Warkworth to Wellsford

Operational Transport Assessment

July 2019

QUALITY ASSURANCE

Prepared by

Jacobs GHD Joint Venture in association with Flow Transportation Specialists Ltd. Prepared subject to the terms of the Professional Services Contract between the Client and Jacobs GHD Joint Venture for the Route Protection and Consenting of the Warkworth to Wellsford Project.

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GLOSSARY OF ABBREVIATIONS

The table below sets out the technical abbreviations.

Term	Meaning
AADT	Annual Average Daily Traffic
AEE	Assessment of Effects on the Environment
ART	Auckland Regional Transport model
ASP	Auckland Strategic Plan land use model
AT	Auckland Transport
CAS	The Transport Agency's Crash Analysis System
DSI	Death and serious injury
HCV(s)	Heavy Commercial Vehicle(s).
km/h	Kilometres per hour
NFDS	National Freight Demands Study
NoR	Notice of Requirement
P2T	Pūhoi to Te Hana SATURN traffic model
P-W	Ara Tūhono Pūhoi to Wellsford project
P-Wk	Pūhoi to Warkworth project
RSD	Relative Standard Deviation
SATURN	Simulation and Assignment of Traffic to Urban Road Networks)
SH1	State Highway 1
SHGDM	State Highway Geometric Design Manual
SIDRA	Signalised and Unsignalised Intersection Design and Research Aid (traffic modelling software for isolated intersections, or for small groups of intersections)
vpd	Vehicles per day
vph	Vehicles per hour

GLOSSARY OF DEFINED TERMS

The table below sets out the defined terms.

Term	Meaning
Annual Average Daily Traffic	The equivalent to the total volume of traffic passing a roadside observation point over the period of a calendar year, divided by the number of days in that year for which traffic volumes were recorded. Measured in vehicles per day.
Corridor	Area that includes the existing SH1 between Warkworth and Te Hana, and the Project
Crash rate	Average number of crashes per year
Future Reference Case Scenario	The Future Reference Case Scenario is the base scenario for future years 2036 and 2046 against which the impacts of the Project are assessed in the traffic and transport assessment. It includes all anticipated land-use and transport network changes, excepting the Project.
Heavy vehicle	A motor vehicle having a gross laden weight exceeding 3500 kg
Indicative Alignment	An indicative road design alignment assessed by the technical experts that may be refined on detailed design within the designation boundary. The Indicative Alignment is a preliminary alignment of a state highway that could be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project will be refined and confirmed at the detailed design stage.
Motorway	Means a motorway declared as such by the Governor-General under section 138 of the PWA or under section 71 of the Government Roading Powers Act 1989.
P2T model	Pūhoi to Te Hana SATURN traffic model
Proposed designation boundary	The boundary of the land to which the notice of requirement applies.
Project	The Ara Tūhono Pūhoi to Wellsford Project: Warkworth to Wellsford section, which extends from Warkworth in the south, to the north of Te Hana.
Project Area	The area within the proposed designation boundary, and immediate surrounds to the extent Project works extend beyond this boundary.
Project Scenario	The Project Scenario is the scenario for future years 2036 and 2046 that assumes the Project has been constructed. It allows the

Term	Meaning
	impacts of the Project to be assessed by comparison with the Future Reference Case Scenario.
SATURN Traffic Model	SATURN is a suite of flexible network analysis programmes developed at the Institute for Transport Studies, University of Leeds in the United Kingdom.
State highway	A road, whether or not constructed or vested in the Crown, that is declared to be a State highway under section 11 of the National Roads Act 1953, section 60 of the Government Roading Powers Act 1989 (formerly known as the Transit New Zealand Act 1989), or under section 103 of the Land Transport Management Act 2003.
The Dome	The highest elevation within the Dome Forest Conservation Area
Travel time reliability	A measure of the variability of travel times, i.e. the variation in travel times from day to day for the same journey undertaken at the same time each day. The less variable travel times are the greater level of travel time reliability.

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1 INTRODUCTION

1.1 Overview of the Project

The NZ Transport Agency (Transport Agency) is lodging a Notice of Requirement (NoR) and applications for resource consent (collectively referred to as the Application) for the Warkworth to Wellsford Project (the Project).

This report is part of a suite of technical assessments prepared to inform the Assessment of Effects on the Environment (AEE) and to support the Application. This assessment report addresses the actual and potential operational transport effects arising from the Project. This assessment considers the effects of the Indicative Alignment and other potential effects that could occur if that alignment shifts within the proposed designation boundary when the design is finalised in the future.

Construction traffic effects are discussed in the Construction Traffic Assessment report.

1.2 Project description

The Project involves the construction, operation and maintenance of a new four lane state highway. The route is approximately 26 km long. The Project commences at the interface with the Pūhoi to Warkworth project (P-Wk) near Woodcocks Road. It passes to the west of the existing State Highway 1 (SH1) alignment near The Dome, before crossing SH1 just south of the Hōteo River. North of the Hōteo River the Project passes to the east of Wellsford and Te Hana, bypassing these centres. The Project ties into the existing SH1 to the north of Te Hana near Maeneene Road.

The key components of the Project, based on the Indicative Alignment, are as follows:

a) A new four lane dual carriageway state highway, offline from the existing State Highway 1, with the potential for crawler lanes on the steeper grades.

b) Three interchanges as follows:

   i. Warkworth Interchange, to tie-in with the Pūhoi to Warkworth section of SH1 and provide a connection to the northern outskirts of Warkworth.

   ii. Wellsford Interchange, located at Wayby Valley Road to provide access to Wellsford and eastern communities including Tomarata and Mangawhai.

   iii. Te Hana Interchange, located at Mangawhai Road to provide access to Te Hana, Wellsford and communities including Port Albert, Tomarata and Mangawhai.

c) Twin bore tunnels under Kraack Road, each serving one direction, which are approximately 850 metres long and approximately 180 metres below ground level at the deepest point.

d) A series of steep cut and fills through the forestry area to the west of the existing SH1 within the Dome Valley and other areas of cut and fill along the remainder of the Project.

e) A viaduct (or twin structures) approximately 485 metres long, to span over the existing SH1 and the Hōteo River.

f) A tie in to existing SH1 in the vicinity of Maeneene Road, including a bridge over Maeneene Stream.

g) Changes to local roads:

   i. Maintaining local road connections through grade separation (where one road is over or under the other). The Indicative Alignment passes over Woodcocks Road, Wayby Valley Road, Whangaripo Valley Road, Silver Hill Road, Mangawhai Road and Maeneene Road. The Indicative Alignment passes under Kaipara Flats Road, Rustybrook Road and Farmers Lime Road.

   ii. Realignment of sections of Wyllie Road, Carran Road, Kaipara Flats Road, Phillips Road, Wayby Valley Road, Mangawhai Road, Vipond Road, Maeneene Road and Waimanu Road.

   iii. Closing sections of Phillips Road, Robertson Road, Vipond Road and unformed roads affected by the Project.

h) Associated works including bridges, culverts, stormwater management systems, soil disposal sites, signage, lighting at interchanges, landscaping, realignment of access points to local roads, and maintenance facilities.

i) Construction activities, including construction yards, lay down areas and establishment of construction access and haul roads.

