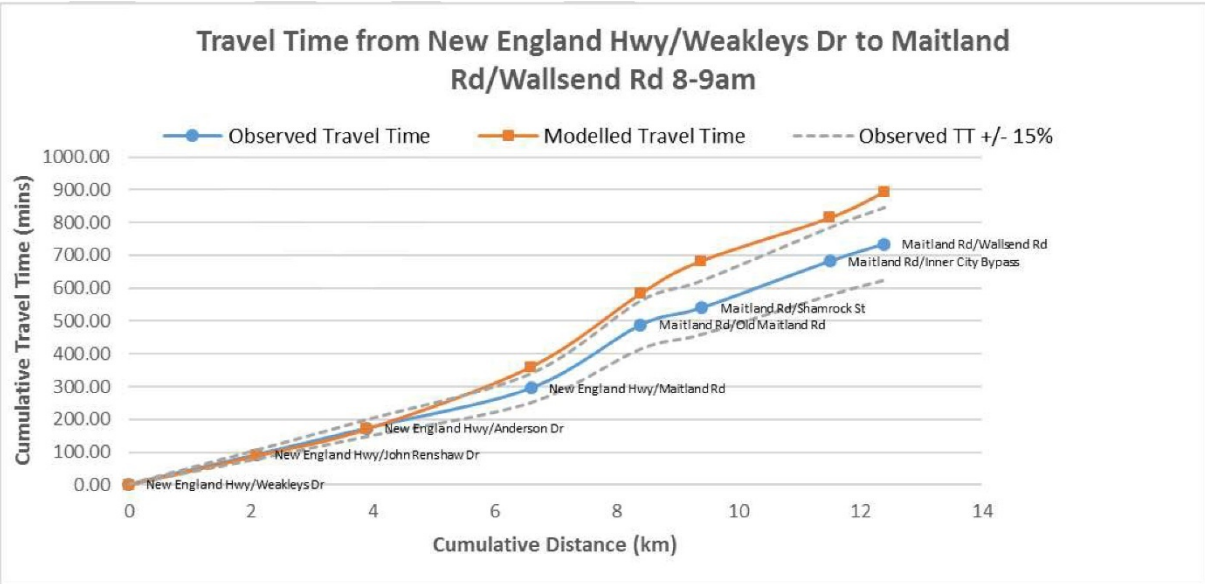


Figure 5-15 Travel time Validation Weakleys Drive to Wallsend Road 8-9 AM

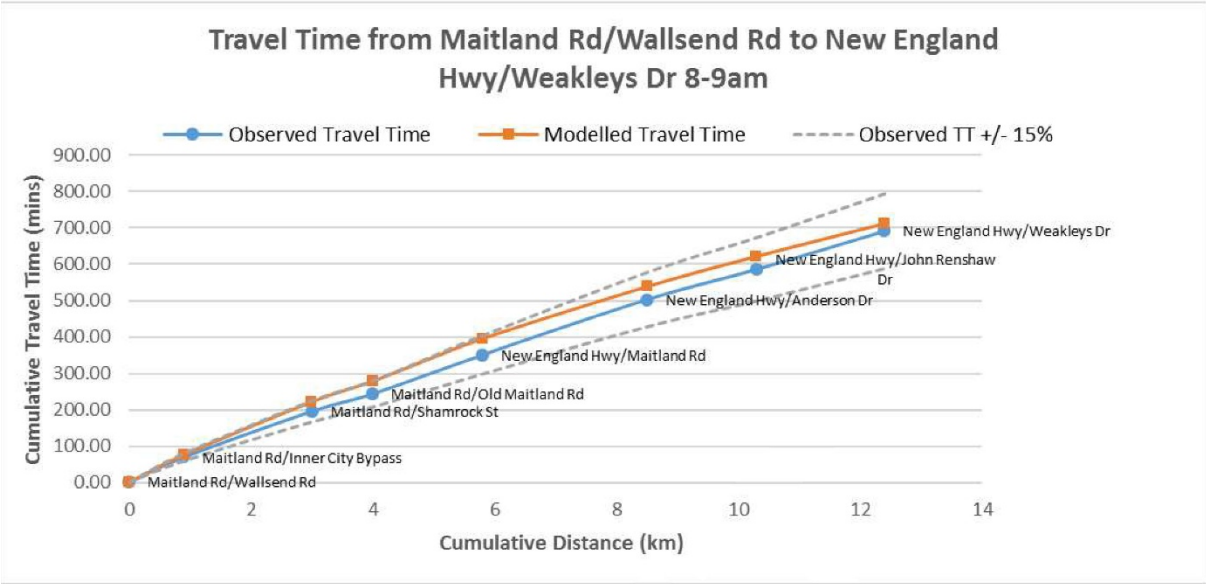


Figure 5-16 Travel time Validation Wallsend Road to Weakleys Drive 8-9 AM

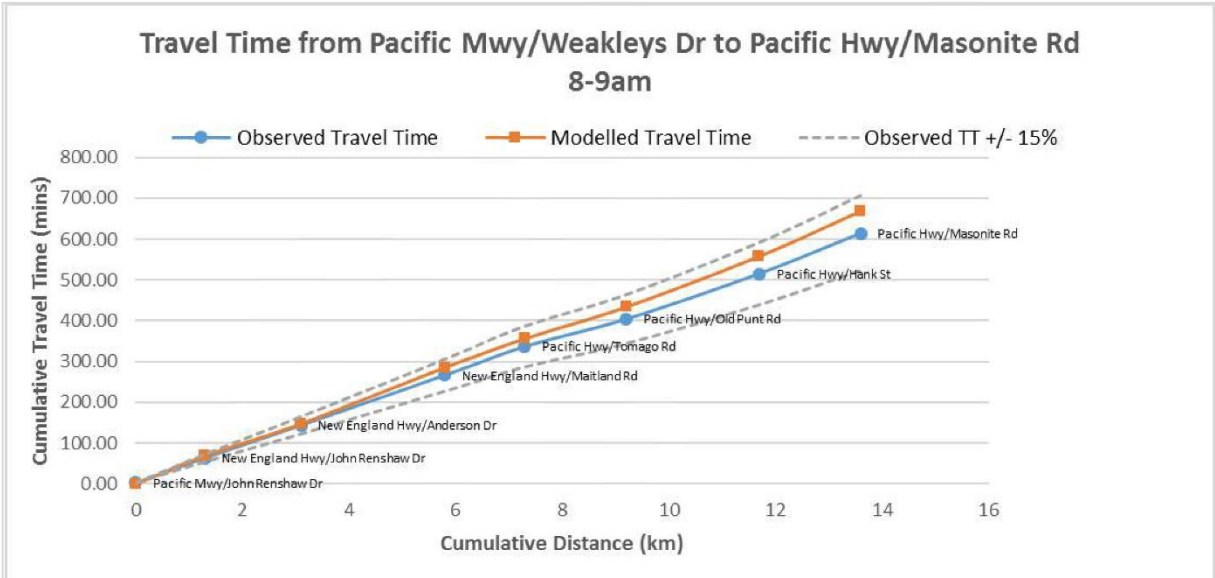


Figure 5-17 Travel time Validation Weakleys Drive to Masonite Road 8-9 AM

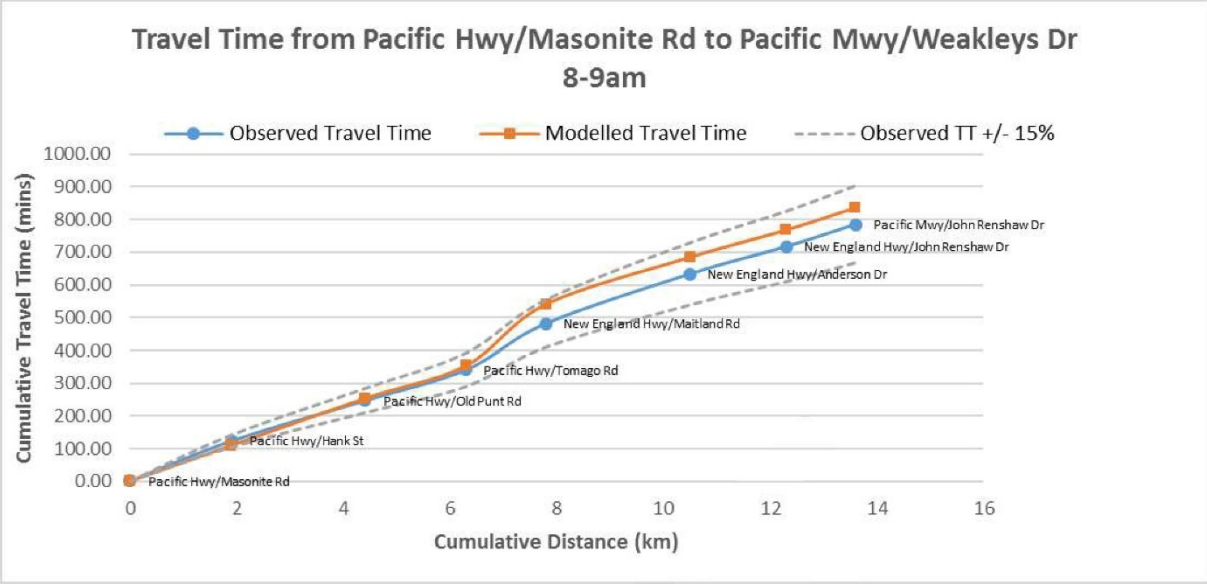


Figure 5-18 Travel time Validation Masonite Road to Weakleys Drive 8-9 AM

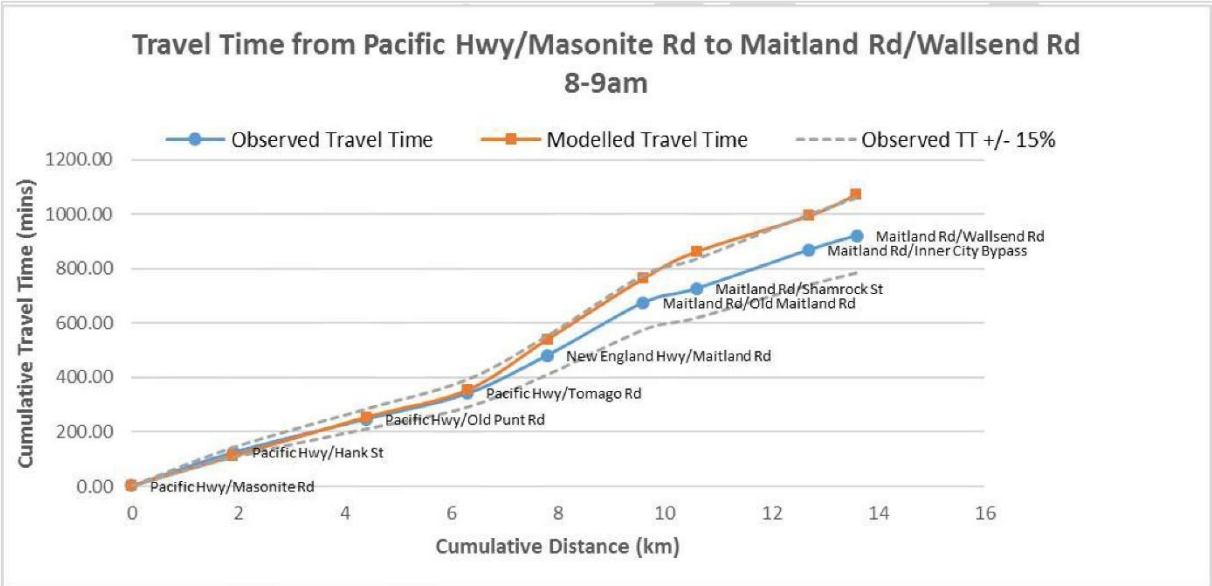


Figure 5-19 Travel time Validation Masonite Road to Wallsend Road 8-9 AM

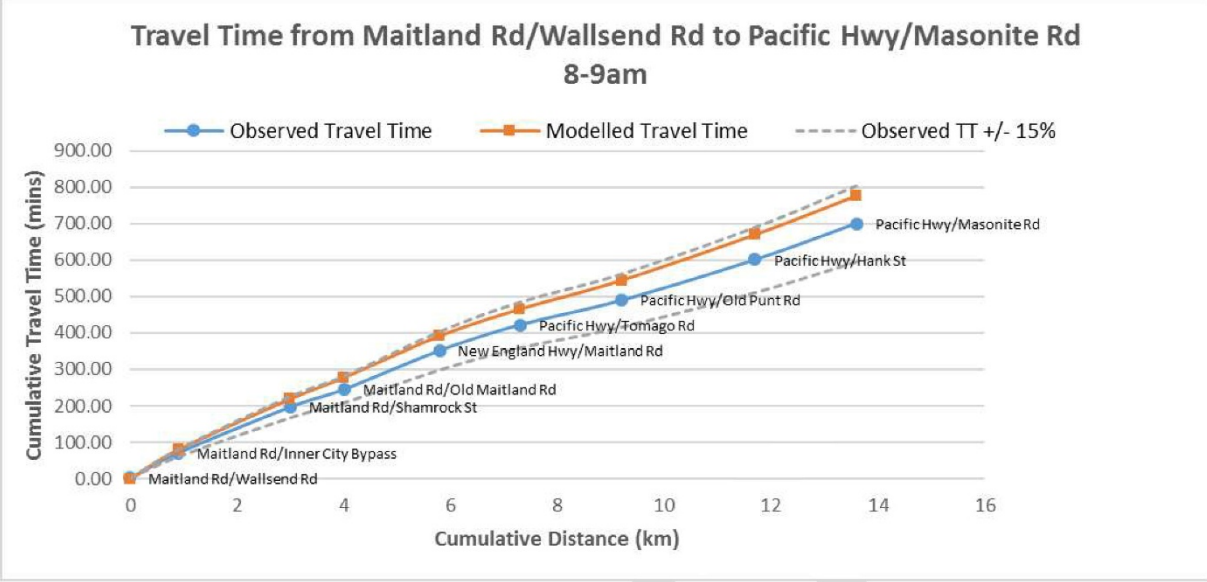


Figure 5-20 Travel time Validation Wallsend Road to Masonite Road 8-9 AM

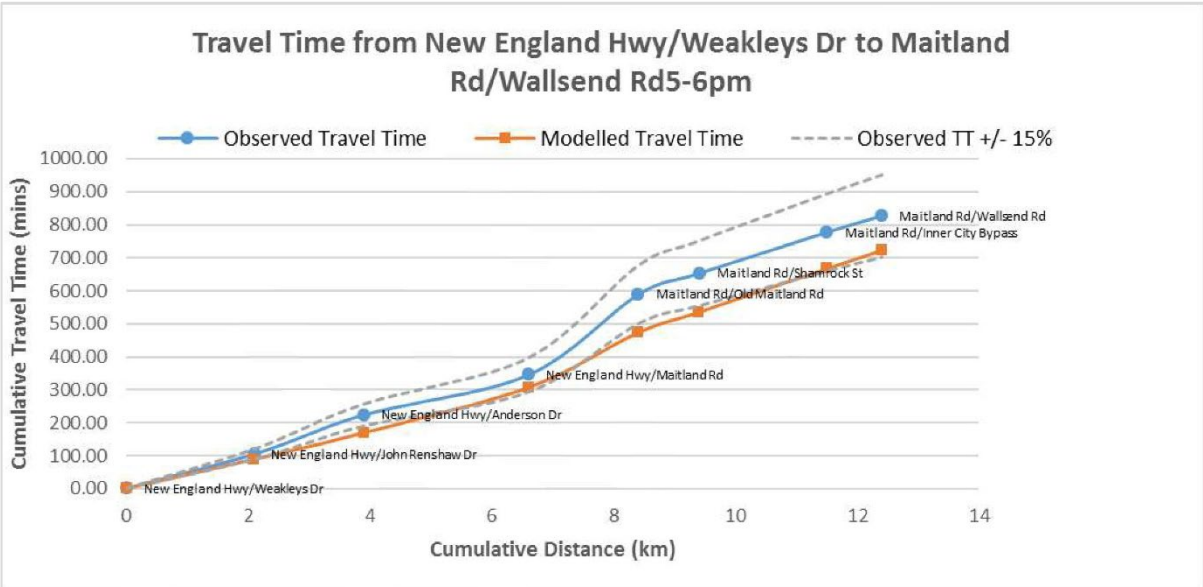


Figure 5-21 Travel time Validation Weakleys Drive to Wallsend Road 5-6 PM

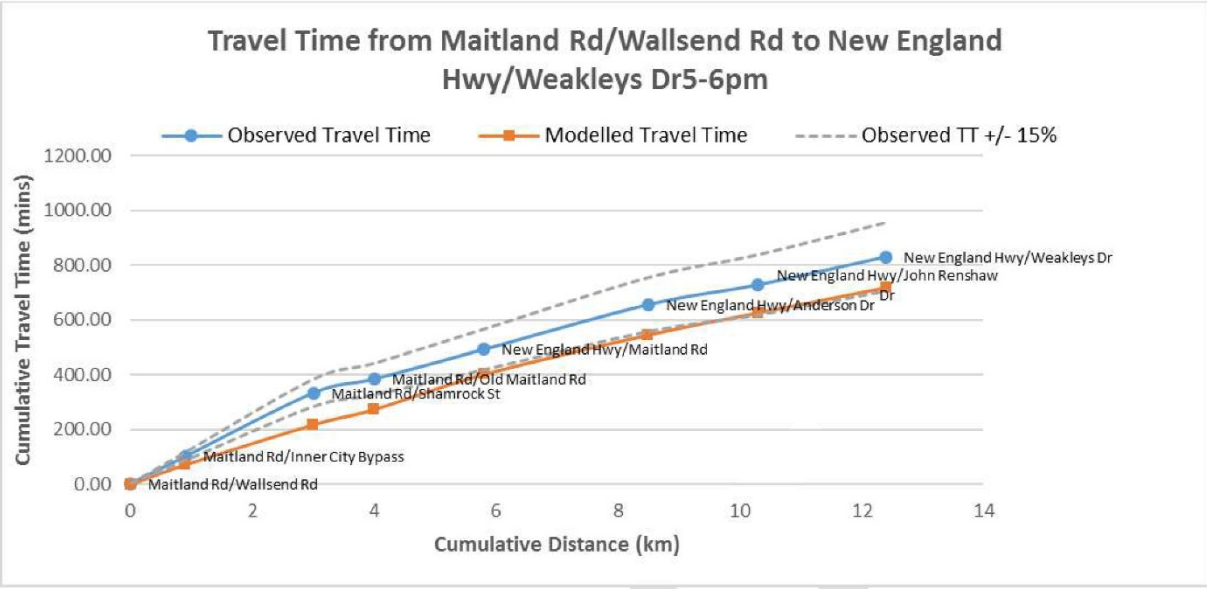


Figure 5-22 Travel time Validation Wallsend Road to Weakleys Drive 5-6 PM

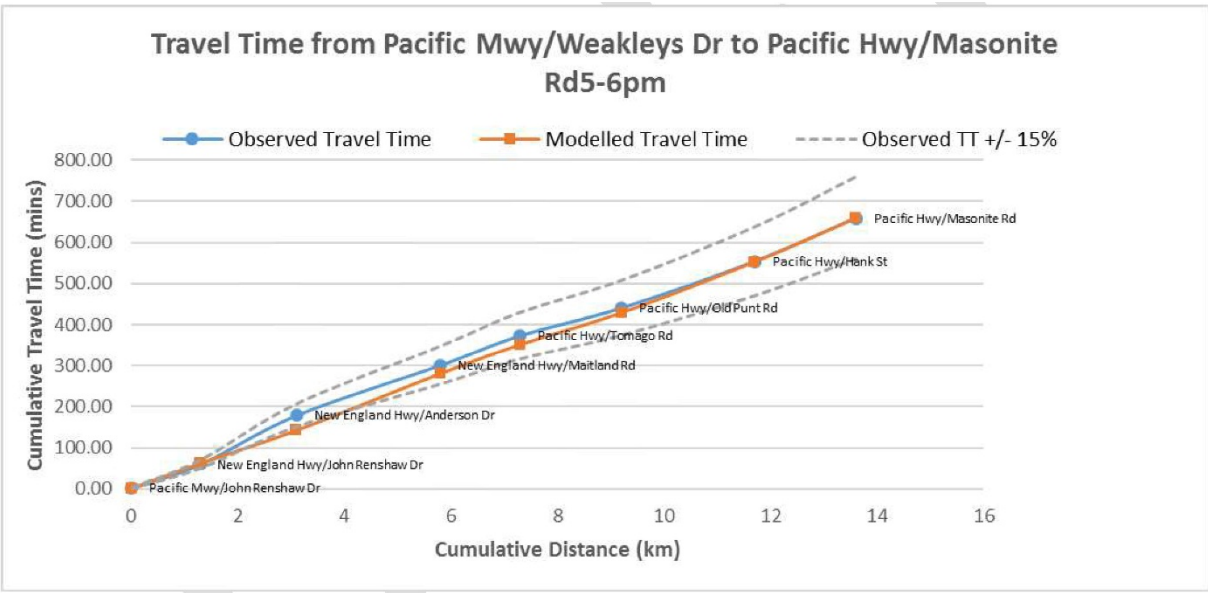


Figure 5-23 Travel time Validation Weakleys Drive to Masonite Road 5-6 PM

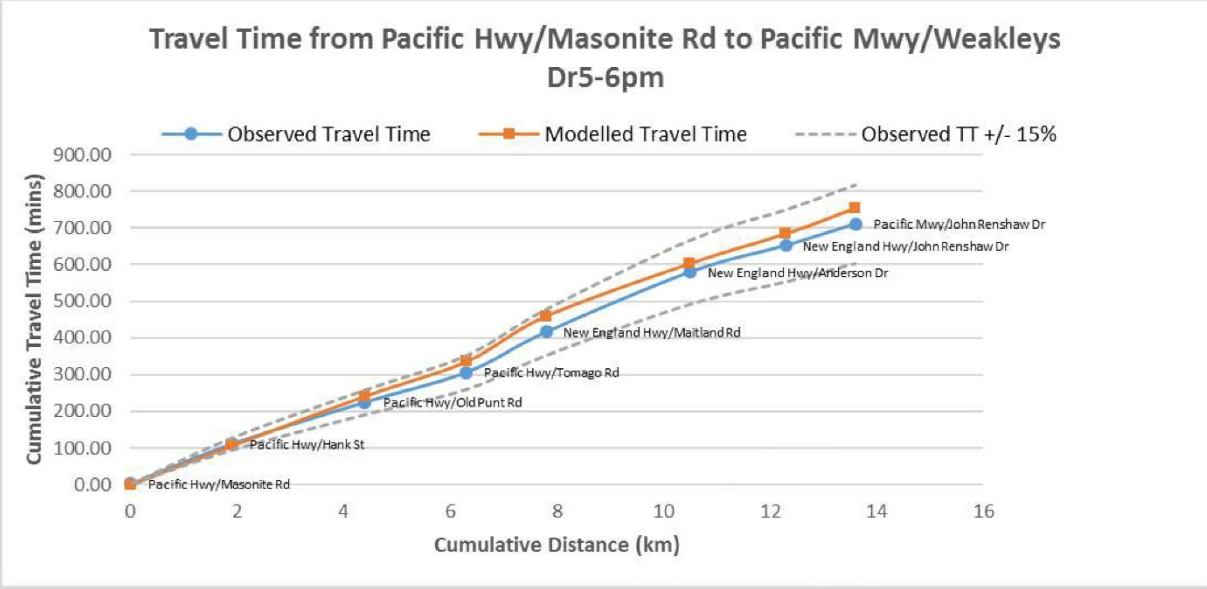


Figure 5-24 Travel time Validation Masonite Road to Weakleys Drive 5-6 PM

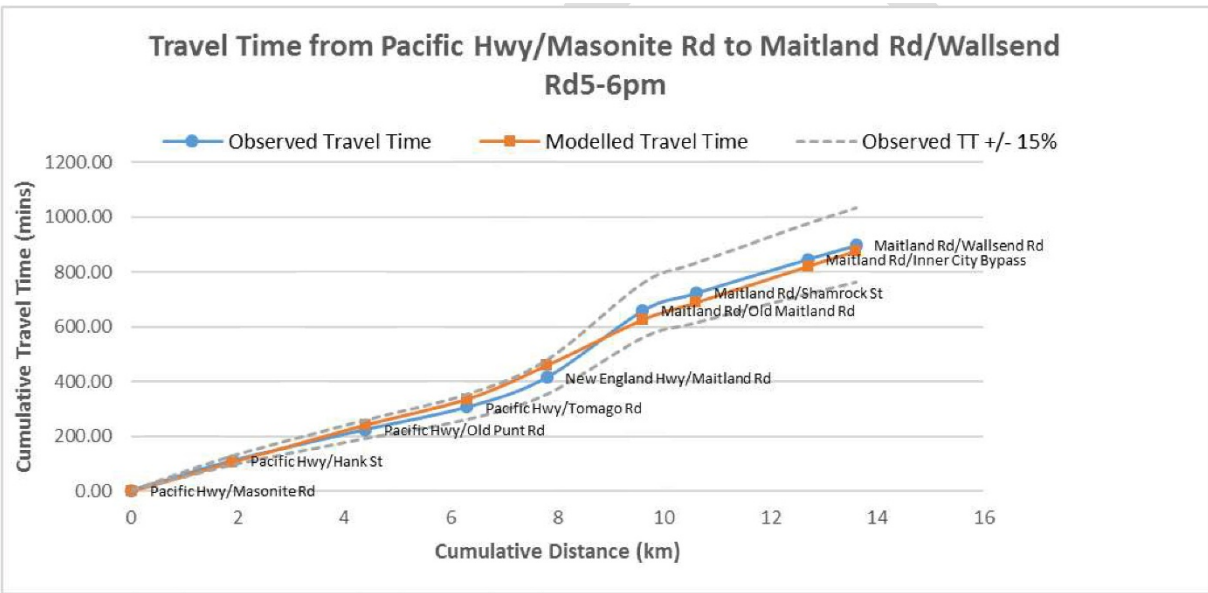


Figure 5-25 Travel time Validation Masonite Road to Wallsend Road 5-6 PM

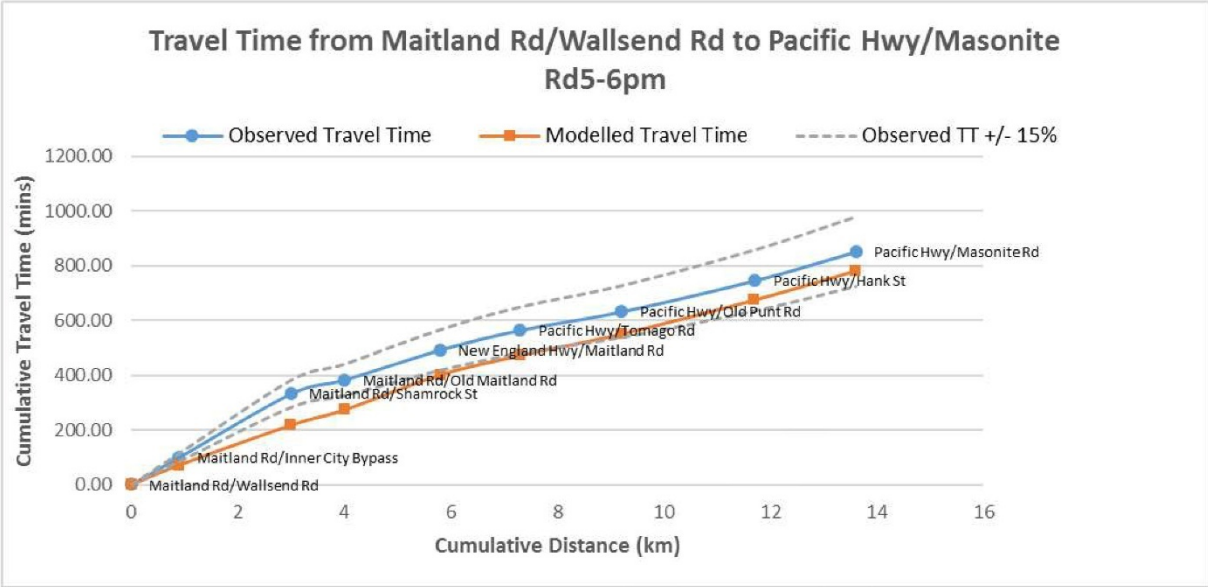


Figure 5-26 Travel time Validation Wallsend Road to Masonite Road 5-6 PM

The travel time validation graphs show the model has a good fit with the observed data. In general, due to near capacity conditions along Maitland Road between Anderson Dr and Inner City by-pass, the modelled travel time values for this section do not entirely fall within the guideline criteria, however the overall traffic conditions are adequately represented for this section in the traffic models.

In other words, since traffic models tend to show case typical (or representative travel times), it is expected to have higher levels of discrepancy between average modelled and observed travel times for less stable sections of the traffic models. In this case, the model remains a good representation of actual traffic conditions, granted that traffic congestion levels (e.g. queuing conditions) remain well represented within the model.

Graphs for all modelled hours are shown in Appendix C

6. Conclusion

The AM and PM peak base case VISSIM models were calibrated and validated as per the Roads and Maritime guidelines for average weekday conditions. The results indicate a good level of calibration with most of the model statistics close or equal to the ideal value of 100 per cent.

The model validation indicated that the modelled travel time is generally within the upper (+15 per cent) and lower (-15 per cent) boundary of observed average travel time values and followed the similar trend with the average survey travel time data.

It can be concluded that the comparison between modelled and observed travel times satisfies Roads and Maritime travel time validation criteria in AM and PM Peak periods.

In summary, it is concluded that the base year traffic models are “fir for purpose“ for the Outer Newcastle Study (ONS), which will inform the strategic design, economic analysis and prioritisation of future state road upgrades in the study area.

Appendix B
Option Testing Report

M1 Pacific Motorway extension to Raymond Terrace

Traffic and Transport Option Testing Report

Transport for NSW | January 2021

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Appendix A	Flow diagrams

1. Introduction

1.1 Background

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 1999.

The project would connect the existing M1 Pacific Motorway at Black Hill and the Pacific Highway at Raymond Terrace within the Newcastle City and Port Stephens local government areas. The project would provide regional benefits and substantial productivity benefits on a national scale. The project location is shown in **Figure 1-1** within its regional context.

1.2 Purpose and objectives

The purpose of this report is to detail the traffic modelling process and development for the project. The microsimulation transport model has been used to provide traffic inputs to:

- Assess the future traffic performance of the concept design
- Provide inputs to the assessment of traffic related impacts for an Environmental Impact Statement (EIS)
- Provide input into an economic analysis for the business case considering the difference between a base case and project case in future years.

1.3 Project description

The project would include the following key features:

- 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 floodplain 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 at 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, temporary wharves, batching plants, soil treatment and environmental controls.

A detailed project description is provided in Chapter 5 of the Environmental Impact Statement. The locality of the project is shown in **Figure 1-2** while the study area is shown in **Figure 1-3**.

1.4 Report outline

The report is structured as follows:

- Chapter 1 – Introduces the project with a summary of the project background, project scope and project requirements
- Chapter 2 – Provides an overview of the assessment methodology that informed for the traffic and transport assessment, including the traffic modelling
- Chapter 3 – Provides an overview of the traffic modelling assumptions and parameters used for this assessment
- Chapter 4 – Provides a summary of the traffic growth forecasting methodology and 'without project' upgrade assessment
- Chapter 5 – Provides an overview of the base traffic model results including traffic volumes, travel times and the performance of the current transport network
- Chapter 6 – Provides an overview of the option operational results including traffic volumes, travel times and the performance of the future transport network
- Chapter 7 – Provides the overview of sensitivity modelling carried out
- Terms and acronyms
- Appendix A – Flow diagrams.

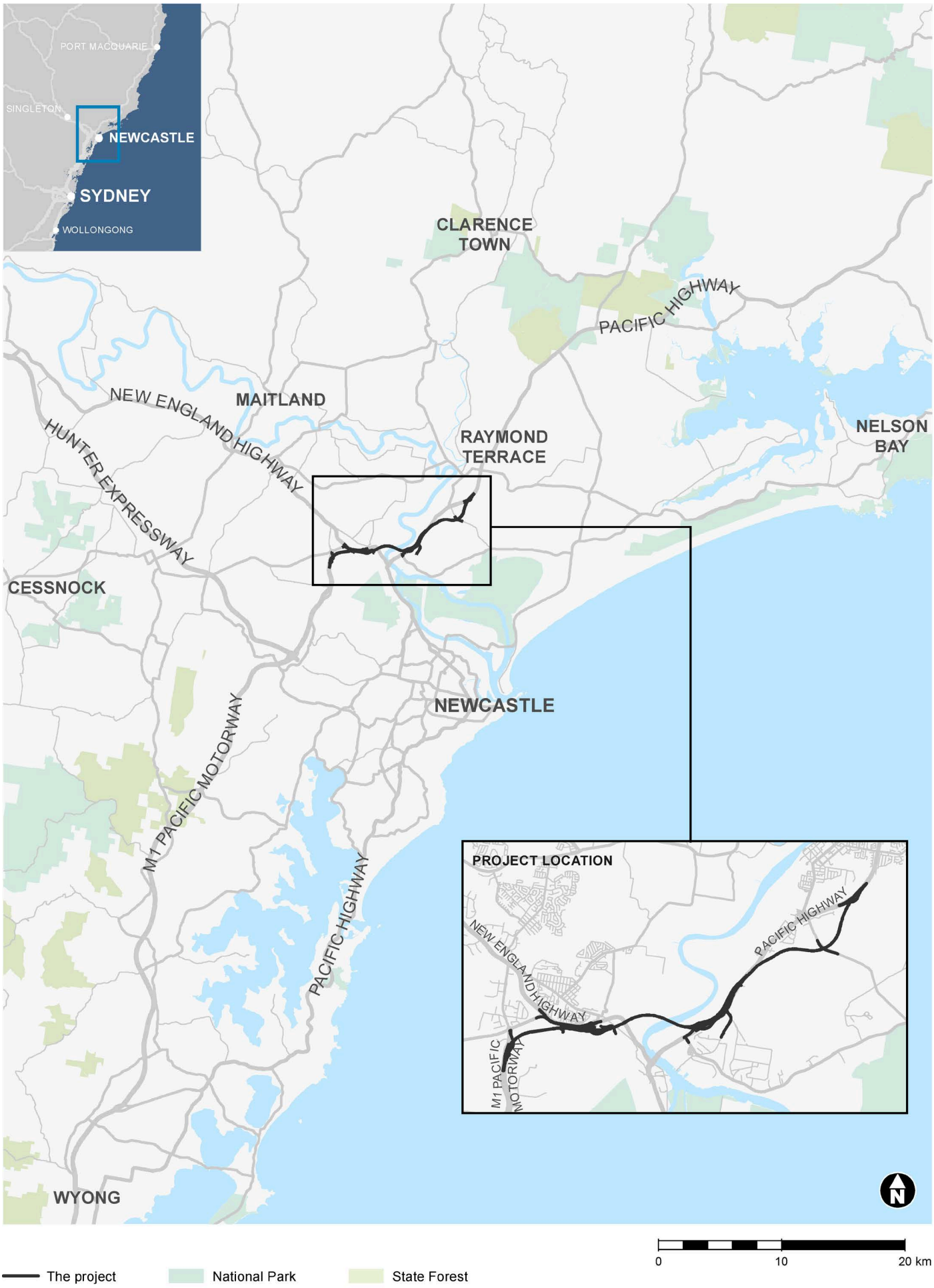

Figure 1-1 Regional context of the project

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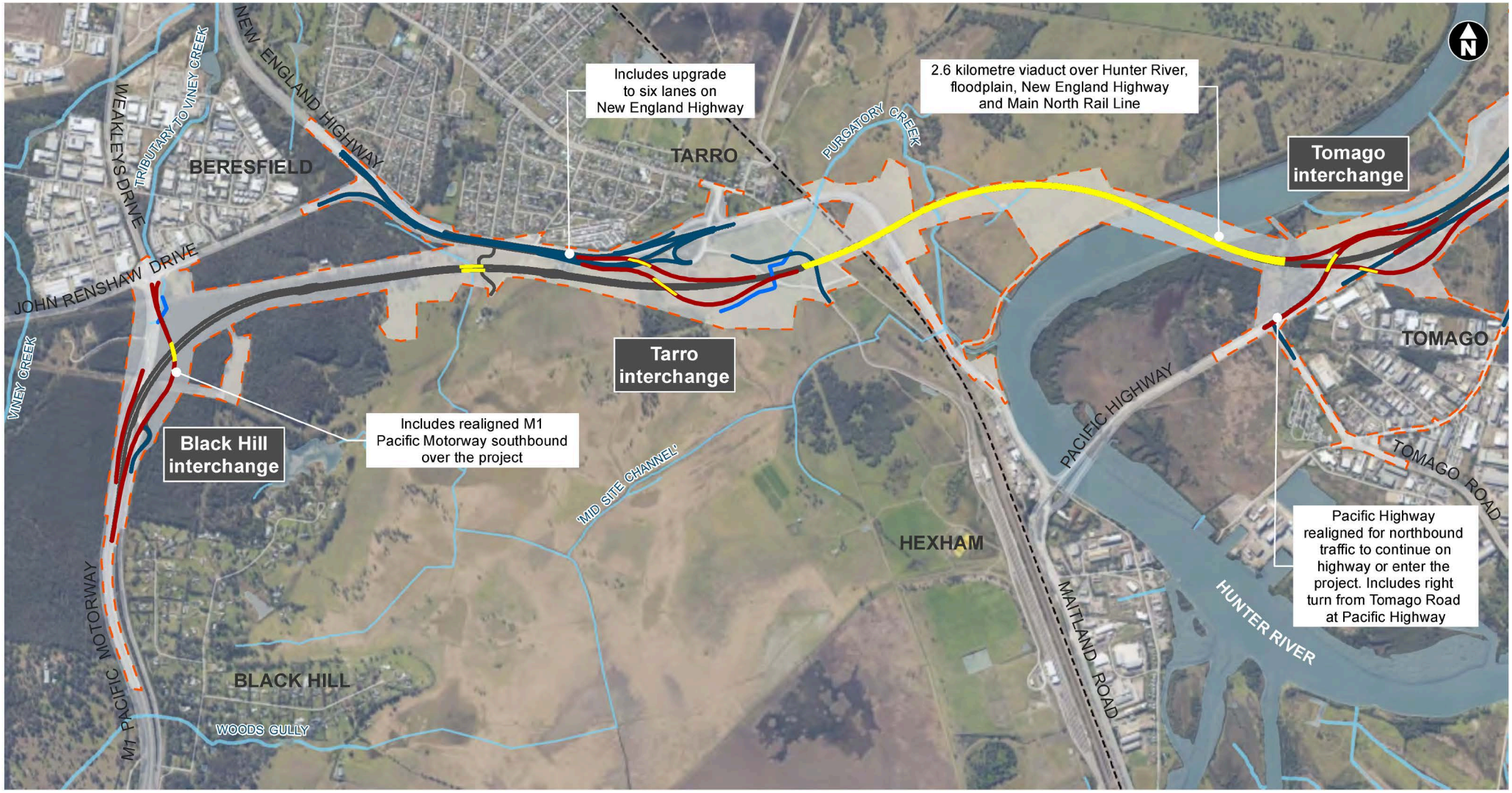

Main alignment
Adjustments to existing roads
New ramp
Creek realignment
Bridges/ Viaduct
Construction footprint
Waterways
Main North Rail Line

0 0.5 1 km

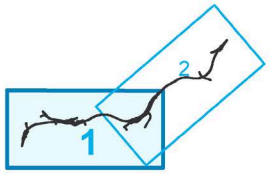

Figure 1-2 Project key features (map 1 of 2)

Page 1 of 2

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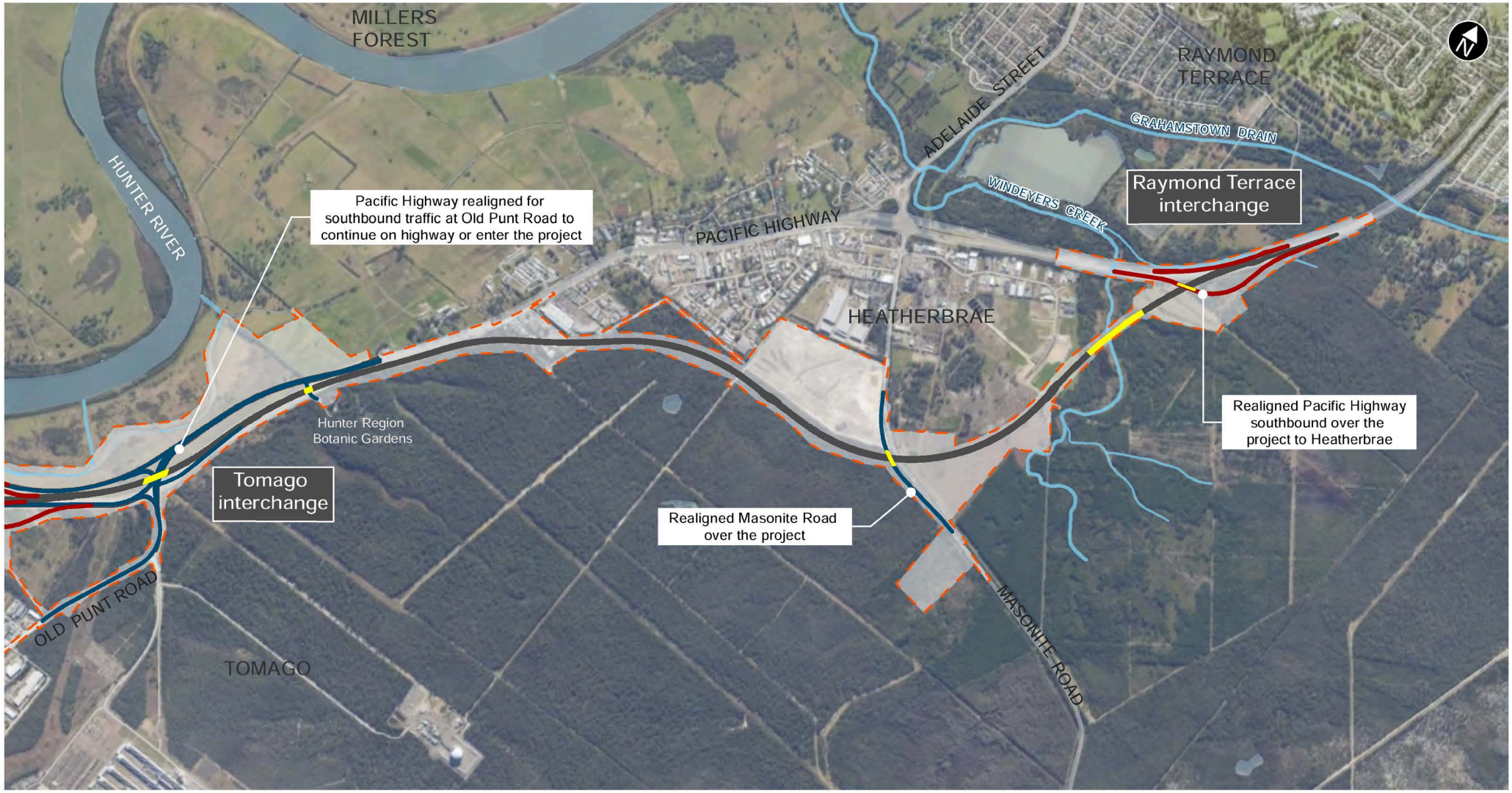

Main alignment
Adjustments to existing roads
New ramp
Bridges/ Viaduct
Construction footprint
Waterways

0 0.5 1 km

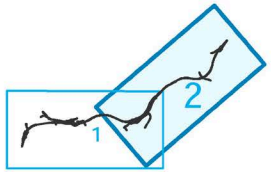

Figure 1-2 Project key features (map 2 of 2)

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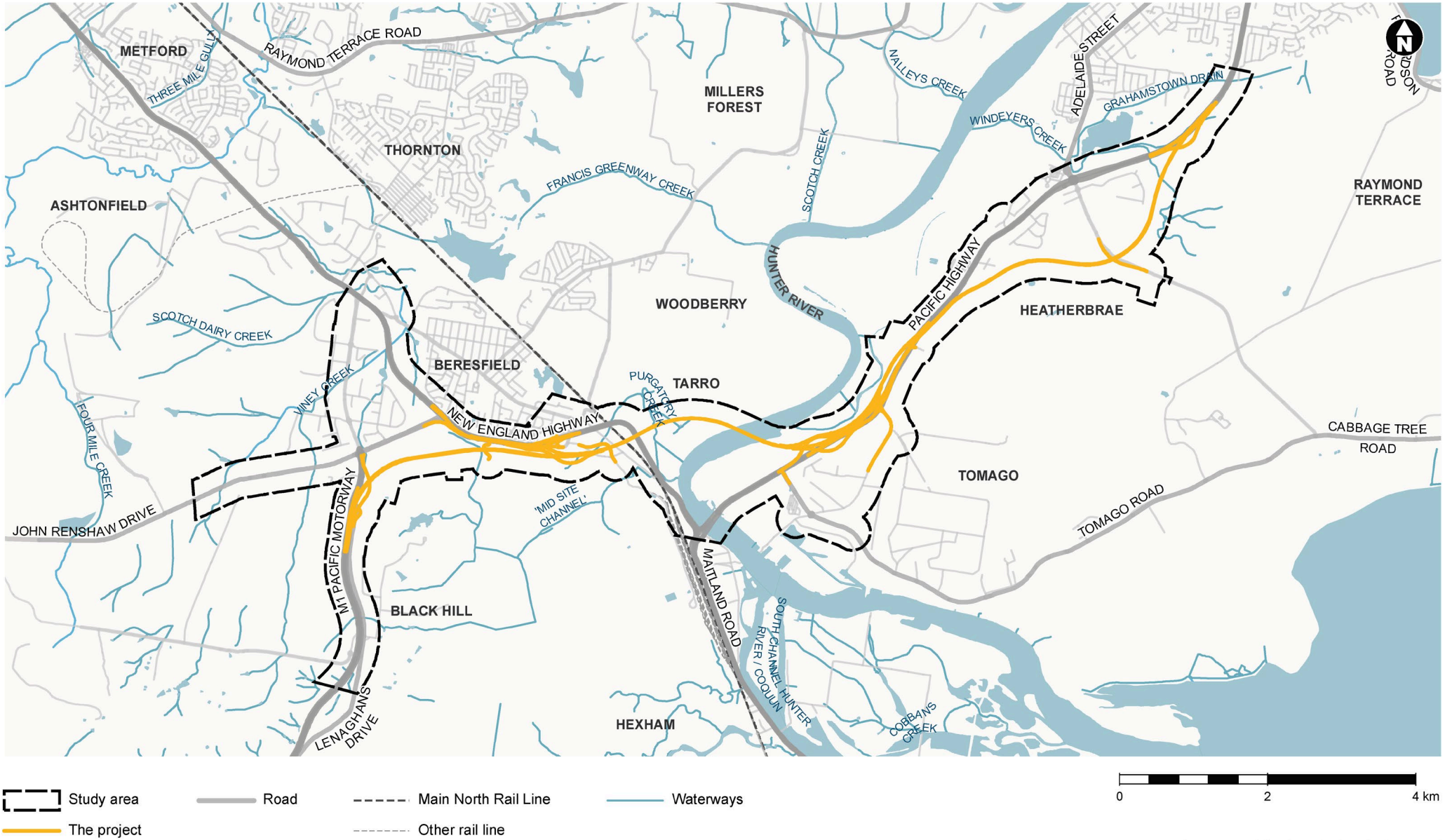

Study area
The project
Road
Main North Rail Line
Other rail line
Waterways

0 2 4 km

Figure 1-3 Project study area

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2. Traffic model methodology

2.1 Traffic model development

The objective of the traffic modelling process is to make the best use of the available transport and traffic data, including existing transport models, to estimate the base and future conditions on the transport network surrounding the project. These transport conditions are used to assess the operational performance of the network based on scenarios with and without the proposed project.