For description and assessment purposes in this report, the Project has been divided into the following areas (as shown in Figure 1 below):

a) Hōteo South: From the southern extent of the Project at Warkworth to the Hōteo River.

b) Hōteo North: Hōteo River to the northern tie in with existing SH1 near Maeneene Road.

For construction purposes, the Hōteo South section is divided into two subsections being:

- South – from the southern tie in with P-Wk to the northern tunnel portals; and

- Central – from the northern tunnel portals to the Hōteo River.

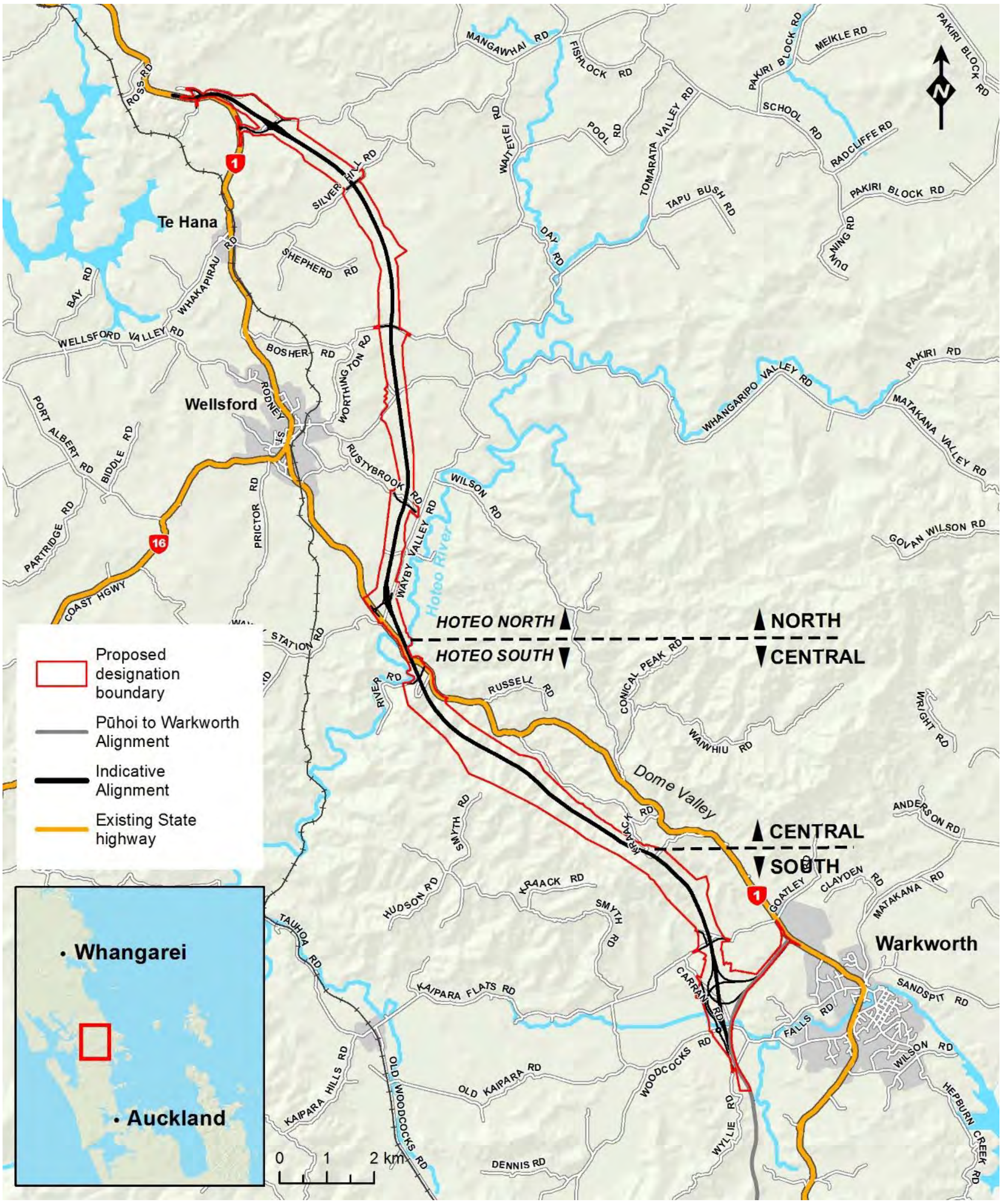

Figure 1 – Project Area

The Indicative Alignment shown on the Project drawings is a preliminary alignment for a state highway that could be constructed within the proposed designation boundary. The Indicative Alignment has been prepared for assessment purposes, and to indicate what the final design of the Project may look like. The final alignment for the Project (including the design and location of associated works including bridges, culverts, stormwater management systems, soil disposal sites, signage, lighting at interchanges, landscaping, realignment of access points to local roads, and maintenance facilities), will be refined and confirmed at the detailed design stage.

A full description of the Project including its design, construction and operation is provided in Section 4: Description of the Project and Section 5: Construction and Operation of the AEE contained in Volume 1 and shown on the Drawings in Volume 3.

1.3 Purpose and scope of this report

The purpose of this report is to inform the AEE and to support the Application.

This report presents the results of an assessment of the operational transport effects of the Project. The assessment was undertaken by forecasting the performance of the transport network for a "Future Reference Case" scenario (Future Reference Case Scenario), in which the Project is not constructed, and a "Project" scenario (Project Scenario), which assumes that the Project is constructed. The performance of the transport network in each of the scenarios is compared to assess the impact of the Project with respect to each of the following elements:

- Traffic volumes;
- Travel times;
- Travel time reliability;
- Crash performance;
- Route resilience; and
- Road freight performance.

This report is set out as follows:

- Section 2 explains the methodology used to carry out the assessment, including information about the transport modelling upon which the assessment is based.
- Section 3 presents the existing transport environment along the corridor.
- Section 4 assesses the Future Reference Case Scenario (i.e. the future scenario without the Project).
- Section 5 compares the Future Reference Case Scenario against the Project Scenario.
- Section 6 provides results of traffic model sensitivity tests.
- Section 7 provides our conclusions.

1.4 Project objectives

The Transport Agency's objectives for the Project are to:

- Increase corridor capacity, improve route quality and safety, and improve freight movement between Warkworth and the Northland Region;
- Provide resilience in the wider state highway network;

- Improve travel time reliability between Warkworth, Wellsford and the Northland Region;
- Provide connections to and from Warkworth, Wellsford and Te Hana;
- Provide a connection at Warkworth that optimises the use of infrastructure from, and maintains the level of service provided by, the Pūhoi to Warkworth project; and
- Alleviate congestion at Wellsford by providing an alternative route for north – south through traffic.

2 ASSESSMENT METHODOLOGY

Section summary

The methodology for assessing the operational transport effects of the Project involves forecasting and comparing two future transport scenarios:

- the Future Reference Case Scenario, which assumes that the Project will not be constructed; and
- the Project Scenario, which assumes that the Project will be constructed.

Both scenarios assume the same land use changes and transport network improvements (with the exception of the Project).

The performance of the transport network under these two scenarios is compared in this report to allow us to assess the operational transport effects of the Project.

2.1 Approach to assessment of operational transport effects

The assessment of the operational transport effects of the Project has been undertaken through the following steps:

1) Forecasting the performance of the transport network in a Future Reference Case Scenario (refer to section 2.3 below), which assumes that the Project is not constructed;

2) Forecasting the performance of the transport network in a Project Scenario, which assumes that the Project is constructed; and

3) Comparing the performance of the transport network under those two scenarios.

The performance of the transport network under the two scenarios was assessed in terms of:

- Traffic volumes;
- Travel times;
- Travel time reliability;
- Route resilience;
- Safety (crash performance);
- Route security; and
- Road freight performance.

Comparing the performance of the transport network in the two scenarios allows us to assess the potential positive and adverse operational transport effects of the Project.

Construction of the Project is assumed to be completed by approximately 2036. The assessment of operational transport effects has been undertaken using the forecast years of 2036 and 2046 as this aligns with the relevant traffic models. There would be no material differences to the assessment if, for example, the Project is opened in 2035 or 2037, rather than 2036. We expect that one or two years of additional traffic growth would not substantially change the assessment; however, significant changes in the future land use assumptions may change the results and would require further assessment.

2.2 Transport models

Much of the assessment of operational transport effects is based on the outputs of the Pūhoi to Te Hana SATURN traffic model (P2T model), which was developed by Jacobs NZ Ltd for the road network from Pūhoi to Te Hana, including the townships of Warkworth and Wellsford. The regional transport demands for the P2T model were sourced from the Auckland Regional Transport[1] model (ART model).

The ART model is a regionally accepted macro (or strategic) tool managed by the Auckland Forecasting Centre.[2] Demand figures from the ART model are the primary source of future year forecasts for most if not all transport project models in the Auckland region.

A full description of the development of the P2T model, including its calibration and validation, and the development of forecast models, is detailed in the following reports:

- Pūhoi to Te Hana Model Development Report, Jacobs NZ Ltd, dated 7 February 2017; and

- Pūhoi to Te Hana Forecasting Report, Jacobs NZ Ltd, dated 9 June 2017.

The above reports associated with the P2T model were independently peer reviewed by Ian Clark of Flow Transportation Specialists. The peer review confirmed that the base models adequately reflect observed traffic flows, journey times, and origin-destination patterns. The peer review also confirmed that the future models seem reasonable, noting that the future forecast depends to a significant extent on the anticipated land use changes, particularly within the Warkworth area.

The geographic scope of the P2T model is shown in Figure 2. The modelled network spans from south of Pūhoi (at the Johnstone's Hill Tunnels) to Topuni (at the intersection of Oruawharo Rd). It includes the Warkworth township and the road network within Wellsford. The model extent was chosen for the purpose of modelling the Ara Tūhono Pūhoi to Wellsford project (P-W) project and future urban growth planned for Warkworth. The extension of the model south to the Johnstone's Hill Tunnels allows traffic in the future year models to choose between the existing SH1 and the P-W project.

1 The ART model used the adjusted i11.4 land use scenario.

2 The Auckland Forecasting Centre (formerly Joint Modelling Application Centre (JMAC)) is a partnership between Auckland Council, Auckland Transport, and the Transport Agency, combining Auckland's transport modelling resources into a single operational unit under common management.