As the project is road-based, the modelling process has been focussed around traffic modelling. The modelling for the project was carried out by using the pre-existing VISSIM microsimulation models developed as part of the Outer Newcastle Study (ONS). **Figure 2-1** gives an overview of the traffic model development process and how the model has been used throughout each phase of its development.

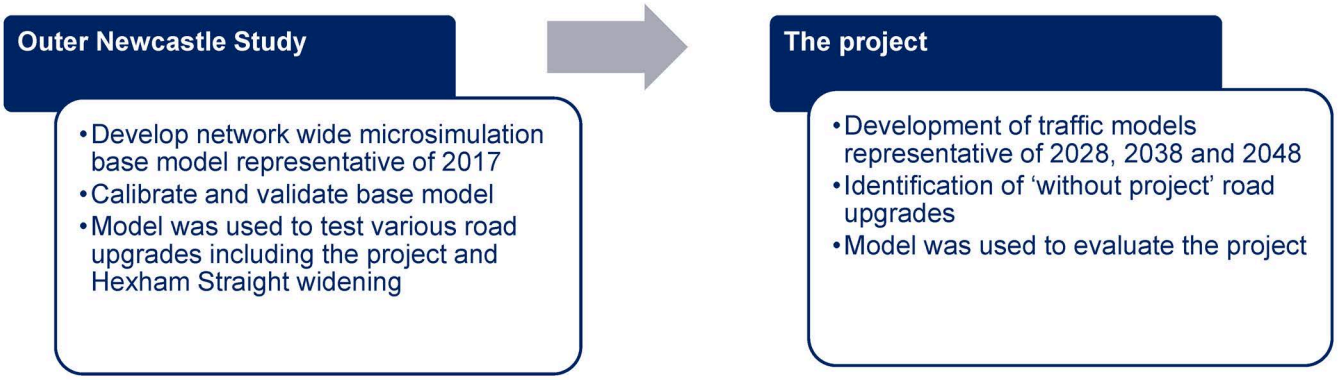

Figure 2-1 Traffic modelling process for the project

2.2 Outer Newcastle Study and base model development

Extensive traffic modelling carried out as part of the ONS led to the development of a calibrated and validated base model. This base model has been used as the foundation for this EIS assessment.

2.2.1 Desktop assessment

As part of the desktop assessment, the following data was collated to inform the traffic model development and impact assessment:

- Existing and future bus routes, stopping patterns and frequencies: Used to model bus routes through the study area
- Transport network project assumptions: Used to develop the future year transport networks
- Aerial photography: Used to validate road network coding of the existing transport network in the traffic and transport models.

As the ONS was used to investigate a range of solutions, the ONS study area including a transport study area wider than the study area for the project. The ONS study area and model area are shown in **Figure 2-2**.

2.2.2 Site investigations

The following data was collected from site investigations to inform an analysis of existing conditions on the transport network, as well as the development of the traffic model used to assess the future impact of the project:

- **Classified intersection volume counts:** Traffic surveys were carried out between 10 October 2017 and 23 October 2017 as part of the ONS at various locations in the ONS study area to gain an understanding of daily traffic volumes and traffic composition. The location of the counts are shown in **Figure 2-3**
- **Automatic traffic counts**: Automatic traffic counts provide a record of traffic volumes every hour over a 24-hour period, typically over a week. These counts were collected in October 2017 and provide information about how traffic volumes vary over the day and the week. Additionally, they also provide information regarding the composition of traffic flows and speeds. This information was used to convert peak hour traffic volumes to daily traffic volumes based on the observed profile of traffic at that location over a day. The location of the midblock automatic traffic counts are shown in **Figure 2-4**
- **Travel time surveys**: Travel time surveys provide a record of the average travel time taken by vehicles along a route and can be broken down into subsections to understand the cumulative travel time along routes. This provides an understanding of where delays are typically experienced along these routes, as well as the typical speeds in each road segment. As travel times along roads are influenced by traffic volumes, intersection capacities and congestion, the data was used to validate the VISSIM base model to ensure that it accurately reflects observed conditions. Travel time surveys were carried out along key corridors in October 2017.

It was originally proposed that traffic counts, as well as travel times and queue length observations, would be collected in 2020 within the study area to inform the growth analysis and future development of the VISSIM model for the project. However, on 12 March 2020, the World Health Organisation declared the coronavirus (COVID-19) as a pandemic. In response to these declarations, the Australian Government introduced a range of restrictions relating to travel, public gatherings and shut down of non-essential services. As such, the COVID-19 situation has dramatically impacted traffic volumes, making it difficult to collect more recent and representative count data for a “typical” period. Planned traffic counts were not collected in 2020, as the COVID-19 pandemic resulted in substantial changes to traffic volumes and were not considered to be representative of an average year. Therefore, existing count data, obtained from previous investigations described above, were used to inform this assessment.

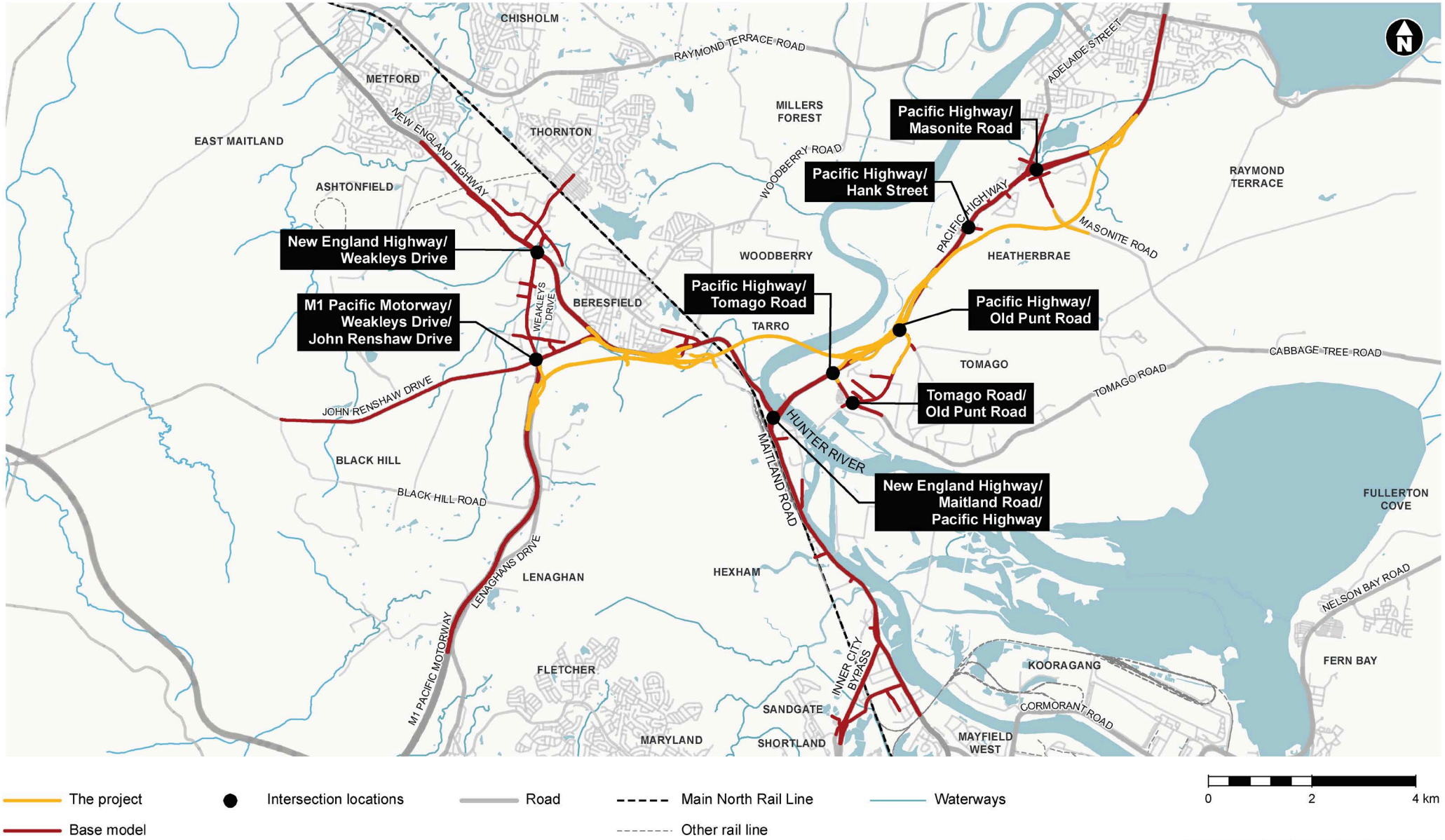

Figure 2-2 ONS modelled and study area (source: ONS, 2017)

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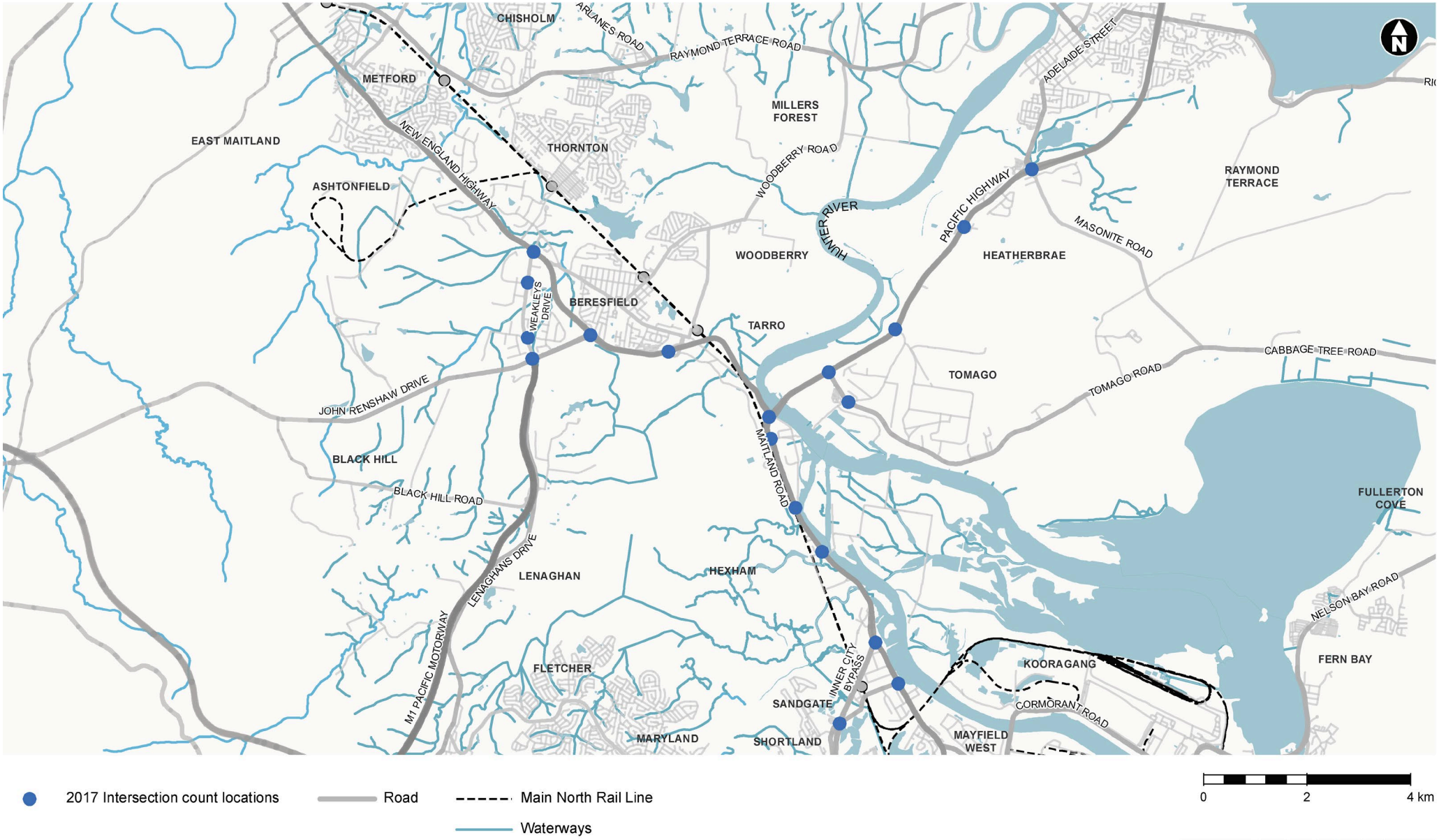

Figure 2-3 Intersection turning movement count locations (source: ONS, 2017)

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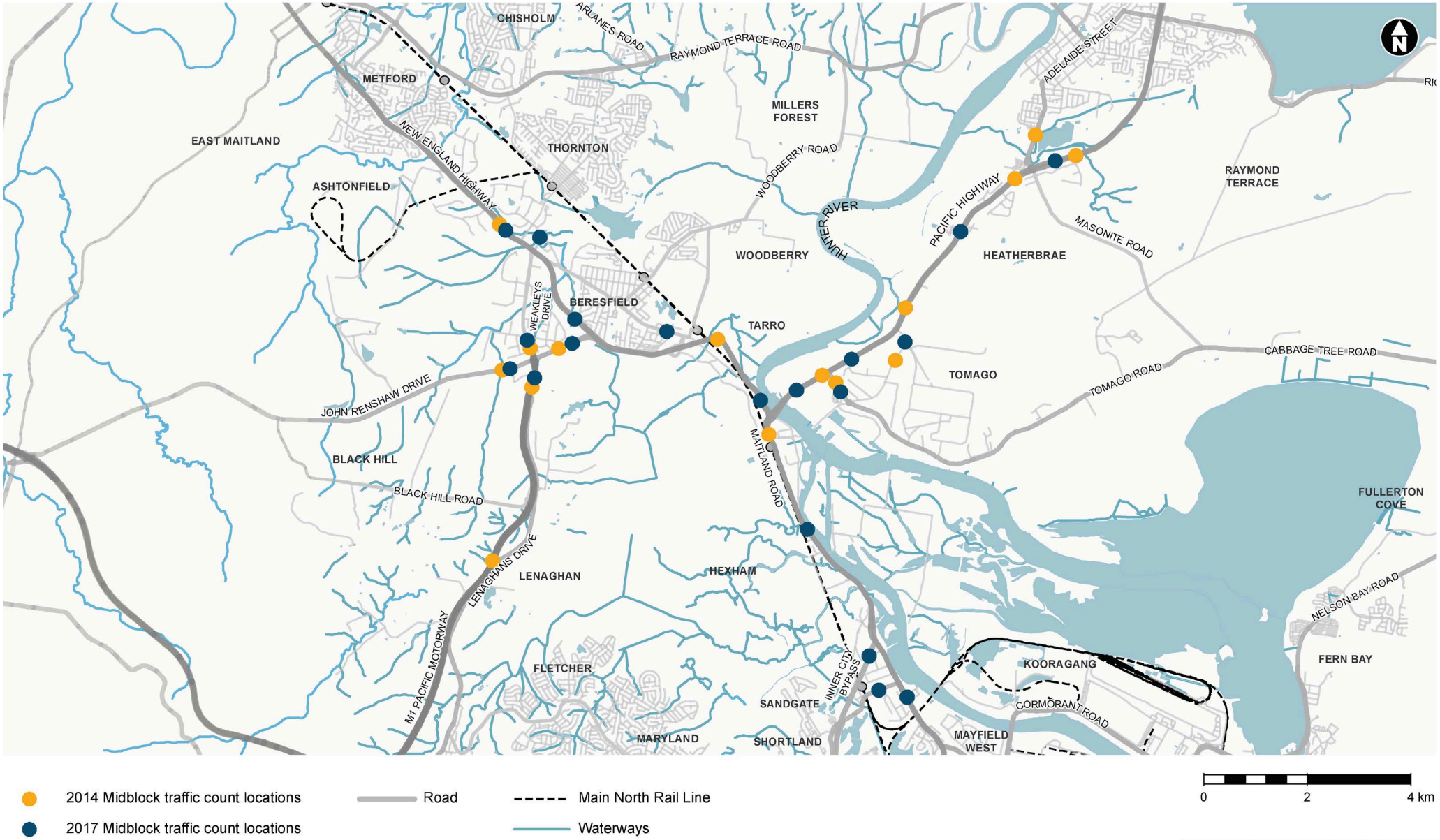

Figure 2-4 Midblock traffic count locations (source: ONS, 2017)

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2.2.3 Sydney Traffic Forecasting Model Review

The updated Sydney Traffic Forecasting Modelling (STFM), which was received from Transport on 25 May 2018, was reviewed in the ONS to confirm that:

- Network coding within the ONS modelling study area is satisfactory
- Traffic origin-destination and associated demands reflect future forecasts.

2.2.4 STFM networking coding updates

Based on the STFM review, the modelled road network within the study area was updated to reflect the existing road geometry, turn restrictions at intersections and road classifications. The travel zone connectivity within the study area was also updated to reflect realistic access to the surrounding road network.

2.2.5 Addressing STFM growth anomalies

The traffic growth between the base year and each forecast year was evaluated for each origin-destination pair. Some anomalies were identified as a result of the following:

- Minimal negative growth was observed between some origin-destination pairs (less than 25 vehicles per hour). Due to the strategic nature of the STFM within the study area, it was assumed that negative growth would not occur and the Origin-Destination (O-D) pairs with negative growth were zeroed out
- Future traffic route choice switching from within the study area to travelling outside of the study area (e.g. trips travelling from Nelson Bay Road using Tomago Road in the base shift to use Cormorant Road in the future). The route switching resulted in negative growth along Tomago Road. Due to the strategic nature of the STFM, it was assumed that an increase in the traffic demand would not enforce such a radical route shift and therefore such negative growth would not occur along Tomago Road
- Adjustments were made to the distribution from the Black Hill employment area to reflect the expected travel patterns.

2.2.6 VISSIM base model development

The ONS developed a microsimulation model to represent 2017 traffic conditions in PTV VISSIM (Version 10.6). The model represents three hours in the morning peak period between 6 and 9am and three hours in the afternoon peak period between 3 and 6pm. Each model was also built with a 30-minute warm-up period to ensure a good representation of traffic conditions at the beginning of the modelling period. The models were calibrated using the following data:

- Classified vehicle turning count data from a survey performed on Wednesday, 18 October 2017
- Classified vehicle midblock count traffic data from a survey performed between Tuesday, 10 October 2017 and Tuesday, 24 October 2017
- Queue length data from surveys performed on the Wednesday, 18 October 2017
- Travel time data from surveys performed on Wednesday, 18 October 2017 and Thursday, 19 October 2017

- Origin-destination data from the survey performed on Tuesday, 7 November 2017
- SCATS detector volume, and phase timing data collected on Wednesday, 18 October 2017.

The 2017 base models for the morning and evening peaks were calibrated and validated in accordance with the Traffic Modelling Guidelines (Roads and Maritime, 2013). The model was endorsed by Transport as fit for the purpose. Full details of the calibration and validation process are described in the Traffic Model Calibration and Validation Report ONS-TA-100-REP-002 which can be found in Appendix A of the Traffic and Transport Working Paper.

2.2.7 Model updates for M1 Pacific Motorway extension to Raymond Terrace

To update the existing calibrated and validated VISSIM model, several small amendments were made to the model to ensure it was suitable to use for the project and to improve model performance. These include:

- Updating the model from PTV VISSIM Version 10.6 to PTV VISSIM Version 20
- Modifying the location of desired decision speed points in the model
- Modifying some lane changing distances in the model
- Updating model connectors
- Modifying some model priority rules.

These changes were implemented as part of the development of future models.

3. Model assumptions and parameters

3.1 Modelling parameters

This section outlines the parameters and assumptions which influenced the traffic modelling and traffic assessment. These are outlined below:

- The year of opening of the project is assumed to be 2028
- The proposal would be assessed for 10 year (2038) and 20 years (2048) post opening
- The proposed 80 per cent concept design was used for the development of the VISSIM model

3.2 Model features

The key features of the project VISSIM model are summarised in **Figure 3-1**.

Model zones	•The VISSIM model covers part of the Newcastle and Port Stephens local government areas (LGAs) in the Hunter Region, north of Newcastle NSW. A total of 52 travel zones are included in the model
Model network	•All state-controlled highways, arterial, distributor and local collector roads are included in the model, some local roads are also included.
Model year	•Calibrated to represent travel conditions in a 2017 base year. •Traffic demand forecasts and networks developed for forecast years 2028, 2038 and 2048.
Time periods	•Peak morning and afternoon three-hour periods: AM (6-9am) and PM (3-6pm).
Vehicle classes	• Light vehicles (Austroads classification 1 and 2) • Medium commercial vehicles (Austroads classification 3 – 5) • Heavy commercial vehicles (Austroads classification 6 – 12)
Trip purpose	•Trip purpose determined by land use, travel demand not defined by trip purpose
Public transport	•Bus services have not been included in the model due to the relatively low levels of bus service in the region.

Figure 3-1 VISSIM model features

3.3 Modelled scenarios

In order to assess the performance of the road network with and without the project and identify the impact of the project, traffic modelling of the following scenarios presented in **Table 3-1** was carried out. Note that the 'without project' scenario is also referred to as the 'without project' scenario in the Traffic and Transport Working Paper.

Table 3-1 Summary of scenarios modelled

Scenario name	Year	The project	Without project upgrades	Description
Base	2017	N	N	Reflects the transport network as it was in 2017 with no new projects or upgrades. The year 2017 was adopted as the existing year, as traffic counts were carried out at this time. The calibration and validation carried out on the base model also ensures the model is representative of real-world conditions
Without project	2028	N	Y	These include the projects specified in **Table 4-6** and provides a model for comparative purposes
Without project	2038	N	Y	
Without project	2048	N	Y	
With project	2028	Y	Y	The projects specified in **Table 4-6** are compared against the future year 'without project' models to determine the impact of the project.
With project	2038	Y	Y	
With project	2048	Y	Y	

4. Future year demand

4.1 Historic traffic growth

Table 4-1 displays traffic count data collected during throughout a two-week period on weekdays at the same location in 2014 and 2017. This data shows some roads have experienced an increase in traffic up to five percent per year, while others have had negative growth.

Traffic volumes were extracted from Transport's traffic volume viewer for four traffic counting stations within the study area to complement the count data. These stations comprised of permanent and temporary traffic counts; thus, data was not available for every year. This data was used to assess the traffic growth within our study area. The average annual daily traffic (AADT) counts for each year are displayed in **Table 4-2**. The results indicate that historically traffic has experienced an increase of about two to three per cent each year. However, the data displays a stagnation of traffic growth since 2015, with the rate of increase reducing to an about one per cent AADT growth.

Table 4-1 Traffic count growth rate comparison for weekday traffic

State road and location	2014 vehicles	2017 vehicles	Growth rate per year
John Renshaw Drive, west of Weakleys Drive	11,600	13,500	5.19%
New England Highway, west of Thornton Road	43,900	42,300	-1.23%
M1 Pacific Motorway, south of John Renshaw Drive	36,000	40,600	4.09%
John Renshaw Drive, west of New England Highway	32,600	32,900	0.31%
Weakleys Drive, north of John Renshaw Drive	20,400	20,900	0.81%
New England Highway, north of Pacific Highway	65,700	61,000	-2.44%
Pacific Highway, south of Old Maitland Road	59,700	56,300	-1.94%
Pacific Highway, north of Hunter River Bridge	49,700	51,900	1.45%
Tomago Road, east of Pacific Highway	15,400	14,200	-2.67%
Pacific Highway north of Masonite Road	23,900	28,300	5.79%
Total	358,900	361,900	0.28%

Table 4-2: Recorded AADT at traffic counting stations within the study area

Location	AADT														Growth rate per year
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	
Pacific Highway, 380 m west of Tomago Road	38,094	38,276*	38,653	39,551	40,500	41,853	42,809	42,992*	42,625	47,342*	47,405*	-	48,614*	48,477	1.9%
New England Highway, 400 m east of Woodlands Close	32,321	35,114*	-	-	-	-	-	-	-	-	32,314*	-	-	-	0.0%
M1 Pacific Motorway, 280 m south of Lenaghans Drive	50,397*	53,005*	52,826	54,787	56,828	57,799*	60,167*	60,303*	64,144*	66,184	-	65,428*	68,402*	-	2.6%
John Renshaw Drive, 570 m west of Kullara Close	-	-	8,048	7,855	8,132	8,941	8,808	8,563*	9,728*	-	-	-	-	-	3.2%

*Indicates traffic data was not recorded for the majority of the year, thus the calculated AADT may be subject to seasonal variation

4.2 Future Black Hill development

The Black Hill employment hub (Black Hill development) is a major development proposed for the region. It is located south of John Renshaw Drive and west of M1 Pacific Motorway, about five kilometres west of the Maitland Road/New England Highway /Pacific Highway intersection. The development is about 300 hectares of net developable area, which is expected to generate substantial traffic volumes onto the adjacent road network. While it is not directly in the study area, it is within the modelled area and trips generated from the development would travel on Maitland Road/Pacific Highway.

4.3 Traffic growth forecasting methodology

The Sydney Traffic Forecasting Model (STFM) was used originally to develop the future growth across the network. The STFM modelling results were analysed and found to overestimate the future growth compared to historical growth rates. As such a 1.5 percent per annum growth rate was adopted which aligns with historic growth in the region. The Black Hill development was not included in future growth of the SFTM therefore a specific assessment and inclusion of future growth for this proposed development was included independently of the yearly growth rate.

The Black Hill development is included in the traffic modelling for future horizon years and it has been assumed that 25 per cent of the development would be complete by 2028, 75 per cent by 2038 and 100 per cent by 2048. The development is a key generator of traffic in the region for future horizon and accounts for about 11 per cent of all trips in the study area by 2038 and 12 per cent by 2048.

The Black Hill development traffic distribution developed in phase 2 of the ONS and adopted for this assessment is displayed in **Table 4-3**.

Table 4-3 Trip distribution from the Black Hill development

Direction	Route	In	Out
South	M1 Pacific Motorway	35%	20%
West	John Renshaw Drive	20%	20%
East	John Renshaw Drive then Pacific Highway (North)	5%	20%
	John Renshaw Drive then Pacific Highway (South)	20%	20%
North	Weakleys Drive	20%	20%

Table 4-4 displays the growth rate assumptions and trips generated from the Black Hill development used to develop the traffic demand matrices for the modelled years.

Table 4-4 Traffic growth rate assumptions

Modelled year	Background growth (both peaks)	Black Hill development	Morning peak Black Hill development trips	Evening peak Black Hill development trips
2017 (base)	N/A	0% of development complete	0	0
2028 (opening year)	1.5%	25% of development complete	1,882	2,159
2038 (future horizon)	1.5%	75% of development complete	5,646	6,476
2048 (future horizon)	1.5%	100% of development complete	7,528	8,635

The trip matrices for years 2028, 2038 and 2048 were developed in a two-stage process. First, the capped growth rates identified as part of the ONS were applied across the network trip matrices. This was followed by adding trips generated from the Black Hill development using the trip generation rates and the trip distribution pattern identified in phase 2 of the ONS. This process is displayed in **Figure 4-1**.

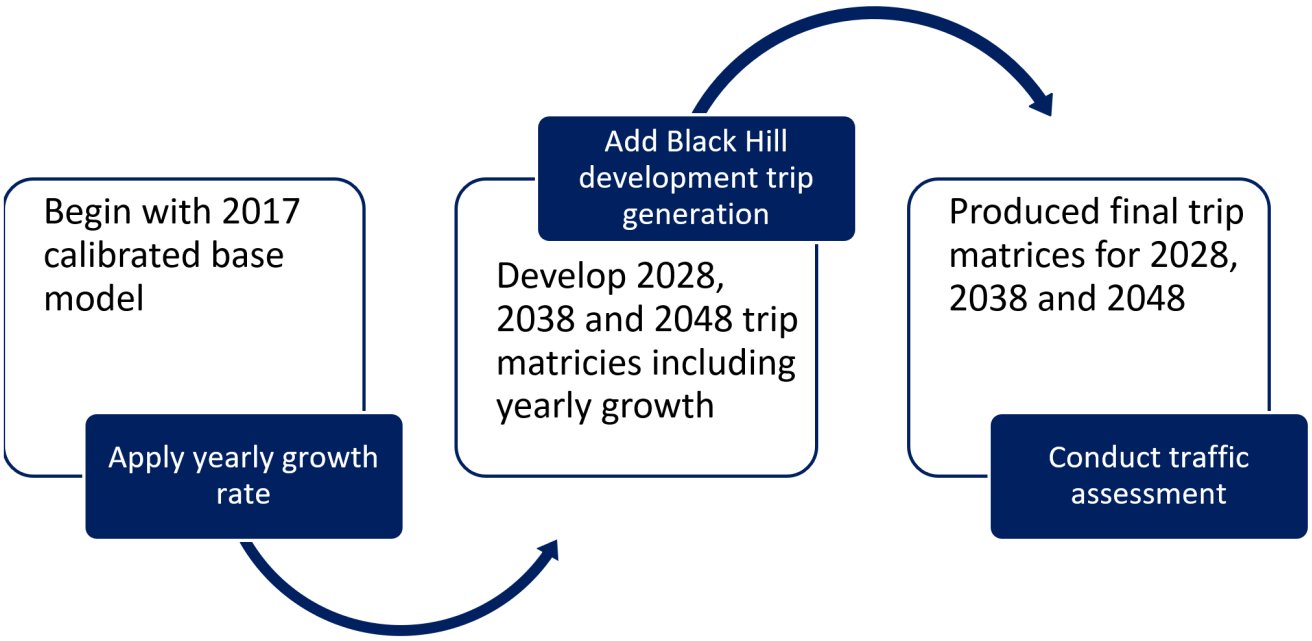

Figure 4-1 Process to develop trip matrices

4.3.1 Daily and seasonal variation in traffic volumes

A Transport permanent count station (ID 05001) located on Pacific Highway, 380 metres west of Tomago Road in Tomago, was used to assess daily and seasonal variations in traffic volumes in 2019. In summary, weekday traffic volumes are higher than weekend traffic volumes, and school holiday volumes are higher than weekend volumes but less than weekday volumes. **Table 4-5** provides a comparison between the AADT and the annual average traffic volumes for weekdays, weekends and school holiday periods.

Table 4-5 Seasonal variation in traffic at traffic counter station 05001

Permanent count station	AADT	% of AADT		
		Annual average weekday	Annual average weekend	Annual average school holiday
Pacific Highway	48,564 (2017)	52,542 (110% of AADT)	36,399 (81% of AADT)	45,599 (107% of AADT)

Figure 4-2 shows the seasonal profiles of traffic at the permanent count station. The data shows seasonal fluctuations in traffic volumes with peaks that coincide with the Christmas/New Year period, Easter and the July and October school holidays. The average daily traffic volume during these periods is substantially higher than the average for the year.

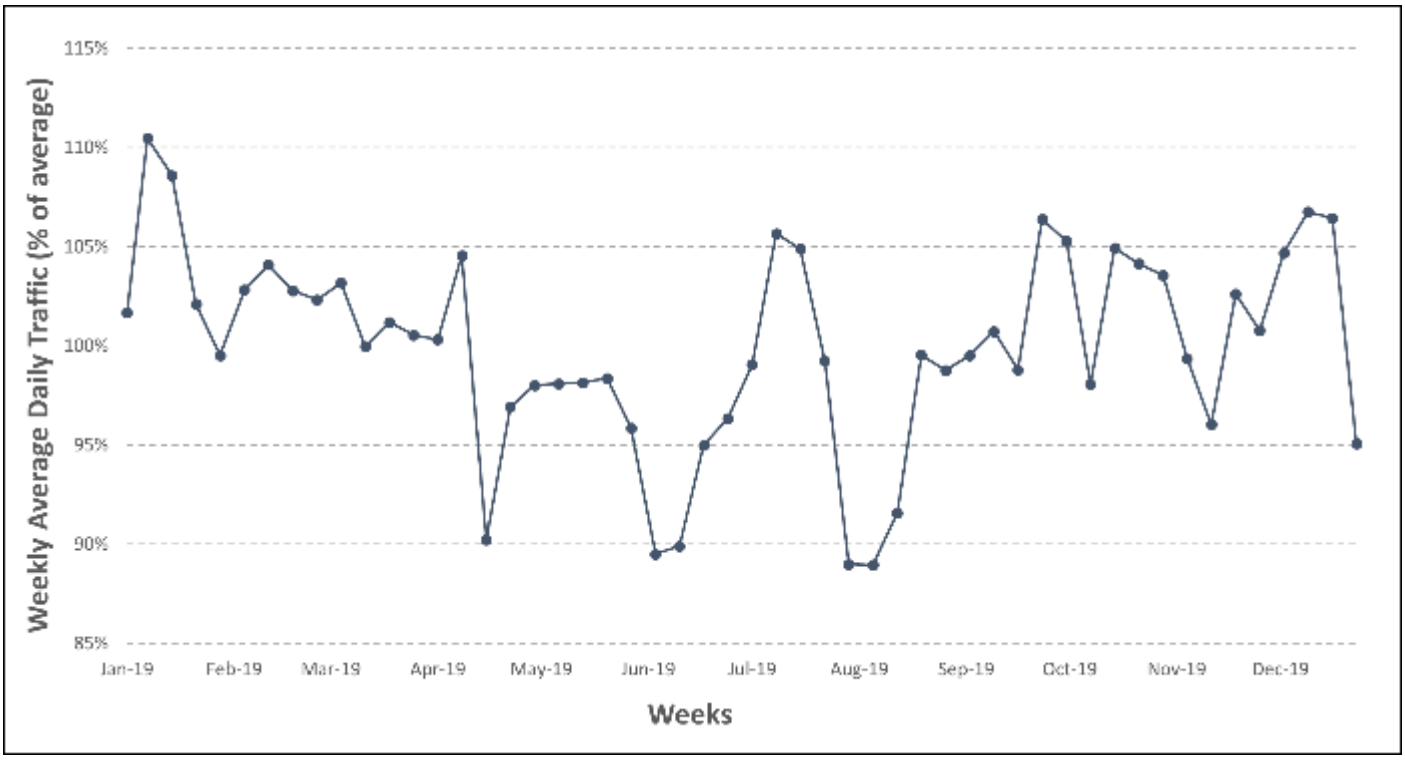

Figure 4-2 Weekly traffic volumes from traffic counter station 05001 in 2019

4.4 Expansion factors

The traffic modelling was carried out for peak periods, which can then be expanded into daily demand by applying appropriate factors. The factors consider the traffic volumes during non-peak hours and weekends relative to peak volumes, road use and location.

Daily expansion factors have been derived from the traffic survey used to inform the traffic modelling outputs. Observations of traffic volumes in the peak periods of 6am to 9am and 3pm to 6pm are compared to the total daily volume to calculate the daily expansion factor for each road in the traffic mode.

The expansion factor to expand daily volumes to annual demand is 345, in accordance with TfNSW guidance[1].

[1] TfNSW parameter workbook Table 53

4.5 'Without project' upgrades

The implementation of 'without project' upgrades provides a baseline against which future scenarios can be compared against to understand the project impact. The 'without project' models represent the envisaged network and demand conditions in a scenario where the project option is not built.

An assessment of the required future 'without project' upgrades was carried out as part of the project. This involved iteratively adding 'without project' upgrades until the future model performed adequately. The 'without project' model development process is shown in **Figure 4-3**.

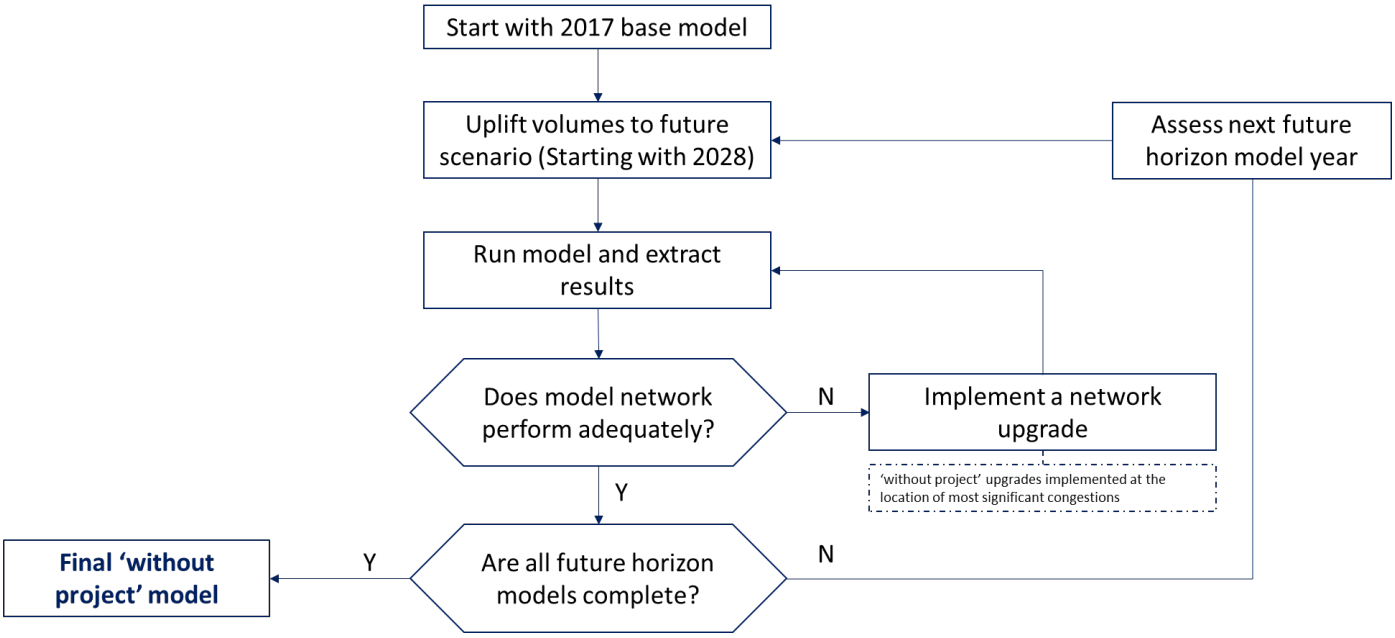

Figure 4-3 'Without project' model development process

The following projects were identified as 'without project' upgrades and included in the 'without project' model:

- **Maitland Road Upgrade** by providing an additional northbound lane south of Wallsend Road
- **Weakleys Drive Upgrades** which include the duplication of Weakleys Drive, from Enterprise Drive to Canavan Drive, and the signalisation of Weakleys Drive/Enterprise Drive and Weakleys Drive/Canavan Drive
- **John Renshaw Drive/Weakleys Drive Intersection Upgrade** which includes double right turn lanes from the west and north approach
- **Duplication of John Renshaw Drive** between Weakleys Drive and the Black Hill development access roads
- **Freeway Ramp signals on the Anderson Drive** eastbound onramp
- **Hexham Straight** which includes the widening of six kilometres of Maitland Road/Pacific Highway between Sandgate and Hexham
- **Removal of roundabouts at the Thornton Road/Glenwood Drive intersection and the Weakleys Drive/Glenwood Drive intersection** to ensure traffic enters the model. This project was identified and implemented for modelling purposes only to ensure vehicles were able to enter the traffic model and were not limited by intersections outside the project scope.

The Hexham Straight project has a funding commitment to proceed, while all other projects implemented in the 'without project' model are projects without funding commitment. However, these other projects were considered to ensure robust modelling and address future traffic demand.

Table 4-6 Summary of 'without project' upgrades

'Without project' project upgrades	Modelled years		
	2028	2038	2048
Maitland Road Upgrade	×	✓	✓
Weakleys Drive Upgrades	×	✓	✓
John Renshaw Drive/Weakleys Drive Intersection Upgrade	✓	✓	✓
Duplication of John Renshaw Drive	✓	✓	✓
Freeway Ramp signals on the Anderson Drive	×	✓	✓
Hexham Straight	✓	✓	✓
Removal of roundabouts at the Thornton Road/Glenwood Drive intersection and the Weakleys Drive/Glenwood Drive intersection[1]	×	✓	✓

[1]This Without project upgrade was implemented for modelling purposes only. It is not considered a necessary project for the future.

5. Base model operational results

5.1 Assessment criteria

Modelling operational traffic provides an overview of the performance of the road network while indicating the impact of the project during operation. This impact can be seen either across the network or at individual locations (i.e. an intersection).

The performance of operational traffic is assessed in several ways, including:

- At a network level:
  - This includes total throughput, total time travelled within the modelled network, total distance travelled, average speed total vehicle stops and latent demand.
- At a single point:
  - At an intersection level, which is calculated from the average delay for vehicles
  - At an interchange level, which is calculated from the density of traffic and the capacity of the entry ramp.

The sections below detail the operational traffic assessment criteria in further detail.

Network performance criteria

Road network performance can be assessed with network-wide statistics. These statistics are extracted from the traffic model for the morning and evening peak periods and include:

- **Total throughput**, which is the number of vehicles that complete their trip through the model area within the modelled periods
- **Total vehicle hours travelled** in the model area (VHT)
- **Total vehicle kilometres travelled** across the model area (VKT)
- **Average network travel speed**, which is the average speed (kilometres per hour) of vehicles in the model area during the modelled periods
- **Total stops**, which is the cumulative total of every instance when a vehicle comes to a stop within the network. A stop is defined as a vehicle's speed dropping below five kilometres per hour until it accelerates to above ten kilometres per hour
- **Latent demand**, which is the total number of vehicles that cannot enter the model due to model constraints such as congestion.

The above statistics are used to compare the performance of each modelled scenario across the assessment periods and horizon years. VHT and VKT are secondary measures as they can vary depending on the network layout for each scenario. Presenting VHT and VKT in isolation can be misleading and they need to be considered in the context of network performance. For this reason, average network travel speed was used as a primary performance metric.

Single point performance criteria

Level of Service performance targets

LoS D is the generally accepted target performance level. If the performance of an intersection, interchange or midblock segment falls below LoS D, investigations should be initiated to determine if suitable

remediation can be provided. However, limited road capacity and high demand mean that LoS E and LoS F are regularly experienced by motorists, particularly during peak periods.

Intersection Level of Service

The performance of an intersection and its LoS is determined by the average delay per vehicle (d). The performance criteria for intersections is shown in **Table 5-1**

Table 5-1 LoS criteria for intersections

LoS	Average delay per vehicle (d) in seconds		
	Unsignalised intersections	Roundabouts	Signalised intersections
A	d ≤ 10	d ≤ 10	d ≤10
B	10 < d ≤ 15	10 < d ≤ 20	10 < d ≤ 20
C	15 < d ≤ 25	20 < d ≤ 35	20 < d ≤ 35
D	25 < d ≤ 35	35 < d ≤ 50	35 < d ≤ 55
E	35 < d ≤ 50	50 < d ≤ 70	55 < d ≤ 80
F	50 < d	70 < d	80 < d

Source: Austroads, Guide to Traffic Management Part 3: Traffic Studies and Analysis, *2017*

Interchange Level of Service

All movements onto and off motorways are made via interchanges, which are designed to permit relatively high-speed merging and diverging manoeuvres while limiting the disruption to the main traffic stream. The evaluation of an interchange considers vehicle interactions that occur within 450 metres of the interchange to calculate a LoS. Interchange road segments are classified as either a merge, diverge or weave and each segment type is evaluated in accordance with the Motorway design guide: Capacity and flow analysis (Roads and Maritime Services, 2017) and the Highway Capacity Manual (Transportation Research Board, 2016). The traffic flows are recorded in Passenger Car Unit (PCU) per hour to estimate the densities of vehicles in the influence area. The classification criteria for an interchange is outlined in **Table 5-2**.

Table 5-2 LoS criteria for basic freeway segments

LoS	Density (pcu/km/lane)	
	Merge and diverge segment	Freeway weaving segment
A	≤ 6	≤ 6
B	> 6–12	> 6–12
C	> 12–17	> 12–17
D	> 17–22	> 17–22
E	> 22	> 22–27
F	Demand exceeds capacity (Volume/Capacity > 1)	> 27 or demand exceeds capacity

Source: Austroads, Guide to Traffic Management Part 3: Traffic Studies and Analysis, *2017*

Ramp metering requirement

Assessment of the requirement for the provision of ramp metering was carried out in line with the Smart Motorway Design Guide: Capacity and Flow Analysis (Roads and Maritime 2015) and Smart Motorway Guidelines (Roads and Maritime 2015). As stated in the guidelines, ramp metering is warranted if peak

hour volumes per lane are greater than 1,700 PCU per hour per lane or if future peak-hour traffic volumes would be greater than 1,700 PCU per hour per lane within ten years on the main alignment.

5.2 Traffic volumes

Traffic surveys were carried out between 10 October 2017 and 23 October 2017 at various locations in the study area to gain an understanding of daily traffic volumes and traffic composition. The average daily traffic volumes observed on key routes throughout the network are presented in **Figure 5-1**. Modelled volumes for each peak hour in 2017 can be viewed in **Appendix A.**

5.3 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 across the assessment periods and horizon years. **Table 5-3** displays the network statistics extracted from the 2017 base VISSIM model.

Table 5-3 2017 network statistics

Network statistic	2017 Base	
	Morning peak	Evening peak
Total throughput (veh)	36,579	43,379
VHT	6,578	8,307
VKT	400,436	460,853
Network speed (km/h)	61	56
Total stops	170,395	251,922
Latent demand (veh)	1	693

The results indicate the evening peak has a greater traffic demand then the morning peak period, which is displayed by higher VHT, VKT and the total number of stops in the evening peak. Ultimately, this leads to a lower network speed in the evening peak compared to the morning peak. Furthermore, almost 700 vehicles are unreleased in the evening, demonstrating congestion is present in the evening period under existing conditions.

5.4 Travel time

Travel times and travel speeds provide a means of assessing the functional performance of the road network in a way that is consistent with the experience of road users during day-to-day travel.

Travel times between the five key locations shown in **Figure 5-2** were extracted from the 2017 base model as part of the ONS. **Table 5-4** and **Table 5-5** display the recorded travel times for the morning peak period and evening peak period respectively.

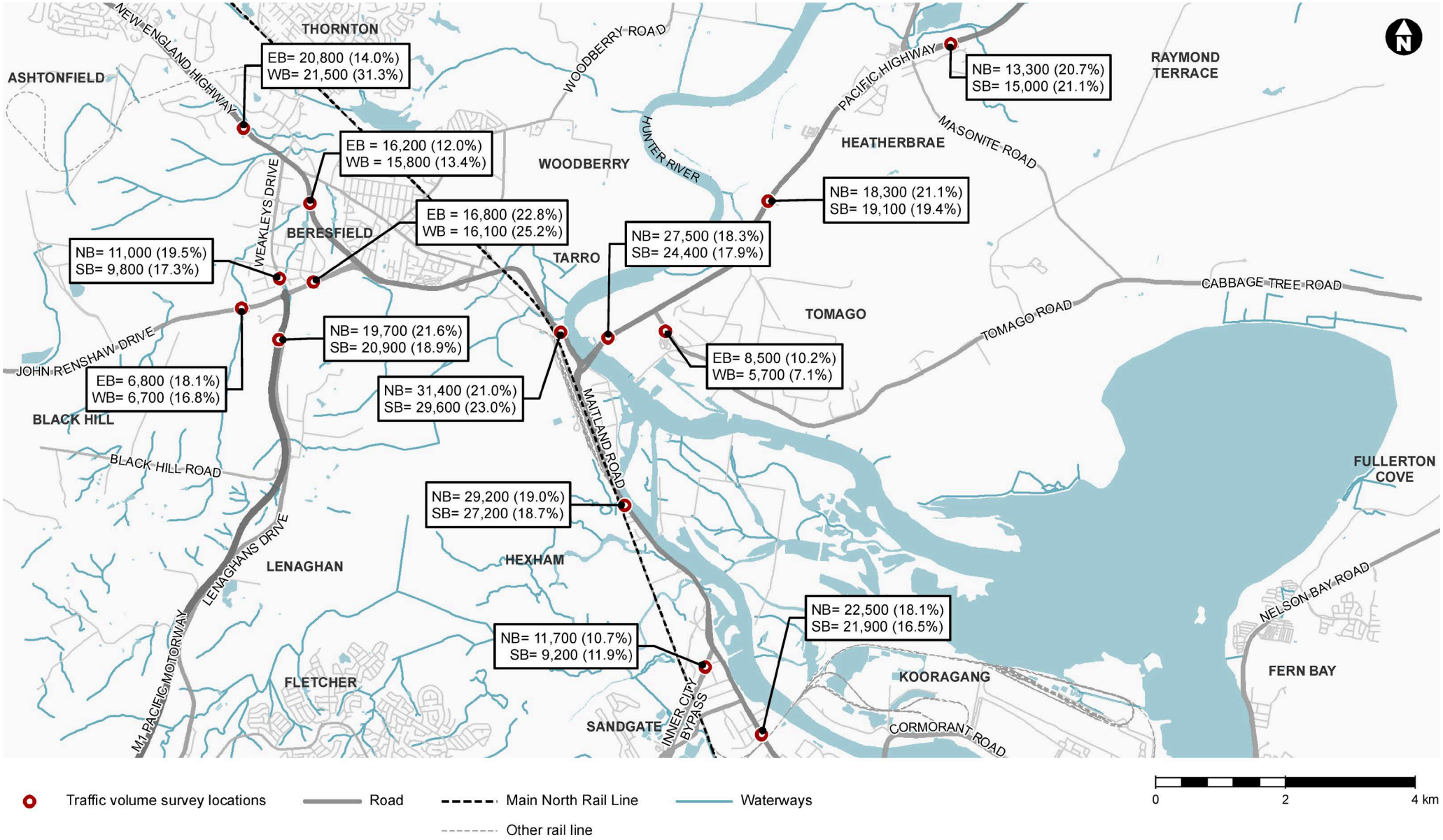

Figure 5-1 Daily traffic volumes of key routes in the network

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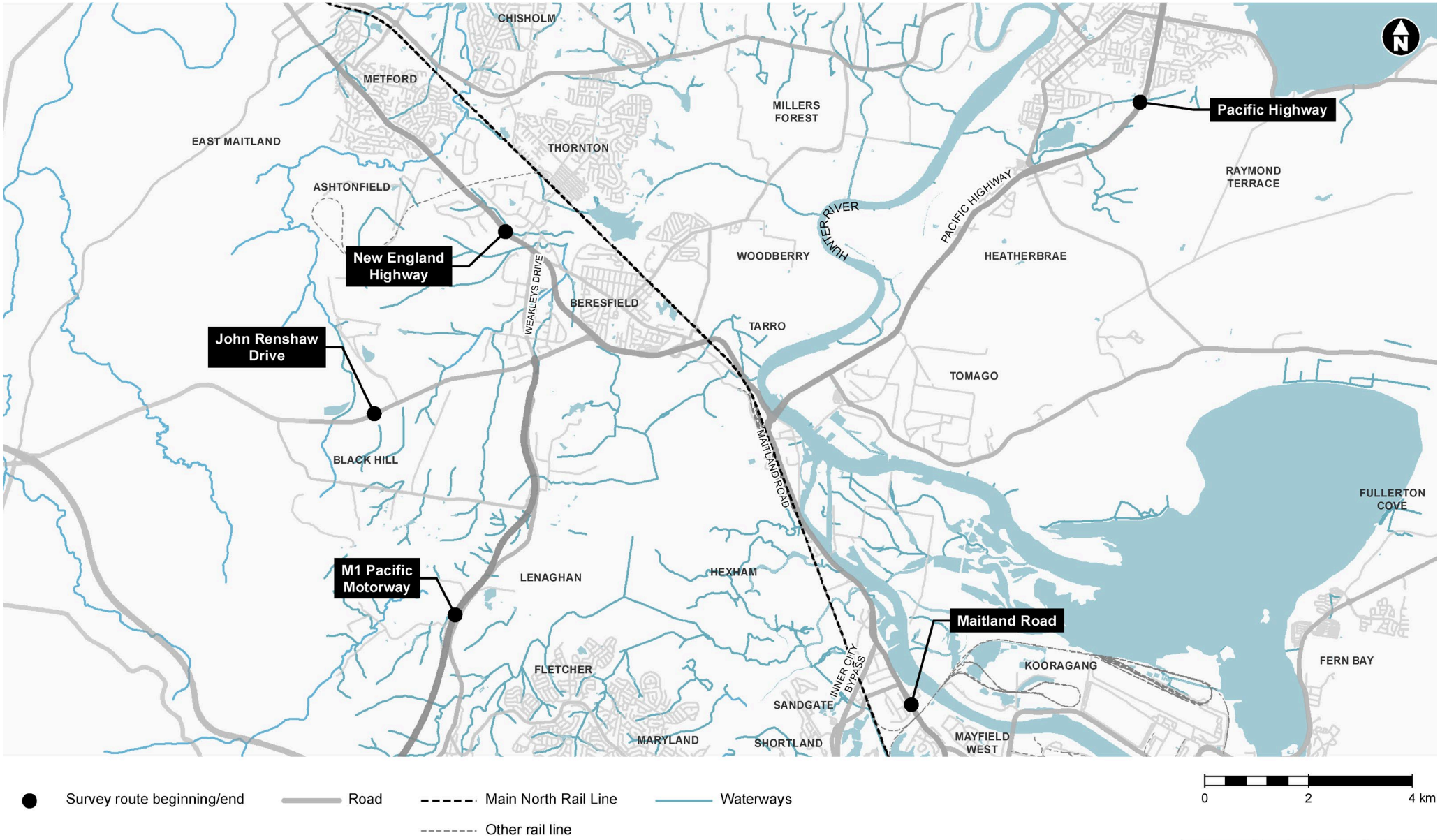

Figure 5-2 Location of travel time gateways in the modelled network

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Table 5-4 Existing travel time and speed – morning peak period

From	To	Distance (km)	2017 Base Model travel time			2017 Base Model speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
New England Hwy	M1 Pacific Motorway South	8.5	07:29	07:31	07:55	68	68	65
	John Renshaw Drive West	5.9	06:12	06:07	06:36	57	58	53
	Maitland Road South	13.5	-	-	18:26			44
	Pacific Highway East	16.3	13:13	14:55	14:47	74	66	66
	Newcastle Inter City Bypass	14.2	12:38	15:13	15:59	67	56	53
	Tomago Road	11.1	10:42	12:20	12:29	62	54	53
	Adelaide Street	14.8	12:12	14:18	14:15	73	62	62
M1 Pacific Motorway South	New England Hwy	8.5	06:59	06:56	07:06	73	74	72
	John Renshaw Drive West	8.9	06:00	06:04	06:02	89	88	88
	Maitland Road South	17.9	-	-	-			
	Pacific Highway East	20.7	16:21	17:30	18:52	76	71	66
	Newcastle Inter City Bypass	18.6	15:55	18:30	20:39	70	60	54
	Tomago Road	15.5	13:59	15:19	19:46	67	61	47
	Adelaide Street	19.2	15:36	18:05	18:04	74	64	64
John Renshaw Drive West	New England Hwy	5.8	05:21	05:26	05:40	65	64	61
	M1 Pacific Motorway South	9.0	06:25	06:40	06:27	84	81	83
	Maitland Road South	15.2	-	-	-			
	Pacific Highway East	18.0	14:53	16:24	17:42	73	66	61
	Newcastle Inter City Bypass	15.8	14:15	17:06	20:57	67	56	45
	Tomago Road	12.8	12:29	14:10	17:51	61	54	43
	Adelaide Street	16.4	14:13	17:24	17:57	69	57	55
	Adelaide Street	14.4	18:36	19:00	19:13	46	45	45
Pacific Highway East	New England Hwy	16.6	15:48	16:08	16:19	63	62	61
	M1 Pacific Motorway South	20.9	18:51	19:02	19:03	66	66	66
	John Renshaw Drive West	18.2	17:20	17:22	17:31	63	63	62
	Maitland Road South	15.9	-	-	-			
	Newcastle Inter City Bypass	16.6	16:27	16:45	17:27	60	59	57
	Tomago Road	10.5	10:17	10:45	10:20	61	58	61
	Adelaide Street	3.2	02:49	02:53	02:58	68	67	65
Newcastle Inter City Bypass	New England Hwy	14.2	12:28	12:44	12:47	68	67	67
	M1 Pacific Motorway South	18.5	15:22	15:34	15:43	72	71	70
	John Renshaw Drive West	15.8	13:58	14:10	14:14	68	67	67
	Maitland Road South	2.4	-	-	-			
	Pacific Highway East	16.6	14:42	14:50	15:04	68	67	66
	Tomago Road	11.4	12:14	12:04	12:06	56	57	57
	Adelaide Street	15.0	13:51	14:01	14:22	65	64	63

From	To	Distance (km)	2017 Base Model travel time			2017 Base Model speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
Tomago Road	New England Hwy	11.4	11:14	11:22	11:39	61	60	59
	M1 Pacific Motorway South	15.6	14:19	14:15	14:20	66	66	65
	John Renshaw Drive West	13.0	12:48	13:00	13:18	61	60	59
	Maitland Road South	10.7	-	-	-			
	Pacific Highway East	10.6	10:25	10:53	10:53	61	58	58
	Newcastle Inter City Bypass	11.3	-	-	-			
	Adelaide Street	9.0	-	-	-			
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	15:11	15:15	15:28	60	60	59
	M1 Pacific Motorway South	19.4	18:17	17:47	18:14	64	65	64
	John Renshaw Drive West	16.7	17:22	16:19	17:16	58	62	58
	Maitland Road South	14.4	17:55	17:13	19:19	48	50	45
	Pacific Highway East	3.1	02:35	02:21	02:47	71	78	66
	Newcastle Inter City Bypass	15.1	15:42	15:52	17:00	58	57	53
	Tomago Road	9.0	-	-	09:45			55

Table 5-5 Existing travel time and speed – evening peak period

From	To	Distance (km)	2017 Base Model travel time			2017 Base Model speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
New England Hwy	M1 Pacific Motorway South	8.5	07:50	11:57	15:41	65	43	33
	John Renshaw Drive West	5.9	06:30	11:26	15:52	54	31	22
	Maitland Road South	13.5	-	-	-			
	Pacific Highway East	16.3	13:49	13:51	13:26	71	71	73
	Newcastle Inter City Bypass	14.2	13:42	14:10	13:31	62	60	63
	Tomago Road	11.1	10:20	10:16	09:57	65	65	67
	Adelaide Street	14.8	13:00	13:05	12:44	68	68	70
M1 Pacific Motorway South	New England Hwy	8.5	07:05	07:28	07:13	72	68	71
	John Renshaw Drive West	8.9	06:07	06:27	06:24	87	82	83
	Maitland Road South	17.9	-	-	-			
	Pacific Highway East	20.7	17:08	17:37	16:52	73	71	74
	Newcastle Inter City Bypass	18.6	17:29	17:38	17:06	64	63	65
	Tomago Road	15.5	13:35	14:02	13:51	69	66	67
	Adelaide Street	19.2	16:24	17:04	16:13	70	67	71
John Renshaw Drive West	New England Hwy	5.8	05:30	05:52	05:28	63	59	64
	M1 Pacific Motorway South	9.0	06:19	06:31	06:16	85	82	86
	Maitland Road South	15.2	-	-	-			
	Pacific Highway East	18.0	15:30	15:51	15:13	70	68	71
	Newcastle Inter City Bypass	15.8	15:11	16:00	15:21	63	59	62
	Tomago Road	12.8	12:02	12:09	11:54	64	63	64
	Adelaide Street	16.4	14:43	15:11	14:38	67	65	67
	Adelaide Street	14.4	17:34	21:16	17:34	49	41	49

From	To	Distance (km)	2017 Base Model travel time			2017 Base Model speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
Pacific Highway East	New England Hwy	16.6	17:23	17:51	16:26	57	56	61
	M1 Pacific Motorway South	20.9	20:18	21:13	19:31	62	59	64
	John Renshaw Drive West	18.2	18:40	19:41	17:24	59	56	63
	Maitland Road South	15.9	-	-	-			
	Newcastle Inter City Bypass	16.6	18:07	18:32	16:53	55	54	59
	Tomago Road	10.5	11:32	10:47	10:05	55	58	62
	Adelaide Street	3.2	02:50	02:49	02:40	68	68	72
Newcastle Inter City Bypass	New England Hwy	14.2	15:31	18:07	14:07	55	47	60
	M1 Pacific Motorway South	18.5	18:10	21:47	16:51	61	51	66
	John Renshaw Drive West	15.8	16:59	19:46	15:47	56	48	60
	Maitland Road South	2.4	-	-	-			
	Pacific Highway East	16.6	17:32	19:39	15:55	57	51	63
	Tomago Road	11.4	14:17	17:32	12:21	48	39	55
	Adelaide Street	15.0	16:33	18:51	15:17	55	48	59
Tomago Road	New England Hwy	11.4	12:30	13:49	11:53	55	49	57
	M1 Pacific Motorway South	15.6	15:04	16:44	15:01	62	56	62
	John Renshaw Drive West	13.0	13:43	15:27	13:29	57	50	58
	Maitland Road South	10.7	-	-	-			
	Pacific Highway East	10.6	11:31	11:29	10:52	55	55	58
	Newcastle Inter City Bypass	11.3	-	-	-			
	Adelaide Street	9.0	10:33	11:05	-	51	49	
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	16:40	17:24	15:38	54	52	58
	M1 Pacific Motorway South	19.4	19:23	20:29	18:48	60	57	62
	John Renshaw Drive West	16.7	17:53	19:04	17:10	56	53	59
	Maitland Road South	14.4	20:19	19:14	16:37	43	45	52
	Pacific Highway East	3.1	02:39	03:04	02:43	69	60	67
	Newcastle Inter City Bypass	15.1	17:28	18:13	16:26	52	50	55
	Tomago Road	9.0	10:38	-	09:30	51		57

On Pacific Highway, travel times for north-eastbound traffic are shorter than travel times for south-westbound traffic. This can be attributed to the additional delays experienced by southbound traffic at the New England Highway/Pacific Highway, Pacific Highway/Tomago Road and Pacific Highway/Old Punt Road intersections. These are described below:

- **New England Highway/Pacific Highway intersection** – the left-turn movement from the New England Highway to Pacific Highway is uncontrolled and therefore is not subject to delays from traffic signals. In contrast, the right turn movement from Pacific Highway to the New England Highway requires traffic to pass through the traffic signals
- **Pacific Highway/Tomago Road intersection** – north-eastbound traffic is delayed only when the pedestrian phase is called for the pedestrian crossing that spans Pacific Highway. Traffic signal data indicates the pedestrian phase is called infrequently. Due to the intersection configurations, southbound traffic is required to stop to allow movements to and from Tomago Road

- **Pacific Highway/Old Punt Road intersection** – operates as a signalised seagull intersection and therefore north-eastbound traffic is not required to stop at the traffic signals. South-westbound traffic is required to stop when traffic signal phasing allows movements to and from Old Punt Road.

Average travel speeds range between 66 to 76 kilometres per hour for north-eastbound traffic and 56 to 66 kilometres per hour for south-westbound traffic.

5.5 Intersection performance

The traffic modelling results from the calibrated and validated 2017 base model were extracted to gain an understanding of current performance for intersections presented in **Figure 5-3**.

Intersection delays and LoS for these key intersections within the study area for the morning and afternoon peak periods is provided in **Table 5-6**. These results are based on modelled average delay for each hour in the VISSIM model.

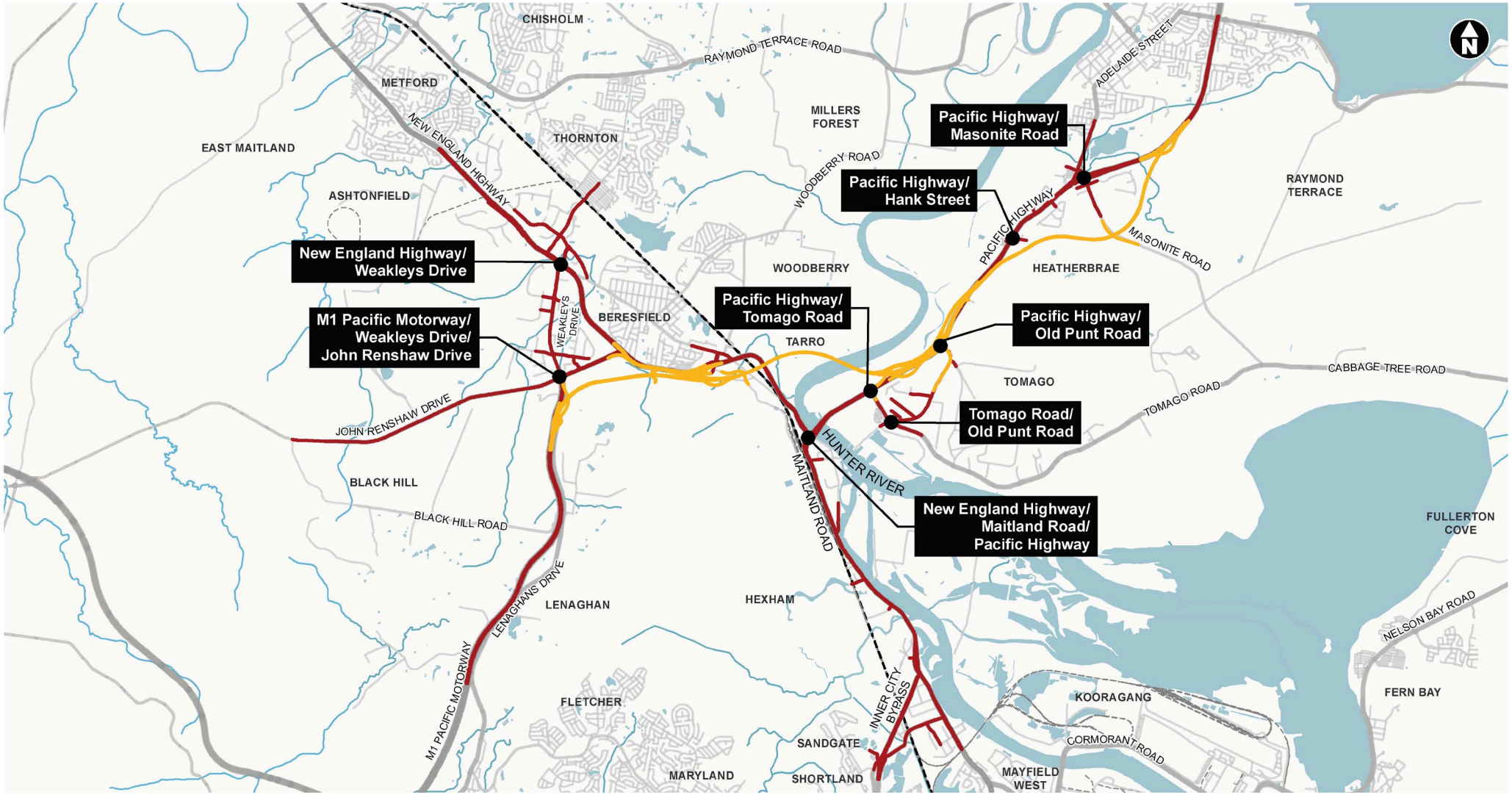

Figure 5-3 Location of intersections assessed in the traffic model

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Table 5-6 Performance of modelled intersections in 2017

Intersection	Type	Morning						Evening					
		6-7am		7-8am		8-9am		3-4pm		4-5pm		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
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised*	18	B	17	B	27	C	15	B	57	E	63	E
New England Highway/Weakleys Drive, Beresfield	Signalised	10	B	9	A	11	B	16	B	19	B	18	B
New England Highway/Maitland Road/Pacific Highway	Signalised	16	B	19	B	19	B	29	C	42	D	19	B
Pacific Highway/Tomago Road, Tomago	Signalised	32	C	19	B	15	B	29	C	35	C	11	B
Pacific Highway/Old Punt Road, Tomago	Signalised	15	B	15	B	18	B	34	C	19	B	10	B
Old Punt Road/Tomago Road, Tomago	Roundabout	5	A	4	A	4	A	2	A	2	A	1	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	8	A	11	B	11	B	18	B	21	C	10	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	7	A	10	B	16	B	17	B	10	A

** At the time of the traffic data collection exercise and the construction of the base model, the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection was a roundabout. The intersection has since been upgraded to a signalised intersection*

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

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6. Option operational results

6.1 Traffic volumes

Modelled peak hour traffic volumes for the various scenarios are presented and **Figure 6-1** (2028, 2038 and 2048 scenarios 'with project'). **Figure 6-2** displays the forecast daily traffic volumes.

Analysis of the modelled traffic flows in 2028 with the project shows the following key impacts throughout the network:

- Substantial reductions in traffic flows are likely on John Renshaw Drive east of Weakleys Drive, with a reduction up to 13 per cent in the morning peak (8-9am) and 19 per cent in the evening peak (5-6pm). This reduction occurs as the project provides an alternative route which vehicles use to travel west-east
- The New England Highway to the west and the Pacific Highway to the east of the existing Hexham bridge are likely to see substantially reduced traffic flow as a result of the project. These locations are expected to see a reduction in traffic flow between 20 to 45 per cent. The reduction in traffic occurs as vehicles use the project as an alternative east-west route
- The largest reduction in traffic in 2028 is expected to occur on Pacific Highway west of Masonite Road, which is likely to experience a 52 per cent reduction in traffic flow in both peak periods. The project would result in a shift in traffic flow from the Pacific Highway to the new motorway reducing traffic through Heatherbrae
- In 2028, the volume of traffic travelling on Old Punt Road would substantially increase in the evening peak period (109 per cent increase) as a result of the project. This outcome is expected to occur due to the improved connectivity to the project. This increase in traffic on Old Punt Road correlates with a decrease in traffic travelling on Tomago Road, as the improved connectivity from Old Punt Road provides an alternative route for vehicles.

Analysis of the 2038 and 2048 volumes show a similar pattern with a reduction in daily traffic on John Renshaw Drive, New England Highway and Pacific Highway. The future horizons also display an increase in traffic on the existing M1 Pacific Motorway, south of Weakleys Drive. This increase is expected as the project provides greater capacity for north and southbound traffic which reduces the unreleased trips that occur in the 'without project' traffic model.

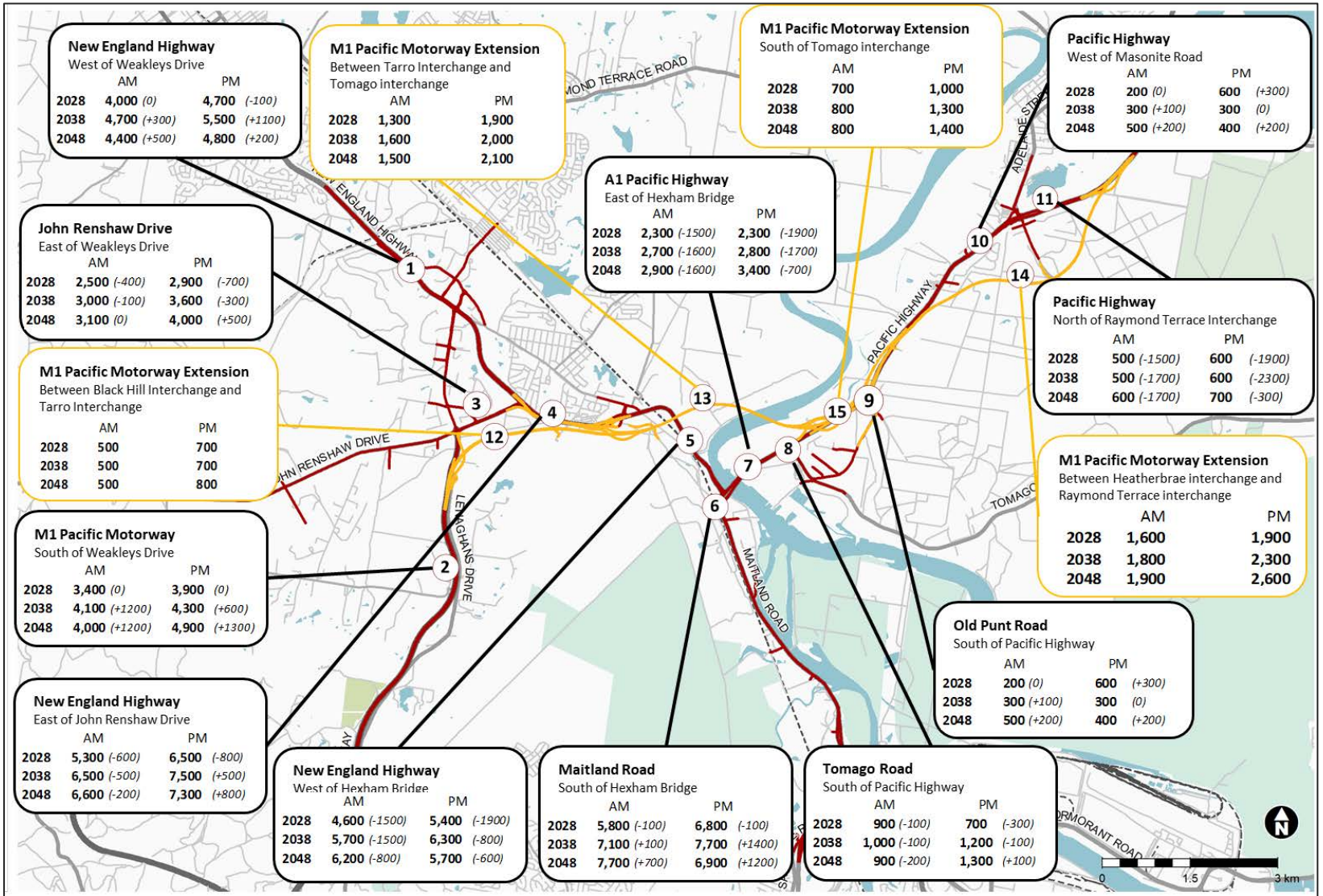


Figure 6-1 Peak period traffic volumes (8am to 9am and 5pm to 6pm)

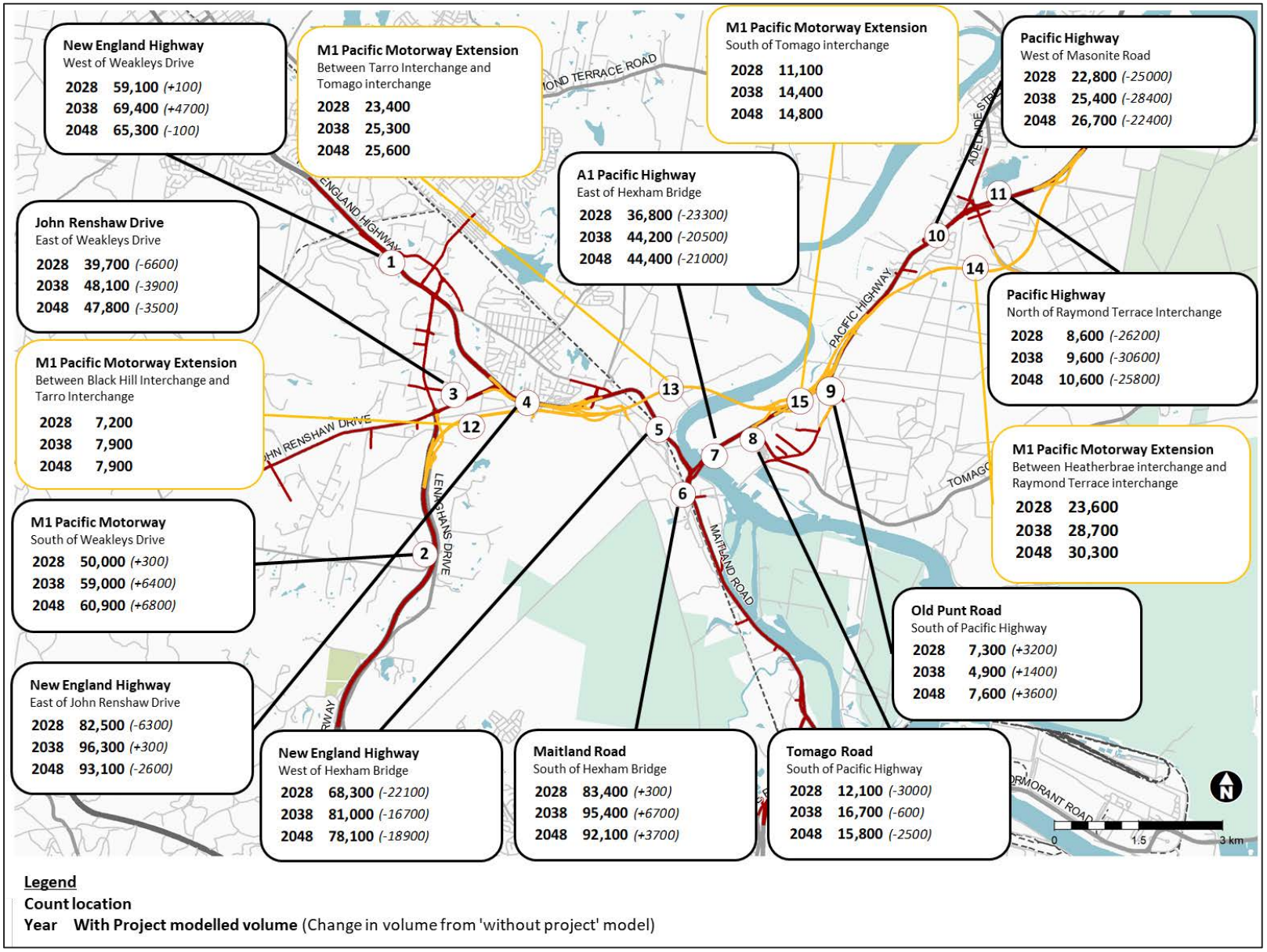


Figure 6-2 Forecast daily traffic volumes with project

6.2 Network statistics

A comparison of network statistics between the 'without project' and 'with project' scenarios are provided in **Table 6-1** for 2028, **Table 6-2** for 2038 and **Table 6-3** for 2048.

Comparison of the 'without project' and 'with project' scenarios for the 2028 horizon year shows the following:

- Substantial increase in average network speed, particularly during the evening peak period. Forecast average network speed is likely to increase by 10 per cent
- VKT remains constant across the 'without project' and 'with project' options. However, there is a substantial reduction in VHT of up to 10 per cent. These improvements, coupled with the constant total throughput between the 'without project' and 'with project' models, indicate vehicles can complete the same quantity of trips but in a faster manner
- Substantial reduction in stops by up to 44 per cent, indicating trips can complete their journeys with less interruption
- During the evening period, the latent demand has increased by about 200 vehicles in the 'with project' model in comparison to the 'without project' model. All unreleased trips in 2028 are associated with the south approach at Maitland Road which is a substantial distance from the project. The increase in latent demand is due to a traffic signal phasing variance at the intersection of Maitland Road and Wallsend Road and is not a direct impact of the project.

Table 6-1 2028 network statistics

Network statistic	2028 morning peak		2028 evening peak	
	Without project	With project	Without project	With project
Total throughput (Veh)	42,801	42,927	47,787	48,048
Vehicle hour travelled (VHT)	8,266	7,547	9,819	8,789
Vehicle kilometres travelled (VKT)	484,922	485,788	534,003	535,272
Network speed (km/h)	59	64	55	61
Total stops	158,252	88,285	215,956	144,703
Latent demand (Veh)	2	2	384	596

Comparison of the 'without project' and project scenarios for the 2038 horizon year shows the following:

- Substantial improvement in the operational performance of the road network is likely. Up to an additional nine per cent of vehicles can complete their trips within the modelled period. The forecasted average network speed is likely to increase by 17 per cent in the morning peak and 31 per cent in the evening peak
- VKT likely to increase by up to nine per cent due to more released traffic on network compared to 'without project' and the project would likely lead to a substantial reduction in VHT of up to 21 per cent
- Substantial reduction in stops of up to 60 per cent, indicating trips can complete their journeys with less interruption
- The 'with project' scenario would also relieve substantial congestion at the edge of the study area during the morning and evening peaks. Up to 3,200 vehicles, which previously were unable to enter the study area, can now enter as a result of network improvements that occur due to the project. These unreleased trips are primary released from the M1 Pacific Motorway and the New England Highway. However, the 'with project' model still exhibits about 1,600 unreleased trips in the evening peak primary from John Renshaw Drive and Maitland Road.

Table 6-2 2038 network statistics

Network statistic	2038 morning peak		2038 evening peak	
	Without project	With project	Without project	With project
Total throughput (Veh)	48,673	50,362	50,993	55,620
Vehicle hours travelled (VHT)	13,168	11,268	16,906	13,364
Vehicle Kilometres travelled (VKT)	566,035	584,027	585,864	636,630
Network speed (km/h)	45	53	37	49
Total stops	1,195,169	401,875	1,477,906	587,527
Latent demand (Veh)	559	3	4,848	1,592

Comparison of the 'without project' and project scenarios for the 2048 horizon year shows:

- Substantial improvement in the operational performance of the road network is likely, particularly during the evening peak period. Forecast average network speed is likely to increase by 22 per cent in each of the peak periods
- VKT is likely to improve by up to 13 per cent due to more released traffic on the network compared to 'without project' and a substantial reduction in VHT of up to 17 per cent is anticipated
- Substantial reduction in stops of up to 56 per cent in the morning peak period, indicating trips are able to complete their journeys with less interruption
- The 'with project' scenario would also relieve congestion at the edge of the study area, during both the morning and evening peaks, with up to 25 per cent fewer vehicles waiting to enter the network at the edge of the model during the peak periods. The project substantially reduces unreleased trips from the M1 Pacific Motorway and the Pacific Highway in the northeast of the model. However, both peak periods still exhibit large amounts of unreleased trips which are mostly associated with the southern approach to Maitland Road and the Black Hill development egress roads onto John Renshaw Drive.

Table 6-3 2048 network statistics

Network statistic	2048 morning peak		2048 evening peak	
	Without project	With project	Without project	With project
Total throughput (Veh)	50,361	53,037	51,081	56,924
Vehicle hours travelled (VHT)	17,933	15,049	22,376	19,311
Vehicle Kilometres travelled (VKT)	584,190	616,524	575,542	651,887
Network speed (km/h)	35	43	29	37
Total stops	2,229,029	961,998	2,177,944	1,946,870
Latent demand (Veh)	4,805	3,505	11,384	8,524

In comparison to the existing road network statistics displayed in **Section 5.3,** the 'with project' results in 2028 displaying similar performance outcomes in each of the peak periods, while also catering for a higher traffic demand. In 2038, the 'with project' network statistics indicate a reduction in network performance outcomes as a result of increased demand which is shown by the levels of unreleased trips in the evening period. This reduction in network performance is amplified in 2048, as the traffic demand continues to grow. The traffic demand growth from 2038 to 2048 in the evening peak results in a greater increase in unreleased trips than total throughput, signifying that between 2038 and 2048 the road network begins to operate close to its capacity.

However, overall, the key network statistics demonstrate the project would provide positive outcomes for the performance of the road network in each of the modelled scenarios. The project results in a more efficient road network that can cater to a higher volume of vehicles, while also maintaining faster travelling speeds for motorists.

6.3 Intersection performance

The operational performance at key intersections within the network is presented in **Table 6-4** to **Table 6-9**.

LoS D is the generally the accepted target performance level. In circumstances where intersection performance falls below LoS D, investigations should be initiated to determine if suitable remediation can be provided. However, limited road capacity and high demand for the project mean that LoS E and LoS F are regularly experienced by motorists, particularly during peak periods.

Table 6-4 Performance of modelled intersections in the morning period for 2028

Intersection	Type	2028 Morning 'without project'						2028 Morning with project					
		6-7am		7-8am		8-9am		6-7am		7-8am		8-9am	
		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	48	D	83	F	83	F	43	D	51	D	60	E
New England Highway/Weakleys Drive, Beresfield	Signalised	10	B	13	B	18	B	16	B	14	B	28	C
New England Highway/Maitland Road/Pacific Highway	Signalised	16	B	18	B	18	B	19	B	27	C	23	C
Pacific Highway/Tomago Road, Tomago	Signalised	32	C	24	C	18	B	27	C	20	C	17	B
Pacific Highway/Old Punt Road, Tomago	Signalised	15	B	10	A	10	A	5	A	5	A	5	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	8	A	11	B	12	B	9	A	11	B	11	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	7	A	8	A	3	A	3	A	3	A

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

Table 6-5 Performance of modelled intersections in the evening period for 2028

Intersection	Type	2028 Evening 'without project'						2028 Evening with project					
		3-4pm		4-5pm		5-6pm		3-4pm		4-5pm		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
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	44	D	70	E	93	F	43	D	64	E	62	E
New England Highway/Weakleys Drive, Beresfield	Signalised	17	B	17	B	20	B	17	B	17	B	33	C
New England Highway/Maitland Road/Pacific Highway	Signalised	36	D	59	E	48	D	33	C	28	C	30	C
Pacific Highway/Tomago Road, Tomago	Signalised	25	C	30	C	18	B	14	B	14	B	15	B
Pacific Highway/Old Punt Road, Tomago	Signalised	10	A	10	B	9	A	5	A	6	A	5	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	14	B	13	B	10	B	13	B	13	B	9	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	10	A	19	B	17	B	5	A	5	A	4	A

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

Table 6-6 Performance of modelled intersections in the morning period for 2038

Intersection	Type	2038 Morning 'without project'						2038 Morning with project					
		6-7am		7-8am		8-9am		6-7am		7-8am		8-9am	
		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	67	E	128	F	180	F	74	E	108	F	124	F
New England Highway/Weakleys Drive, Beresfield	Signalised	10	B	23	C	58	E	17	B	17	B	28	C
New England Highway/Maitland Road/Pacific Highway	Signalised	16	B	34	C	25	C	22	C	37	D	36	D
Pacific Highway/Tomago Road, Tomago	Signalised	32	C	46	D	19	B	31	C	22	C	18	B
Pacific Highway/Old Punt Road, Tomago	Signalised	15	B	33	C	10	A	5	A	5	A	5	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	8	A	13	B	14	B	11	B	12	B	12	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	10	A	9	A	3	A	4	A	4	A

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

Table 6-7 Performance of modelled intersections in the evening period for 2038

Intersection	Type	2038 Evening 'without project'						2038 Evening with project					
		3-4pm		4-5pm		5-6pm		3-4pm		4-5pm		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
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	68	E	111	F	120	F	74	E	147	F	151	F
New England Highway/Weakleys Drive, Beresfield	Signalised	19	B	31	C	104	F	19	B	20	B	41	D
New England Highway/Maitland Road/Pacific Highway	Signalised	59	E	82	F	83	F	38	D	33	C	38	D
Pacific Highway/Tomago Road, Tomago	Signalised	43	D	90	F	101	F	19	B	16	B	15	B
Pacific Highway/Hank Street, Heatherbrae	Signalised	15	B	17	B	49	D	13	B	16	B	9	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	17	B	29	C	62	E	6	A	6	A	5	A

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

Table 6-8 Performance of modelled intersections in the morning period for 2048

Intersection	Type	2048 Morning 'without project'						2048 Morning with project					
		6-7am		7-8am		8-9am		6-7am		7-8am		8-9am	
		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	107	F	155	F	181	F	101	F	134	F	142	F
New England Highway/Weakleys Drive, Beresfield	Signalised	10	B	48	D	91	F	19	B	41	D	62	E
New England Highway/Maitland Road/Pacific Highway	Signalised	16	B	42	D	76	E	27	C	41	D	38	D
Pacific Highway/Tomago Road, Tomago	Signalised	32	C	60	E	41	D	77	E	66	E	31	C
Pacific Highway/Old Punt Road, Tomago	Signalised	15	B	61	E	22	C	7	A	6	A	6	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	8	A	18	B	15	B	11	B	13	B	13	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	8	A	29	C	15	B	3	A	4	A	4	A

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

Table 6-9 Performance of modelled intersections in the evening period for 2048

Intersection	Type	2048 Evening 'without project'						2048 Evening with project					
		3-4pm		4-5pm		5-6pm		3-4pm		4-5pm		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
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	94	F	126	F	131	F	109	F	157	F	136	F
New England Highway/Weakleys Drive, Beresfield	Signalised	26	C	54	D	91	F	25	C	53	D	96	F
New England Highway/Maitland Road/Pacific Highway	Signalised	72	E	83	F	83	F	58	E	99	F	70	E
Pacific Highway/Tomago Road, Tomago	Signalised	55	D	84	F	89	F	43	D	131	F	120	F
Pacific Highway/Hank Street, Heatherbrae	Signalised	17	B	67	E	73	E	15	B	22	C	10	B
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	31	C	89	F	416	F	6	A	6	A	5	A

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

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

- New England Highway/ Pacific Highway/Maitland Road: The project would substantially improve the performance of this intersection during the evening period as vehicles travelling on the New England Highway between Tarro and Tomago would reroute to the project. This is most evident in the 2038 evening model, under 'without project' conditions, as the intersection operates at a LoS E or worse in each of the three modelled hours. When modelled with the project, the intersection operates as a satisfactory LoS D (or better) in each of the three modelled hours. The project markedly reduces the traffic demand for the right turn movement from the Pacific Highway to the New England Highway. This substantially reduces the overall demand at the intersection and would enable the reallocation of green time to other movements at the intersection, ultimately improving the performance of the intersection
- Intersections along the Pacific Highway between Maitland Road and Masonite Road would improve in performance. This is particularly noticeable in the 2038 and 2048 horizon years when flows on the Pacific Highway are forecast to exceed the capacity of these intersections. Removal of the main east-west movements along the Pacific Highway on this section improves the performance the Maitland Road and Masonite Road intersections with Pacific Highway and reduces volumes to within capacity
- Pacific Highway/Masonite Road: The project provides a bypass of Heatherbrae, which substantially reduces the traffic demand and throughput at the Pacific Highway/Masonite Road roundabout. The reduction in demand is evidenced in the evening peak in both 2038 and 2048, as the intersection improves from operating at LoS E (in 2038) and LoS F (in 2048) to LoS A in both years as a result of the project
- M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection: The project would improve the performance of this intersection, as traffic travelling to or from the east of the model extent would reroute to use the project in 2028.

Despite the improvements that occur at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection as a result of the project, the intersection is expected to perform at an unsatisfactory LoS from 2038 onwards. This poor performance can be attributed to a high level of traffic demand from the Black Hill development, which is a key driver of congestion in the region due to the size and large proportion (about 20 per cent) of heavy vehicles accessing the site.

In 2038, it has been assumed that 75 per cent of the Black Hill development is complete, which is a key catalyst of the excessive traffic demand at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. Given the development access points are located west of the junction, about 1,800 vehicles generated from the Black Hill development site would use the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection during each hour of the peak periods. In 2048, it has been assumed the Black Hill development would be fully operational and 100 per cent of trips generated from the development would be released. This exacerbates the congestion and trips traversing through this critical junction, with an increase to about 2,400 vehicles in each peak hour.

Furthermore, the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection has been modelled in the evening peak period to operate at a cycle time of 170 seconds in 2038 and 180 seconds in 2048. This is greater than the typical accepted cycling time of 150 seconds as specified by the Traffic Modelling Guidelines (Roads and Maritime, 2013). This deviation from the guidance is to ensure optimal performance of the network. With a lower cycle time queues extend at the southern and northern approach of the intersection blocking access to the M1 Pacific Motorway (southern approach) and New England Highway (northern approach).

Ultimately, the high volume of vehicles generated from the Black Hill development site contributes substantially to the poor performance of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill in future horizon years. To capture the isolated impact of the Black Hill development on the project and wider network, sensitivity testing been carried out and documented in **Chapter 7**.