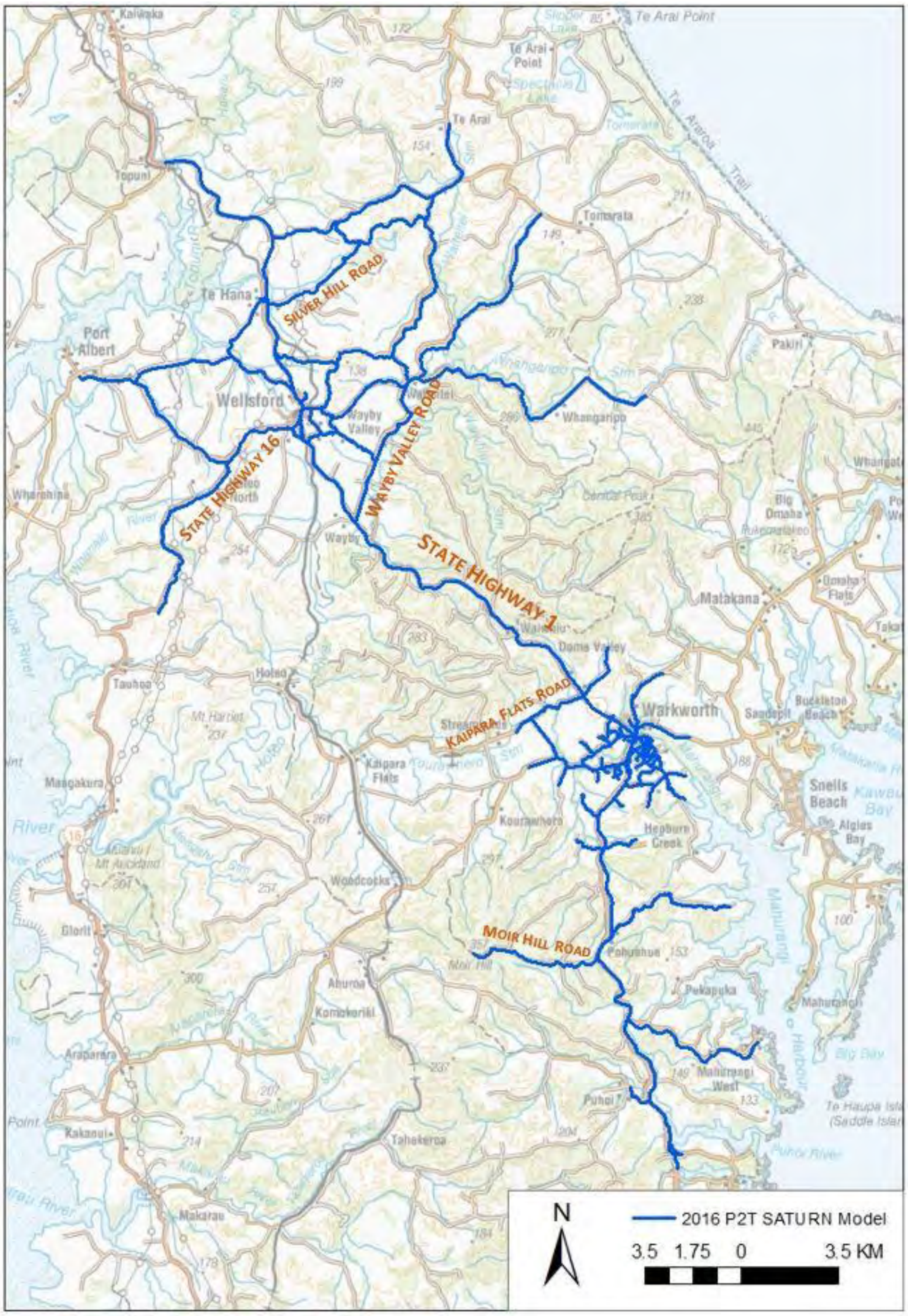

Figure 2 – P2T model coverage

The models used for this assessment cover three one-hour time periods[3]:

- Weekday morning peak hour (8:00 am to 9:00 am);
- Weekday inter peak (12:00 pm to 1:00 pm); and
- Weekday evening peak hour (4:30 pm to 5:30 pm).

[3] The Model Development Report includes the development of holiday period models. These models were not used for the assessment, as they were based on limited data.

The P2T model has a base year of 2016. Three sources of traffic count data were used to calibrate the models. These were:

- State highway count data covering January 2013 to October 2016;
- Classified turning count data for the SH1/Hill Street intersection, collected in October 2016; and
- Count data for other intersections around Warkworth, carried out in 2013.

Traffic demand matrices were developed for the P2T model based on demand figures from the ART model for the weekday morning peak, inter peak, and evening peak periods. Details of the matrix estimation process, as well as calibration, validation, and future forecasting, are included in the Base Year Calibration Report and Forecasting Report. These reports contain specific information about key model performance parameters.

Two vehicle classes are defined in the model: light vehicles and heavy commercial vehicles (HCVs).

Future year demands have been developed for 2026, 2036, and 2046 based on outputs from the ART model. The details of estimating the future year matrices are detailed in the Forecasting Report.

Annual Average Daily Traffic (AADT) volumes used in this report have been derived by factoring up the peak hour model volumes. The factors used were based on an analysis of observed relationships between hourly and daily traffic in the Project Area and associated transport network. The analysis used count data from three sites along the existing SH1: south of Centennial Park Road in Wellsford, south of McKinney Road in Warkworth, and south of Pūhoi Road (see Appendix A).

2.3 Future reference case scenario

The Future Reference Case Scenario considers the future transport network without the Project. This scenario includes all anticipated land-use and transport network changes, but assumes that the Project is not constructed. As the Project is expected to open around 2036, this assessment uses the forecast years 2036 and 2046.

It is common practice for projects to be assessed against a "Future Do Minimum" scenario, which only includes future committed projects. Committed projects are those which have funding committed for their construction. However, in areas of significant land use change, such a scenario can be "out of balance", and a model can then give less sensible results, if significant land use change is included without an appropriate level of investment in transport to support that land use change. As a result of the land use change anticipated, particularly within the Warkworth area, a number of uncommitted projects have been included within the Future Reference Case Scenario (see Section 2.5 below). However, sensitivity tests have been carried out using models that include only those projects that have committed funding, with results provided within Section 6.1.

2.4 Land use assumptions

Land use forecasts (based on population and employment) were input into the P2T model to develop the Future Reference Case Scenario. These land use forecasts were primarily based on the ART model scenario i11.4, which contains the latest land use assumptions reflecting Auckland Council/Auckland Transport's growth expectations (incorporated into the P2T model in September 2017).

The Pūhoi to Te Hana Forecasting Report provides further details of the development of the future year models. See Appendix B for a comparison of the input demographics in the i11.4 scenario and the previous land use scenario, i9.

2.5 Transport network assumptions

A number of transport network changes and improvements are anticipated to take place over time. The changes and improvements included in the P2T model were based on advice provided by the Transport Agency and Auckland Transport relating to projects that are most likely to be constructed in future years.

The following changes and improvements to the transport network are included in the P2T model in both the Future Reference Case Scenario and Project Scenario.

- **Pūhoi to Warkworth project (under construction):** The P-Wk section of the P-W project will be a four lane section connecting SH1 north of the Johnstone's Hill tunnels with SH1 north of Warkworth. At the southern end, south facing ramps are to be provided at Pūhoi Road. At the northern end, the P-Wk project will connect into SH1 north of Warkworth at a roundabout.

- **SH1 Dome Valley safety improvements (committed):** This project will improve safety along SH1 through providing improved and widened shoulders and shoulder barriers, providing wider centre medians or median safety barriers, and improvements to the passing lanes[4]. These safety improvements are delivered through the Safe Roads Alliance being an alliance established by the Transport Agency to deliver a programme of road and roadside safety improvements to the state highway network.

- **Matakana link road (committed):** The Matakana link road project will provide a connection from the existing SH1 north of Hudson Road to Matakana Road in the area around Clayton Road. This project is scheduled to be open prior to P-Wk opening.

- **Western Collector (Stage 1 constructed, remaining stages in planning):** The Western Collector is a proposed local access road, which will provide a transport connection for proposed developments to the west of the existing SH1 as shown in the Transport for Future Urban Growth Transport Assessment[5] The Western Collector alignment is yet to be determined, but will take traffic to the western side of Warkworth, between McKinney Road in the south and Hudson Road in the north. Stage 1 of the Western Collector, connecting Mansel Drive to Falls Road, was completed in March 2016.

- **Hauiti Drive to John Andrew Drive new secondary arterial (planned, not committed):** This link will connect Hauiti Drive, Blue Gum Drive and John Andrew Drive in Warkworth. Hauiti Drive and Blue Gum Drive are currently cul-de-sacs.

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4 This project will lead to safety improvements along the corridor, but will have minimal effects in terms of the traffic capacity along the route, so it has not been explicitly included in the traffic model.

5 Auckland Transport, Auckland Council, NZ Transport Agency. Transport for Future Urban Growth – Warkworth. Transport Assessment. 30 May 2016. 342-16-PS.

- **Alnwick Street Connection (planned, not committed):** This link will connect Alnwick Street south to Alnwick Street north.

- **Sandspit Link (planned, not committed**): Sandspit Link will provide a connection from the Matakana Road (around Clayton Road) to Sandspit Road in the area east of Matakana Road.