6.4 Travel time

Trave time and speed between key locations Is shown for each peak period in **Table 6-10** to **Table 6-15**

Table 6-10 Travel times for 2028 morning peak

From	To	Distance (km)	2028 Without project travel time			2028 project travel time			2028 Without project speed			2028 project speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am	6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
New England Hwy	M1 Pacific Motorway South	8.5	08:17	08:25	10:03	08:29	08:33	10:26	62	61	51	60	60	49
	John Renshaw Drive West	5.9	07:23	07:26	08:27	07:31	07:36	08:50	48	47	42	47	46	40
	Maitland Road South	13.5	12:01	14:13	16:20	11:45	13:04	12:54	67	57	50	69	62	63
	Pacific Highway East	16.3	13:22	14:48	15:20	09:58	10:01	10:02	73	66	64	98	98	98
	Newcastle Inter City Bypass	14.2	12:37	14:23	15:14	12:34	13:20	13:11	67	59	56	68	64	64
	Tomago Road	11.1	10:37	11:41	13:14	10:13	10:13	10:15	63	57	50	65	65	65
	Adelaide Street	14.8	12:43	14:18	14:46	10:48	10:47	10:50	70	62	60	82	82	82
M1 Pacific Motorway South	A43-New England Highway	8.5	07:13	07:19	07:29	07:08	07:14	07:28	71	70	68	72	71	68
	John Renshaw Drive West	8.9	06:45	06:47	06:55	06:38	06:37	08:47	79	78	77	80	80	61
	Maitland Road South	17.9	16:23	18:59	21:11	15:51	17:09	16:34	65	57	51	68	63	65
	Pacific Highway East	20.7	17:38	19:34	20:35	11:23	11:34	11:32	71	64	60	109	108	108
	Newcastle Inter City Bypass	18.6	16:59	19:08	20:13	16:37	17:37	17:14	66	58	55	67	63	65
	Tomago Road	15.5	14:51	16:29	18:54	14:12	14:23	14:16	63	56	49	66	65	65
	Adelaide Street	19.2	17:13	18:49	19:57	12:21	12:30	12:37	67	61	58	93	92	91
John Renshaw Drive West	A43-New England Highway	5.8	06:29	07:38	08:17	06:29	06:39	06:37	54	45	42	54	52	52
	M1 Pacific Motorway South	9.0	07:42	10:24	11:21	07:44	08:28	08:15	70	52	47	69	63	65
	Maitland Road South	15.2	15:12	18:46	24:43	14:57	16:38	16:35	60	48	37	61	55	55
	Pacific Highway East	18.0	16:51	20:24	22:53	13:20	14:16	13:51	64	53	47	81	76	78
	Newcastle Inter City Bypass	15.8	16:05	20:18	23:27	15:56	17:20	16:43	59	47	40	60	55	57
	Tomago Road	12.8	13:47	17:03	20:58	13:19	13:55	13:50	56	45	37	58	55	55
	Adelaide Street	16.4	15:58	19:31	22:33	14:14	14:52	14:45	62	50	44	69	66	67
Maitland Road South	A43-New England Highway	13.5	12:26	12:51	14:23	12:33	12:57	12:56	65	63	56	65	63	63
	M1 Pacific Motorway South	17.8	15:20	15:48	17:16	15:30	15:54	15:59	70	68	62	69	67	67
	John Renshaw Drive West	15.1	15:35	15:41	17:02	15:23	15:43	15:33	58	58	53	59	58	58
	Pacific Highway East	16.0	14:13	15:03	16:37	13:14	13:52	13:55	67	64	58	72	69	69
	Newcastle Inter City Bypass	2.3	02:34	02:43	03:30	02:45	02:56	02:55	54	51	40	51	48	48
	Tomago Road	10.7	11:35	11:41	13:16	11:34	11:43	11:50	56	55	49	56	55	54
	Adelaide Street	14.4	13:48	14:16	15:53	13:53	14:09	14:25	63	60	54	62	61	60

From	To	Distance (km)	2028 Without project travel time			2028 project travel time			2028 Without project speed			2028 project speed		
			6-7am	7-8am	8-9am	6-7am	7-8am	8-9am	6-7am	7-8am	8-9am	6-7am	7-8am	8-9am
Pacific Highway East	A43-New England Highway	16.6	16:00	16:15	15:52	10:05	10:05	10:10	62	61	63	99	99	98
	M1 Pacific Motorway South	20.9	19:02	19:08	19:05	11:26	11:30	11:34	66	65	66	110	109	108
	John Renshaw Drive West	18.2	18:36	19:10	18:37	12:42	12:43	12:43	59	57	59	86	86	86
	Maitland Road South	15.9	15:41	16:07	17:24	13:31	14:16	14:00	61	59	55	71	67	68
	Newcastle Inter City Bypass	16.6	16:29	16:20	16:20	14:25	14:25	14:31	60	61	61	69	69	68
	Tomago Road	10.5	10:09	10:24	10:02	08:14	08:33	08:10	62	60	63	76	74	77
	Adelaide Street	3.2	02:49	02:44	02:45	03:29	03:46	04:45	68	70	70	55	51	40
Newcastle Inter City Bypass	A43-New England Highway	14.2	12:47	12:54	12:54	12:38	12:58	13:01	67	66	66	67	66	65
	M1 Pacific Motorway South	18.5	15:39	15:48	15:40	15:33	15:52	15:50	71	70	71	71	70	70
	John Renshaw Drive West	15.8	15:34	15:42	15:32	15:16	15:44	15:38	61	60	61	62	60	61
	Maitland Road South	2.4	03:25	03:22	03:04	03:14	03:17	03:20	42	43	47	45	44	43
	Pacific Highway East	16.6	14:36	15:01	15:02	13:22	13:45	13:41	68	66	66	75	72	73
	Tomago Road	11.4	11:54	11:48	11:37	11:39	11:42	11:34	57	58	59	59	58	59
	Adelaide Street	15.0	14:00	14:10	14:14	13:54	14:04	14:08	64	64	63	65	64	64
Tomago Road	A43-New England Highway	11.4	10:51	11:19	11:12	10:32	11:10	10:37	63	60	61	65	61	64
	M1 Pacific Motorway South	15.6	13:48	14:06	13:55	12:51	12:56	12:42	68	67	67	73	73	74
	John Renshaw Drive West	13.0	13:30	13:58	13:51	13:57	13:46	13:38	58	56	56	56	57	57
	Maitland Road South	10.7	10:26	11:14	12:46	10:50	11:59	11:41	61	57	50	59	53	55
	Pacific Highway East	10.6	10:14	10:26	10:33	08:57	08:55	09:10	62	61	60	71	71	69
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	-	-	-	-	-	-	-	-	-	-	-	-
Adelaide Street (Heatherbrae, north of roundabout)	A43-New England Highway	15.1	15:17	15:13	15:12	11:45	11:46	11:54	59	60	60	77	77	76
	M1 Pacific Motorway South	19.4	18:04	18:09	18:00	12:59	13:12	13:13	64	64	65	90	88	88
	John Renshaw Drive West	16.7	18:01	18:00	17:53	14:50	14:19	14:09	56	56	56	68	70	71
	Maitland Road South	14.4	15:04	15:29	16:45	14:52	15:41	15:34	57	56	52	58	55	56
	Pacific Highway East	3.1	02:17	02:30	02:22	02:21	02:35	02:22	80	73	78	78	71	78
	Newcastle Inter City Bypass	15.1	15:38	15:37	15:42	15:34	15:37	15:36	58	58	58	58	58	58
	Tomago Road	9.0	-	-	09:22	-	-	09:04	-	-	58	-	-	60

Table 6-11 Travel times for 2028 evening peak

From	To	Distance (km)	2028 Without project travel time			2028 project travel time			2028 Without project speed			2028 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
New England Hwy	M1 South	8.5	08:21	09:53	11:45	08:21	09:30	10:05	61	52	44	61	54	51
	John Renshaw Drive West	5.9	07:46	08:55	10:06	07:48	08:33	08:48	45	40	35	45	41	40
	Maitland Road South	13.5	12:17	12:46	13:03	12:01	12:03	12:20	66	63	62	67	67	66
	Pacific Highway East	16.3	13:38	13:57	14:01	09:59	10:00	10:07	72	70	70	98	98	97
	Newcastle Inter City Bypass	14.2	13:25	13:49	14:14	13:16	13:13	13:33	63	61	60	64	64	63
	Tomago Road	11.1	09:58	10:04	10:21	10:00	10:00	10:07	67	66	65	67	67	66
	Adelaide Street	14.8	12:55	13:11	13:11	10:53	10:55	10:49	69	67	67	81	81	82
M1 South	A43-New England Highway	8.5	07:10	07:23	09:16	07:06	07:13	09:08	71	69	55	72	71	56
	John Renshaw Drive West	8.9	06:39	07:04	08:42	06:28	14:59	08:42	80	75	61	82	36	61
	Maitland Road South	17.9	17:01	18:18	20:26	16:42	16:40	16:49	63	59	53	64	64	64
	Pacific Highway East	20.7	18:14	19:13	21:17	11:25	11:32	11:32	68	65	58	109	108	108
	Newcastle Inter City Bypass	18.6	18:06	19:12	21:13	17:25	17:41	17:59	62	58	52	64	63	62
	Tomago Road	15.5	14:29	15:28	16:31	14:21	14:24	14:30	64	60	56	65	65	64
	Adelaide Street	19.2	17:30	18:15	20:35	12:22	12:25	12:23	66	63	56	93	93	93
John Renshaw Drive West	A43-New England Highway	5.8	06:38	06:37	06:46	06:39	06:39	08:03	52	52	51	52	52	43
	M1 South	9.0	07:30	08:06	08:11	07:47	08:23	08:48	72	66	66	69	64	61
	Maitland Road South	15.2	15:36	16:12	16:39	15:16	15:28	15:55	58	56	55	60	59	57
	Pacific Highway East	18.0	16:50	17:28	17:39	13:19	13:36	13:51	64	62	61	81	79	78
	Newcastle Inter City Bypass	15.8	16:47	17:17	17:58	16:37	16:38	17:16	57	55	53	57	57	55
	Tomago Road	12.8	13:19	13:31	13:50	13:15	13:20	13:32	58	57	55	58	58	57
	Adelaide Street	16.4	16:21	16:43	16:52	14:26	14:37	14:37	60	59	58	68	67	67
Maitland Road South	A43-New England Highway	13.5	14:07	17:55	17:23	13:25	13:36	14:21	57	45	47	60	60	57
	M1 South	17.8	16:44	20:52	20:14	16:25	16:56	17:40	64	51	53	65	63	60
	John Renshaw Drive West	15.1	17:02	21:32	20:57	16:25	17:32	17:44	53	42	43	55	52	51
	Pacific Highway East	16.0	15:02	16:23	16:21	13:28	13:58	14:27	64	58	59	71	69	66
	Newcastle Inter City Bypass	2.3	03:17	03:36	03:32	03:20	03:41	03:45	42	39	39	42	38	37
	Tomago Road	10.7	11:31	12:34	12:50	11:31	11:55	12:38	56	51	50	56	54	51
	Adelaide Street	14.4	14:29	15:40	15:34	14:09	14:33	14:58	60	55	55	61	59	58

From	To	Distance (km)	2028 Without project travel time			2028 project travel time			2028 Without project speed			2028 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
Pacific Highway East	A43-New England Highway	16.6	16:40	18:37	17:58	10:16	10:12	10:16	60	54	55	97	98	97
	M1 South	20.9	19:19	21:42	21:04	11:26	11:25	11:29	65	58	59	110	110	109
	John Renshaw Drive West	18.2	19:41	22:40	21:07	13:25	14:08	13:34	56	48	52	81	77	81
	Maitland Road South	15.9	15:44	16:39	16:07	13:12	13:15	13:37	61	57	59	72	72	70
	Newcastle Inter City Bypass	16.6	16:54	17:48	17:28	14:29	14:28	14:44	59	56	57	69	69	67
	Tomago Road	10.5	-	10:23	09:53	-	08:29	08:05	-	61	64	-	74	78
	Adelaide Street	3.2	02:43	02:43	02:47	03:54	06:08	04:44	71	70	69	49	31	41
Newcastle Inter City Bypass	A43-New England Highway	14.2	15:05	18:03	17:19	14:26	13:57	14:07	56	47	49	59	61	60
	M1 South	18.5	17:48	21:18	20:11	17:29	17:46	17:26	62	52	55	63	62	64
	John Renshaw Drive West	15.8	18:04	21:48	20:59	17:32	18:06	17:34	52	44	45	54	52	54
	Maitland Road South	2.4	-	-	-	-	-	-	-	-	-	-	-	-
	Pacific Highway East	16.6	16:00	16:35	16:25	14:28	14:28	14:19	62	60	61	69	69	70
	Tomago Road	11.4	12:25	13:22	12:57	12:40	13:28	12:27	55	51	53	54	51	55
	Adelaide Street	15.0	15:22	15:48	15:34	15:10	15:01	14:43	59	57	58	60	60	61
Tomago Road	A43-New England Highway	11.4	11:49	13:20	13:04	11:02	11:06	11:03	58	51	52	62	61	62
	M1 South	15.6	14:35	16:19	16:02	12:12	12:14	12:12	64	57	59	77	77	77
	John Renshaw Drive West	13.0	14:58	17:09	16:53	14:12	15:14	14:37	52	45	46	55	51	53
	Maitland Road South	10.7	11:04	11:30	11:36	11:07	11:05	11:19	58	56	55	57	58	56
	Pacific Highway East	10.6	-	11:02	10:49	-	09:58	09:43	-	58	59	-	64	65
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	10:13	10:07	-	09:25	09:29	-	53	53	-	57	57	-
Adelaide Street (Heatherbrae, north of roundabout)	A43-New England Highway	15.1	15:44	18:21	17:49	12:00	12:08	12:04	58	49	51	76	75	75
	M1 South	19.4	18:35	21:14	20:52	13:13	13:21	13:22	63	55	56	88	87	87
	John Renshaw Drive West	16.7	18:59	21:53	21:35	15:10	16:12	15:39	53	46	47	66	62	64
	Maitland Road South	14.4	15:16	16:17	16:16	14:42	14:53	15:03	57	53	53	59	58	57
	Pacific Highway East	3.1	02:24	02:47	02:56	02:23	02:27	02:25	76	66	63	77	75	76
	Newcastle Inter City Bypass	15.1	16:21	17:30	17:39	15:44	15:50	16:15	55	52	51	57	57	56
	Tomago Road	9.0	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-12 Travel times for 2038 morning peak

From	To	Distance (km)	2038 Without project travel time			2038 project travel time			2038 Without project speed			2038 project speed		
			6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00
New England Hwy	M1 South	8.5	09:57	12:24	19:43	09:41	11:11	16:33	52	41	26	53	46	31
	John Renshaw Drive West	5.9	08:46	11:41	17:30	08:44	10:38	14:54	40	30	20	40	33	24
	Maitland Road South	13.5	12:18	17:21	27:01	11:56	16:34	23:33	66	47	30	68	49	34
	Pacific Highway East	16.3	13:36	17:17	24:43	09:59	10:07	10:09	72	57	40	98	97	97
	Newcastle Inter City Bypass	14.2	13:03	17:36	26:02	12:39	16:38	22:21	65	48	33	67	51	38
	Tomago Road	11.1	11:24	14:57	23:26	10:22	13:25	15:47	59	45	28	64	50	42
	Adelaide Street	14.8	13:04	17:18	24:00	10:53	11:02	10:59	68	51	37	81	80	81
M1 South	New England Hwy	8.5	07:57	08:35	28:46	07:51	08:01	10:27	64	59	18	65	64	49
	John Renshaw Drive West	8.9	07:17	08:05	22:30	07:00	07:32	09:03	73	66	24	76	71	59
	Maitland Road South	17.9	16:55	23:59	46:04	16:20	20:35	30:20	63	45	23	66	52	35
	Pacific Highway East	20.7	18:24	23:00	45:36	11:28	11:38	11:45	68	54	27	108	107	106
	Newcastle Inter City Bypass	18.6	17:56	24:16	45:37	17:06	20:58	29:16	62	46	24	65	53	38
	Tomago Road	15.5	16:10	21:13	41:42	14:41	17:23	23:08	58	44	22	63	54	40
	Adelaide Street	19.2	17:41	21:13	45:35	12:20	12:51	12:51	65	54	25	93	89	89
John Renshaw Drive West	New England Hwy	5.8	07:05	09:47	23:32	07:47	13:40	26:05	49	35	15	45	25	13
	M1 South	9.0	08:04	11:36	24:04	09:21	16:08	26:24	67	46	22	57	33	20
	Maitland Road South	15.2	15:51	21:14	45:34	16:31	22:51	46:37	57	43	20	55	40	19
	Pacific Highway East	18.0	17:16	22:59	45:22	15:05	20:07	35:33	63	47	24	72	54	30
	Newcastle Inter City Bypass	15.8	16:54	24:24	45:13	17:35	26:06	45:55	56	39	21	54	36	21
	Tomago Road	12.8	14:50	20:02	41:42	14:59	20:50	37:44	52	38	18	51	37	20
	Adelaide Street	16.4	16:30	24:18	44:21	15:51	21:30	35:35	60	41	22	62	46	28
Maitland Road South	New England Hwy	13.5	13:03	13:39	14:30	12:55	13:19	13:40	62	59	56	63	61	59
	M1 South	17.8	15:57	17:23	19:56	15:58	16:19	16:43	67	61	54	67	65	64
	John Renshaw Drive West	15.1	16:16	18:51	20:55	16:21	16:55	17:03	56	48	43	56	54	53
	Pacific Highway East	16.0	14:52	15:21	15:40	13:33	14:02	14:20	64	62	61	71	68	67
	Newcastle Inter City Bypass	2.3	02:47	02:51	02:52	02:46	02:51	02:53	50	49	49	50	49	48
	Tomago Road	10.7	12:43	12:52	12:19	11:49	11:55	12:17	51	50	52	55	54	52
	Adelaide Street	14.4	14:29	14:33	14:55	14:05	14:27	14:39	60	59	58	61	60	59

From	To	Distance (km)	2038 Without project travel time			2038 project travel time			2038 Without project speed			2038 project speed		
			6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00
Pacific Highway East	New England Hwy	16.6	17:48	22:18	16:55	10:08	10:09	10:16	56	45	59	98	98	97
	M1 South	20.9	20:41	25:26	22:22	11:30	11:31	11:35	61	49	56	109	109	108
	John Renshaw Drive West	18.2	20:42	26:44	23:45	13:08	13:38	13:33	53	41	46	83	80	81
	Maitland Road South	15.9	17:24	20:33	17:33	13:45	14:20	19:21	55	46	54	69	67	49
	Newcastle Inter City Bypass	16.6	18:15	21:00	16:57	14:30	14:45	17:52	54	47	59	69	67	56
	Tomago Road	10.5	10:21	11:18	10:10	08:22	08:31	08:13	61	56	62	75	74	77
	Adelaide Street	3.2	02:57	02:54	02:50	03:18	04:22	03:02	65	66	68	58	44	63
Newcastle Inter City Bypass	New England Hwy	14.2	13:14	15:57	17:38	13:04	15:23	16:55	64	53	48	65	55	50
	M1 South	18.5	16:12	18:27	22:57	16:07	17:27	19:18	68	60	48	69	63	57
	John Renshaw Drive West	15.8	16:03	19:46	24:21	16:09	18:08	19:46	59	48	39	59	52	48
	Maitland Road South	2.4	03:25	03:37	04:52	03:26	03:40	05:08	42	40	30	42	40	28
	Pacific Highway East	16.6	14:59	16:45	18:26	13:42	15:22	16:58	67	60	54	73	65	59
	Tomago Road	11.4	12:58	14:28	14:43	12:05	13:23	14:32	53	47	46	57	51	47
	Adelaide Street	15.0	14:22	16:31	18:16	14:11	16:15	17:58	63	55	49	64	56	50
Tomago Road	New England Hwy	11.4	10:52	11:09	12:05	10:32	10:45	10:28	63	61	56	65	63	65
	M1 South	15.6	14:03	15:14	17:12	13:22	12:46	12:58	67	62	55	70	73	72
	John Renshaw Drive West	13.0	14:06	16:01	17:50	13:32	13:59	13:57	55	49	44	58	56	56
	Maitland Road South	10.7	10:21	11:11	12:49	10:58	12:07	17:08	62	57	50	58	53	37
	Pacific Highway East	10.6	10:26	10:43	10:40	09:22	09:33	09:38	61	59	60	68	67	66
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	-	-	-	-	-	-	-	-	-	-	-	-
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	17:02	19:48	16:01	11:45	11:50	11:50	53	46	57	77	77	77
	M1 South	19.4	19:43	24:01	21:10	13:14	13:12	13:05	59	48	55	88	88	89
	John Renshaw Drive West	16.7	19:35	25:00	22:53	14:34	15:12	15:12	51	40	44	69	66	66
	Maitland Road South	14.4	16:39	19:35	16:42	15:04	15:44	20:25	52	44	52	57	55	42
	Pacific Highway East	3.1	02:20	02:30	02:24	02:22	02:35	02:26	79	73	76	77	71	76
	Newcastle Inter City Bypass	15.1	17:06	20:10	15:51	15:32	15:55	18:57	53	45	57	58	57	48
	Tomago Road	9.0	-	-	09:30	-	-	09:06	-	-	57	-	-	59

Table 6-13 Travel times for 2038 evening peak

From	To	Distance (km)	2038 Without project travel time			2038 project travel time			2038 Without project speed			2038 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
New England Hwy	M1 South	8.5	11:14	24:12	44:00	10:15	15:50	26:38	46	21	12	50	32	19
	John Renshaw Drive West	5.9	11:04	26:09	43:11	09:32	14:13	22:02	32	13	8	37	25	16
	Maitland Road South	13.5	13:12	13:51	13:58	12:09	12:11	12:48	61	58	58	67	66	63
	Pacific Highway East	16.3	14:02	14:35	15:17	10:01	10:06	10:10	70	67	64	98	97	96
	Newcastle Inter City Bypass	14.2	14:41	16:14	16:35	12:56	13:06	13:17	58	52	51	66	65	64
	Tomago Road	11.1	10:07	10:03	10:10	09:48	09:41	10:00	66	66	66	68	69	67
	Adelaide Street	14.8	13:28	14:02	14:52	10:58	11:03	10:57	66	63	60	81	80	81
M1 South	New England Hwy	8.5	08:01	12:11	26:20	07:57	09:26	15:23	64	42	19	64	54	33
	John Renshaw Drive West	8.9	07:18	07:44	28:36	07:10	20:01	11:30	73	69	19	74	27	46
	Maitland Road South	17.9	18:11	22:20	36:24	16:56	19:13	24:01	59	48	29	63	56	45
	Pacific Highway East	20.7	19:01	22:15	36:56	11:28	11:39	13:18	65	56	34	109	107	93
	Newcastle Inter City Bypass	18.6	20:05	25:27	37:33	17:57	20:26	24:25	55	44	30	62	54	46
	Tomago Road	15.5	14:53	19:51	29:34	14:25	17:09	20:49	63	47	31	65	54	45
	Adelaide Street	19.2	18:14	20:44	36:33	12:26	12:38	14:14	63	55	31	92	91	81
John Renshaw Drive West	New England Hwy	5.8	07:18	09:35	12:11	07:47	13:49	28:04	47	36	28	45	25	12
	M1 South	9.0	09:02	11:12	14:00	10:35	19:16	33:13	59	48	38	51	28	16
	Maitland Road South	15.2	17:09	18:48	21:43	16:15	20:11	36:56	53	48	42	56	45	25
	Pacific Highway East	18.0	17:52	19:30	22:47	14:12	18:22	33:53	60	55	47	76	59	32
	Newcastle Inter City Bypass	15.8	18:05	21:35	23:27	16:54	20:32	37:27	53	44	40	56	46	25
	Tomago Road	12.8	13:49	15:23	17:33	13:45	19:03	31:50	56	50	44	56	40	24
	Adelaide Street	16.4	17:23	19:18	22:01	15:11	19:32	33:53	57	51	45	65	50	29
Maitland Road South	New England Hwy	13.5	16:22	26:18	23:39	14:12	16:31	17:28	50	31	34	57	49	46
	M1 South	17.8	19:06	29:14	26:56	19:07	27:46	27:16	56	36	40	56	38	39
	John Renshaw Drive West	15.1	19:36	29:51	27:25	18:06	23:54	24:27	46	30	33	50	38	37
	Pacific Highway East	16.0	16:19	23:59	22:38	14:22	15:12	15:47	59	40	42	67	63	61
	Newcastle Inter City Bypass	2.3	04:36	10:15	10:10	03:20	05:24	06:12	30	14	14	42	26	22
	Tomago Road	10.7	12:47	19:19	17:43	12:14	12:49	13:47	50	33	36	53	50	47
	Adelaide Street	14.4	15:56	23:16	21:49	15:08	15:44	16:18	54	37	40	57	55	53

From	To	Distance (km)	2038 Without project travel time			2038 project travel time			2038 Without project speed			2038 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
Pacific Highway East	New England Hwy	16.6	18:11	29:15	40:37	10:17	14:13	13:59	55	34	25	97	70	71
	M1 South	20.9	21:09	30:12	43:24	11:30	11:41	12:01	59	41	29	109	107	104
	John Renshaw Drive West	18.2	21:31	29:15	43:49	14:11	21:16	20:16	51	37	25	77	51	54
	Maitland Road South	15.9	17:07	24:53	40:41	13:41	13:37	13:48	56	38	23	70	70	69
	Newcastle Inter City Bypass	16.6	18:37	27:30	42:58	14:26	14:55	15:11	53	36	23	69	67	65
	Tomago Road	10.5	-	13:44	25:44	-	08:29	08:03	-	46	24	-	74	78
	Adelaide Street	3.2	02:45	02:45	03:02	04:22	03:04	05:40	70	70	63	44	63	34
Newcastle Inter City Bypass	New England Hwy	14.2	16:09	24:54	21:25	13:40	15:07	16:05	53	34	40	62	56	53
	M1 South	18.5	18:46	27:15	24:19	18:38	26:14	25:30	59	41	46	59	42	43
	John Renshaw Drive West	15.8	19:20	28:23	25:18	17:33	22:43	23:19	49	33	37	54	42	41
	Maitland Road South	2.4	-	-	-	-	-	-	-	-	-	-	-	-
	Pacific Highway East	16.6	15:53	22:47	20:34	13:46	13:59	14:26	63	44	48	72	71	69
	Tomago Road	11.4	12:10	17:12	15:23	11:36	11:42	12:16	56	40	44	59	58	56
	Adelaide Street	15.0	15:23	21:40	19:33	14:27	14:28	14:52	59	42	46	62	62	61
Tomago Road	New England Hwy	11.4	13:50	27:25	38:40	11:08	12:38	13:00	49	25	18	61	54	53
	M1 South	15.6	16:15	29:52	41:52	13:01	15:31	16:30	58	31	22	72	60	57
	John Renshaw Drive West	13.0	16:47	30:04	41:59	15:08	20:18	20:54	46	26	19	51	38	37
	Maitland Road South	10.7	12:47	26:32	38:11	11:04	11:00	11:27	50	24	17	58	58	56
	Pacific Highway East	10.6	-	24:04	31:17	-	09:30	09:41	-	26	20	-	67	66
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	11:11	18:34	-	09:26	09:29	-	48	29	-	57	57	-
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	17:31	28:49	43:06	12:12	15:51	15:01	52	31	21	74	57	60
	M1 South	19.4	20:18	29:42	44:20	13:15	13:29	13:38	57	39	26	88	86	85
	John Renshaw Drive West	16.7	20:21	30:18	45:15	15:58	22:47	22:43	49	33	22	63	44	44
	Maitland Road South	14.4	16:43	23:59	43:49	15:11	15:14	15:12	52	36	20	57	57	57
	Pacific Highway East	3.1	02:42	03:31	09:44	02:24	02:49	04:21	68	52	19	76	65	42
	Newcastle Inter City Bypass	15.1	17:46	27:13	44:56	15:52	16:13	15:43	51	33	20	57	56	58
	Tomago Road	9.0	-	-	-	-	-	-	-	-	-	-	-	-

Table 6-14 Travel times for 2048 morning peak

From	To	Distance (km)	2048 Without project travel time			2048 project travel time			2048 Without project speed			2048 project speed		
			6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00
New England Hwy	M1 South	8.5	12:09	20:29	28:02	11:36	20:54	24:58	42	25	18	44	25	21
	John Renshaw Drive West	5.9	11:01	20:52	27:48	10:34	21:45	25:05	32	17	13	33	16	14
	Maitland Road South	13.5	13:19	20:12	29:14	12:19	16:40	23:25	61	40	28	66	49	35
	Pacific Highway East	16.3	14:33	20:23	25:35	09:58	10:05	10:07	67	48	38	98	97	97
	Newcastle Inter City Bypass	14.2	14:02	20:13	28:37	12:53	16:22	22:03	61	42	30	66	52	39
	Tomago Road	11.1	12:47	18:41	22:18	13:03	15:47	15:25	52	36	30	51	42	43
	Adelaide Street	14.8	13:52	20:13	25:02	10:43	11:00	11:00	64	44	35	83	81	81
M1 South	New England Hwy	8.5	08:56	13:45	38:37	08:15	09:43	18:46	57	37	13	62	53	27
	John Renshaw Drive West	8.9	08:17	15:00	36:01	07:21	09:31	15:09	64	35	15	72	56	35
	Maitland Road South	17.9	19:31	31:07	59:07	16:42	21:31	33:24	55	34	18	64	50	32
	Pacific Highway East	20.7	20:45	30:43	55:53	11:30	11:48	17:41	60	40	22	108	105	70
	Newcastle Inter City Bypass	18.6	20:09	30:53	58:03	17:13	21:04	31:45	55	36	19	65	53	35
	Tomago Road	15.5	19:00	29:15	54:50	17:28	20:24	24:50	49	32	17	53	46	37
	Adelaide Street	19.2	20:24	30:04	55:00	12:25	12:52	18:36	56	38	21	93	89	62
John Renshaw Drive West	New England Hwy	5.8	08:47	16:56	33:56	10:56	24:22	37:25	39	20	10	32	14	9
	M1 South	9.0	09:47	18:04	34:20	13:48	27:52	38:36	55	30	16	39	19	14
	Maitland Road South	15.2	18:26	30:23	57:28	19:32	33:07	56:24	49	30	16	47	27	16
	Pacific Highway East	18.0	19:52	31:46	54:43	17:46	29:15	44:47	54	34	20	61	37	24
	Newcastle Inter City Bypass	15.8	19:14	32:58	56:22	20:07	35:13	55:36	49	29	17	47	27	17
	Tomago Road	12.8	17:43	29:45	52:43	19:55	32:44	48:25	43	26	15	39	23	16
	Adelaide Street	16.4	19:03	32:14	53:29	19:07	30:28	44:55	52	31	18	52	32	22
Maitland Road South	New England Hwy	13.5	14:03	16:00	21:18	13:24	14:06	14:30	58	51	38	61	58	56
	M1 South	17.8	16:55	20:21	26:15	16:48	17:14	17:36	63	52	41	64	62	61
	John Renshaw Drive West	15.1	17:39	22:38	27:46	17:29	18:19	18:28	51	40	33	52	50	49
	Pacific Highway East	16.0	15:31	16:39	18:03	14:10	16:14	15:00	62	57	53	68	59	64
	Newcastle Inter City Bypass	2.3	02:40	02:50	02:57	02:39	02:51	02:54	52	49	47	53	49	48
	Tomago Road	10.7	13:46	15:32	14:57	15:04	17:40	15:21	47	41	43	43	36	42
	Adelaide Street	14.4	15:02	15:36	17:08	14:54	16:18	15:30	57	55	50	58	53	56

From	To	Distance (km)	2048 Without project travel time			2048 project travel time			2048 Without project speed			2048 project speed		
			6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00	6.00 - 7.00	7.00 - 8.00	8.00 - 9.00
Pacific Highway East	New England Hwy	16.6	20:07	29:32	24:03	10:15	10:20	10:20	50	34	41	97	96	96
	M1 South	20.9	22:41	34:37	31:13	11:32	11:34	11:40	55	36	40	109	108	107
	John Renshaw Drive West	18.2	22:08	34:45	31:23	13:34	14:08	14:22	49	31	35	81	77	76
	Maitland Road South	15.9	19:11	28:10	24:35	14:03	15:18	19:55	50	34	39	68	62	48
	Newcastle Inter City Bypass	16.6	20:00	28:44	24:00	14:52	15:27	18:26	50	35	41	67	64	54
	Tomago Road	10.5	11:41	17:52	11:05	08:33	09:15	08:19	54	35	57	74	68	76
	Adelaide Street	3.2	04:31	04:15	02:58	02:51	03:05	04:30	42	45	65	67	62	43
Newcastle Inter City Bypass	New England Hwy	14.2	15:40	23:38	30:06	15:09	21:40	23:40	54	36	28	56	39	36
	M1 South	18.5	18:20	25:54	35:39	18:16	22:59	26:59	60	43	31	61	48	41
	John Renshaw Drive West	15.8	18:29	27:50	36:52	18:30	24:13	27:47	51	34	26	51	39	34
	Maitland Road South	2.4	03:34	04:39	08:51	03:40	04:37	08:47	41	31	16	40	31	17
	Pacific Highway East	16.6	16:58	23:18	28:11	15:56	22:44	24:22	59	43	35	63	44	41
	Tomago Road	11.4	15:18	21:50	24:23	16:26	24:10	22:56	45	31	28	42	28	30
	Adelaide Street	15.0	16:28	23:07	26:12	16:18	23:26	24:37	55	39	34	55	39	37
Tomago Road	New England Hwy	11.4	11:43	12:43	15:17	11:16	12:14	11:27	58	54	45	61	56	60
	M1 South	15.6	14:26	19:17	20:33	13:43	13:29	13:23	65	49	46	68	70	70
	John Renshaw Drive West	13.0	14:42	18:53	21:32	14:02	15:38	14:57	53	41	36	56	50	52
	Maitland Road South	10.7	10:37	11:35	16:02	11:28	12:45	18:07	60	55	40	56	50	35
	Pacific Highway East	10.6	10:34	10:35	10:47	09:33	09:45	09:54	60	60	59	67	65	64
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	-	-	-	-	-	-	-	-	-	-	-	-
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	18:11	27:07	23:47	11:54	11:55	11:59	50	33	38	76	76	76
	M1 South	19.4	20:45	31:06	29:23	13:09	13:26	13:32	56	37	40	89	87	86
	John Renshaw Drive West	16.7	20:51	32:57	31:38	15:30	15:52	16:04	48	31	32	65	63	63
	Maitland Road South	14.4	17:26	25:43	23:59	15:22	16:53	21:00	50	34	36	56	51	41
	Pacific Highway East	3.1	02:21	02:35	02:26	02:23	02:32	02:24	78	71	76	77	72	76
	Newcastle Inter City Bypass	15.1	18:20	25:49	22:33	15:52	16:30	19:18	49	35	40	57	55	47
	Tomago Road	9.0	-	-	09:49	-	-	09:16	-	-	55	-	-	58

Table 6-15 Travel times for 2048 evening peak

From	To	Distance (km)	2048 Without project travel time			2048 project travel time			2048 Without project speed			2048 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
New England Hwy	M1 South	8.5	12:44	23:52	37:04	12:34	25:52	38:31	40	21	14	41	20	13
	John Renshaw Drive West	5.9	12:48	26:22	38:11	11:26	25:58	38:45	28	13	9	31	14	9
	Maitland Road South	13.5	13:34	14:17	13:19	12:30	12:36	13:04	60	57	61	65	64	62
	Pacific Highway East	16.3	14:39	15:51	24:23	10:02	10:05	10:13	67	62	40	98	97	96
	Newcastle Inter City Bypass	14.2	14:30	14:50	14:19	13:27	13:35	13:49	59	57	59	63	63	62
	Tomago Road	11.1	10:08	10:19	09:59	10:31	10:26	10:42	66	65	67	63	64	62
	Adelaide Street	14.8	13:56	15:00	24:38	11:01	11:00	11:00	64	59	36	80	81	81
M1 South	New England Hwy	8.5	08:21	14:18	34:49	08:19	10:15	21:44	61	36	15	61	50	24
	John Renshaw Drive West	8.9	07:44	08:39	39:21	09:07	07:10	22:16	69	62	14	58	74	24
	Maitland Road South	17.9	18:26	24:07	44:23	17:11	19:46	29:22	58	44	24	62	54	37
	Pacific Highway East	20.7	19:36	24:31	37:53	11:29	12:03	19:50	63	51	33	108	103	63
	Newcastle Inter City Bypass	18.6	19:29	25:47	43:02	18:16	21:04	29:25	57	43	26	61	53	38
	Tomago Road	15.5	15:12	21:46	37:24	15:05	18:12	25:25	61	43	25	62	51	37
	Adelaide Street	19.2	18:53	23:04	40:34	12:27	13:00	20:33	61	50	28	92	88	56
John Renshaw Drive West	New England Hwy	5.8	11:45	30:20	34:15	10:50	28:18	34:57	30	11	10	32	12	10
	M1 South	9.0	13:26	33:14	38:29	13:57	34:49	35:33	40	16	14	39	15	15
	Maitland Road South	15.2	20:08	35:43	44:00	18:35	33:09	42:22	45	25	21	49	27	21
	Pacific Highway East	18.0	20:53	36:58	48:19	16:33	32:09	39:06	52	29	22	65	34	28
	Newcastle Inter City Bypass	15.8	20:29	36:16	44:46	19:15	33:17	43:03	46	26	21	49	29	22
	Tomago Road	12.8	17:13	34:13	40:58	16:59	33:28	39:27	45	22	19	45	23	19
	Adelaide Street	16.4	20:08	36:50	47:51	17:11	31:30	39:40	49	27	21	57	31	25
Maitland Road South	New England Hwy	13.5	18:14	34:18	40:42	15:16	28:55	32:04	45	24	20	53	28	25
	M1 South	17.8	20:29	37:07	44:41	21:03	42:42	44:43	52	29	24	51	25	24
	John Renshaw Drive West	15.1	21:18	38:09	45:58	19:41	38:47	45:18	43	24	20	46	23	20
	Pacific Highway East	16.0	17:44	32:38	47:20	15:02	19:31	26:43	54	29	20	64	49	36
	Newcastle Inter City Bypass	2.3	03:17	04:00	03:51	03:19	04:24	04:24	43	35	36	42	32	32
	Tomago Road	10.7	13:54	28:06	33:06	13:34	18:05	24:26	46	23	19	47	36	26
	Adelaide Street	14.4	17:17	31:58	46:08	15:43	19:30	27:26	50	27	19	55	44	31

From	To	Distance (km)	2048 Without project travel time			2048 project travel time			2048 Without project speed			2048 project speed		
			15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00	15.00 - 16.00	16.00 - 17.00	17.00 - 18.00
Pacific Highway East	New England Hwy	16.6	20:47	44:34	07:05	10:25	30:41	38:09	48	22	15	96	32	26
	M1 South	20.9	23:08	43:27	08:50	11:27	15:34	30:21	54	29	18	109	80	41
	John Renshaw Drive West	18.2	24:11	44:35	09:48	15:08	34:33	47:39	45	25	16	72	32	23
	Maitland Road South	15.9	19:09	39:37	06:21	14:45	20:25	30:11	50	24	14	65	47	32
	Newcastle Inter City Bypass	16.6	19:52	40:09	06:34	15:38	21:31	30:43	50	25	15	64	46	32
	Tomago Road	10.5	-	33:15	52:24	-	09:20	12:59	-	19	12	-	67	48
	Adelaide Street	3.2	02:45	04:59	22:34	03:11	05:05	03:16	70	39	8	60	38	59
Newcastle Inter City Bypass	New England Hwy	14.2	18:11	33:05	45:28	14:33	27:52	32:10	47	26	19	59	31	26
	M1 South	18.5	20:46	34:27	48:13	21:09	40:10	42:30	53	32	23	52	28	26
	John Renshaw Drive West	15.8	21:22	36:24	49:16	19:10	36:40	44:25	44	26	19	50	26	21
	Maitland Road South	2.4	-	-	-	-	-	-	-	-	-	-	-	-
	Pacific Highway East	16.6	17:30	31:42	44:46	14:09	17:15	28:02	57	31	22	70	58	36
	Tomago Road	11.4	13:22	24:30	41:40	12:40	13:41	26:06	51	28	16	54	50	26
	Adelaide Street	15.0	16:51	30:32	46:15	14:51	17:45	28:27	54	30	20	61	51	32
Tomago Road	New England Hwy	11.4	14:11	18:36	19:46	13:03	29:13	32:47	48	37	35	52	23	21
	M1 South	15.6	16:41	21:33	24:03	13:35	17:33	40:45	56	44	39	69	53	23
	John Renshaw Drive West	13.0	17:40	23:12	24:59	17:20	38:38	44:58	44	34	31	45	20	17
	Maitland Road South	10.7	12:34	16:25	17:03	12:47	18:35	27:44	51	39	37	50	34	23
	Pacific Highway East	10.6	-	14:56	25:13	-	12:33	19:49	-	43	25	-	51	32
	Newcastle Inter City Bypass	11.3	-	-	-	-	-	-	-	-	-	-	-	-
	Adelaide Street	9.0	11:28	12:51	-	09:37	09:44	-	47	42	-	56	56	-
Adelaide Street (Heatherbrae, north of roundabout)	New England Hwy	15.1	20:08	46:43	12:13	12:10	31:49	36:35	45	19	13	75	29	25
	M1 South	19.4	22:59	47:06	15:31	13:30	17:04	30:03	51	25	15	86	68	39
	John Renshaw Drive West	16.7	23:10	49:53	15:36	16:54	36:49	49:53	43	20	13	59	27	20
	Maitland Road South	14.4	18:40	44:10	09:22	16:13	21:35	23:20	46	20	12	53	40	37
	Pacific Highway East	3.1	04:27	11:43	20:57	02:26	02:27	02:27	41	16	9	75	75	75
	Newcastle Inter City Bypass	15.1	19:07	44:47	10:51	16:59	22:49	24:13	47	20	13	53	40	37
	Tomago Road	9.0	-	-	-	-	-	-	-	-	-	-	-	-

The morning peak hour results indicate travel times for most origin and destination combinations are likely to reduce as a result of the project when compared with the 'without project' scenarios. This is consistent for all the future years modelled. Key morning peak hour outcomes include:

- The project would result in a 35 to 60 per cent improvement in travel times from the New England Highway and the M1 Pacific Motorway at the western edge of the study area to Pacific Highway at the eastern edge of the study area. These improvements equate to a travel time saving of about 15 minutes per vehicle in 2048. The benefits are the result of the additional east-west capacity and higher travel speeds that are enabled by the project
- As a result of the project, travel times from the Pacific Highway to either the New England Highway or the M1 Pacific Motorway would improve by at least 36 per cent in 2028. In 2038, the travel time savings would be about 40 per cent and by 2048 about 60 per cent. In 2048, this improvement in travel time equates to a saving of 15-20 minutes per vehicle. These substantial improvements to east-west travel time in the morning peak are pronounced for trips that travel on the New England Highway and Pacific Highway between Tarro and Tomago as they bypass the existing bridge over the Hunter River which causes substantial congestion in the 'without project' models
- The project also substantially improves travel times to and from Maitland Road, as travel times from to key locations would be reduced by greater than 22 per cent in each of the future horizon years. Much of this can be attributed to the reduction in traffic at the Pacific Highway/Maitland Road/New England Highway intersection and the wider traffic benefits to the network the project delivers
- The project results in a reduction in travel time from trips originating from John Renshaw Drive However, in future horizons travel times 'with project' are still lengthy. As discussed in **Section 4.3** the Black Hill development is a key generator of traffic in future years with access and egress points located on John Renshaw Drive. The high levels of traffic demand from the development are distributed onto the network via John Renshaw Drive, which results in substantial delays and queues for vehicles at the western approach of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. These delays are reflected in the poor travel time performance for vehicles originating from John Renshaw Drive.

The evening peak hour results indicate travel times for most origin and destination combinations are likely to improve as a result of the project when compared with the 'without project' scenarios. This is consistent for all the future years modelled. Key evening peak hour outcomes include:

- The project would result in a 28 to 64 per cent improvement in travel times from the New England Highway and the M1 Pacific Motorway at the western edge of the study area to Pacific Highway at the eastern edge of the network. These improvements equate to a travel time saving of about 15 minutes per vehicle in 2048. These benefits are the result of the additional east-west capacity and higher travel speeds that are enabled by the project
- As a result of the project, travel times from the Pacific Highway to either the New England Highway or the M1 Pacific Motorway would improve by at least 45 per cent in 2028. In 2038, the travel time savings would be about 66 per cent and in 2048 about 42 per cent. In 2048, this improvement in travel time equates to a saving of 30 minutes per vehicle. These substantial improvements to east-west travel time in the evening peak are pronounced for trips that travel on the New England Highway and the Pacific Highway between Tarro and Tomago as they bypass the existing bridge over the Hunter River which causes substantial congestion in the 'without project' models. These substantial improvements to east-west travel time in the evening peak are pronounced for trips that travel on the New England Highway and the Pacific Highway between Tarro and Tomago. These trips bypass the existing bridge over the Hunter River which causes substantial congestion in the 'without project' models
- The project also improves travel times to and from Maitland Road as travel times to key locations, with a reduction by greater than 12 per cent in each of the future horizon years. Much of this can be attributed to the reduction in traffic at the Pacific Highway/Maitland Road/New England Highway intersection

- The project results in an improvement in travel time from trips originating from John Renshaw Drive, however in future horizons with the project travel times are still lengthy. As discussed, **Section 4.3** the Black Hill development is a key generator of traffic in future years with access and egress points located on John Renshaw Drive. The high levels of traffic from the development are distributed onto the network via John Renshaw Drive, which results in substantial delays and queues for vehicles at the western approach of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. These delays are reflected in the poor travel time performance for vehicles originating from John Renshaw Drive.

Overall, when comparing travel times for journeys through the network between the 'without project' and the 'with project' scenarios, the project substantially reduces travel times in both the morning and evening peaks across all future modelled years. This is also reflected in the VHT comparisons carried out in the network statistics analysis presented earlier in **Chapter 6** and is most pronounced for journeys that currently use the New England Highway between Tarro and Raymond Terrace that would instead use the main alignment in the 'with project' scenario.

These improvements would substantially reduce travel time movements between Newcastle, Raymond Terrace, Maitland and other regional industrial areas. Furthermore, the project would provide key infrastructure for movements along the eastern coast of Australia, improving travel time and travel time reliability between Brisbane in the north and Melbourne and Sydney. While the model covers the morning and evening peak periods, it is expected travel times in off peak periods between Maitland and Raymond Terrance and Black Hill and Raymond Terrace would also markedly improve as vehicles are required to travel less distance while operating at a high speed without the traffic signals interrupting traffic flow. However, some routes are not expected to attain benefits as a result of the project. In particular, trips originating from John Renshaw Drive west from 2038 onwards have comparable travel times for the 'without project' and 'with project' models. A reason for this is the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection which displays substantial congestion, much of which can be attributed to the Black Hill development due to is high trip generation rates. Further sensitivity analysis and consideration of additional infrastructure upgrades as the Black Hill development expands has been documented in **Chapter 7**.

6.5 Interchange analysis

A merge and diverge analysis was carried out at each motorway entry and exit ramp to determine the performance of the ramp-motorway junction (merge/diverge influence area). This was based on calculations for freeway merge and diverge segments stipulated in the Transportation Research Board's Highway Capacity Manual 2016 (HCM 2016) (Transportation Research Board 2016). **Figure 6-4** to **Figure 6-7** display the volumes of on and off ramps at the interchanges. **Table 6-16** to **Table 6-18** presents the analysis results for merge and diverge segments in the modelled future horizon years for the interchanges displayed in **Figure 6-3**:

- Black Hill interchange
- Tarro interchange
- Tomago interchange
- Raymond Terrace interchange.

LoS D is the generally accepted target performance level. In circumstances where an intersection performance falls below LoS D, investigations should be initiated to determine if suitable remediation can be provided. LoS is evaluated by both density and capacity and pink shading represents interchange segments where operations are worse than LoS D. In some instances, due to a nearby signalised intersection an interchange assessment could not be conducted. In these cases, these assessments are represented by N/A.

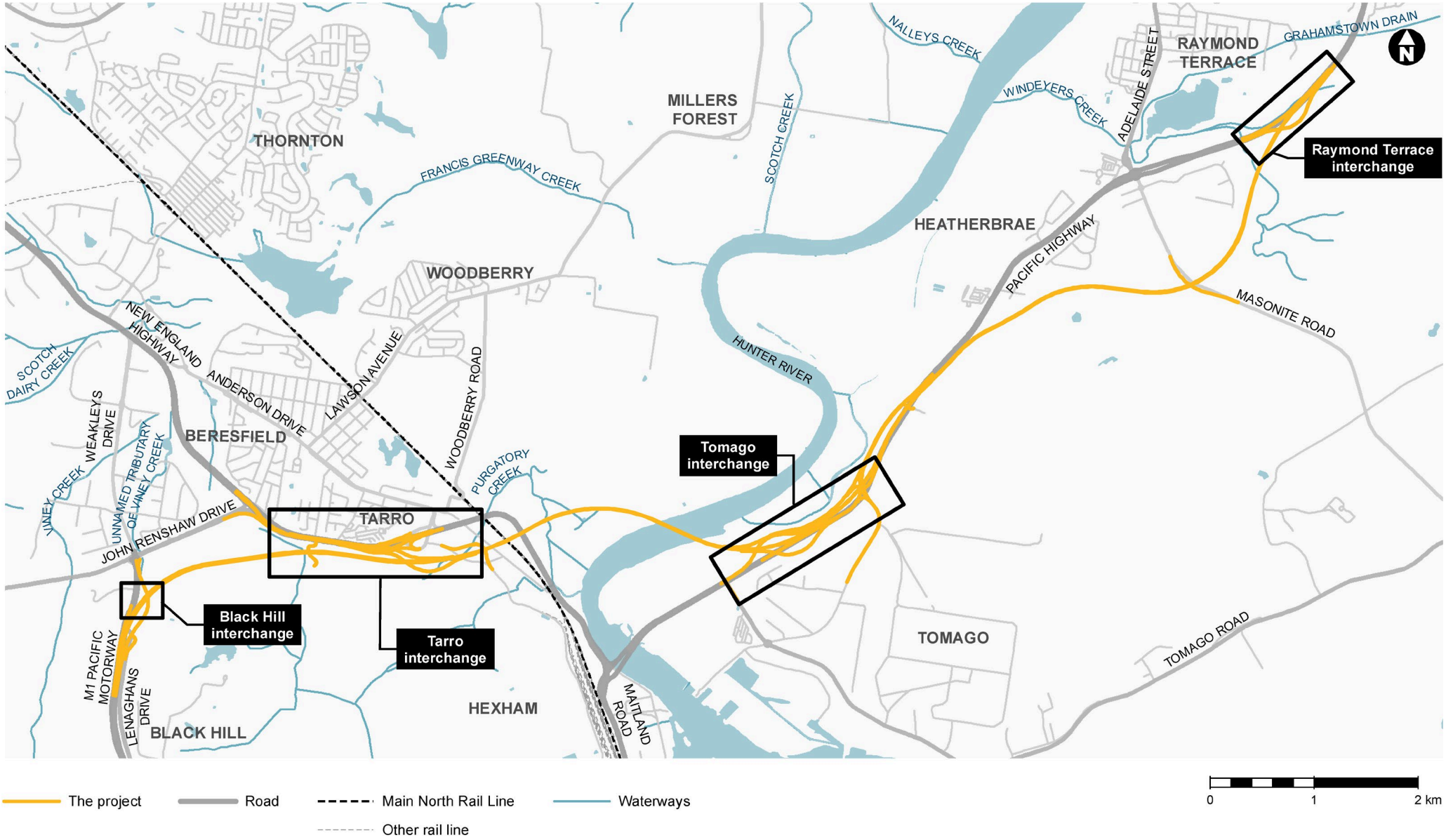


Figure 6-3 Location of project interchanges

Date: 12/01/2021 Path: J:\IE\Projects\04_Eastern\IA230000\22_Spatial\GIS\Directory\Templates\Figures\EIS\3_TechnicalReports\Traffic\IA230000_CD_TRF_024_interchanges_JAC_A4P_50000_V02.mxd

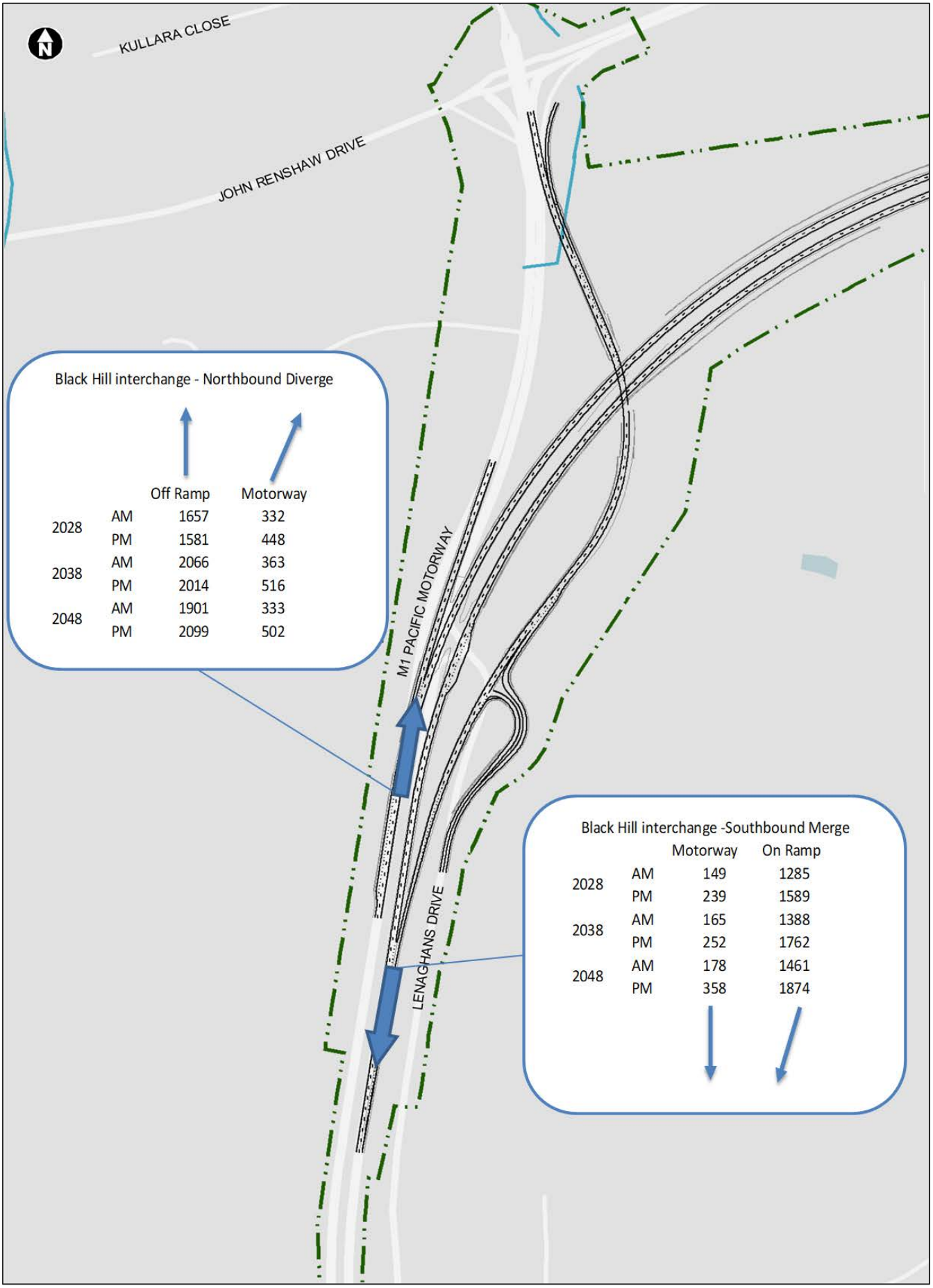
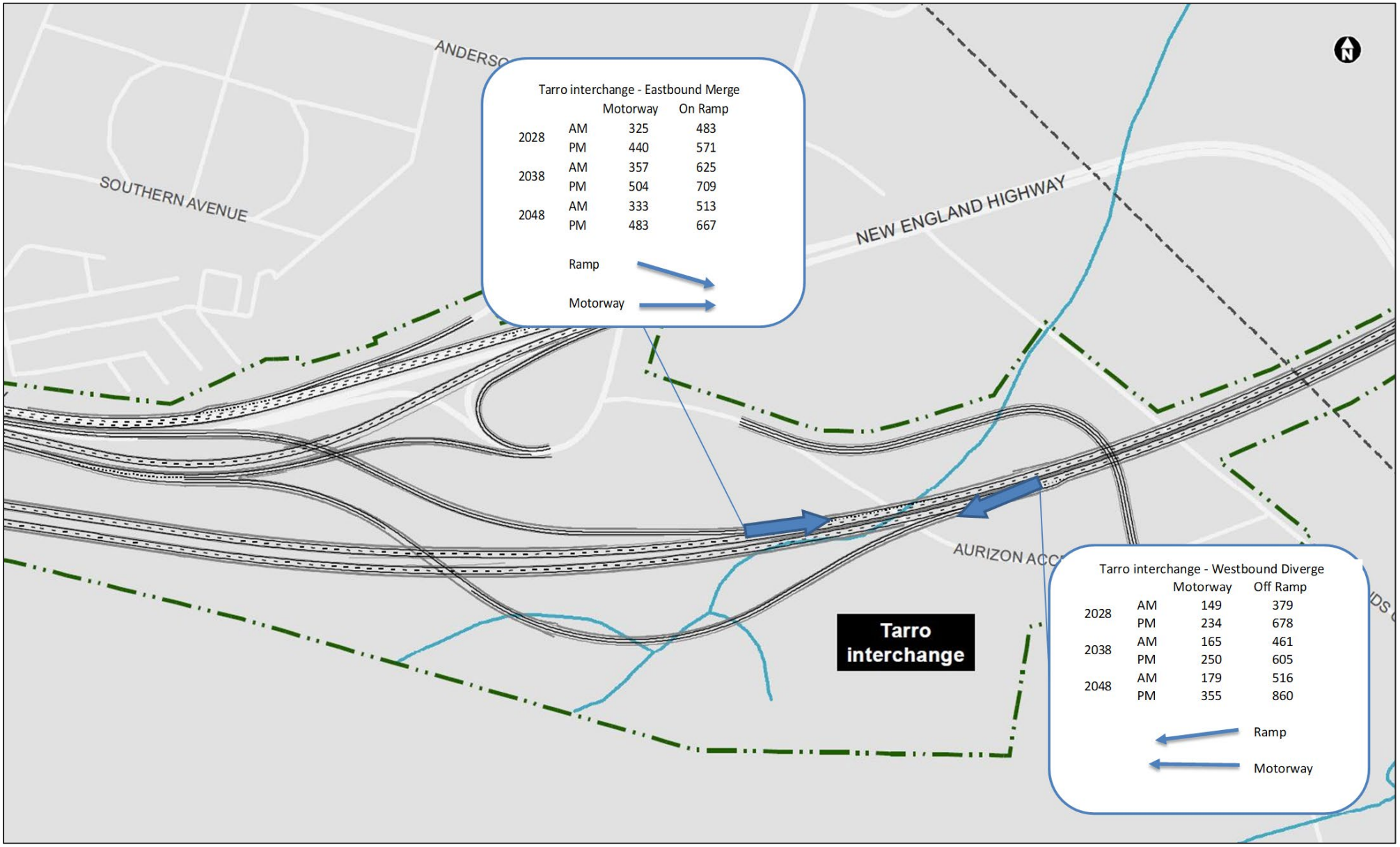


Figure 6-4 Black Hill interchange volume



Tarro interchange - Eastbound Merge

		Motorway	On Ramp
2028	AM	325	483
	PM	440	571
2038	AM	357	625
	PM	504	709
2048	AM	333	513
	PM	483	667

Tarro interchange - Westbound Diverge

		Motorway	Off Ramp
2028	AM	149	379
	PM	234	678
2038	AM	165	461
	PM	250	605
2048	AM	179	516
	PM	355	860

Figure 6-5 Tarro interchange volume

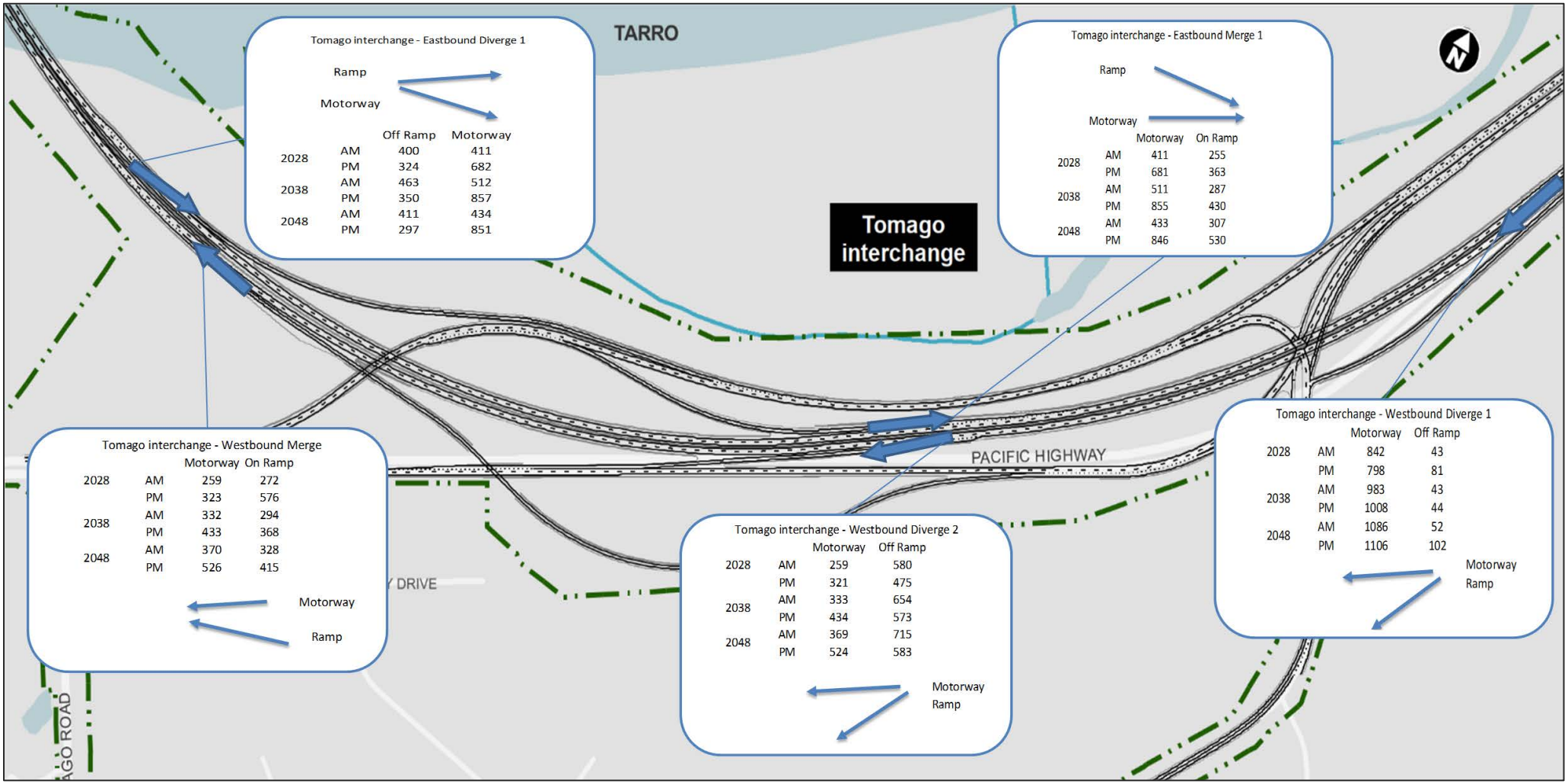


Figure 6-6 Tomago interchange volume

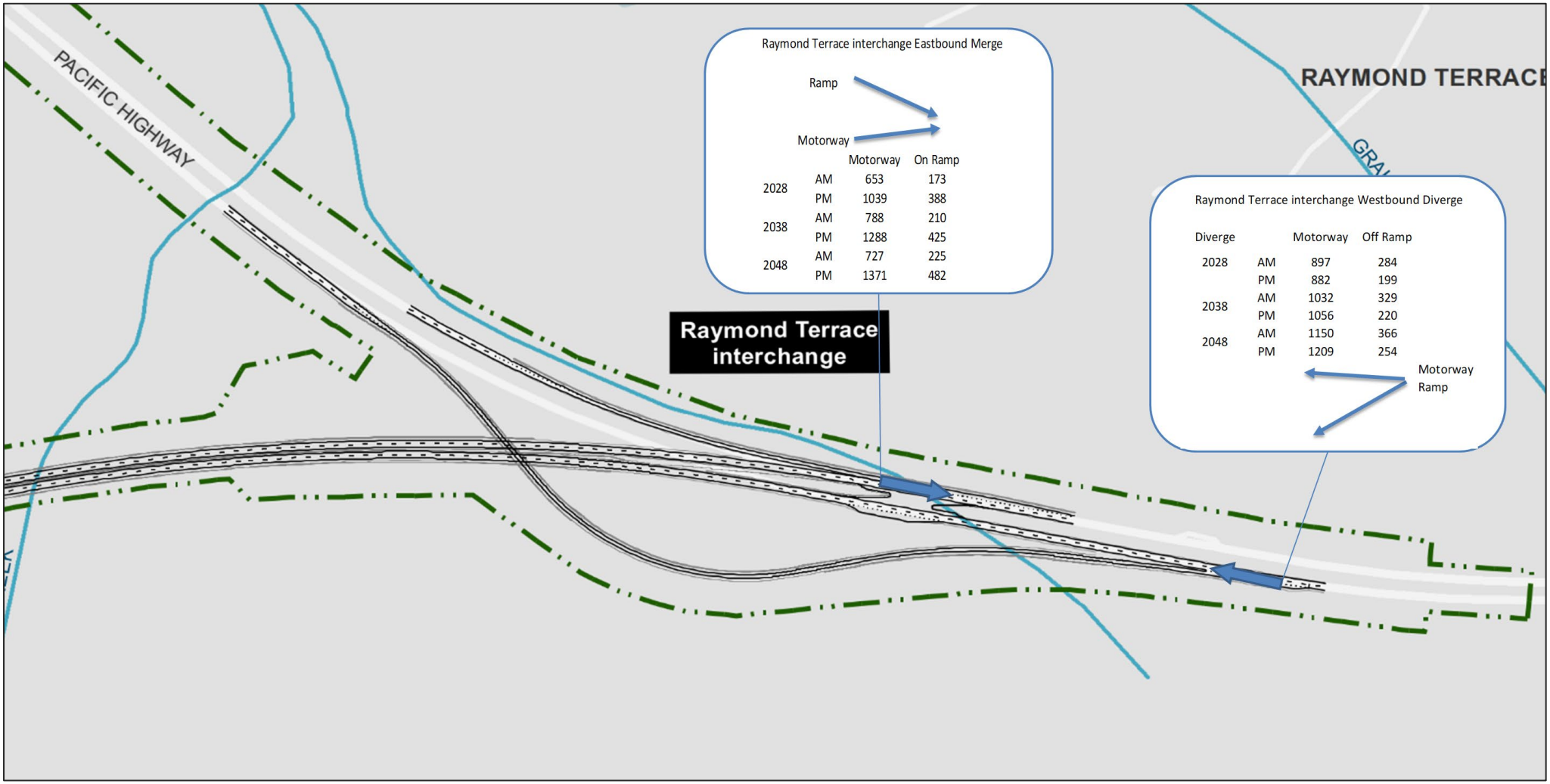


Figure 6-7 Raymond Terrace interchange volume

Table 6-16 Performance of modelled interchanges for 2028

Intersection	Morning peak									Evening peak								
	6.00 - 7.00			7.00 - 8.00			8.00 - 9.00			16.00-17.00			16.00-17.00			17.00-18.00		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange - Northbound Diverge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.0	0.8	B	8.7	0.8	B	9.8	0.9	B	12.2	1.1	F	12.7	1.1	F	11.9	1.1	F
Tarro interchange - Eastbound Merge	5.0	0.2	A	6.3	0.4	B	6.5	0.3	B	5.8	0.3	A	6.7	0.4	B	7.5	0.4	B
Tarro interchange - Westbound Diverge	1.9	0.4	A	1.8	0.3	A	1.9	0.3	A	2.9	0.4	A	3.7	0.6	A	2.5	0.4	A
Tomago interchange - Eastbound Merge 1	4.9	0.2	A	5.1	0.2	A	5.7	0.2	A	6.0	0.2	A	7.3	0.3	B	7.3	0.3	B
Tomago interchange - Westbound Diverge 1	4.0	0.3	A	2.2	0.3	A	2.2	0.4	A	2.4	0.3	A	3.6	0.2	A	2.7	0.3	A
Tomago interchange - Westbound Diverge 2	7.5	0.3	B	5.6	0.2	A	6.4	0.3	B	5.5	0.2	A	6.2	0.2	A	6.0	0.2	A
Tomago interchange - Eastbound Diverge 1	1.3	0.2	A	1.5	0.3	A	2.4	0.3	A	1.8	0.2	A	2.7	0.2	A	4.3	0.2	A
Tomago Interchange - Westbound Merge	5.8	0.2	A	5.1	0.2	A	5.0	0.2	A	7.8	0.5	B	9.4	0.6	B	7.0	0.4	B
Raymond Terrace interchange Eastbound Merge	4.4	0.2	A	5.1	0.2	A	5.6	0.3	A	6.7	0.3	B	8.4	0.4	B	8.4	0.4	B
Raymond Terrace interchange Westbound Diverge	10.3	0.3	B	7.7	0.3	B	8.6	0.3	B	7.5	0.2	B	8.4	0.3	B	8.4	0.3	B

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

Table 6-17 Performance of modelled interchanges for 2038

Intersection	Morning peak									Evening peak								
	6.00 - 7.00			7.00 - 8.00			8.00 - 9.00			16.00-17.00			16.00-17.00			17.00-18.00		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange - Northbound Diverge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.0	0.8	B	8.8	0.8	B	9.2	0.8	B	11.8	1.0	F	12.3	1.1	F	11.5	1.0	F
Tarro interchange - Eastbound Merge	5.7	0.3	A	7.1	0.4	B	7.6	0.4	B	7.0	0.4	B	7.9	0.5	B	8.7	0.5	B
Tarro interchange - Westbound Diverge	2.0	0.4	A	1.9	0.3	A	2.0	0.3	A	2.9	0.3	A	3.6	0.4	A	2.6	0.4	A
Tomago interchange - Eastbound Merge 1	5.3	0.2	A	5.5	0.2	A	6.3	0.2	B	7.2	0.3	B	8.5	0.4	B	8.5	0.4	B
Tomago interchange - Westbound Diverge 1	4.7	0.4	A	2.9	0.4	A	2.8	0.4	A	3.0	0.3	A	4.4	0.3	A	3.5	0.4	A
Tomago interchange - Westbound Diverge 2	8.7	0.3	B	6.8	0.3	B	7.4	0.3	B	6.7	0.3	B	7.5	0.3	B	7.6	0.3	B
Tomago interchange - Eastbound Diverge 1	1.9	0.2	A	2.1	0.3	A	3.1	0.3	A	3.3	0.2	A	4.0	0.2	A	5.7	0.3	A
Tomago Interchange - Westbound Merge	6.3	0.3	B	5.6	0.2	A	5.4	0.2	A	6.1	0.3	A	7.7	0.4	B	6.2	0.3	A
Raymond Terrace interchange Eastbound Merge	4.9	0.2	A	5.6	0.3	A	6.4	0.3	B	7.8	0.4	B	9.6	0.5	B	9.7	0.5	B
Raymond Terrace interchange Westbound Diverge	11.7	0.4	B	8.9	0.3	B	9.5	0.3	B	8.7	0.3	B	9.6	0.3	B	9.7	0.3	B

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

Table 6-18 Performance of modelled interchanges for 2048

Intersection	Morning peak									Evening peak								
	6.00 - 7.00			7.00 - 8.00			8.00 - 9.00			16.00-17.00			16.00-17.00			17.00-18.00		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange - Northbound Diverge	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Black Hill interchange - Southbound Merge	9.4	0.8	B	8.9	0.8	B	9.8	0.9	B	11.2	1	F	12.2	1.1	F	12.6	1.1	F
Tarro interchange - Eastbound Merge	6.0	0.3	A	7.1	0.4	B	6.7	0.3	B	7.5	0.5	B	8.0	0.5	B	8.3	0.5	B
Tarro interchange - Westbound Diverge	2.2	0.5	A	2.1	0.4	A	2.2	0.3	A	3.2	0.3	A	3.0	0.3	A	3.4	0.6	A
Tomago interchange - Eastbound Merge 1	5.4	0.2	A	5.8	0.2	A	6.1	0.2	A	7.6	0.3	B	7.9	0.3	B	9.1	0.4	B
Tomago interchange - Westbound Diverge 1	5.3	0.4	A	3.3	0.4	A	3.1	0.5	A	3.4	0.4	A	4.8	0.3	A	4.3	0.4	A
Tomago interchange - Westbound Diverge 2	9.7	0.4	B	7.7	0.3	B	8.2	0.3	B	7.4	0.3	B	7.9	0.3	B	8.4	0.3	B
Tomago interchange - Eastbound Diverge 1	2.0	0.2	A	2.2	0.4	A	2.5	0.3	A	3.7	0.2	A	4.2	0.2	A	5.7	0.3	A
Tomago Interchange - Westbound Merge	7.0	0.3	B	6.1	0.3	A	5.8	0.2	A	6.5	0.3	B	8.1	0.4	B	6.9	0.3	B
Raymond Terrace interchange Eastbound Merge	5.1	0.2	A	5.9	0.3	A	6.3	0.3	B	8.4	0.4	B	9.7	0.5	B	10.4	0.6	B
Raymond Terrace interchange Westbound Diverge	12.9	0.4	C	9.9	0.4	B	10.4	0.3	B	9.5	0.3	B	10.9	0.4	B	10.9	0.4	B

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

The Black Hill interchange southbound merge between Weakleys Drive and the M1 Pacific Motorway operates at an LoS F during each of the assessed evening peak periods in each year. The merge operates at a LoS F due to the demand for the entry ramp exceeding its capacity during the assessed 15-minute peak period. This does not create problems on the M1 Pacific Motorway, as demonstrated by the its density remaining less than 15 PCU/km/ln, which would typically align with a LoS C. The M1 Pacific Motorway would continue to operate without major disruption as the number of vehicles entering is constrained by the single-entry lane. The excess demand does result in queueing on Weakleys Drive which extends to the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. This queueing impacts all southbound movements at the intersection and results in extensive queuing for the north, east and west approaches. All other merges assessed operate at an acceptable LoS C or better in each of the modelled scenarios indicating the M1 Pacific Motorway would experience minimal decrease in performance due to merge points.

All diverge points assessed operate at a LoS C or better in each of the modelled future horizon years. However, the Weakleys Drive northbound diverge cannot be assessed due to the influence of the downstream M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection. Queueing at the southern approach to this intersection extends to the northbound Weakleys Drive diverge point, causing a negative impact on the operation of the junction.

Overall, the interchange assessment shows the project would operate at a LoS C or better at the merge and diverge points for each of the modelled scenarios. This is with the exception of the northbound Weakleys Drive diverge which is impacted by the John Renshaw Drive/Weakleys/M1 Pacific Motorway Drive intersection and cannot be assessed as part of a merge and diverge analysis. Overall, it is expected that merging and diverging manoeuvres on the M1 Pacific Motorway would reduce the speed of vehicles on the main alignment, however the reduction in speed would be relatively minor and the interchanges are considered to operate at a satisfactory level.

Assessment of the requirement for the provision of ramp metering was carried out in line with the Smart Motorway Design Guide: Capacity and Flow Analysis (Roads and Maritime 2015) and Smart Motorway Guidelines (Roads and Maritime 2015).

As stated in the guidelines, ramp metering is warranted if peak hour volumes per lane are greater than 1,700 PCU per hour per lane or if future peak-hour traffic volumes would be greater than 1,700 PCU per hour per lane within ten years on the main alignment. The southbound entry ramp at the Black Hill interchange has a volume greater than 1,700 PCU per lane by 2038 and 2048 during the evening periods. The high volume does not substantially impact the M1 Pacific Motorway performance. However, it does result in queuing on the ramp that impacts the upstream John Renshaw Drive/Weakleys Drive intersection. All other motorway flows are below this threshold. Accordingly, ramp metering is not considered to be required in any of the forecast horizon years.

7. Options testing

7.1 Sensitivity modelling overview

The Black Hill development located south west of the John Renshaw/Weakleys Drive intersection is a major driver of traffic demand in the VISSIM model. It accounts for about 11 per cent of all traffic demand in 2038. Traffic congestion around the Black Hill development was found to be substantive. This is demonstrated by the poor performance of the John Renshaw/Weakleys Drive intersection and the southbound merge between John Renshaw Drive and the M1 Pacific Motorway (southbound Black Hill interchange merge) which both would operate at a LoS F in 2038. To quantify the impact of the Black Hill development, sensitivity testing was carried out. The following two scenarios were tested:

- Scenario 1 – Incorporating on and off ramps at the Black Hill Road interchange with the M1 Pacific Motorway to allow for direct connection to the development site from the south
- Scenario 2 – No traffic generated from the Black Hill development.

The sensitivity modelling was carried out for in both peak periods for 2038. This provides a good balance to test the impact of the Black Hill development as 75% of the development is assumed to have been constructed. This horizon year has also been selected as it occurs 10 years after the opening of the project.

7.2 Scenario 1 - Black Hill Road interchange

The first sensitivity test was the implementation of south facing ramps at the Black Hill Road/Lenaghans Drive interchange to connect to the Black Hill developments and provide an alternate access. The objective of this modelling was to reduce the amount of traffic travelling through the John Renshaw Drive/Weakleys Drive intersection and the southbound Black Hill interchange merge by providing alternative access and egress to the Black Hill development site from the south.

It should be noted that for the purposes of assessment, the southern access to the Black Hill development has been assumed at Black Hill Road but there may potentially be alternate connections that may be feasible to achieve a similar outcome.

To achieve this, the model was extended to include Lenaghans Drive and the M1 Pacific Motorway to the Black Hill Road interchange, as this was not part of the original traffic model. Links connecting to the Black Hill development were also extended to connect to Black Hill Road in the south. Route closures were also implemented in the model to restrict ‘rat-running’ through the Black Hill development . To simplify the model, no background traffic was added to Black Hill Road or Lenaghans Drive. The model layout is shown in **Figure 7-1**.

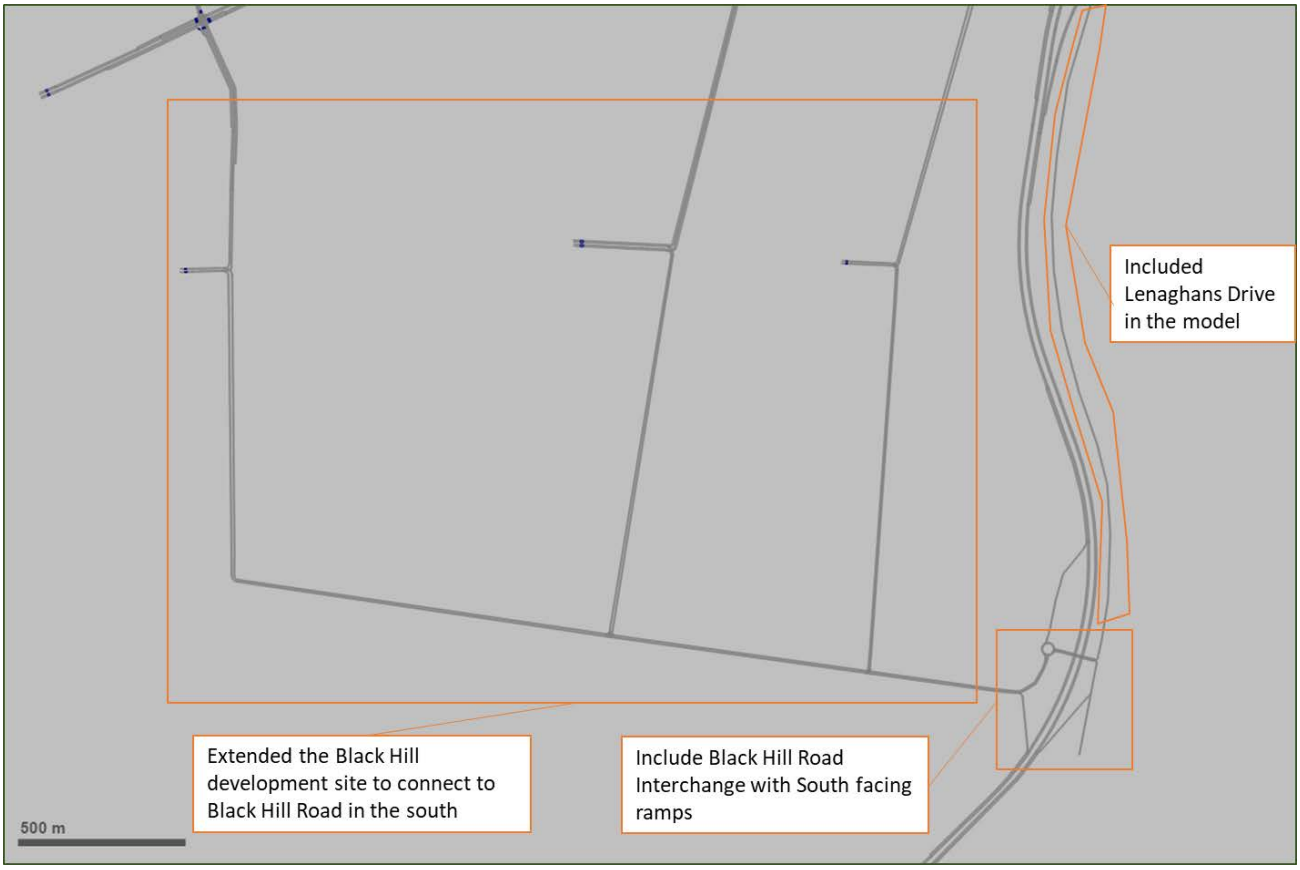


Figure 7-1 Scenario 1 - Black Hill Road interchange modelled layout

7.2.1 Scenario 1 - Sensitivity results

Tables outlining network statistics, intersection performance, queues and ramps data associated with Scenario 1 are shown in the sections below.

Network statistics

Table 7-1 2038 sensitivity modelling scenario 1 - network statistics comparison

Network statistics	2038 morning peak			2038 evening peak		
	Project	Scenario 1	% Change	Project	Scenario 1	% Change
Total throughput	50,362	50,614	0.50%	55,620	56,634	1.82%
VHT	11,268	10,834	-3.85%	13,364	12,136	-9.19%
VKT	584,027	588,795	0.82%	636,630	652,223	2.45%
Network speed (km/h)	53	55	4.26%	49	54	10.91%
Total stops	401,875	385,199	-4.15%	587,527	310,310	-47.18%
Latent demand	3	8	N/A	1,592	1,358	-14.71%
Average delay (secs)	210	180	-14.32%	259	185	-28.70%
Total delay (hr)	3,669	3,123	-14.88%	5,062	3,568	-29.52%

Intersection performance

Table 7-2 2038 sensitivity modelling scenario 1 - intersection performance comparison

Intersection name	Type	2038 With Project				Scenario 1			
		8-9am		5-6pm		8-9am		5-6pm	
		Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	124	F	151	F	119	F	100	F
New England Highway/Weakleys Drive, Beresfield	Signalised	28	C	41	D	26	C	46	D
New England Highway/Maitland Road/Pacific Highway	Signalised	36	D	38	D	38	D	29	C
Pacific Highway/Tomago Road, Tomago	Signalised	18	B	15	B	24	C	21	C
Pacific Highway/Old Punt Road, Tomago	Signalised	5	A	5	A	10	B	12	B
Pacific Highway/Hank Street, Heatherbrae	Signalised	12	B	9	A	12	B	9	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	4	A	5	A	4	A	6	A

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

Queues

Table 7-3 2038 sensitivity modelling scenario 1 – queue length comparison

Intersection name	Approach name	2038 With Project						Scenario 1					
		8-9am			5-6pm			8-9am			5-6pm		
		Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)
John Renshaw/ Weakleys intersection	Southern	184	701	746	123	461	542	73	187	215	81	228	245

Ramps

Table 7-4 2038 sensitivity modelling scenario 1 - modelling ramp assessment comparison

Interchange	2038 With Project						Scenario 1					
	8-9am			5-6pm			8-9am			5-6pm		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange southbound merge	9.2	0.8	B	11.5	1.0	F	8.5	0.7	B	10.1	0.9	B

7.2.2 Scenario 1 - Discussion

The results in **Section 7.2.1** display improved performance for the network with the addition of south facing ramps connecting the Black Hill development via Black Hill Road to the M1 Pacific Motorway. The morning peak period displays modest improvements in performance with VHT reduced by about four per cent and delays reduced by about 15 per cent. There is no notable impact on delays at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, however, queues at the southern approach to the intersection were substantially reduced. The reduction in 95th percentile queue length from about 700 metres to 190 metres would improve northbound flow on the M1 Pacific Motorway, as the potential of queues extending to the south from the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection is no longer an issue.

The evening peak displays substantial improvements with a nine per cent decrease in VHT, a 10 per cent increase in speed and a 14 per cent reduction in unreleased trips which coincides with a two per cent increase in vehicle throughput. The average delay across the network was also been reduced by about 30 per cent. The operation of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection shows substantial improvement as the average vehicle delays were reduced from 151 seconds to 100 seconds.

In both peak periods, the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection continues to operate at a LoS F, however, the inclusion of south facing ramps connecting to Black Hill Road has reduced traffic demand at the intersection. The demand reduction was most significant for the left turn movement from Weakleys Drive (southern approach) into John Renshaw Drive (western departure) and right turn from John Renshaw Drive (western approach) into Weakleys Drive (southern departure).

The reduction in traffic demand for the right turn from John Renshaw Drive (western approach) into Weakleys Drive (southern departure) results in improved performance of the southbound Black Hill interchange merge. In the project model, this merge was operating at a LoS F due to traffic demand on the ramp from Weakleys Drive exceeding its capacity. As the demand for this movement has been reduced by about 250 vehicles in the evening peak hour, the ramp is expected to perform satisfactorily and operate at LoS B.

Overall, the provision of south facing ramps connecting Black Hill Road to the M1 Pacific Motorway would improve the performance of the road network, particularly during the evening peak. This improvement is a result of more direct access to the Black Hill development site from the south, which reduces the distance travelled by vehicles accessing and departing the site and consequently reduces the number of vehicles travelling the network surrounding the Black Hill development.

7.3 Scenario 2 - No traffic generated from the Black Hill development

The second sensitivity test carried out aimed to quantify the impact of the Black Hill development on the road network. This was achieved by removing all traffic to and from the Black Hill development from the traffic model through adjustments to the trip matrices. No other changes to the model were implemented. This modelling represents a scenario where the Black Hill development is not constructed, compared to the assumed base scenario of 75 per cent development occurring at Black Hill by 2038.

7.3.1 Scenario 2 - Sensitivity results

Tables outlining network statistics, intersection performance, queues and ramps data associated with Scenario 2 are shown in the sections below.

Network statistics

Table 7-5 2038 sensitivity modelling scenario 2 - network statistics comparison

Network statistics	2038 morning peak			2038 evening peak		
	Project	Scenario 2	% Change	Project	Scenario 2	% Change
Total throughput	50,362	45,912	-8.84%	55,620	51,262	-7.84%
VHT	11,268	9,221	-18.16%	13,364	10,352	-22.54%
VKT	584,027	540,123	-7.52%	636,630	599,399	-5.85%
Network speed (km/h)	53	59	11.50%	49	58	18.97%
Total stops	401,875	255,304	-36.47%	587,527	230,145	-60.83%
Latent demand	3	5	N/A	1,592	852	-46.50%
Average delay (secs)	210	142	-32.35%	259	146	-43.73%
Total delay (hr)	3,669	2190	-40.30%	5,062	2,505	-50.52%

Intersection performance

Table 7-6 2038 sensitivity modelling scenario 2 - intersection performance comparison

Intersection name	Type	2038 With Project				Scenario 2			
		8-9am		5-6pm		8-9am		5-6pm	
		Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS
M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive, Black Hill	Signalised	124	F	151	F	70	E	51	D
New England Highway/Weakleys Drive, Beresfield	Signalised	28	C	41	D	20	C	33	C
New England Highway/Maitland Road/Pacific Highway	Signalised	36	D	38	D	34	C	25	C

Intersection name	Type	2038 With Project				Scenario 2			
		8-9am		5-6pm		8-9am		5-6pm	
		Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS	Avg Delays (sec)	LoS
Pacific Highway/Tomago Road, Tomago	Signalised	18	B	15	B	18	B	20	B
Pacific Highway/Old Punt Road, Tomago	Signalised	5	A	5	A	5	A	9	A
Pacific Highway/Hank Street, Heatherbrae	Signalised	12	B	9	A	12	B	10	A
Pacific Highway/Masonite Road, Heatherbrae	Roundabout	4	A	5	A	4	A	6	A

Queues

Table 7-7 2038 sensitivity modelling scenario 2 - queue length comparison

Intersection name	Approach name	2038 With Project						Scenario 2					
		8-9am			5-6pm			8-9am			5-6pm		
		Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)	Avg. (m)	95th %tile	Max. (m)
John Renshaw/ Weakleys intersection	Southern	184	701	746	123	461	542	62	149	185	62	176	193

Ramps

Table 7-8 2038 sensitivity modelling scenario 2 - ramp assessment comparison

Interchange	2038 With Project						Scenario 2					
	8-9am			5-6pm			8-9am			5-6pm		
	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS	Density (pcu/km/ln)	V/C	LoS
Black Hill interchange southbound merge	9.2	0.8	B	11.5	1.0	F	10.1	0.9	B	11.1	0.97	B

7.3.2 Scenario 2 - Discussion

The results in **Section 7.3.1** display a substantial improvement in performance for the road network with the removal of all traffic generated by the Black Hill development. The morning peak period displays improvements through a reduction in VHT and VKT, total throughput is also reduced after the removal of all Black Hill development traffic. This results in an 11 per cent increase to the network speed and a 40 per cent decrease in total delay. Delays at the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive are reduced from 124 seconds to 70 seconds which correlates to an improvement from LoS F to LoS E.

Queues at the southern approach to the intersection were substantially reduced. The reduction in 95th percentile queue length from about 700 metres to 150 metres would improve flow on the M1 Pacific Motorway, as the potential of queues extending to the south from the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection is no longer an issue.

The evening peak displays substantial improvements with a 22 per cent decrease in VHT, a 19 per cent increase in speed, a 46 per cent reduction in unreleased trips, which coincides with a seven per cent decrease in vehicle throughput. The average delay across the network has also been reduced by about 43 per cent. The operation of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection substantially improves as average vehicle delay is reduced from 150 seconds to 51 seconds, which correlates to an improvement from LoS F to LoS D. Queue length at the southern approach of the M1 Pacific Motorway/Weakleys Drive/John Renshaw Drive intersection was also improved, with the 95th percentile queue length reducing from about 460 metres to 180 metres.

In the evening peak, reduction in traffic demand for the right turn from John Renshaw Drive (western approach) into Weakleys Drive (southern departure) resulted in improved performance of the southbound Black Hill interchange merge. In comparison to sensitivity scenario 1, the demand reduction is not as pronounced, as the network-wide improvements released vehicles from elsewhere in the modelled network then use the southbound merge. In the project model, this merge was operating at a LoS F due to the traffic demand on the ramp from Weakleys Drive exceeding its capacity. As the demand for this movement has been reduced by about 100 vehicles in the evening peak hour, the ramp is expected to perform sufficiently and operate at LoS B.

Overall, the sensitivity testing shows the removal of all Black Hill traffic from the 2038 model would improve the performance of the road network. This improvement is a result of less traffic demand which limits the build-up of queues and delays.