- **Matakana Road to Sandspit realignment (planned, not committed):** The Matakana Rd to Sandspit realignment project will realign Sandspit Road from its current connection at Matakana Road to a connection further north. This realignment will provide spacing between the Matakana Road intersection and the Elizabeth Street / Hill Street intersection. In the model it is assumed the connection will be at the current Melwood Road / Matakana Road intersection.

- **Southern Network (planned, not committed):** The Southern Network will support development in the south of Warkworth. The network will comprise of collector roads either side of SH1. Figure 3 presents the general layout of this road network.

The changes and improvements are shown spatially in Figure 3 and Figure 4, and more detail is included in Appendix C.

Figure 3 - Changes to the transport network adopted as the Future Reference Case

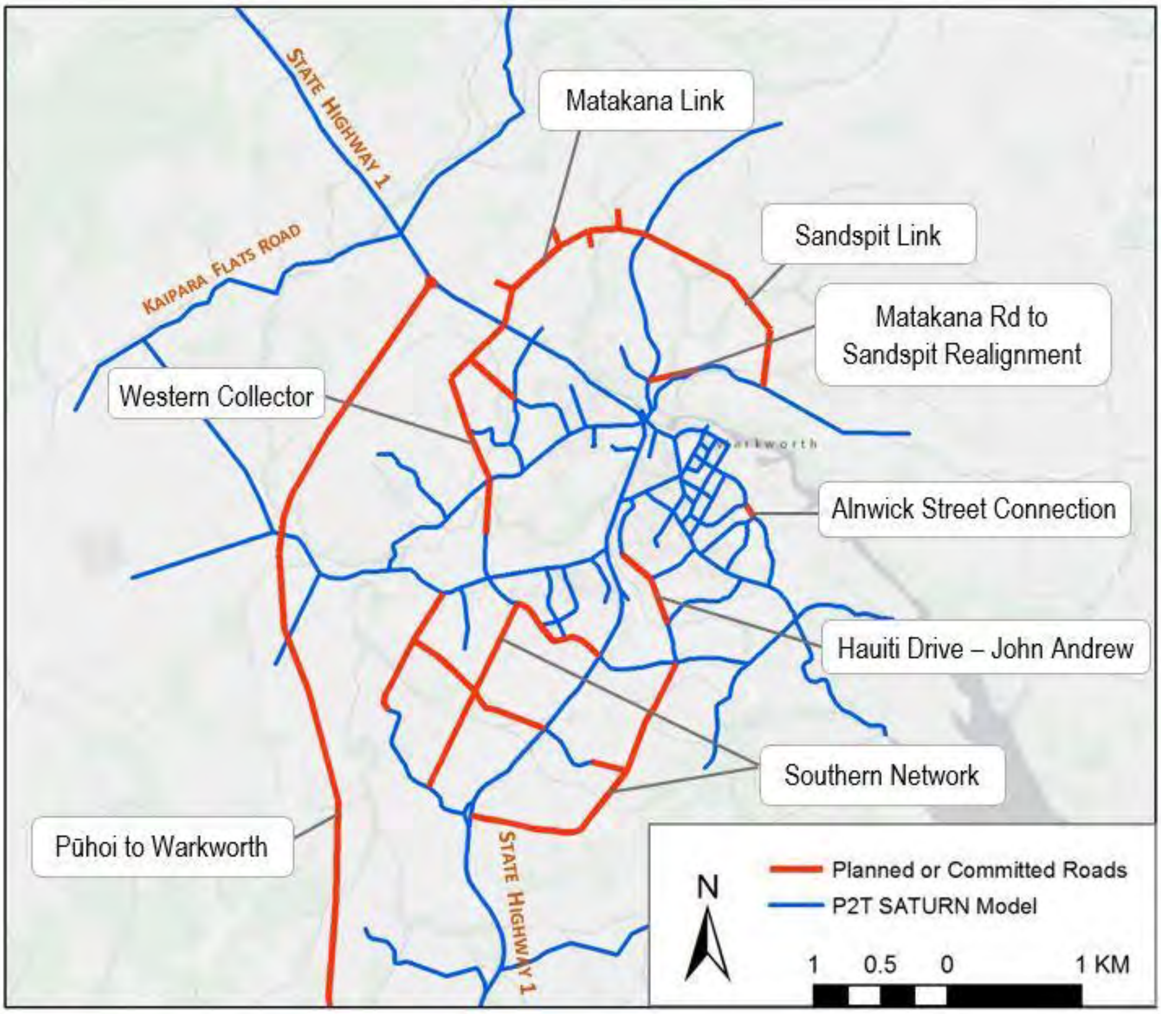

Figure 4 – Changes to the transport network adopted as the Future Reference Case, Warkworth detail

2.6 Project scenario

The Project scenario has the same network, land use, and demand assumptions as the Future Reference Case, but it also includes the Project as described in Section 1.2 above.

The Project is modelled using the Indicative Alignment as a four lane highway connecting the P-Wk project in the south, to SH1 north of Te Hana. A system interchange at Warkworth with connections to the P-Wk project is proposed as part of the Indicative Alignment. Service interchanges are proposed as part of the Indicative Alignment at Wayby Valley Road (Wellsford interchange) and Mangawhai Road (Te Hana interchange). The alignment of the Project and locations of the interchanges can be seen in the general arrangement drawings in Volume 3: Drawing Set.

3 EXISTING TRANSPORT ENVIRONMENT

Section summary

This section describes the current transport network and its performance.

The SH1 corridor between Auckland and Whangārei is of national strategic significance as it provides the primary strategic inter-regional transport route between the Auckland and Northland regions. SH1 carries high volumes of freight traffic, with approximately 12% of traffic being HCVs between Warkworth and Wellsford. The freight lines, and the activities they support, are therefore highly dependent on the quality and reliability of SH1. However, the existing SH1 route is currently closed a number of times a year as a result of events such as crashes, flooding or slips. The connection between Auckland and Northland is vulnerable to long-term closure after a major natural event, such as major slips and flooding.

The Warkworth to Te Hana section of SH1 is characterised by varied topography and geology which bring with them associated challenges in alignment geometry. Also, SH1 can be subject to busy traffic conditions, particularly at Warkworth (at the southern end of the Project), Wellsford, and at some geometric constraints along the route.

There are six passing or climbing lanes between Warkworth and Te Hana, with three northbound and three southbound. These lanes do not meet (and fall well short of) the Transport Agency's current passing lane requirements with respect to length or spacing.

The 2016 AADT volume on SH1 is approximately 20,000 vpd through Warkworth and 12,000 vpd in the Dome Valley between Goatley Road and Wayby Valley Road. Demand is at its highest between 2pm and 4pm on Sunday, with a two-way peak volume of around 1,100 vph. Traffic volumes along the corridor are much higher during key holiday periods than they are during a typical day. These higher volumes result in congestion on the road network and delays for all road users.

A total of 204 crashes were reported on the Warkworth to Te Hana section of SH1 in the five-year period from 2012 to 2016. The most common type of crash along this section of SH1 is cornering crashes, with head-on and rear-end crashes being the second and third most common type of crash, respectively. However, the majority of the fatal and serious injuries resulted from head-on crashes, with cornering crashes resulting in the most minor and non-injury crashes.

3.1 Existing transport network

SH1 is the main strategic route between Auckland and Northland. The One Network Road Classification (ONRC)[6] framework identifies this section of SH1 as being of national strategic importance. As the vehicular and traffic demands on this route have changed, sections of this route have been upgraded from time to time. With a significant increase in traffic towards the end of the 20th century and the beginning of the 21st century, the geometric issues associated with the current alignment have become a growing issue. This route has a medium-high risk rating, based on its crash performance over recent years.

[6] NZ Transport Agency. 2013. One Network Road Classification. https://nzta.govt.nz/roads-and-rail/road-efficiency-group/onrc/

In the Project Area, the Warkworth to Te Hana section of SH1 serves the dual purposes of providing for inter-regional transport of people and goods between Auckland and Northland, as well as providing access to local areas between Warkworth and Te Hana, primarily Wellsford and Te Hana (see section 3.3 below on connections to other settlements). As a consequence of this dual function, there is a mix of regional and local traffic on SH1.

The Warkworth to Te Hana section of SH1 between Warkworth and Te Hana is characterised by varied topography and geology, which bring with them associated challenges in alignment geometry. SH1 can be subject to busy traffic conditions, particularly at Warkworth (just to the south of the Project area), Wellsford, and at particular geometric constraints along the route.

SH1 is a single carriageway road that follows the undulating landform, with restricted sightlines and steep grades in some locations and limited passing lanes. The route intersects with local roads between Warkworth and Te Hana. Many of the intersections do not have adequate acceleration and deceleration lanes, which increases the potential for conflicts between SH1 traffic and local traffic. These factors contribute to a number of crashes, particularly through the Dome Valley (refer to section 3.8 for crash data).

The posted speed limit along SH1 is generally 100 km/h. Since December 2007, the speed limit has been reduced to 80 km/h through the Dome Valley, between L Phillips Road (Sheep World) and Wayby Valley Road. This reduction was an initiative by the Transport Agency to help address the poor safety record through this section of SH1. The speed limit is 50 km/h through Wellsford and 70 km/h through Te Hana.

3.2 Passing lanes

There are six passing or climbing lanes[7] along SH1 between Warkworth and Te Hana, with three northbound and three southbound. A passing lane is located either side of the "Top of the Dome"[8], which provides passing opportunities on the steep uphill sections in both northbound and southbound directions. The other northbound passing lanes are located north of the Waitaraire Bridge (within the Dome Valley south of the Hōteo River) and north of Wayby Valley Road. The other southbound passing lanes are located immediately south of Wellsford and north of Te Hana.

The State Highway Geometric Design Manual[9] (SHGDM) recommends that passing lanes are a minimum of 800m long including tapers and are located with an average spacing of 10 to 15 km.

The Transport Agency's Passing and Overtaking Policy[10] requires that state highways that carry more than 12,000 vpd (as does this section of SH1) should provide 1.5 km long passing lanes at 5 km spacing on flat terrain. For rolling terrain, the Policy recommends

[7] Where passing lanes are located on sections of highway that have severe gradients, which will cause a speed reduction of at least 25km/h for a 5kw/tonne design vehicle, they are classified as climbing lanes. However, they also provide a useful passing lane facility. For simplicity, both passing and climbing lanes are referred to as passing lanes in this Report.

[8] The "Top of the Dome" is a high point in the Dome Valley section of the existing SH1 with steep slopes on either side. It is the location of a café and scenic lookout.

[9] New Zealand Transport Agency. State Highway Geometric Design Manual (Draft), Part 5 – Vertical Alignment. 17 January 2002.

[10] NZ Transport Agency. Transit Planning Policy Manual version 1, Appendix 3E – Passing and Overtaking. Effective from 1 August 2007. https://nzta.govt.nz/assets/resources/appendix-3e-passing-overtaking-policy/docs/passing-overtaking-appendix-3e.pdf

that a 2+1 lane arrangement[11] should be provided. The existing passing lanes do not meet (and fall well short of) these requirements.[12]

While the existing passing lanes between Warkworth and Te Hana meet the SHGDM recommended spacing, only two of the passing lanes meet the current recommended length.

3.3 Local roads

The Warkworth to Te Hana section of SH1 intersects with a number of local roads that provide access to small towns or settlements, including Mangawhai. Some of these local roads serve sparsely populated rural areas, whereas others serve more closely settled rural communities and settlements. The location of these roads is shown in Figure 5.

The local roads serving rural communities and settlements between Warkworth and Te Hana include:

- Kaipara Flats Road and Goatley Road: These roads intersect with SH1 to form a four-way intersection, north of Warkworth. SH1 has no deceleration lanes or right-turn bay, and has narrow shoulders. Goatley Road is a no exit road.
- Christine Place: SH1 has no deceleration lanes and has poor sightlines (i.e. below current standards) in both directions for a 100km/h speed environment.
- Kraack Road: This road intersects with SH1 just to the west of the Top of the Dome Cafe. SH1 has no deceleration lane or right-turn bay, and has poor geometry, creating a hazardous intersection.
- Waiwhiu Road: This road intersects with SH1 in the hilly, forested country to the north of the Dome Valley. The intersection is poorly defined with no deceleration lanes or turning bays.
- Several minor rural roads and forestry roads intersect with SH1 between Waiwhiu Road and Wayby Station Road. These roads mostly have poorly-defined geometry and poor operating circumstances (fast-moving traffic, poor sight lines).
- Wayby Valley Road and Wayby Station Road: This intersection was upgraded in 2013 to form a four-way intersection with protected right-turn bays. This intersection has reasonable sight lines.
- Matheson Road: This intersection with SH1 is inside the 50 km/h environment of the Wellsford township. It has a right turning bay and shoulder areas on both sides of the road.
- School Road: This road intersects with SH1 inside the 50 km/h environment of the Wellsford township. It provides access to the western settlements of Port Albert, Wharehine and Tapora, along with the Kaipara Harbour.

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[11] The Transport Agency Planning Policy Manual defines a 2+1 lane as "A continuous alternating passing lane, which switches between one direction of traffic flow and the other."

[12] NZ Transport Agency Warkworth to Wellsford Scheme Assessment Report, Jacobs, dated 16 September 2016.

- Whakapirau Road: This road intersects with SH1 in Te Hana. It provides access to the western settlements of Port Albert, Wharehine and Tapora, along with the Kaipara Harbour. There is a right turn bay on SH1 at this intersection.