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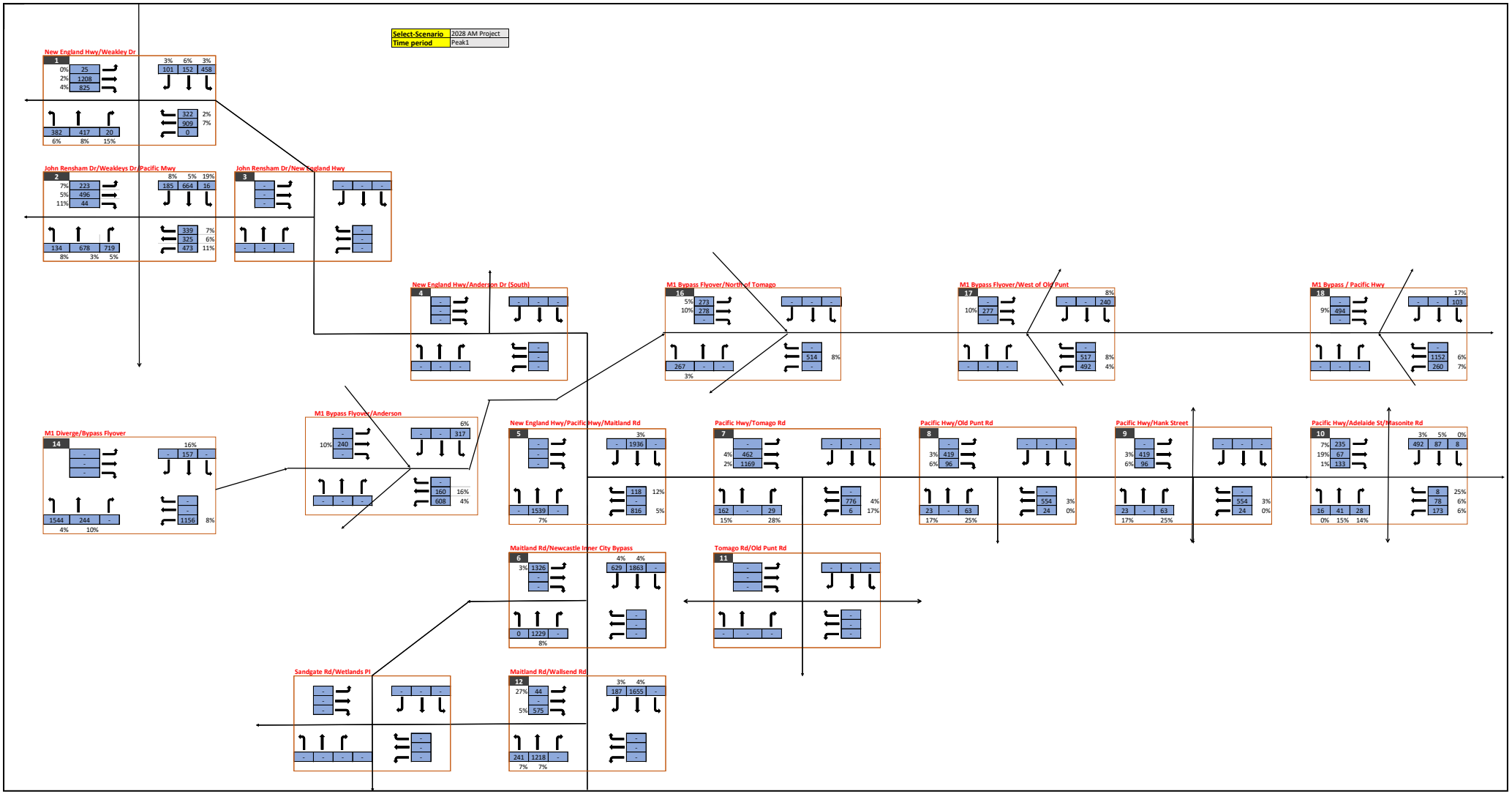
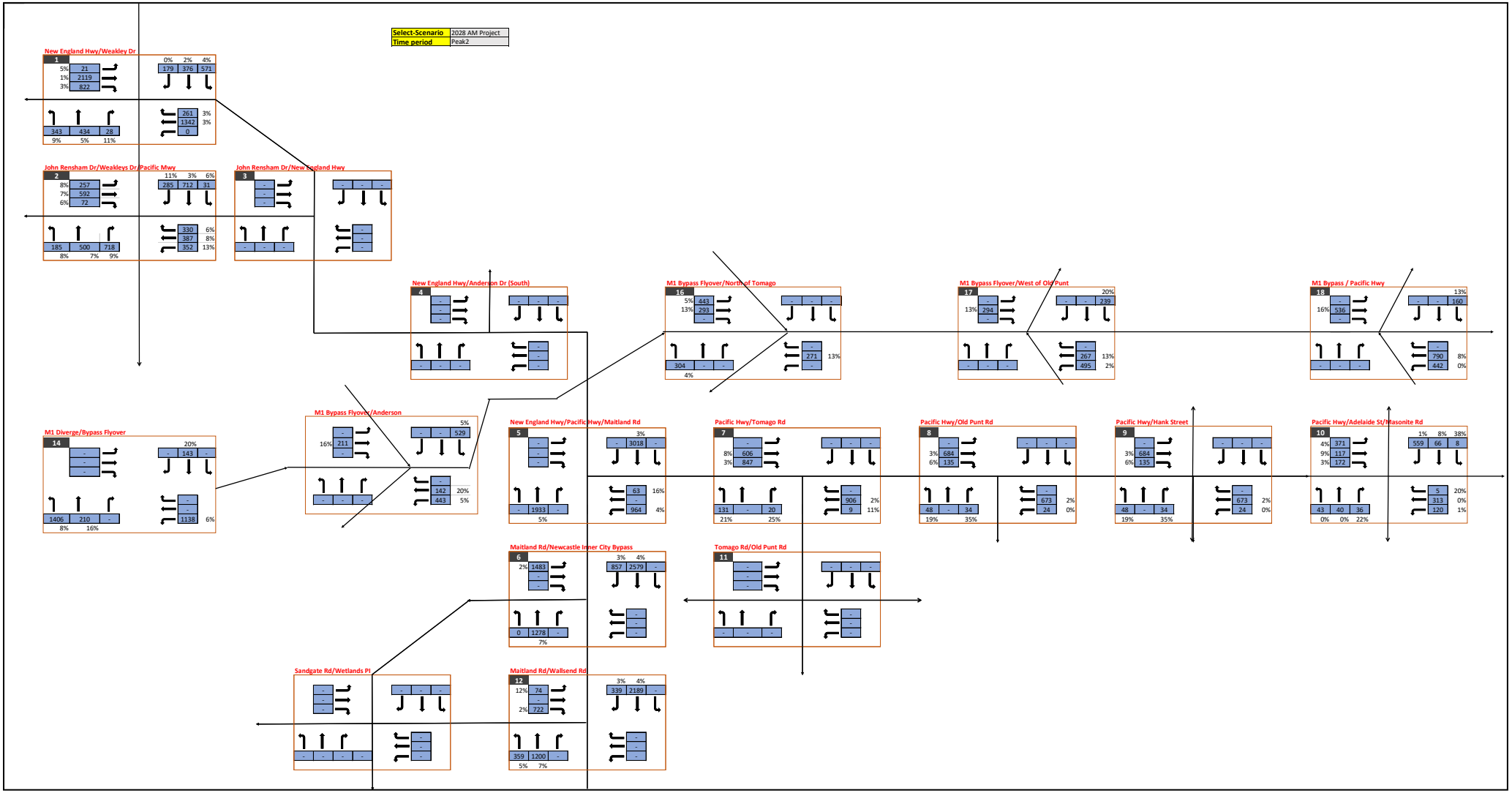
Terms and acronyms

Term/ Acronym	Description
ARTC	Australian Rail Transport Corporation
AADT	Average Annual Daily Traffic
Without project	Future traffic models with network updates required for the road network to function. This is without project
EIS	Environmental Impact Statement
FSI	Fatal and serious injury
HML	higher mass limits
LoS	Level of Service
LGAs	local government areas
the project	M1 Pacific Motorway extension to Raymond Terrace
NLTN	National Land Transport Network
O-D	Origin-Destination
ONS	Outer Newcastle Study
OoHW	out-of-hours work'
PCU	passenger car units
PBS	Performance Based Standards
PTV	A traffic software development company that develops VISSIM
SEARs	Secretary's Environmental Assessment Requirements
SUP	shared user path
STFM	Sydney Traffic Forecasting Mode
TEC	Threatened Ecological Communities
TCP	Traffic Control Plan
TMP	Traffic Management Plan
Transport	Transport for New South Wales
VHT	vehicle hours travelled
VKT	vehicle kilometres travelled

Appendix A - Flow Diagrams

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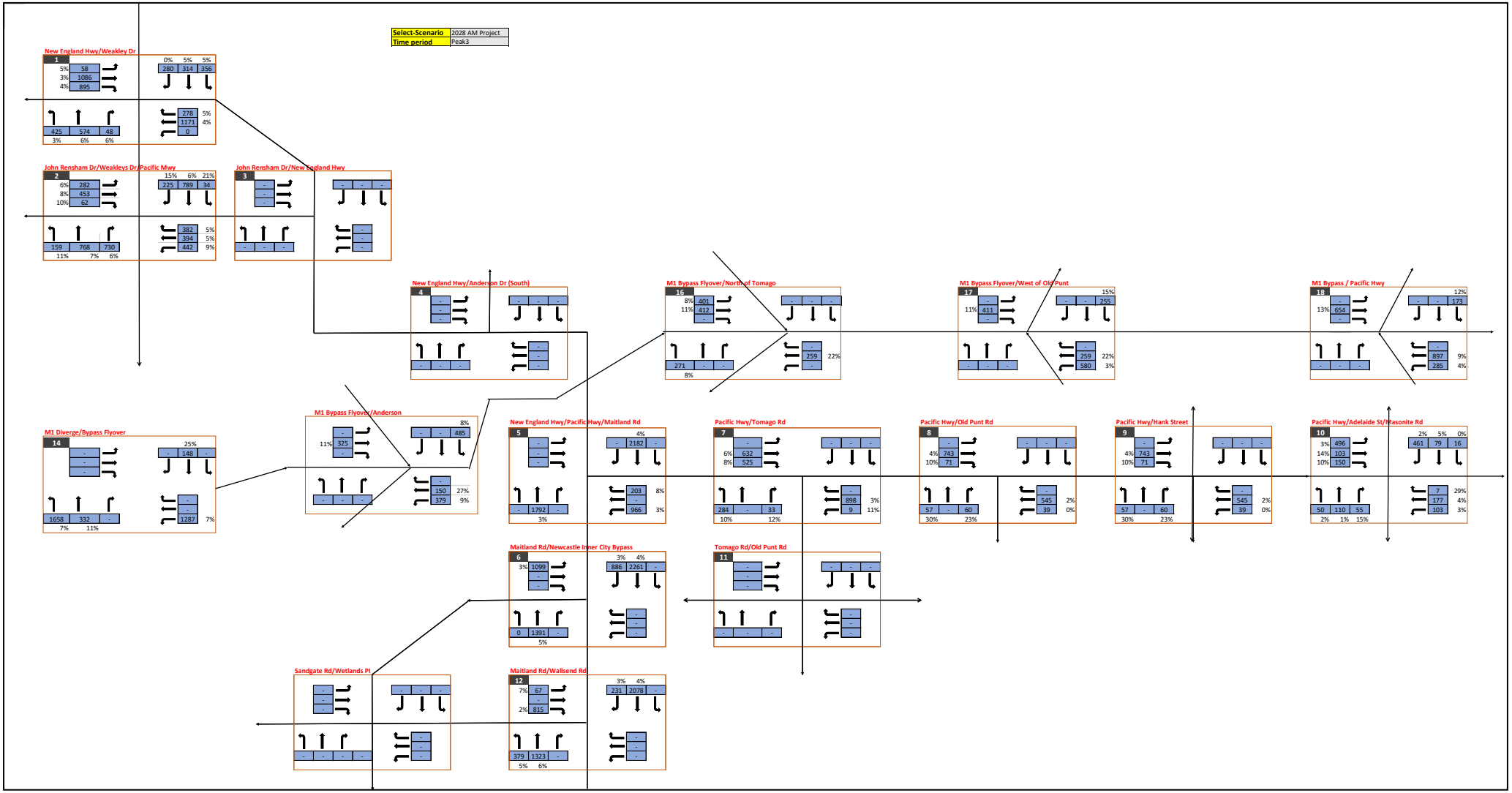
Time period Peak2
New England Hwy/Weakley Dr
John Rensham Dr/Weakleys Dr/Pacific Mwy
John Rensham Dr/New England Hwy
New England Hwy/Anderson Dr (South)
M1 Bypass Flyover/North of Tomago
M1 Bypass Flyover/West of Old Punt
M1 Bypass / Pacific Hwy
M1 Diverge/Bypass Flyover
M1 Bypass Flyover/Anderson
New England Hwy/Pacific Hwy/Maitland Rd
Pacific Hwy/Tomago Rd
Pacific Hwy/Old Punt Rd
Pacific Hwy/Hank Street
Pacific Hwy/Adelaide St/Masonite Rd
Maitland Rd/Newcastle Inner City Bypass
Tomago Rd/Old Punt Rd
Sandgate Rd/Wetlands Pl
Maitland Rd/Wallsend Rd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John Rensham Dr/Weakleys Dr/Pacific Mwy
John Rensham Dr/New England Hwy
New England Hwy/Anderson Dr (South)
M1 Bypass Flyover/North of Tomago
M1 Bypass Flyover/West of Old Punt
M1 Bypass / Pacific Hwy
M1 Diverge/Bypass Flyover
M1 Bypass Flyover/Anderson
New England Hwy/Pacific Hwy/Maitland Rd
Pacific Hwy/Tomago Rd
Pacific Hwy/Old Punt Rd
Pacific Hwy/Hank Street
Pacific Hwy/Adelaide St/Masonite Rd
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Tomago Rd/Old Punt Rd
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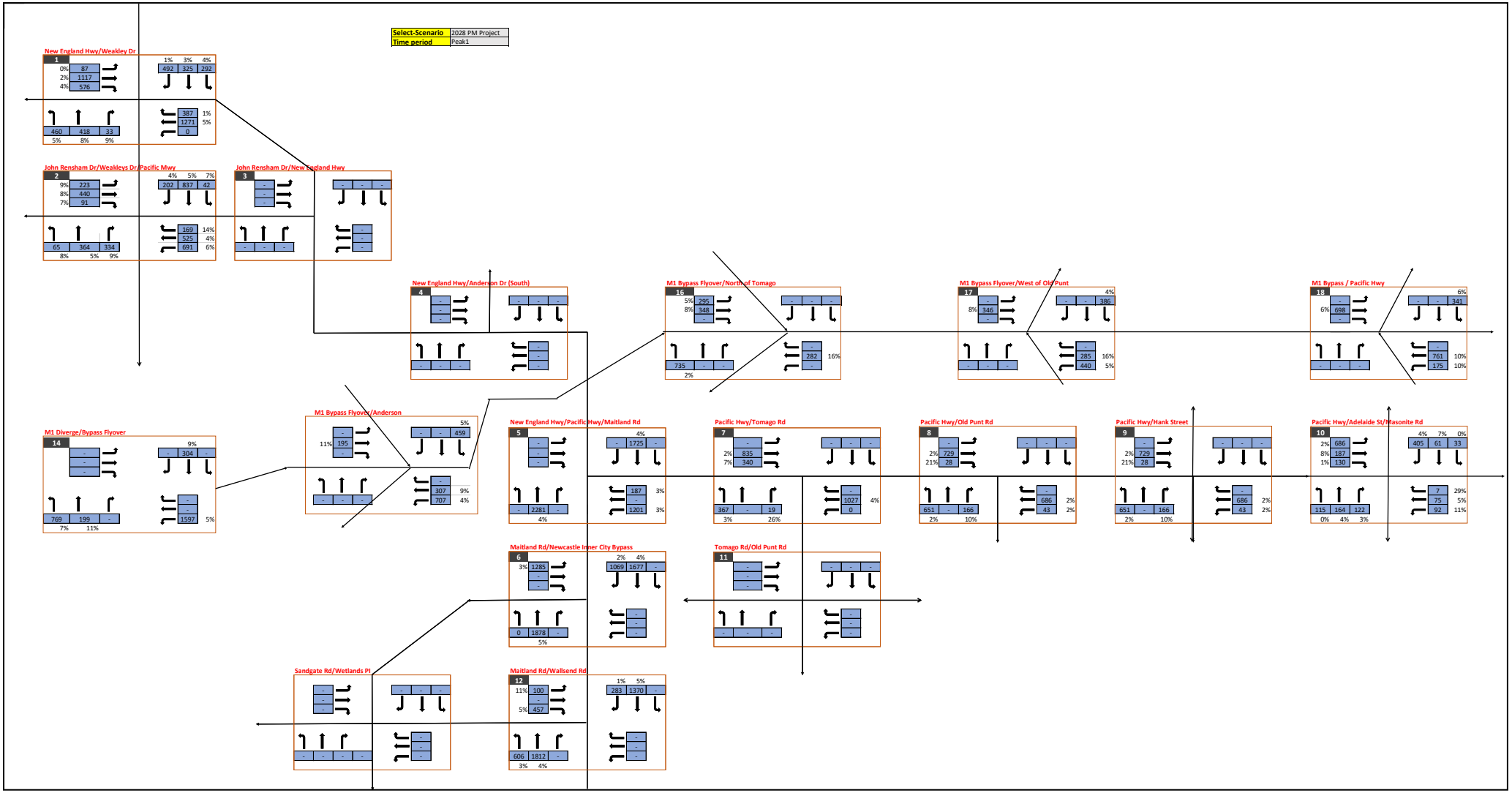
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John Rensham Dr/Weakleys Dr/Pacific Mwy
John Rensham Dr/New England Hwy
New England Hwy/Anderson Dr (South)
M1 Bypass Flyover/North of Tomago
M1 Bypass Flyover/West of Old Punt
M1 Bypass / Pacific Hwy
M1 Diverge/Bypass Flyover
M1 Bypass Flyover/Anderson
New England Hwy/Pacific Hwy/Maitland Rd
Pacific Hwy/Tomago Rd
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Pacific Hwy/Hank Street
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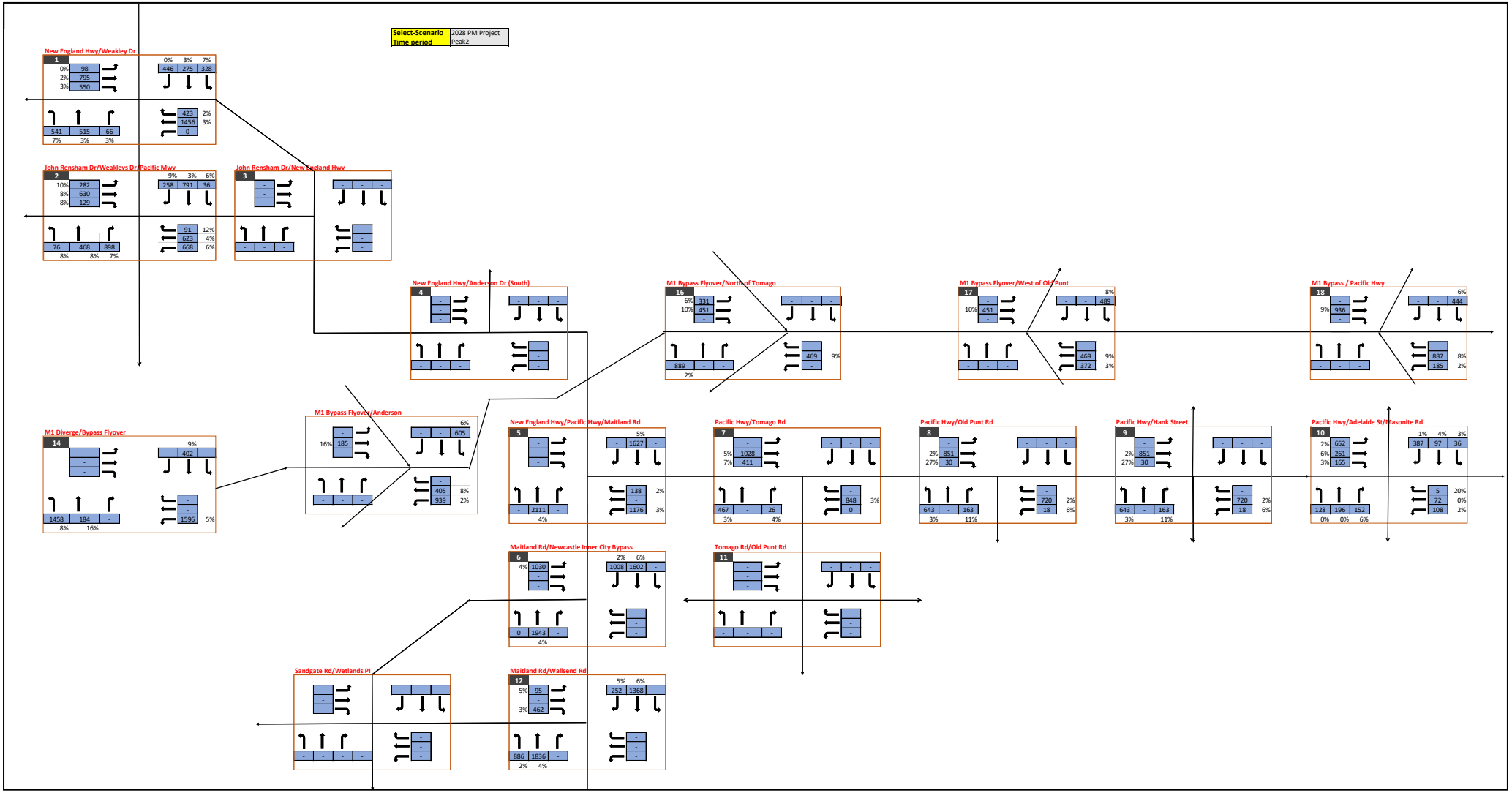
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John Rensham Dr/Weakleys Dr/Pacific Mwy
John Rensham Dr/New England Hwy
New England Hwy/Anderson Dr (South)
M1 Bypass Flyover/North of Tomago
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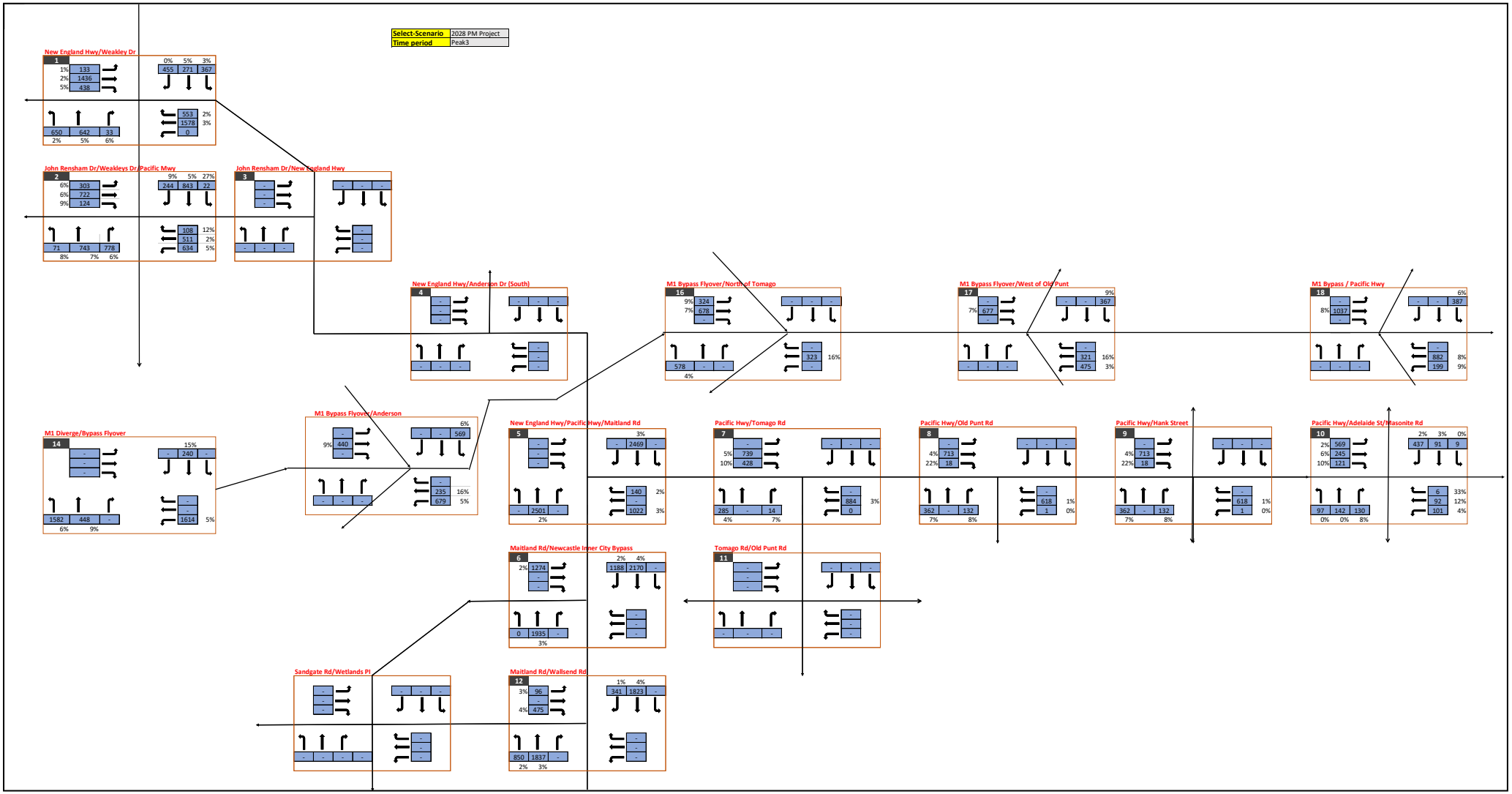
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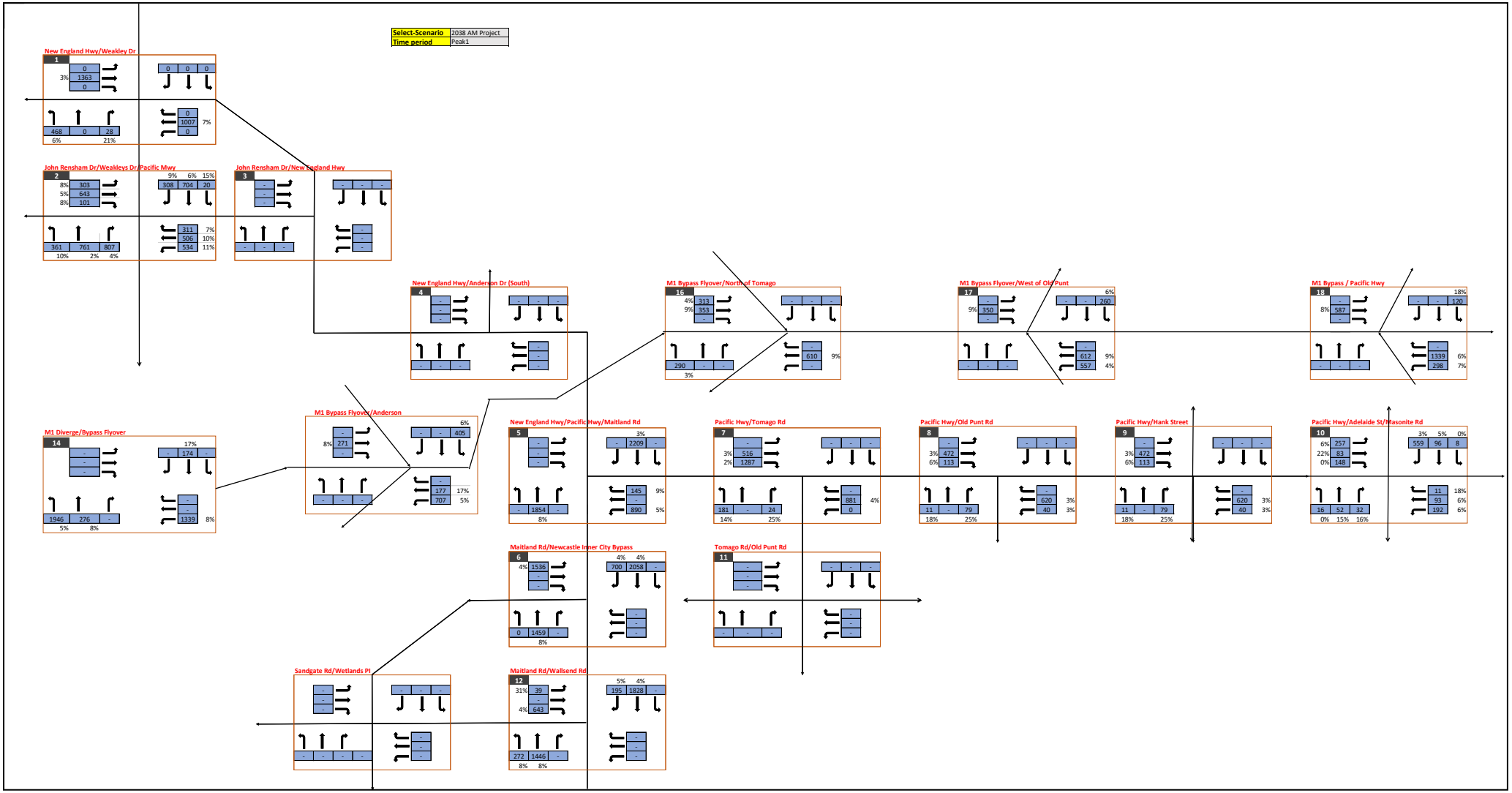
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M1 Bypass Flyover/North of Tomago
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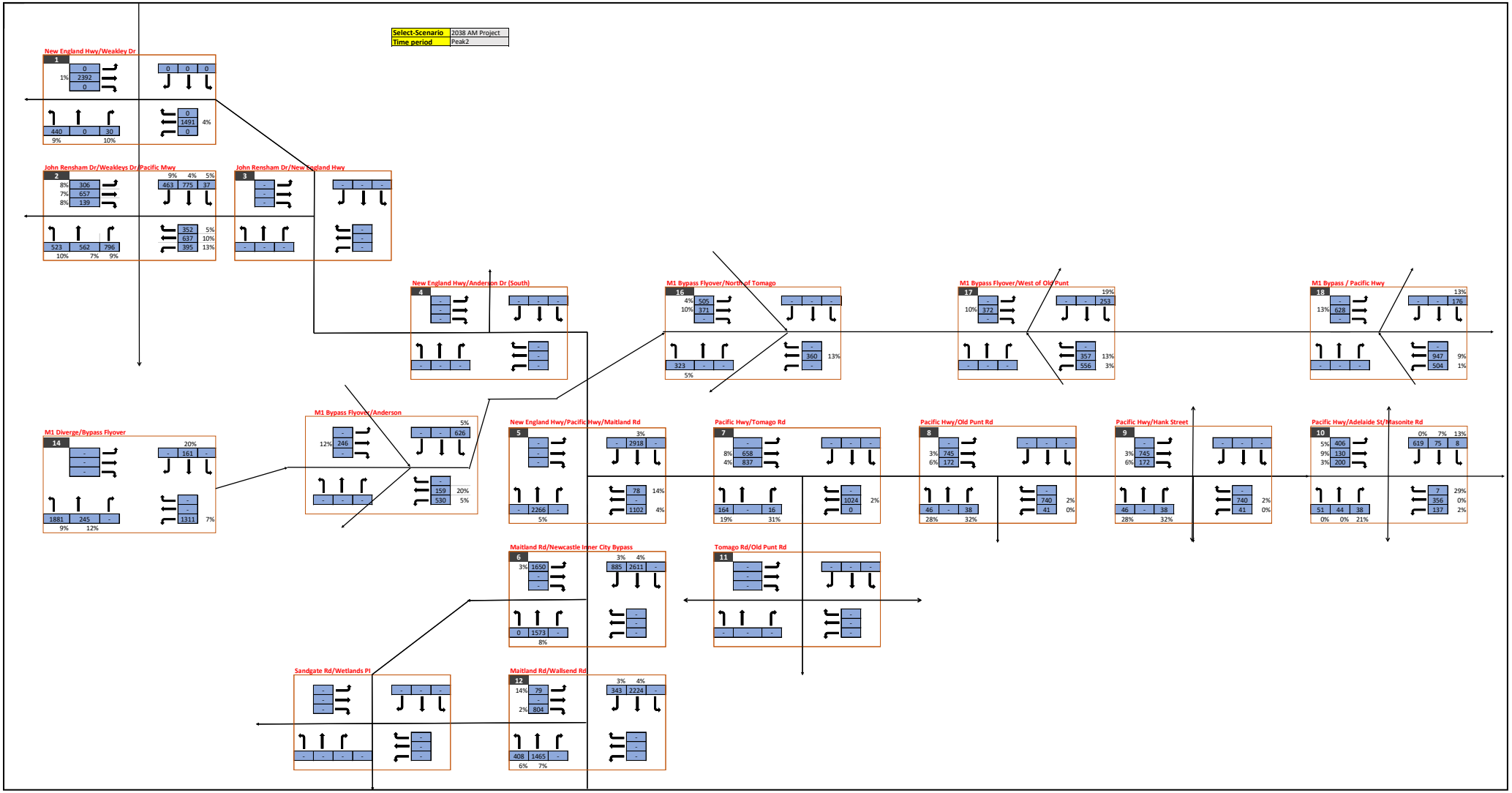
Maitland Rd/Wallsend Rd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John Rensham Dr/New England Hwy
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M1 Bypass Flyover/North of Tomago
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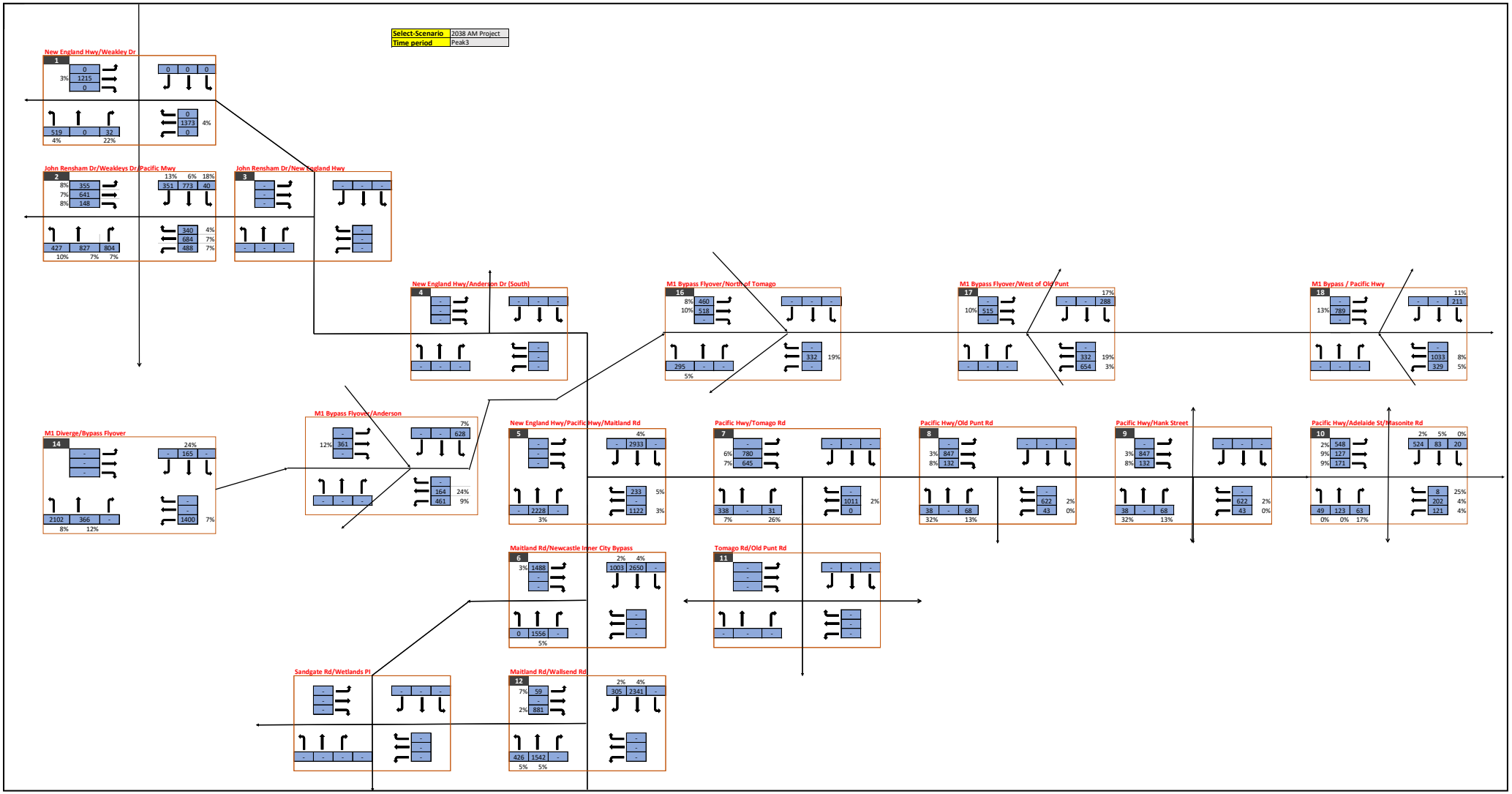
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John Rensham Dr/New England Hwy
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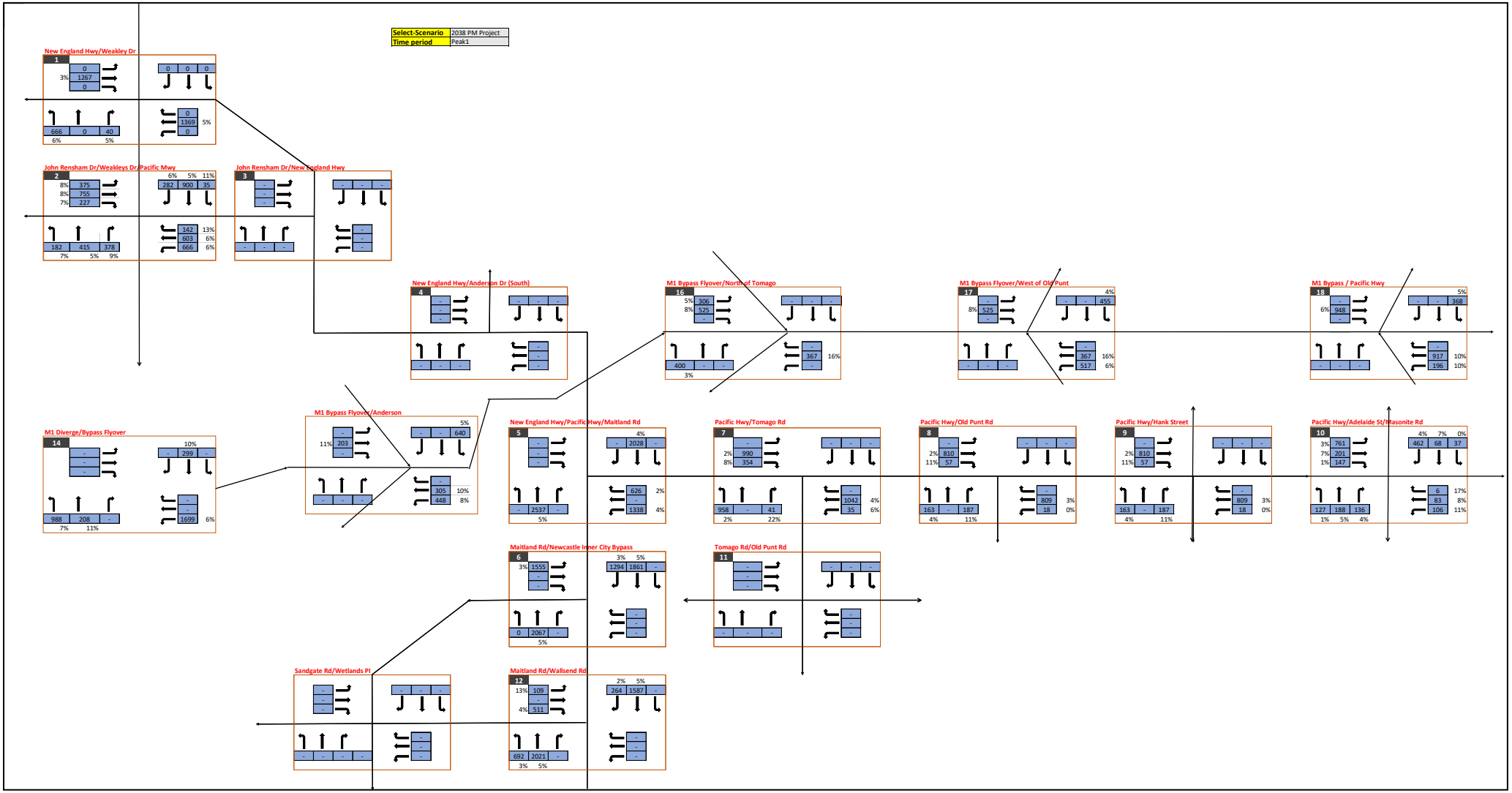
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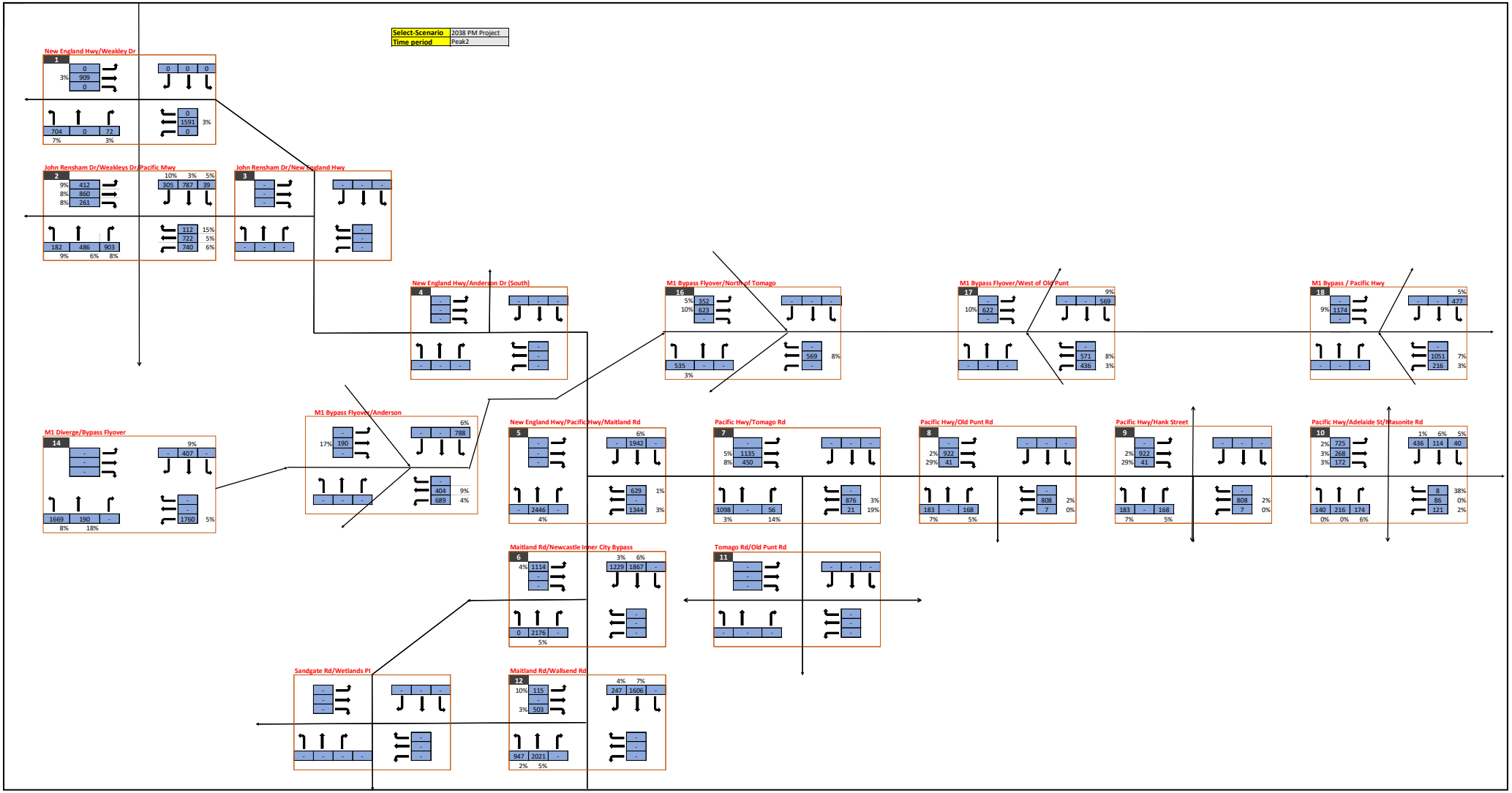
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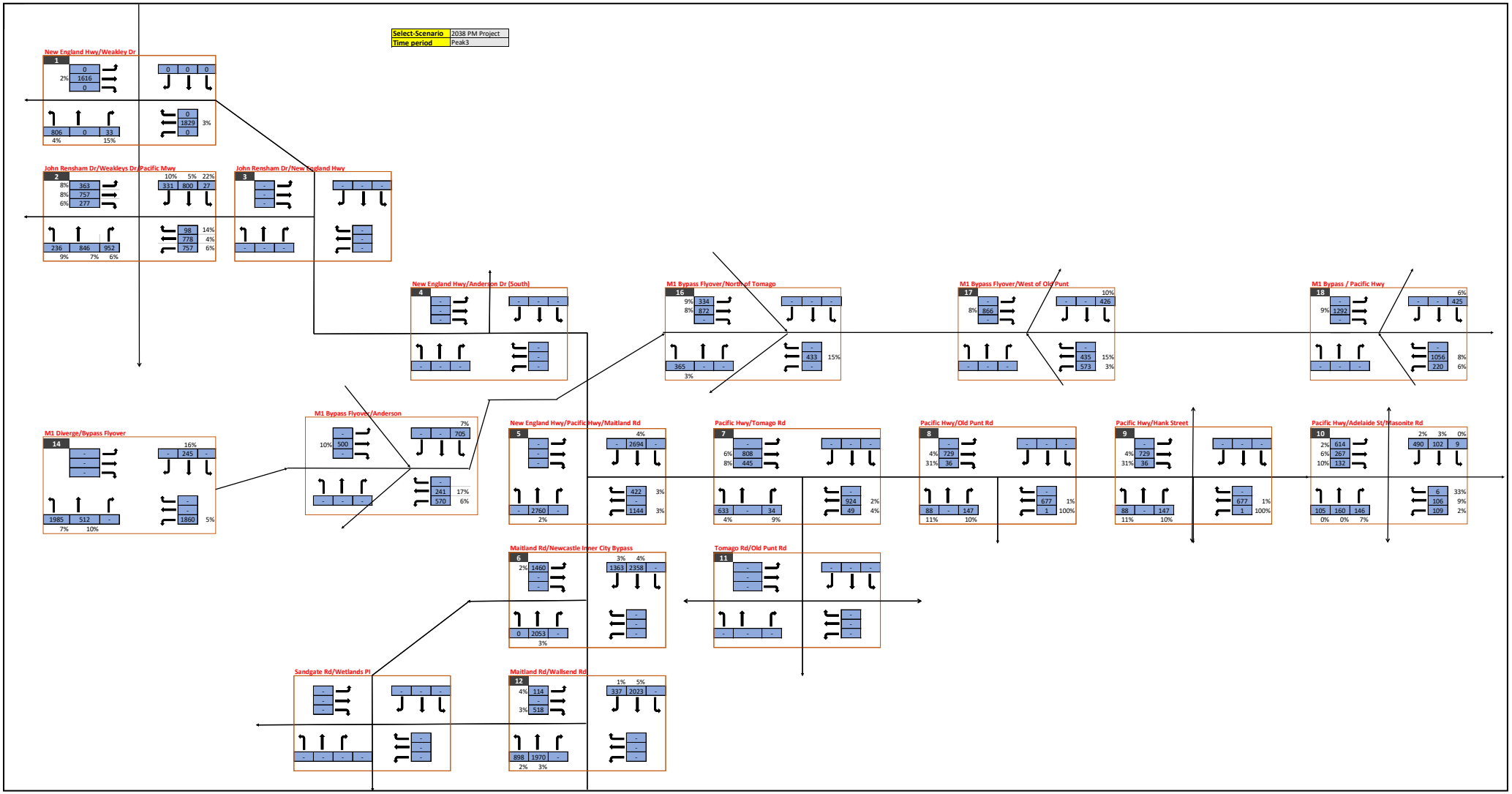
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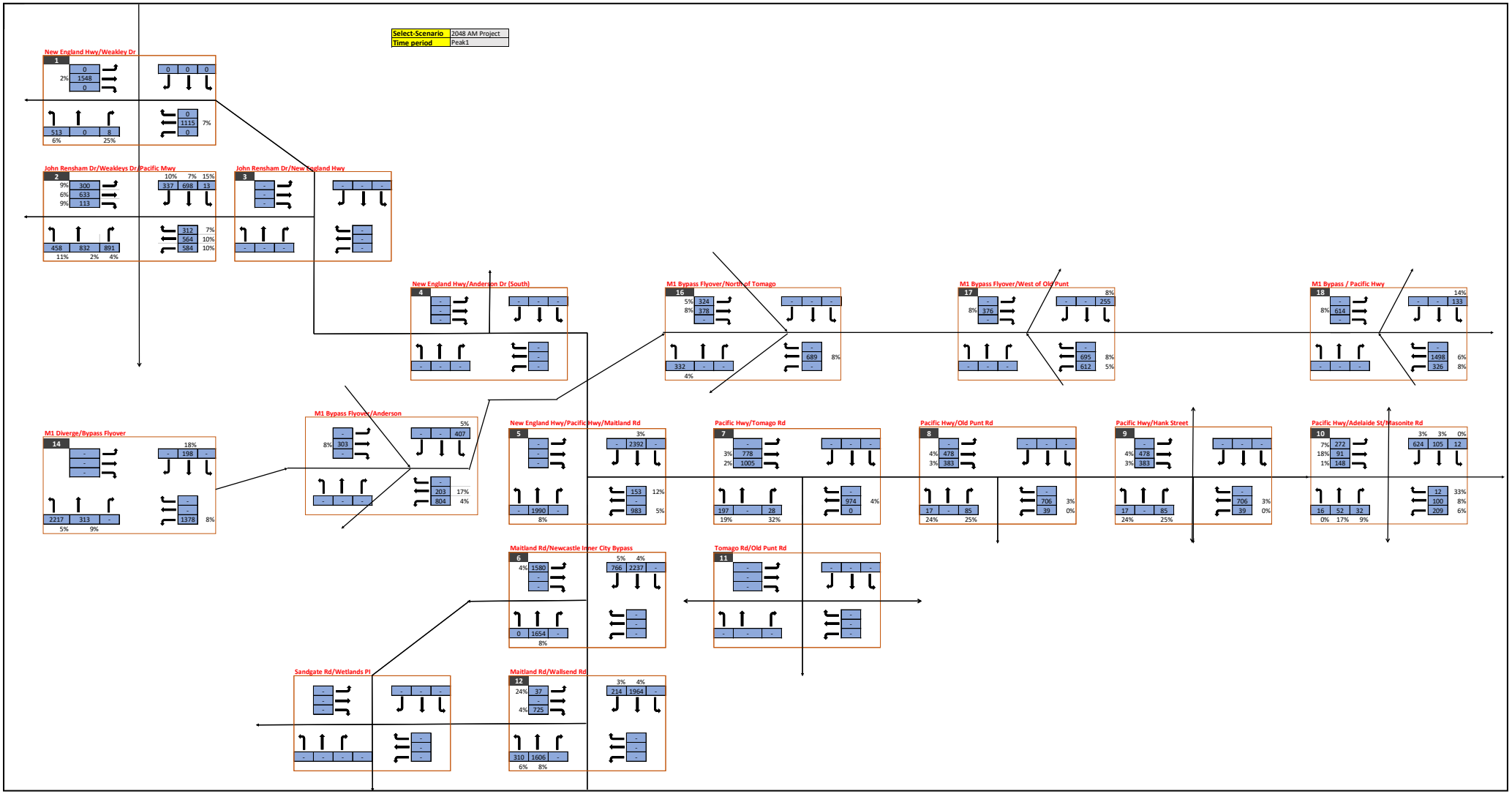
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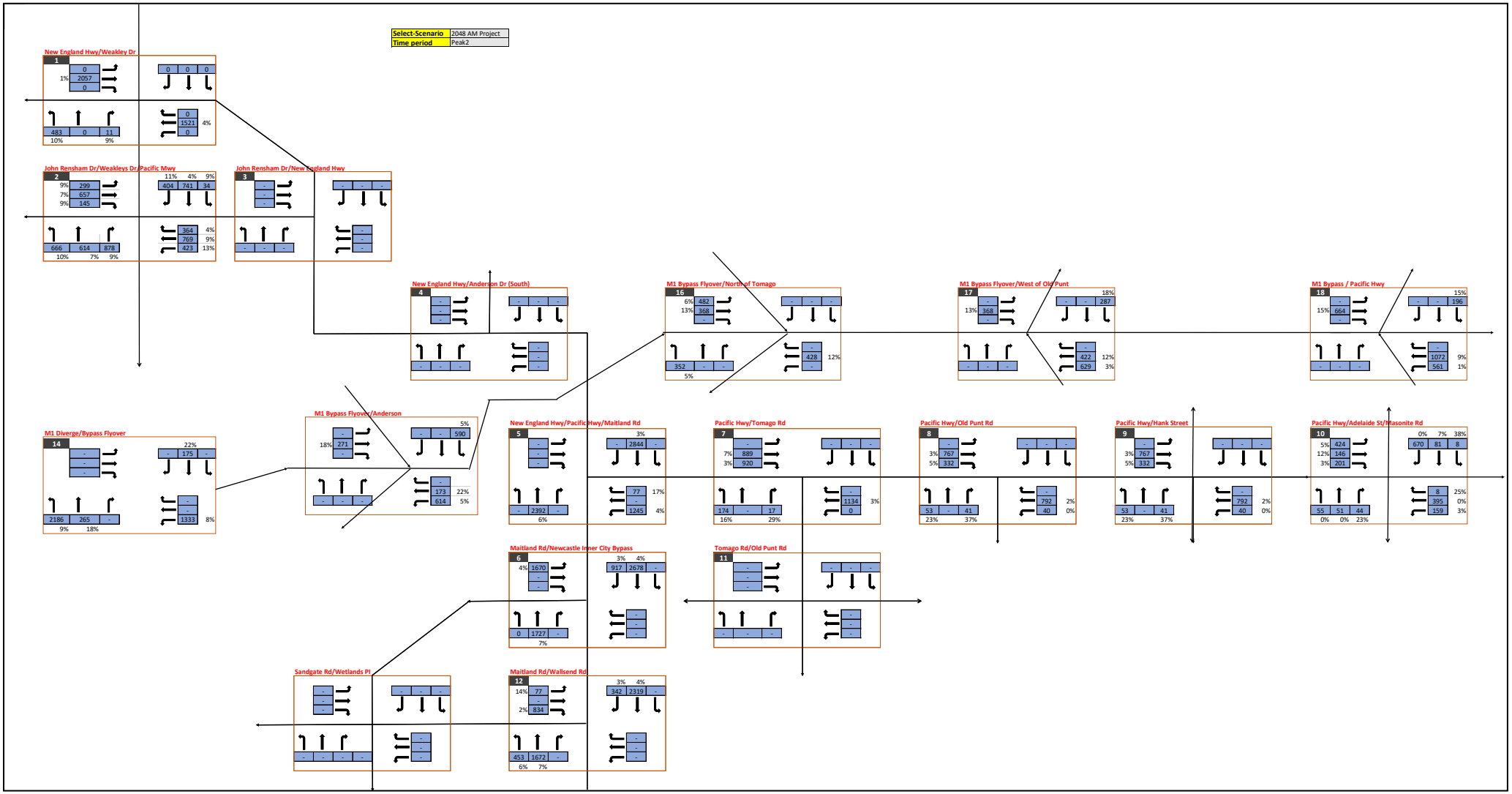
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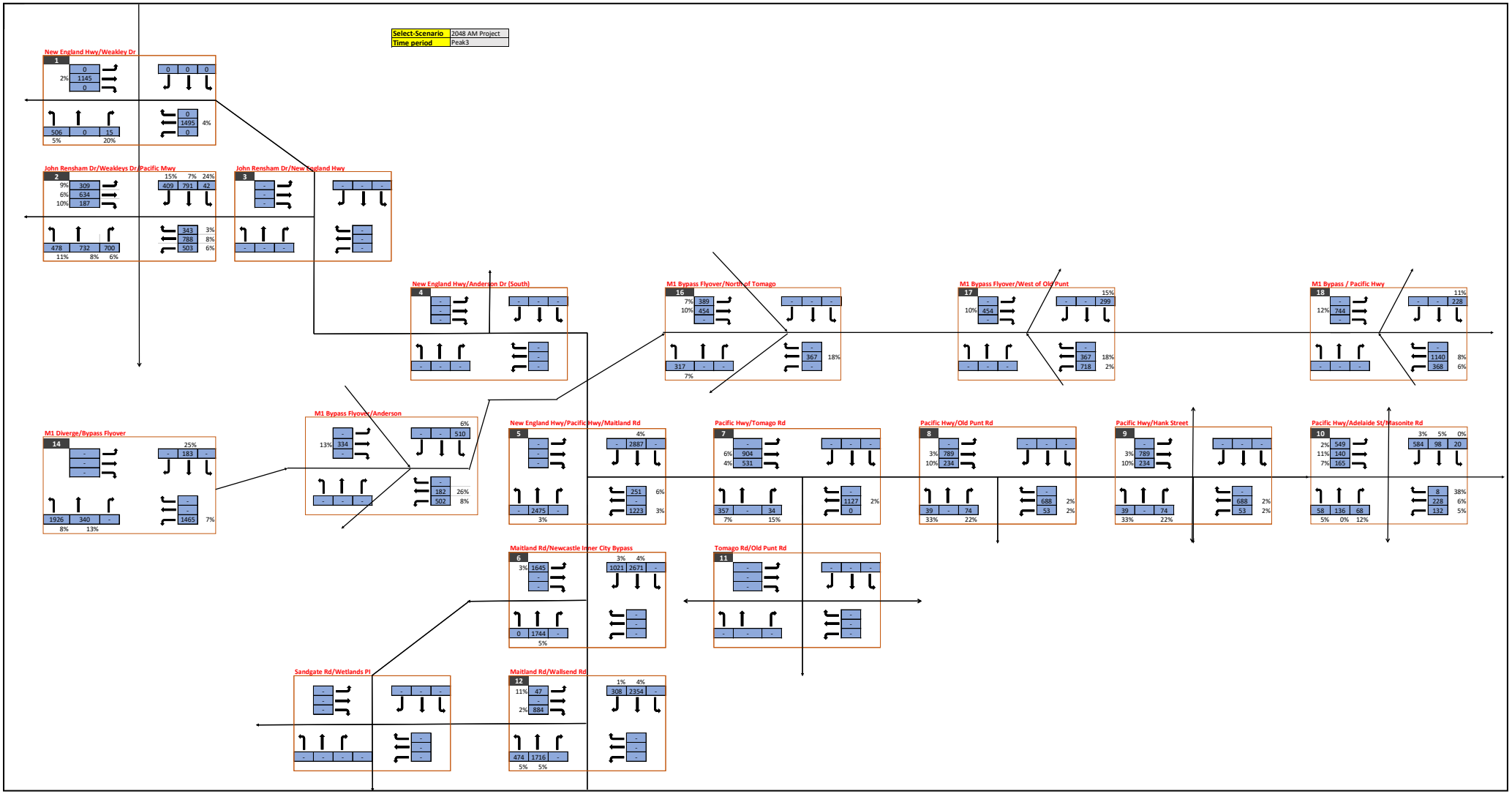
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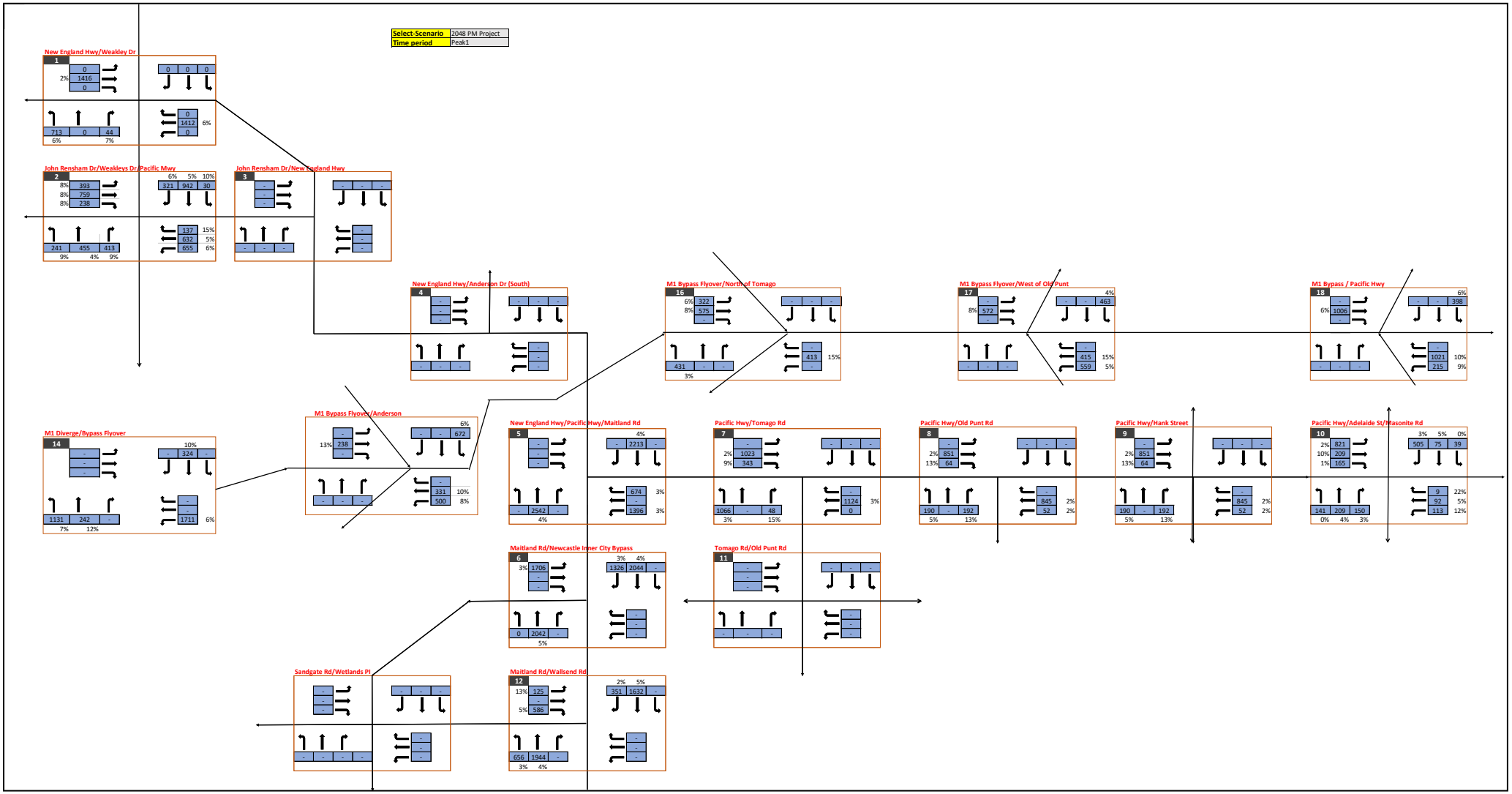
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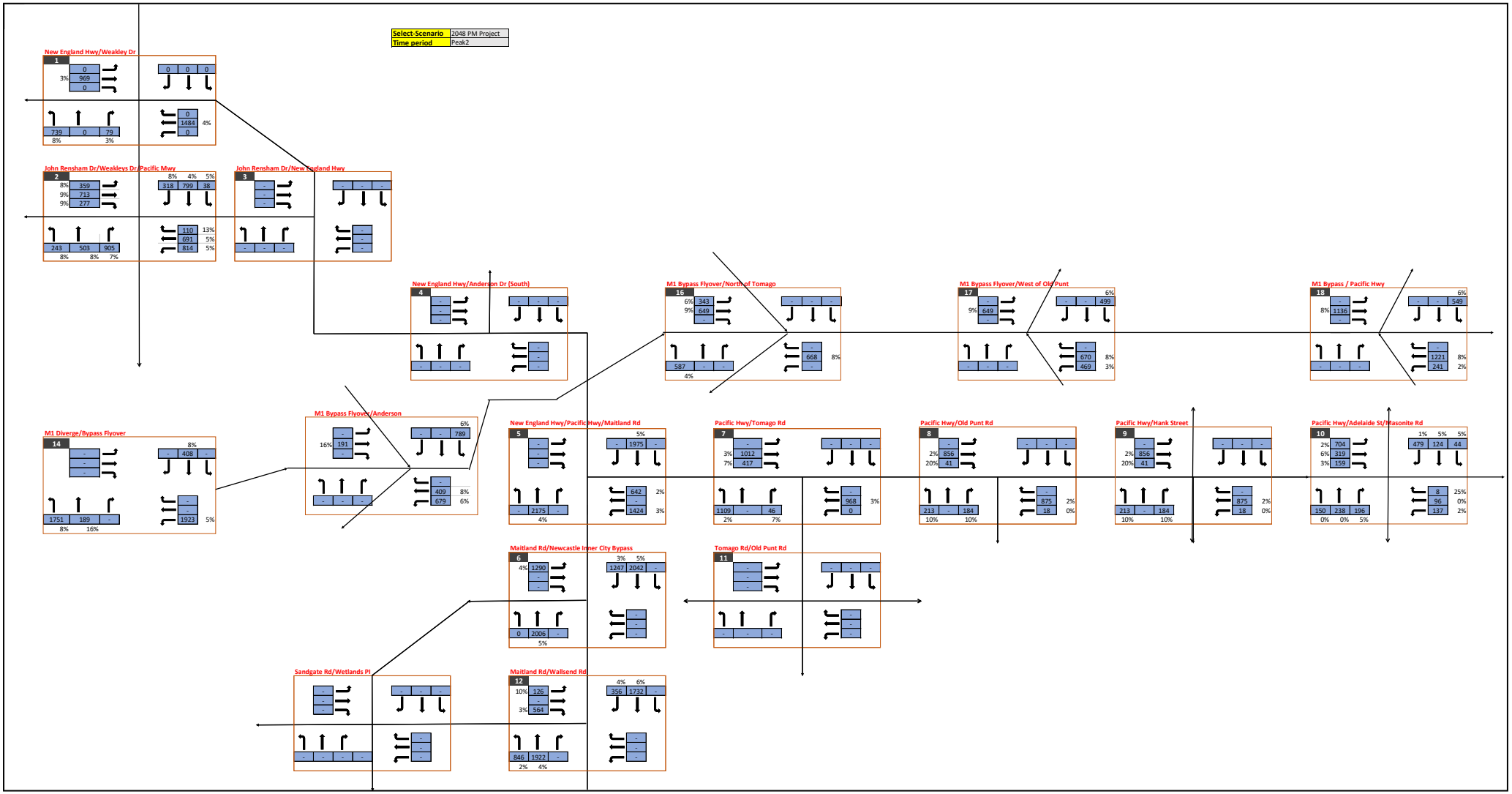
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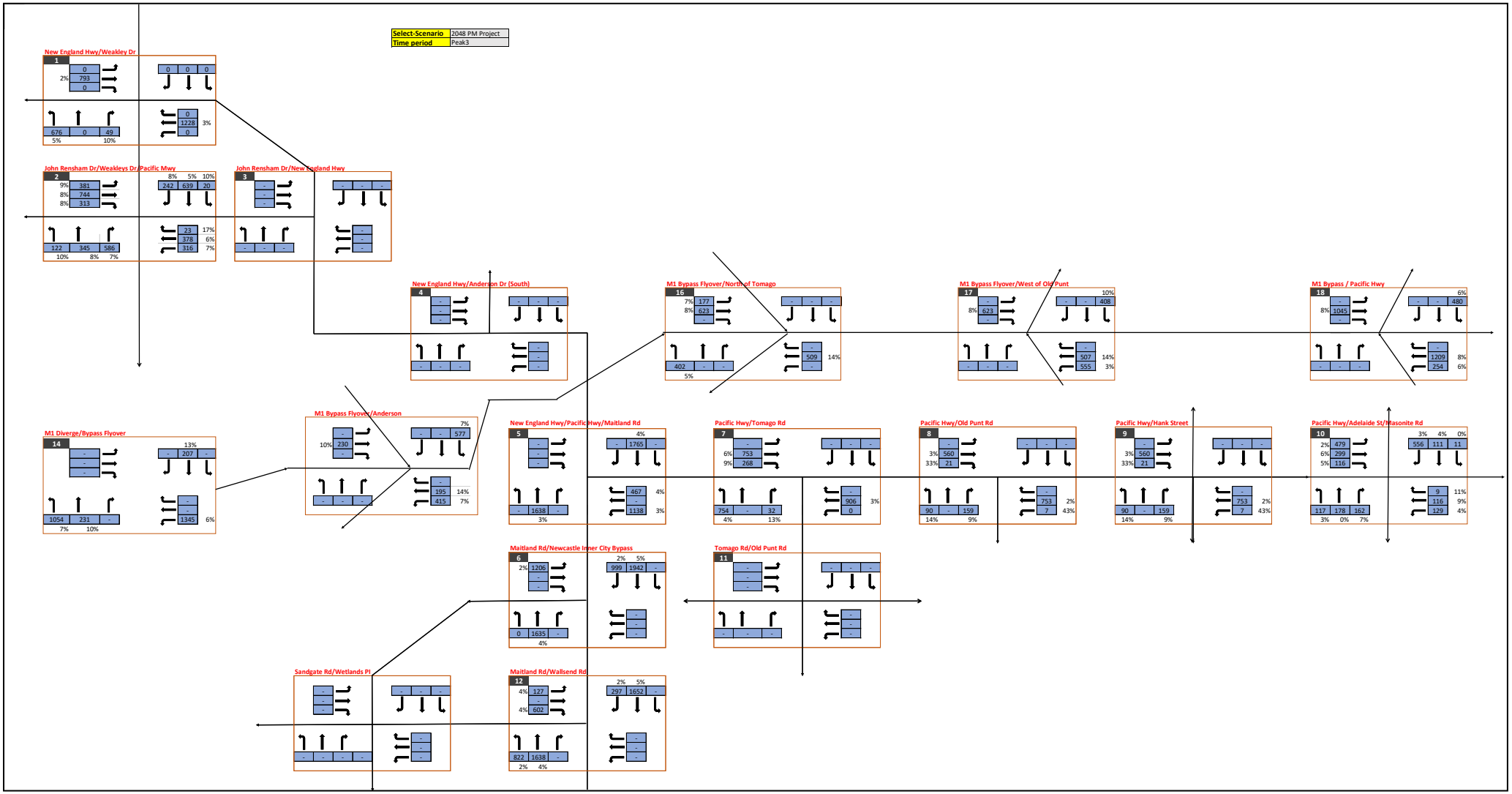
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Pacific Hwy/Adelaide St/Masonite Rd
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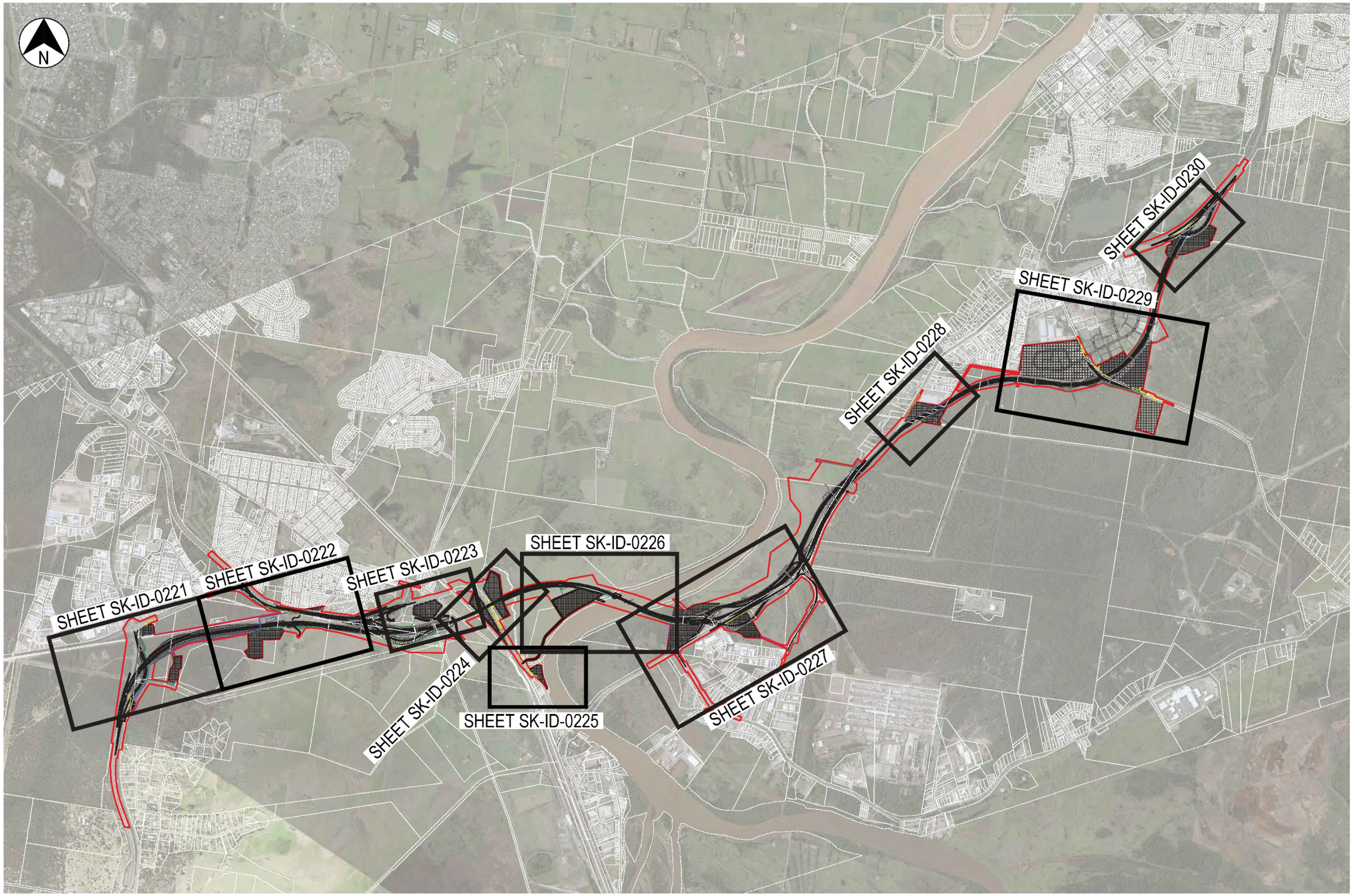
Maitland Rd/Wallsend Rd

Appendix C
Ancillary Facility Access Strategy



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Date: 4/02/2020

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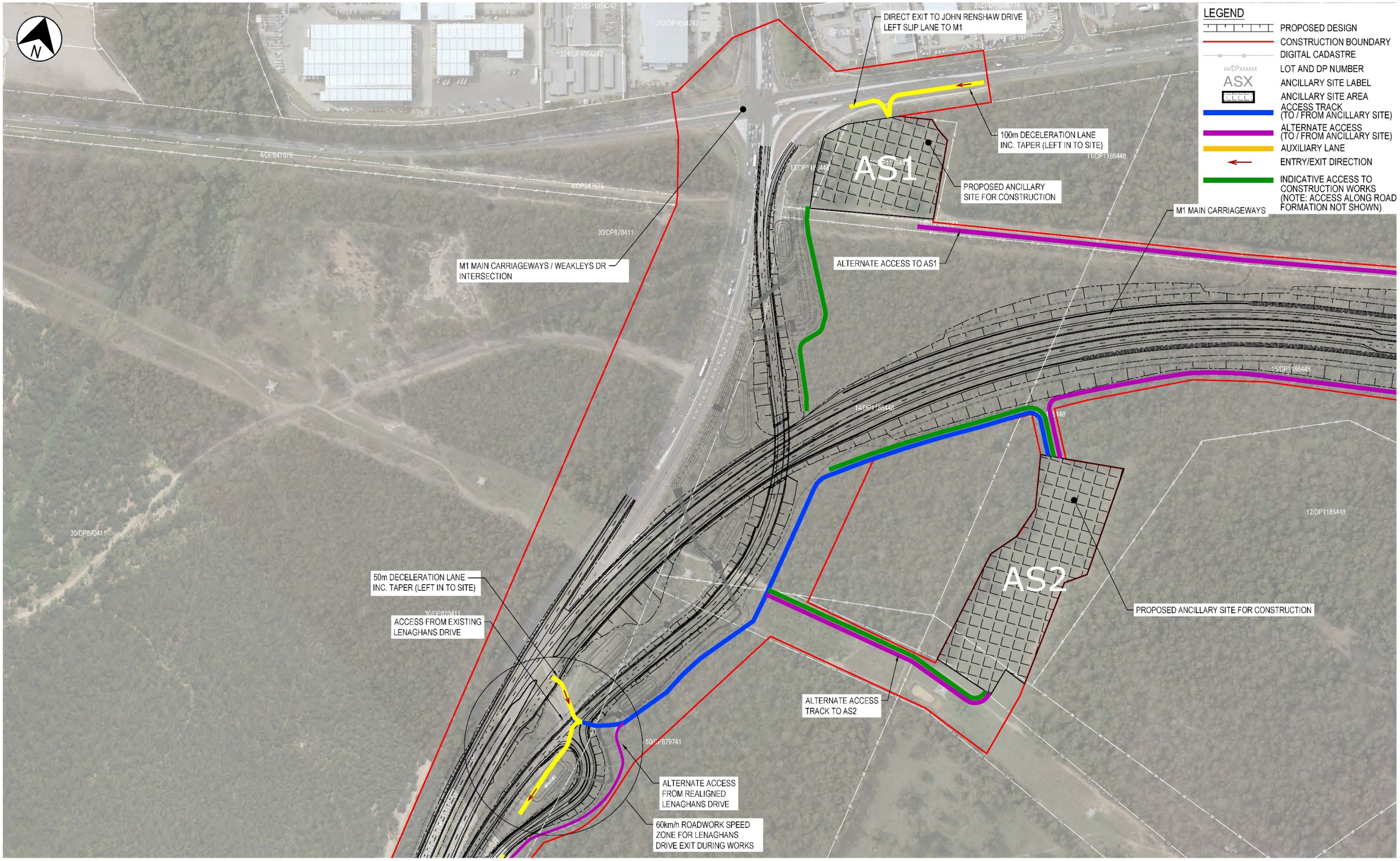
ANCILLARY SITE ACCESS STRATEGY
KEY PLAN



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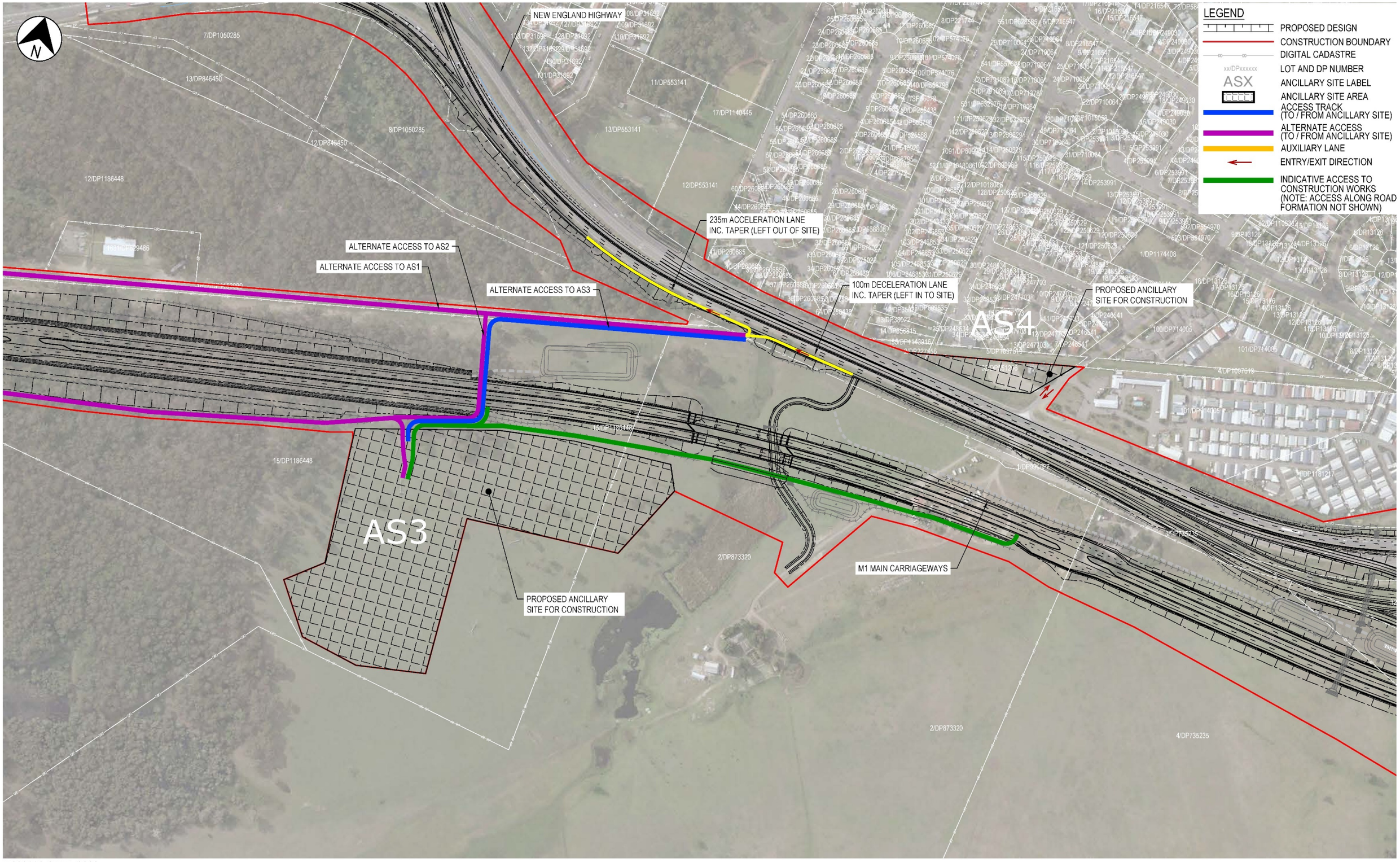
ANCILLARY SITE ACCESS STRATEGY
BLACK HILL INTERCHANGE



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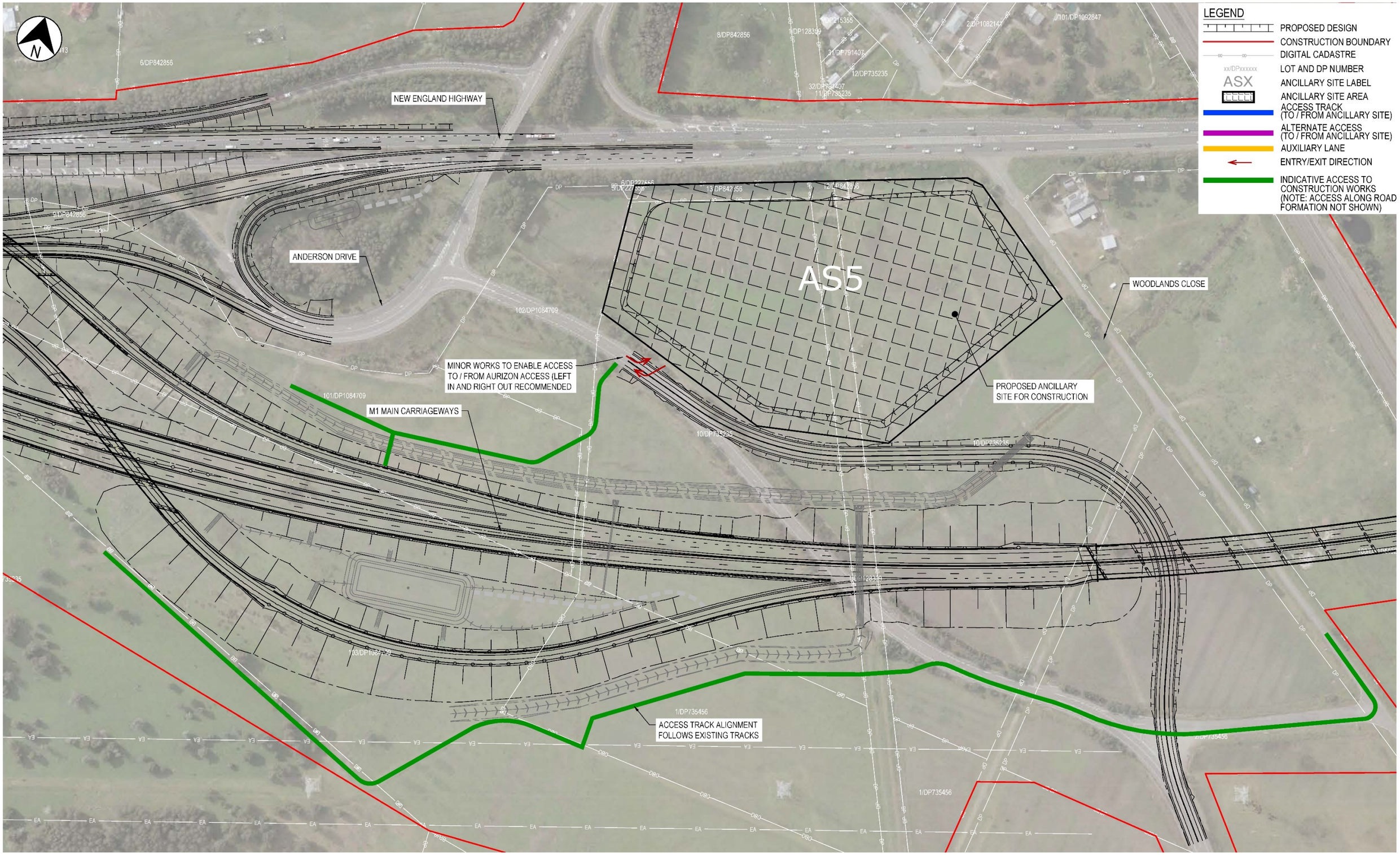

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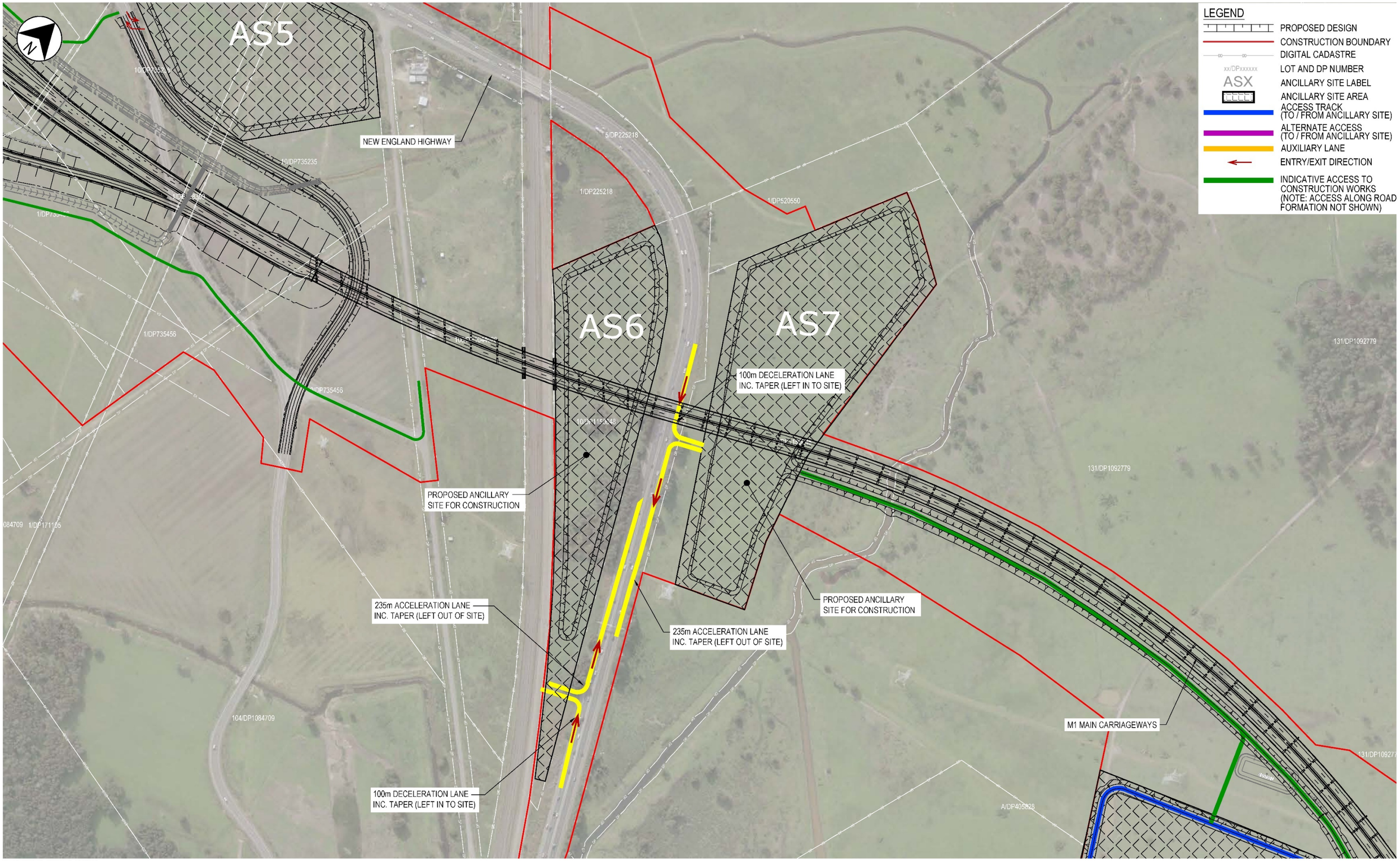
TARRO INTERCHANGE



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Date: 4/02/2020

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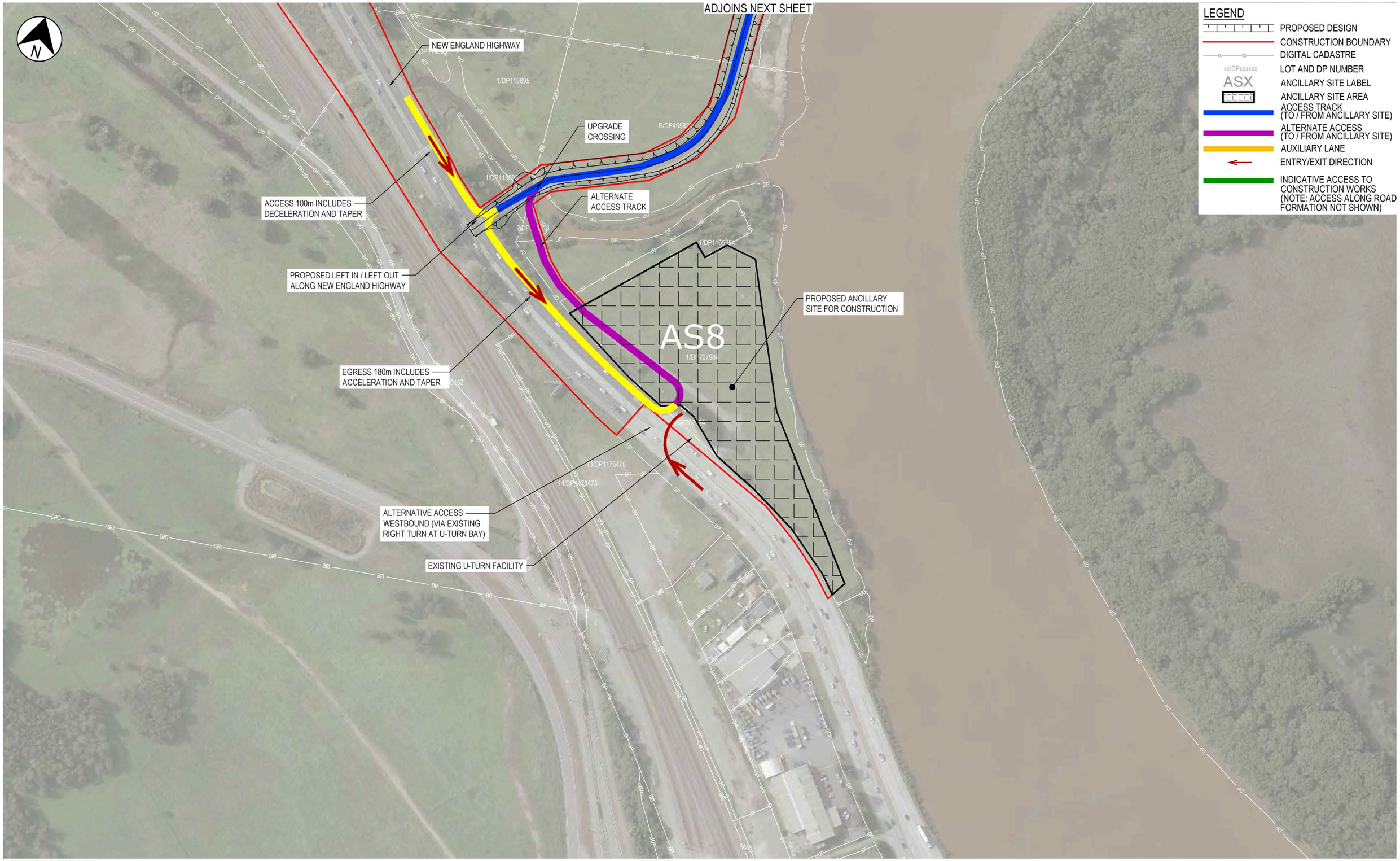
M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
ANCILLARY SITE ACCESS STRATEGY
TARRO INTERCHANGE



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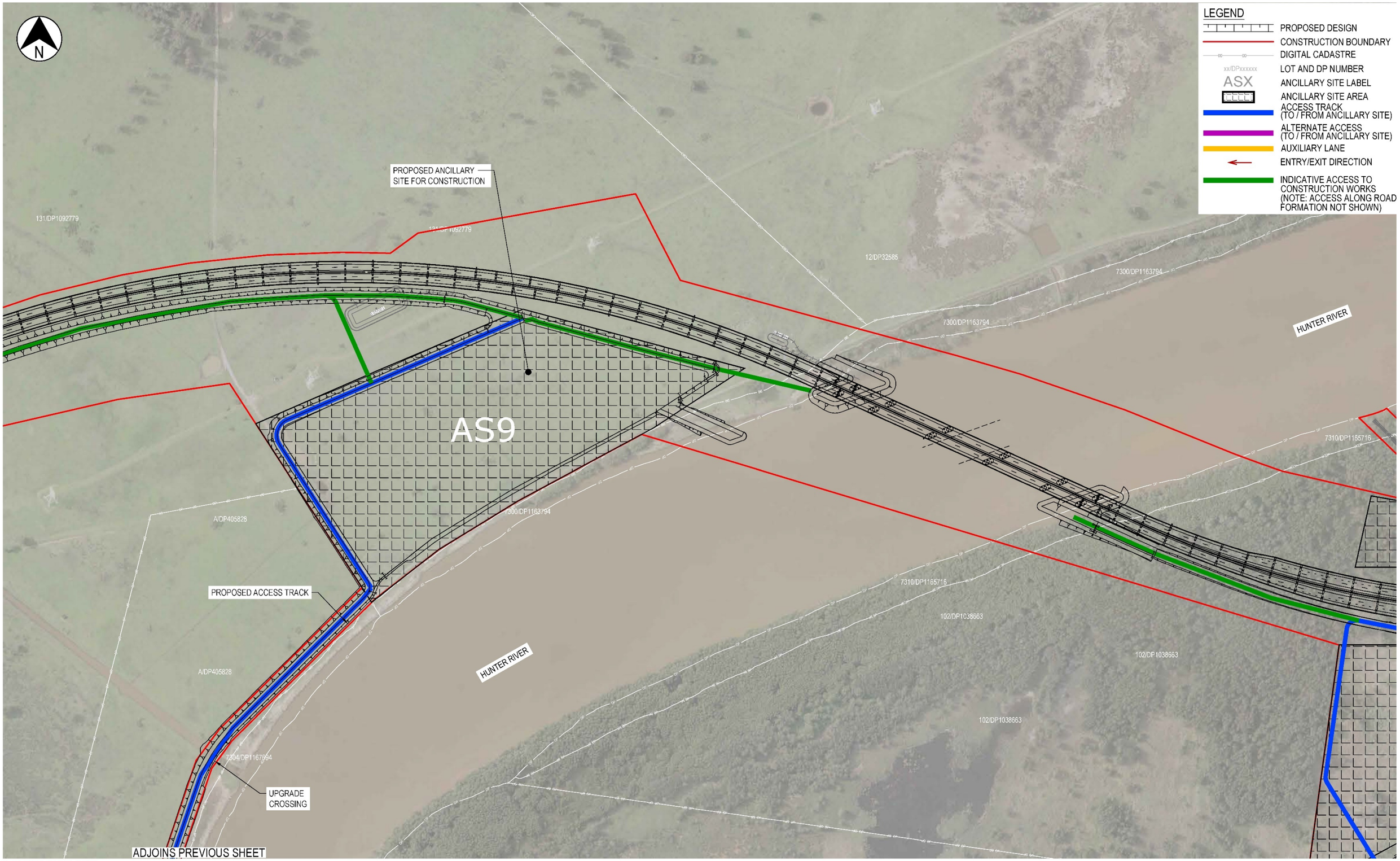
MAITLAND ROAD / NEW ENGLAND HIGHWAY, HEXHAM