- Silver Hill Road: This unsealed road provides a link between Te Hana and Waiteitei Road, and services the Silver Hill quarry.

- Mangawhai Road: This road intersects with SH1 north of Te Hana. It carries the Twin Coast Discovery Highway east to Mangawhai and beyond. It also serves communities at Te Arai and provides a link to Tomarata and Pakiri. There is a right turn bay on SH1 at this intersection.

- Vipond Road: This is a no exit road that intersects with SH1 north of Mangawhai Road. It is paved for about 50 m and then changes to an unpaved road that provides access to a farm and residential properties. A curve in SH1 to the south limits sight lines in that direction.

- Maeneene Road and Waimanu Road: These unsealed no exit roads intersect SH1 north of Te Hana. They provide access to private farms and residences. A curve in SH1 to the north limits sight lines in that direction.

- In addition, there are a number of private properties that have accesses on SH1.

Other local roads provide connections or access between SH1 and places of interest to tourists. These local roads consequently convey higher traffic flows than the land use pattern would otherwise dictate. These local roads are:

- L Phillips Road (Sheep World): The intersection with SH1 has no deceleration lanes and no right-turn bay, but has reasonable sight lines and shoulder width.

- Top of the Dome Café (opposite Kraack Road): SH1 has no deceleration lane or right-turn bay. It has acute horizontal and vertical geometry, creating a hazardous intersection.

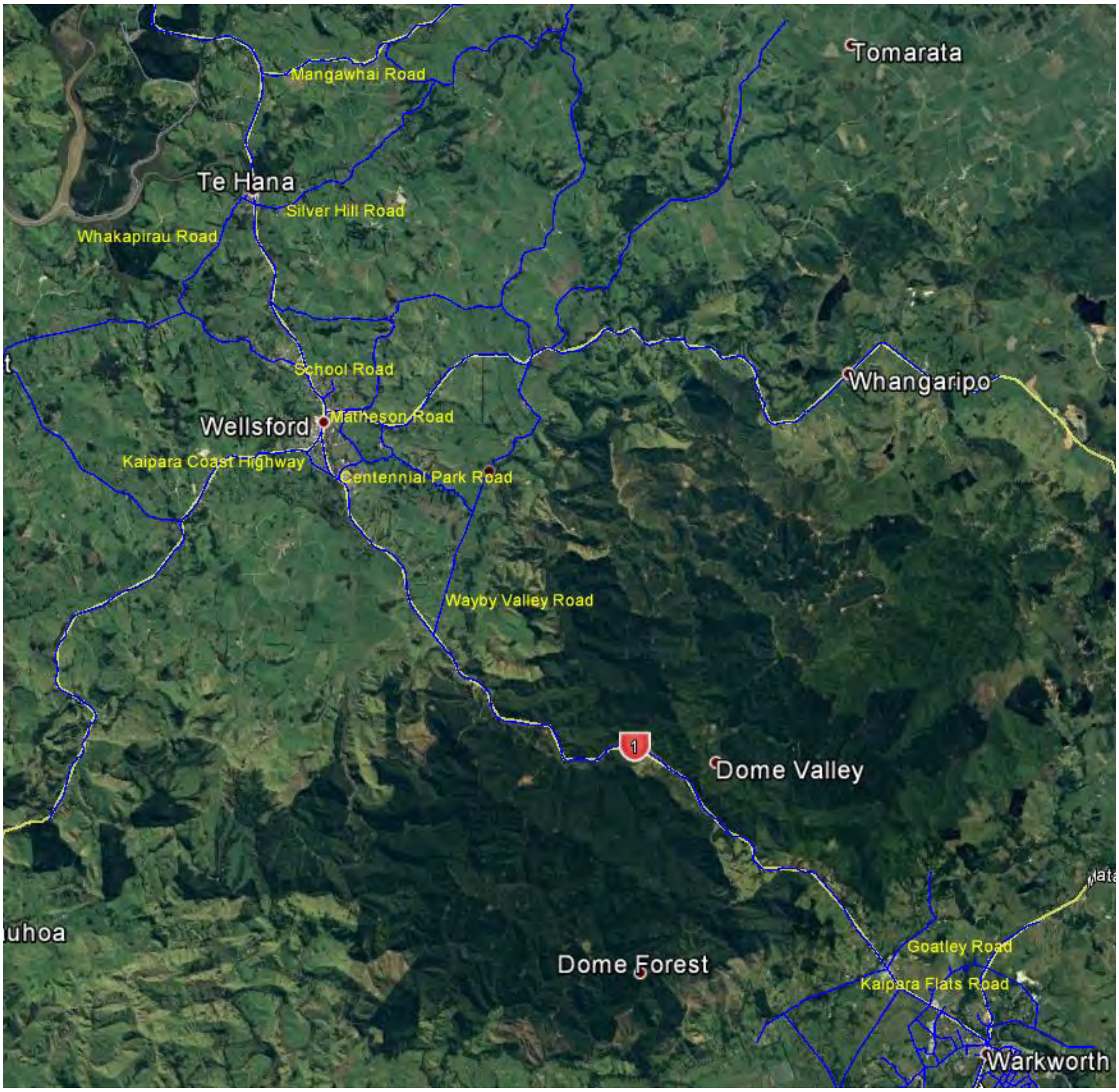

Figure 5 – Local Roads connecting to SH1 [as per model network]

3.4 Traffic volumes

3.4.1 General traffic volumes

The existing weekday AADT volume on SH1 is approximately 20,000 vpd through Warkworth, 12,000 vpd through the Dome Valley between Goatley Road and Wayby Valley Road, and 12,000 vpd between Wellsford and Te Hana.[13]

SH1 carries high volumes of freight traffic, with about 12% of traffic being HCVs.[14]

[13] Weekday AADT (Tuesday – Thursday) from Transport Agency TMS count sites south of Hill Street, south of Wayby Valley Road, and north of Matheson Road for 2013-2016. Counts are only taken a few weeks per year at these sites, and do not include December or January when traffic volumes are highest.

[14] Transport Agency TMS counts south of Centennial Park Rd, Wellsford, 2013-2016.

Average daily traffic volumes on SH1 between Warkworth and Wellsford[15] for each month of 2016 are shown in Figure 6. This Figure shows that traffic volumes vary throughout the year, with a noticeable decrease over the winter months. Traffic volumes are the highest in December (13,000 vpd) and lowest in June (9,000 vpd). We consider this trend results from the recreational travel demand along the route for destinations in Kaipara and Northland, which increases during the summer months.