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Drawn: HAIL, SCOTT

Date: 4/02/2020

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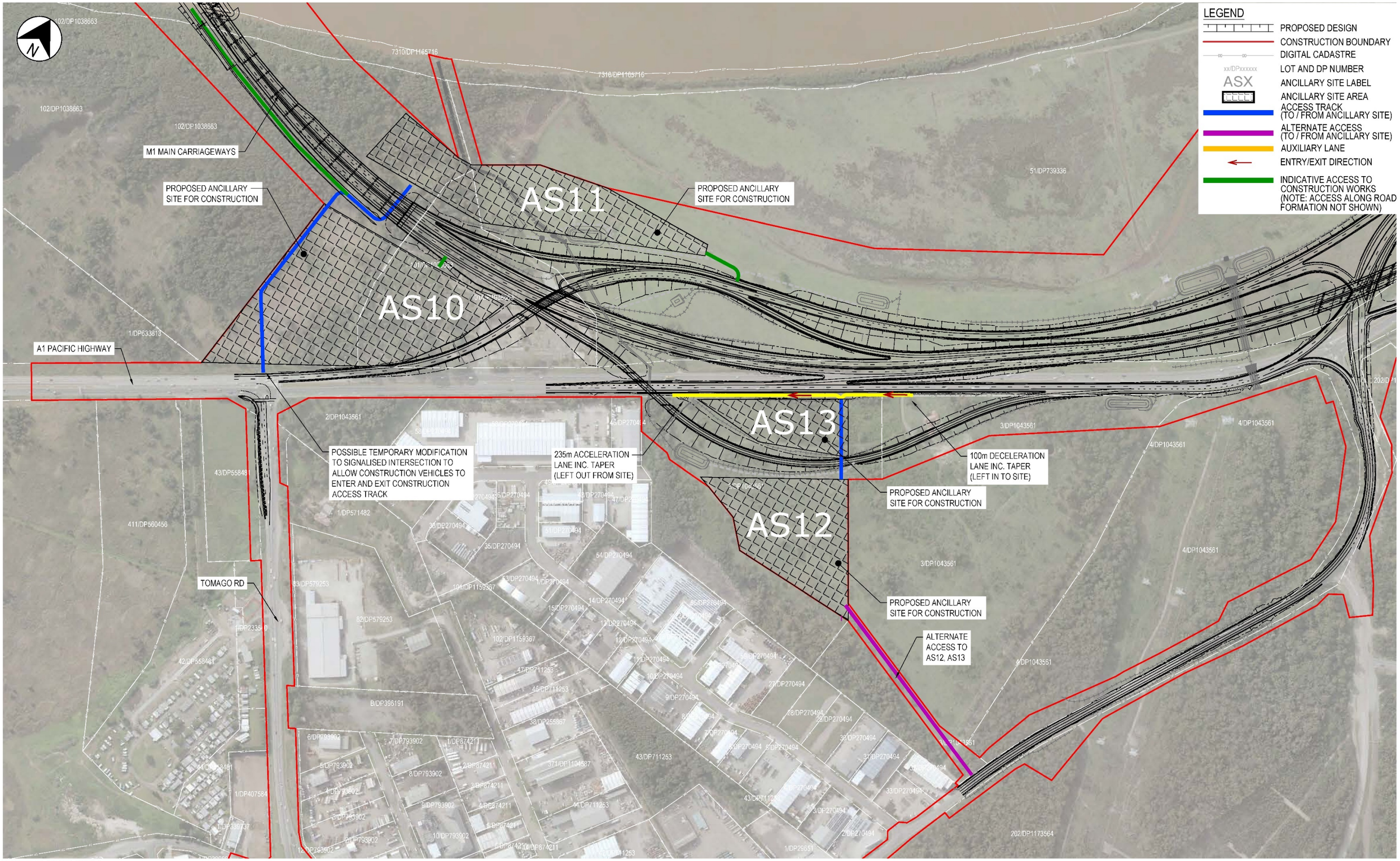

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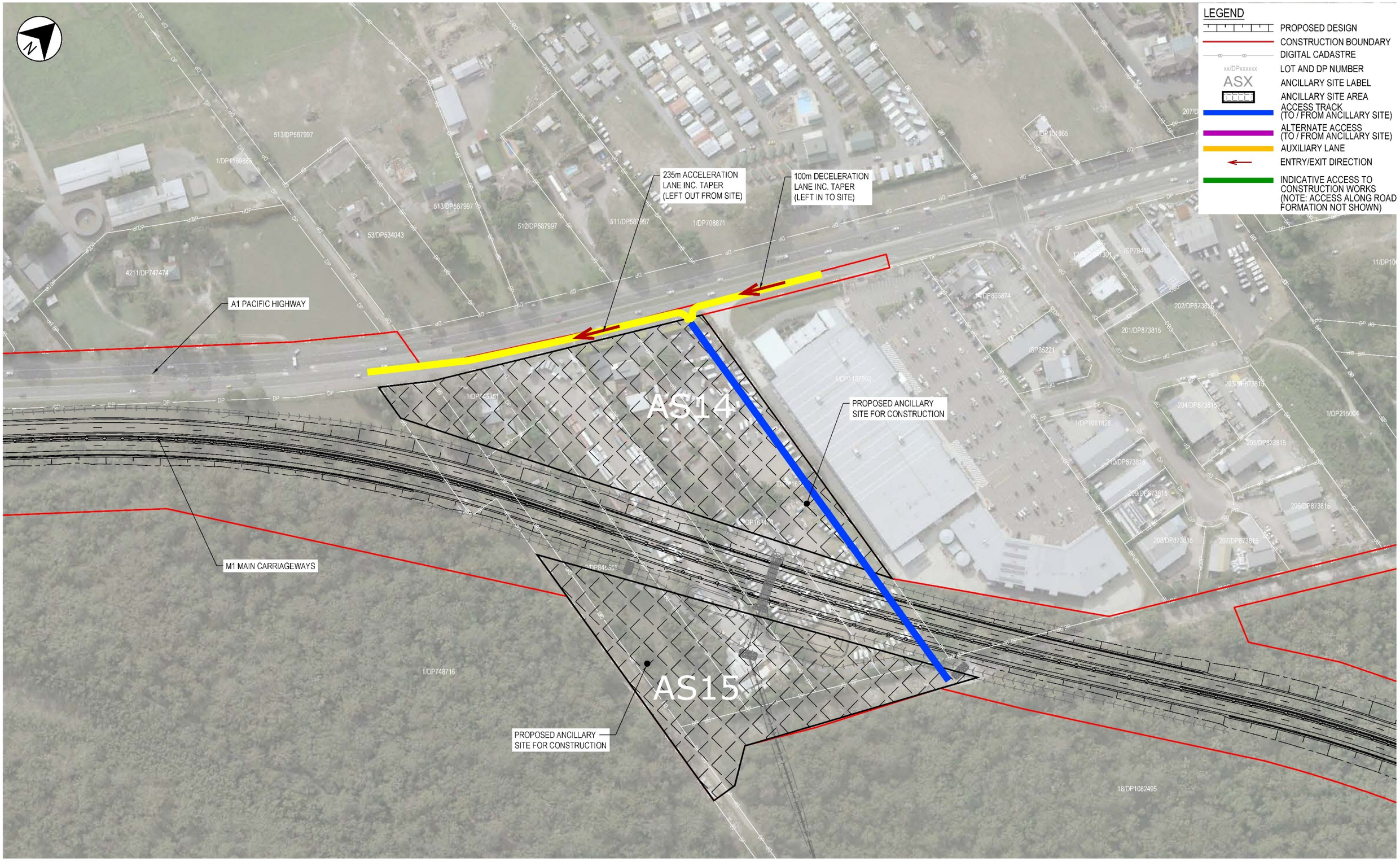
Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
ANCILLARY SITE ACCESS STRATEGY
TOMAGO INTERCHANGE



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Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:2500 (A3) 25 0 25 50 75 100 125m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
ANCILLARY SITE ACCESS STRATEGY
HEATHERBRAE INTERCHANGE

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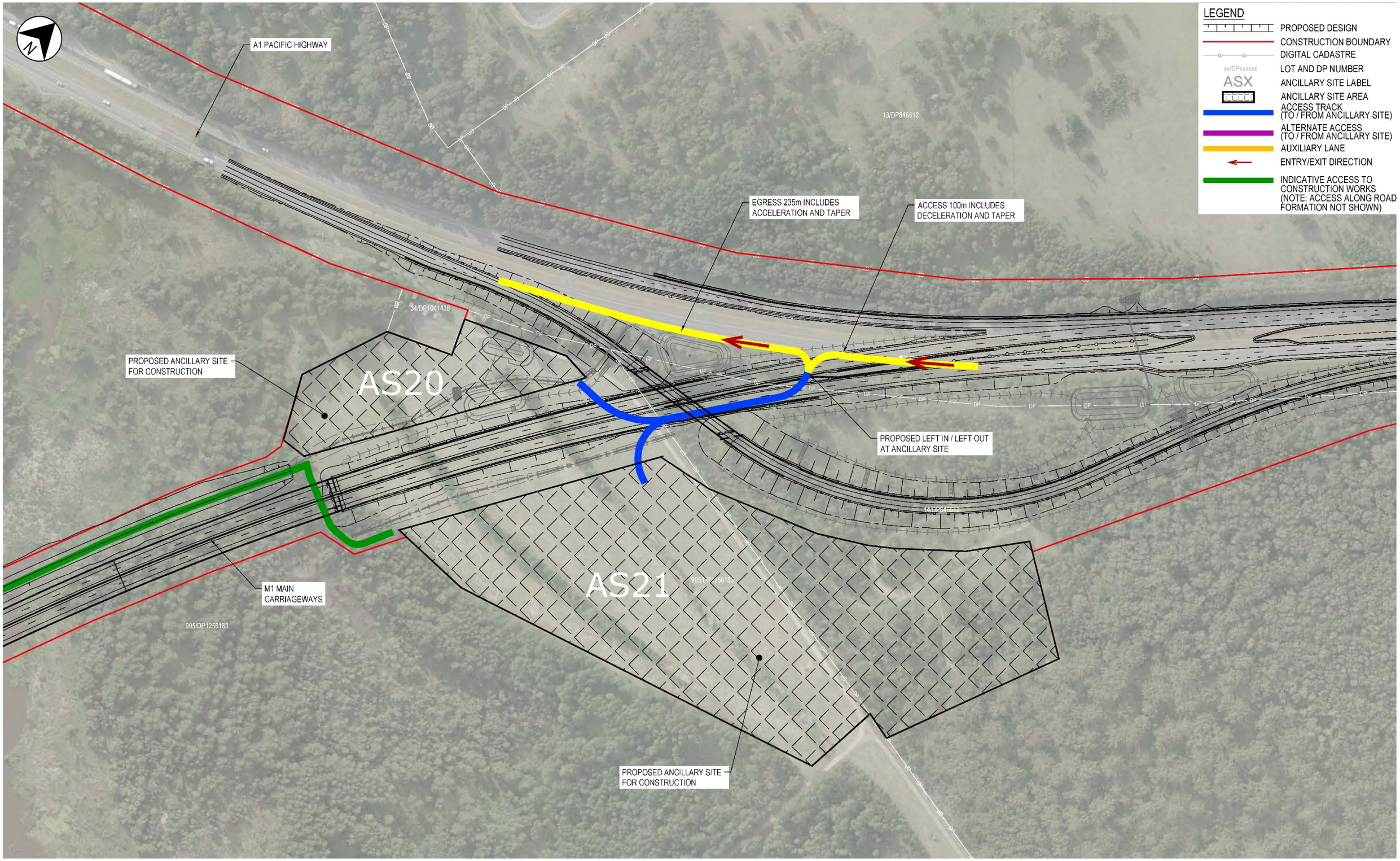
Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:5000 (A3) 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
ANCILLARY SITE ACCESS STRATEGY
MASONITE ROAD OVERBRIDGE



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Drawn: HAIL, SCOTT

Date: 4/02/2020

SCALE 1:2500 (A3) 25 0 25 50 75 100 125m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
ANCILLARY SITE ACCESS STRATEGY
RAYMOND TERRACE INTERCHANGE

Appendix D
Property Access Strategy

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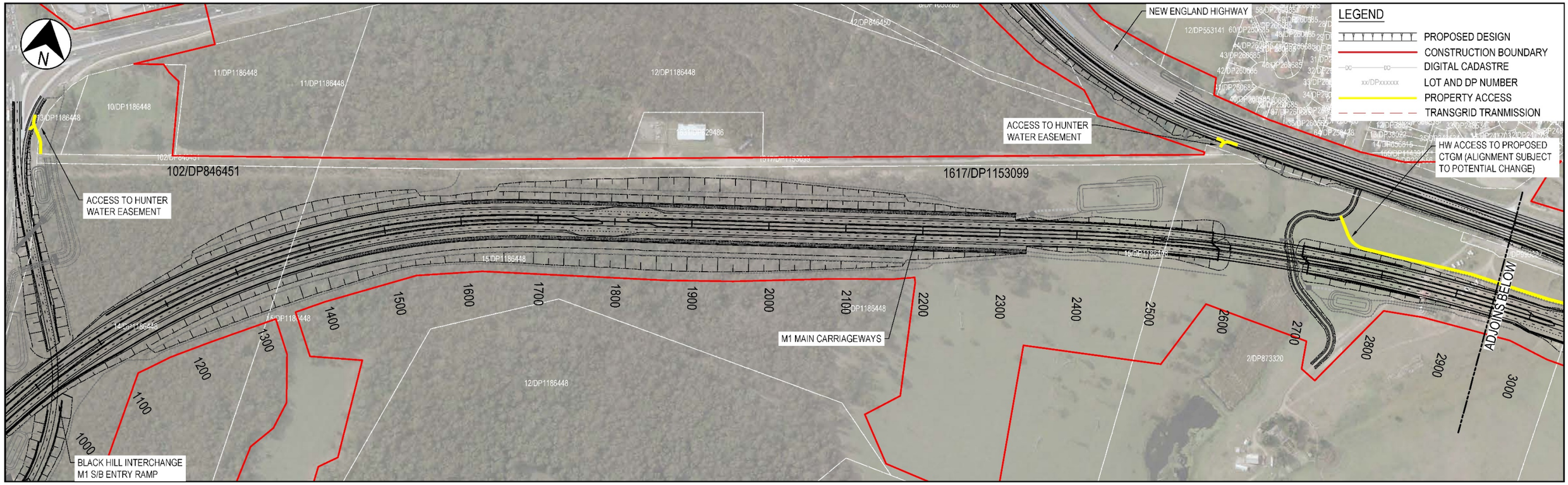
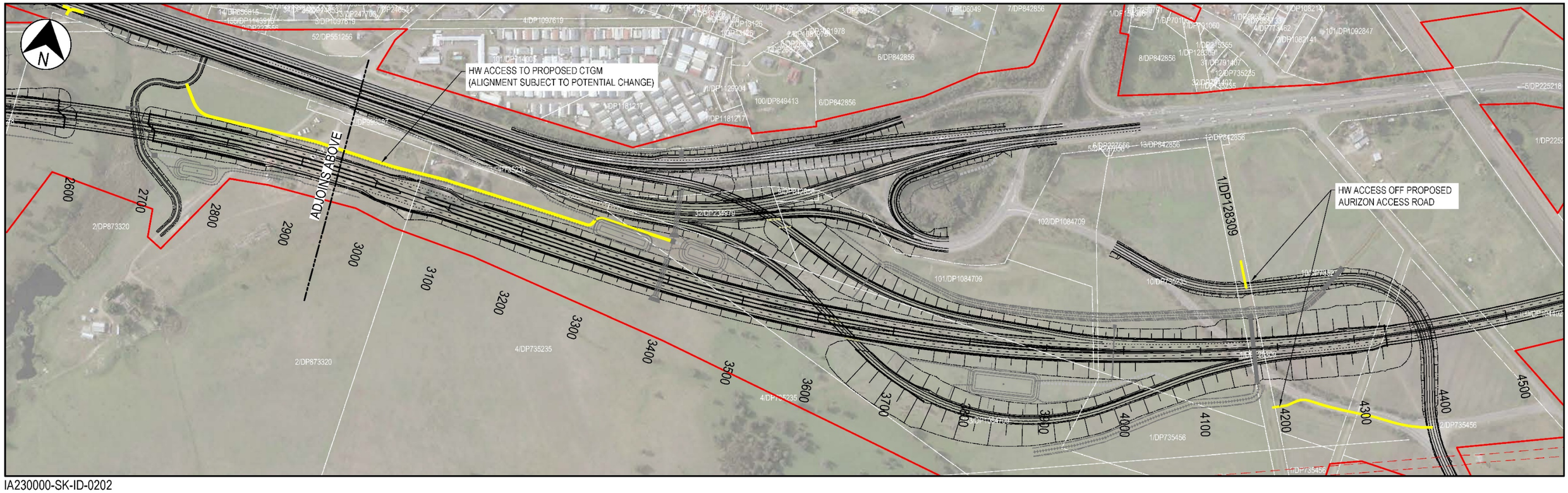
Drawn: HAIL, SCOTT

Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
TRANSGRID INFRASTRUCTURE AT BLACK HILL





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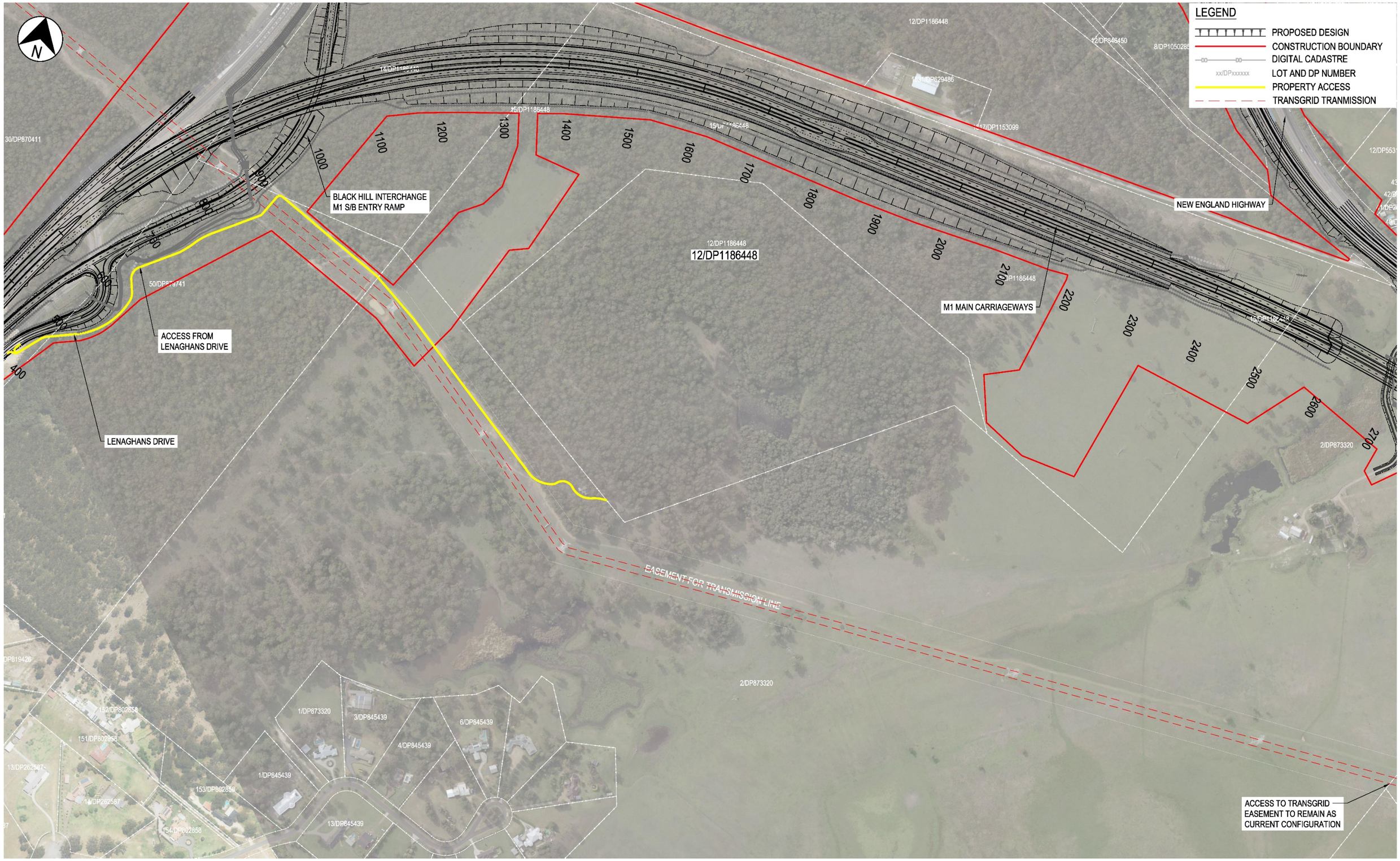
Drawn: HAIL, SCOTT

Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
HUNTER WATER EASEMENT



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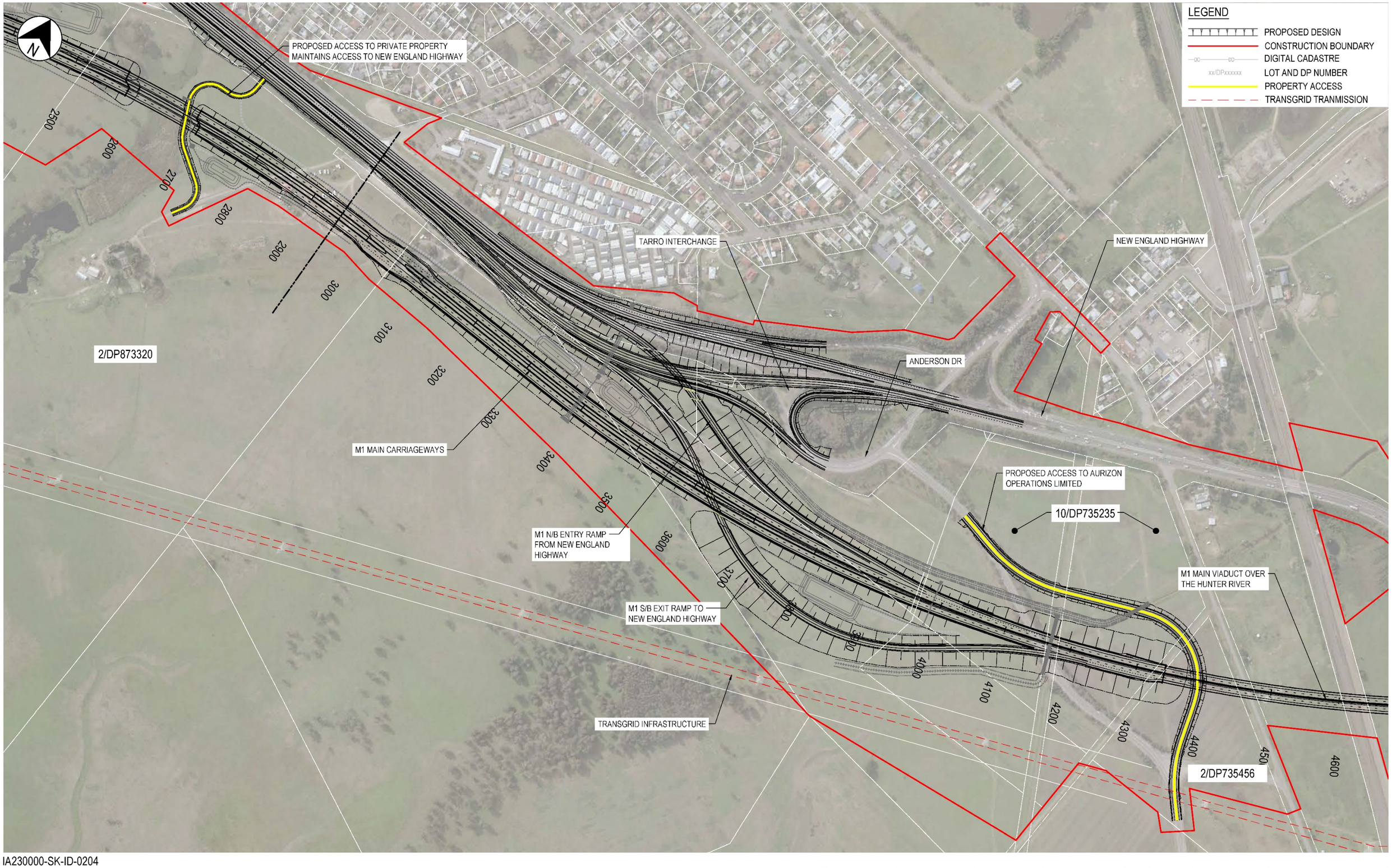
Drawn: HAIL, SCOTT
Date: 30/03/2021

SCALE 1:5000 (A3) 0 50 100 150 200 250m

M1 MOTORWAY EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
CITY OF NEWCASTLE



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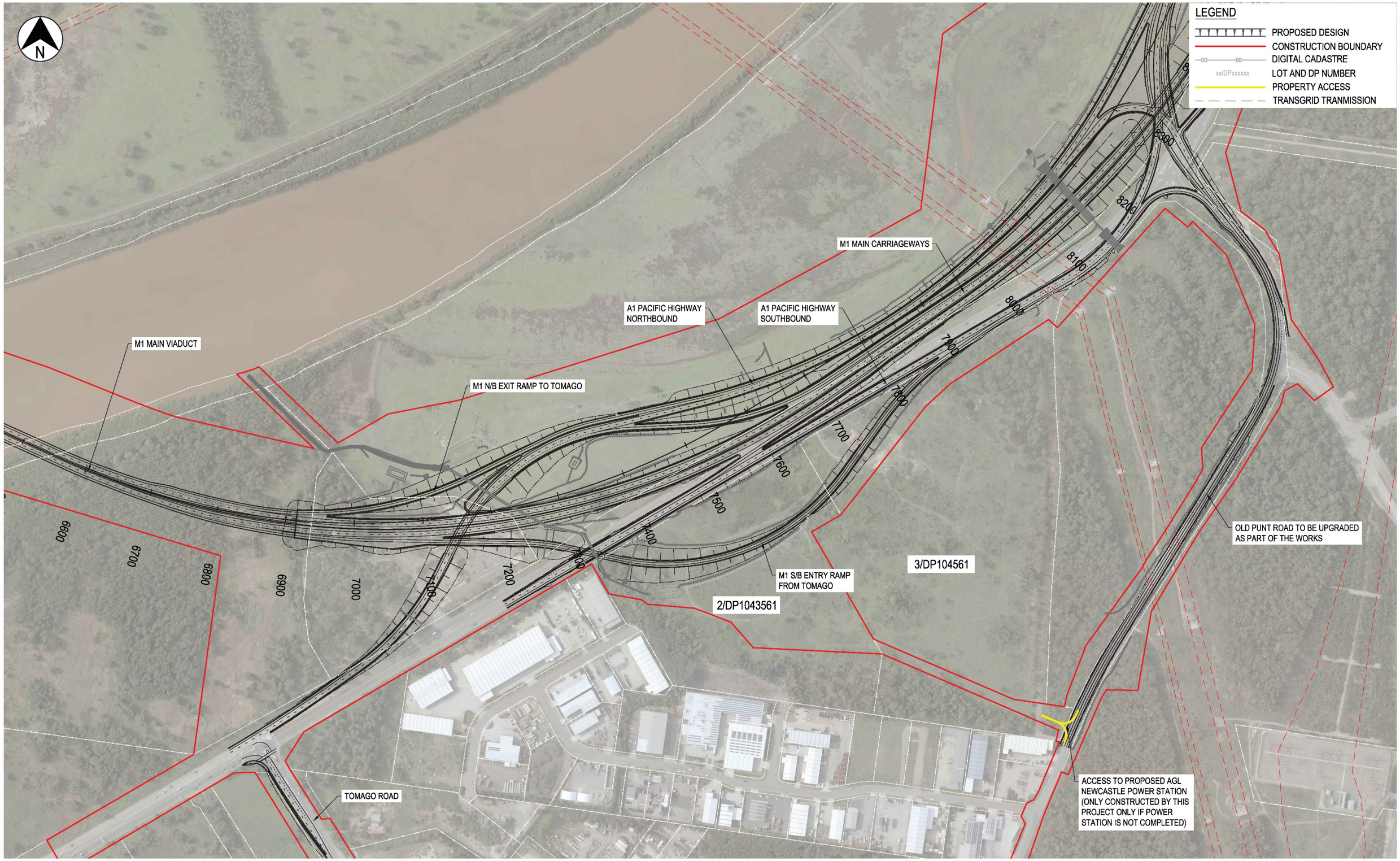
Drawn: HAIL, SCOTT

Date: 4/02/2020

SCALE 1:2000 (A3) 20 0 20 40 60 80 100m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
PRIVATE PROPERTY AND AURIZON OPERATIONS LIMITED



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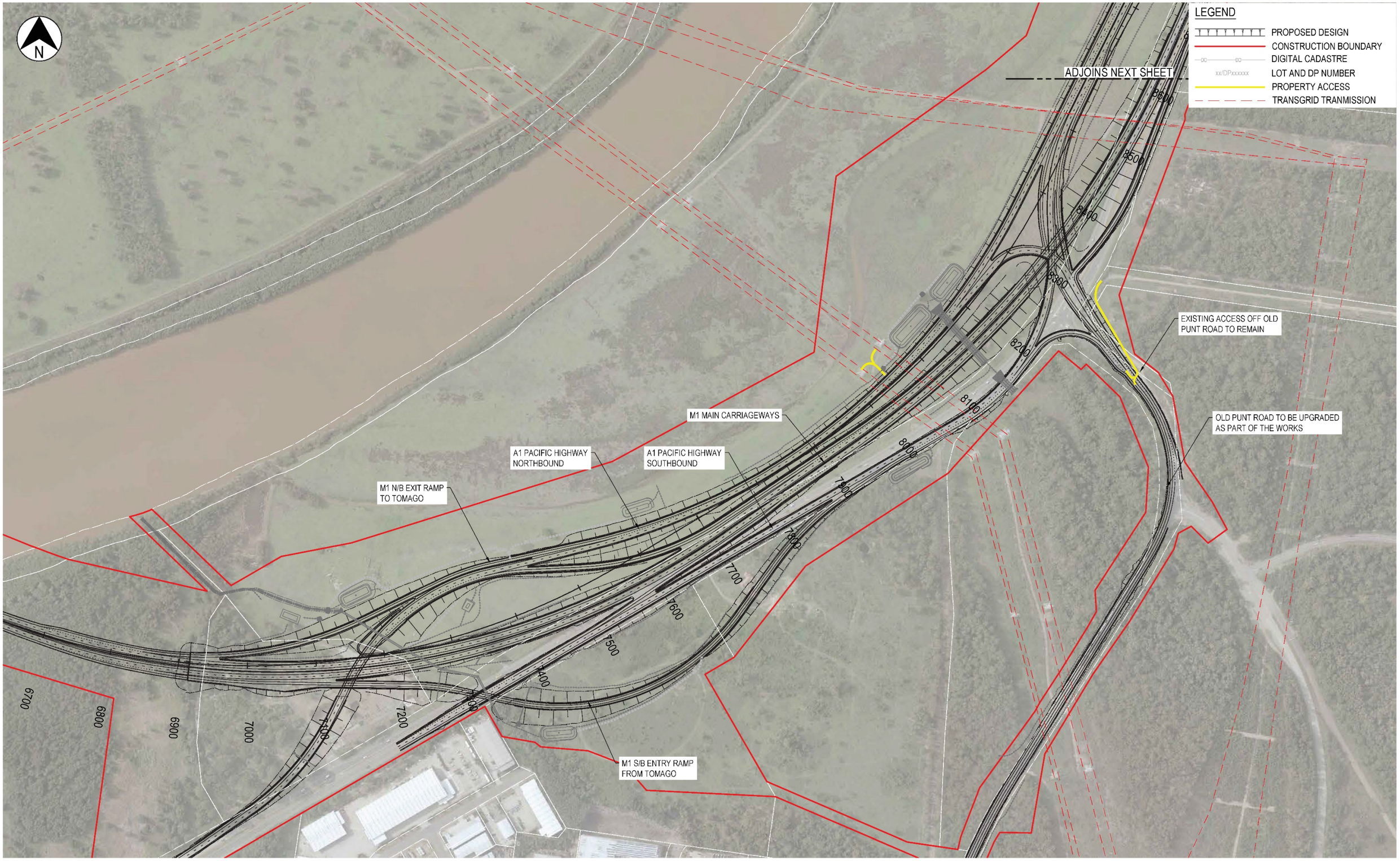
Drawn: HAIL, SCOTT
Date: 30/03/2021

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MOTORWAY EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
AGL MACQUARIE AT TOMAGO



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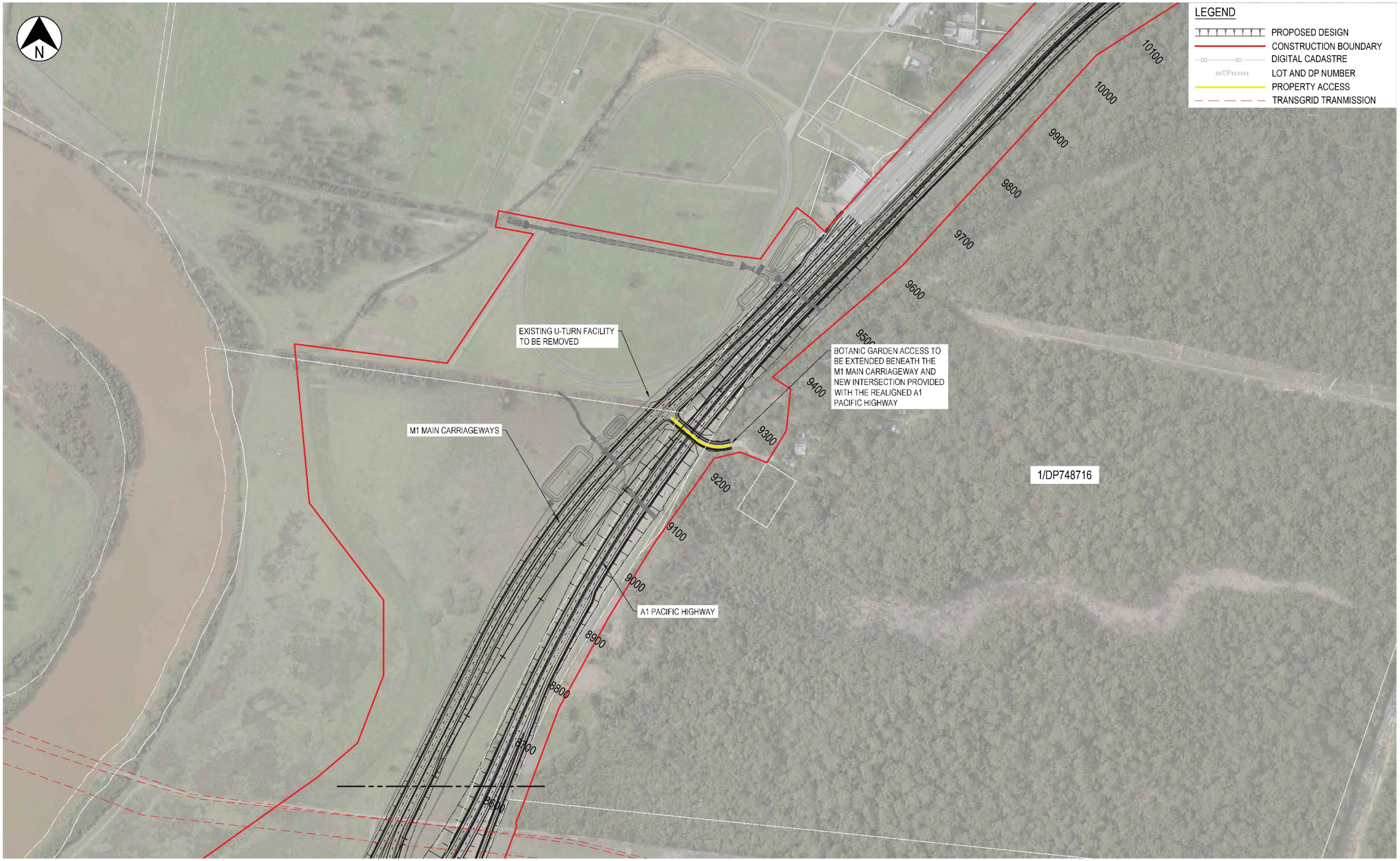
Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
TRANSGRID INFRASTRUCTURE AT TOMAGO



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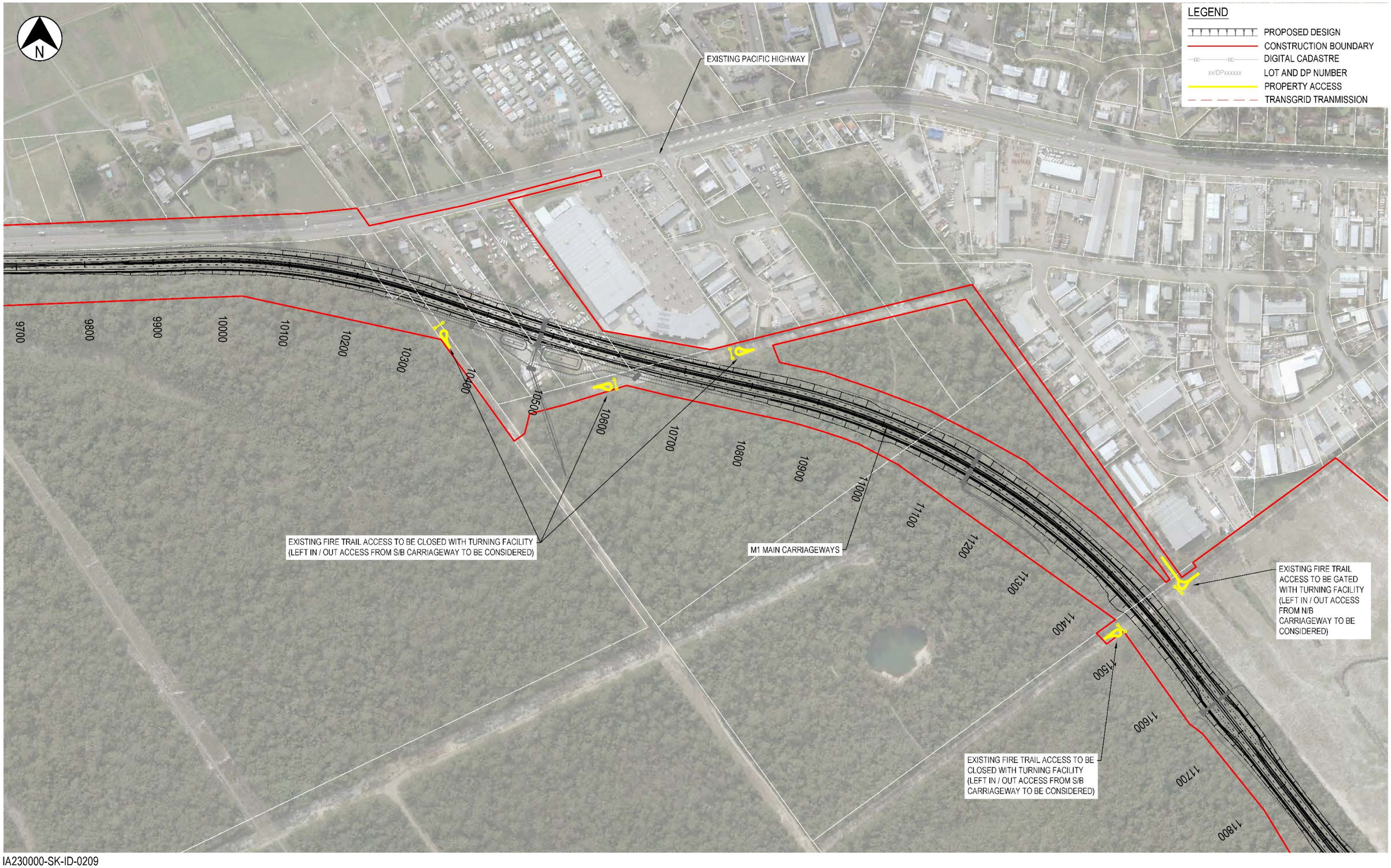
Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
HUNTER REGION BOTANIC GARDENS



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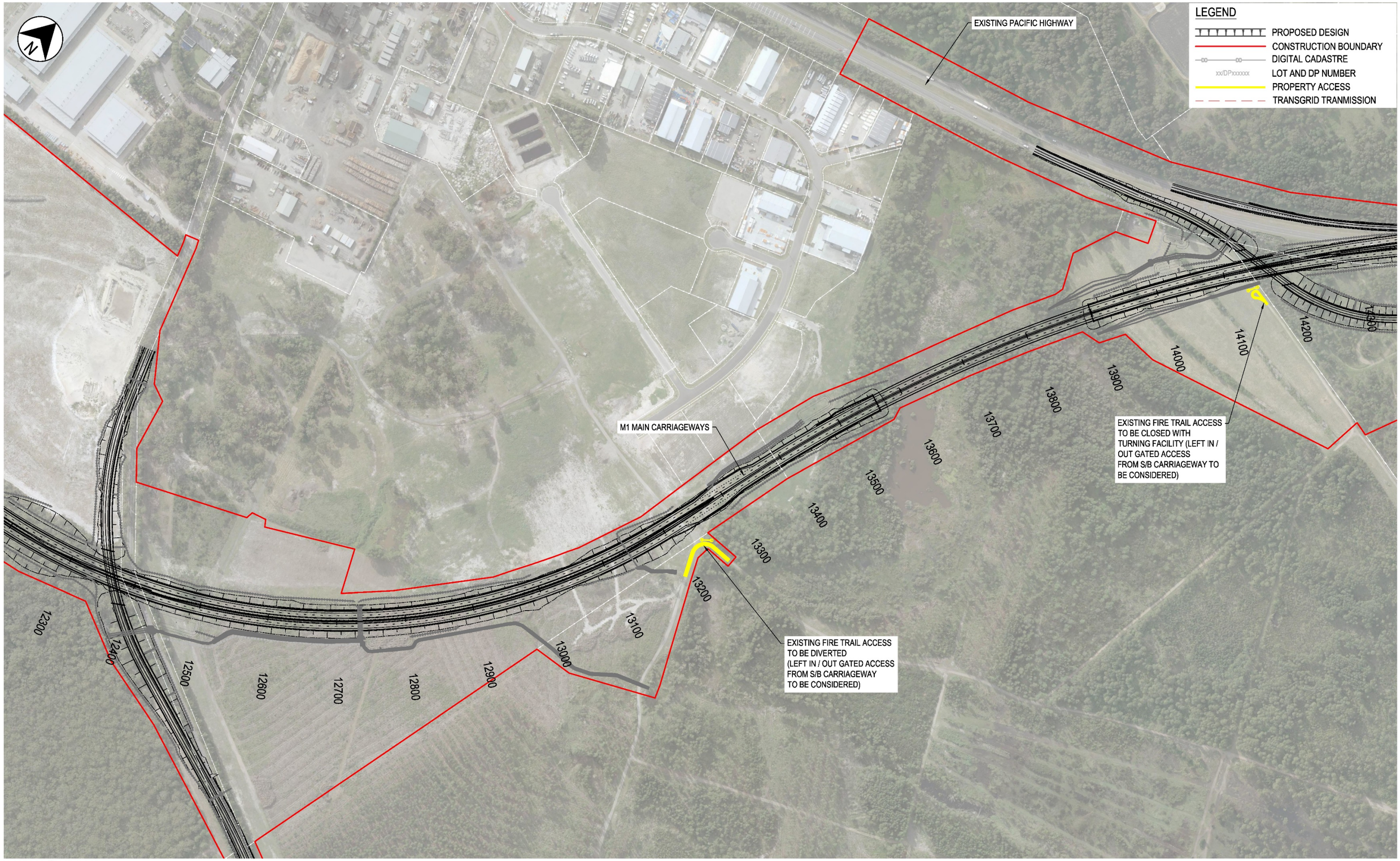
Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
HUNTER WATER CORPORATION AND OTHER PROPERTIES SEVERED BY THE M1 MAIN CARRIAGEWAYS



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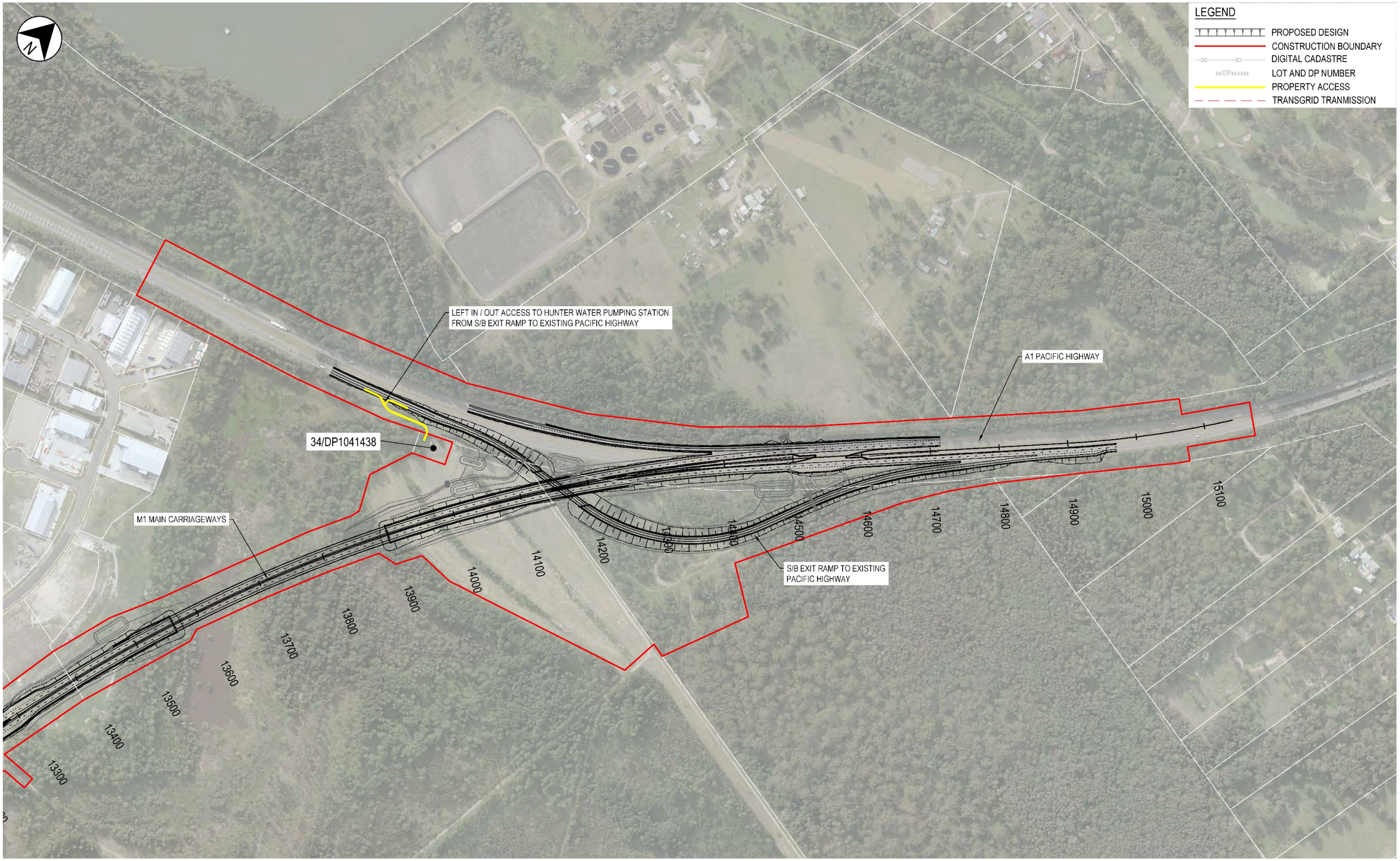
Drawn: HAIL, SCOTT

Date: 30/03/2021

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MOTORWAY EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
FIRE TRAILS SEVERED BY THE M1 MAIN CARRIAGEWAYS



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Drawn: HAIL, SCOTT
Date: 4/02/2020

SCALE 1:5000 (A3) 50 0 50 100 150 200 250m

M1 MAIN CARRIAGEWAYS EXTENSION TO RAYMOND TERRACE
PROPERTY ACCESS STRATEGY
HUNTER WATER PUMPING STATION AT RAYMOND TERRACE