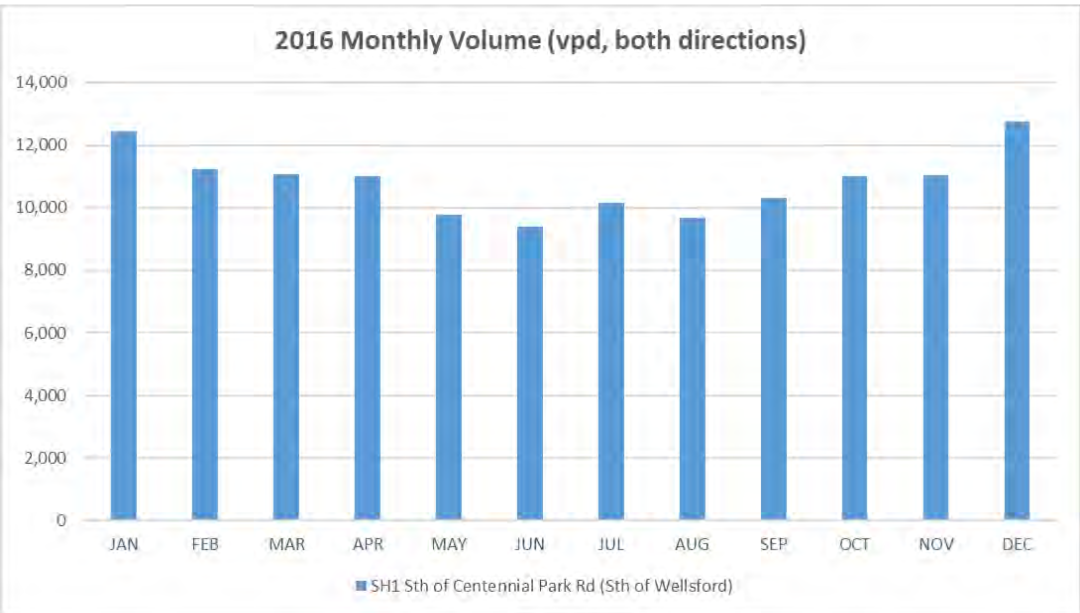

Figure 6 – SH1 2016 Monthly traffic volumes before the Project

Daily traffic profiles along SH1[16] are shown in Figure 7. These profiles have been averaged over a three-year period (2014-2016). The midweek profile is an average of Tuesday, Wednesday, and Thursday data. Demand is at its highest between 2pm and 4pm on Sunday, with a two-way peak volume of around 1100 vph. The midweek peak two-way volume is about 830 vph.

Figure 7 shows that traffic volumes on Friday, Saturday and Sunday are higher than traffic volumes on other days of the week. We consider this pattern reflects the recreational travel demand along SH1 for destinations in Kaipara and Northland.

15 Based on the Transport Agency's TMS counts measured at the count site South of Centennial Park Road.

16 Based on the Transport Agency's TMS counts measured at the count site South of Centennial Park Road.

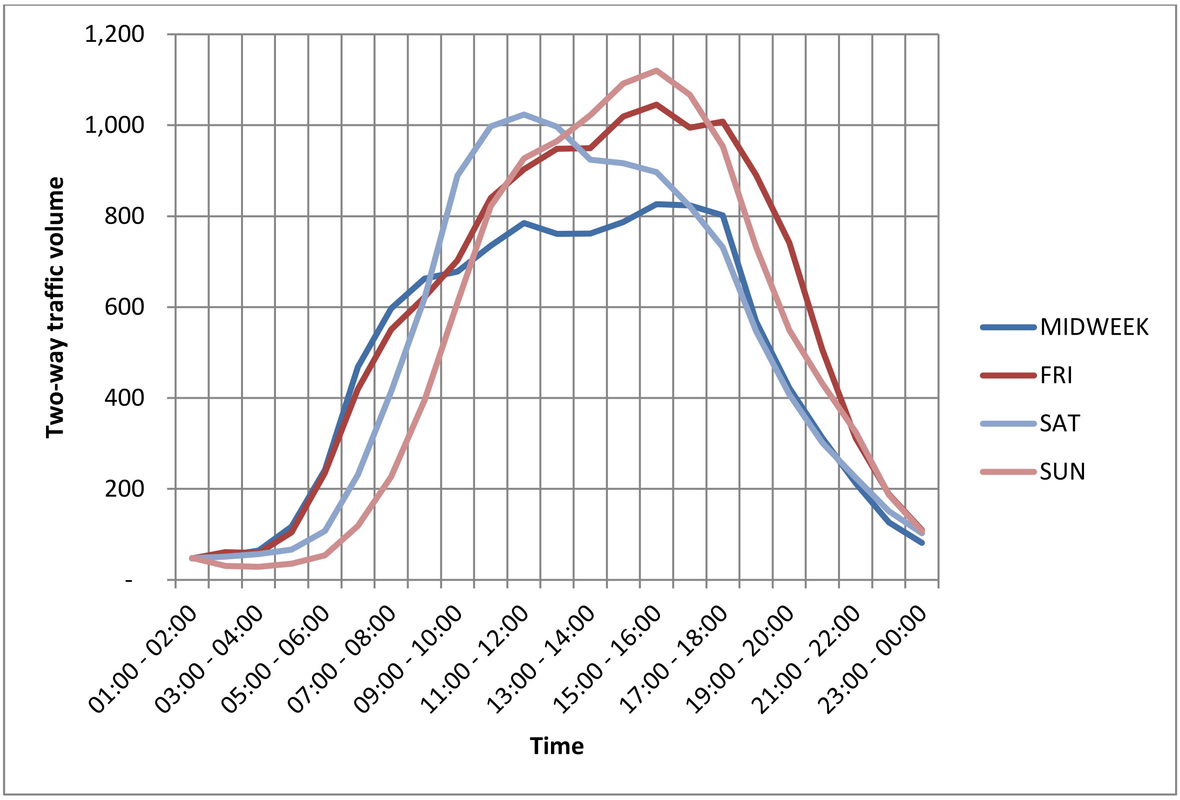

Figure 7 – Daily traffic demand profiles

3.4.2 Holiday traffic volumes

Traffic volumes along the Warkworth to Te Hana section of SH1 are much higher during key holiday periods than they are during a typical day. These higher volumes result in congestion on the road network and cause delays to holiday makers, local residents and other traffic. To determine the scale of differences in travel patterns between a typical day and holiday periods, traffic count data was collected from the Transport Agency's TMS database for a typical weekday and typical holiday start and end days.[17,18] This data is shown in Figure 8 and Figure 9.

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[17] Values for a "typical" holiday start (evening) were calculated by averaging the traffic volumes for the last work day before all holidays. Values for a "typical" holiday end were calculated by averaging the traffic volumes for all holiday end days for the years 2014 to 2016.

[18] Volumes are from the Transport Agency's TMS, site ID: 01N00347, SH1 South of Centennial Park Road.

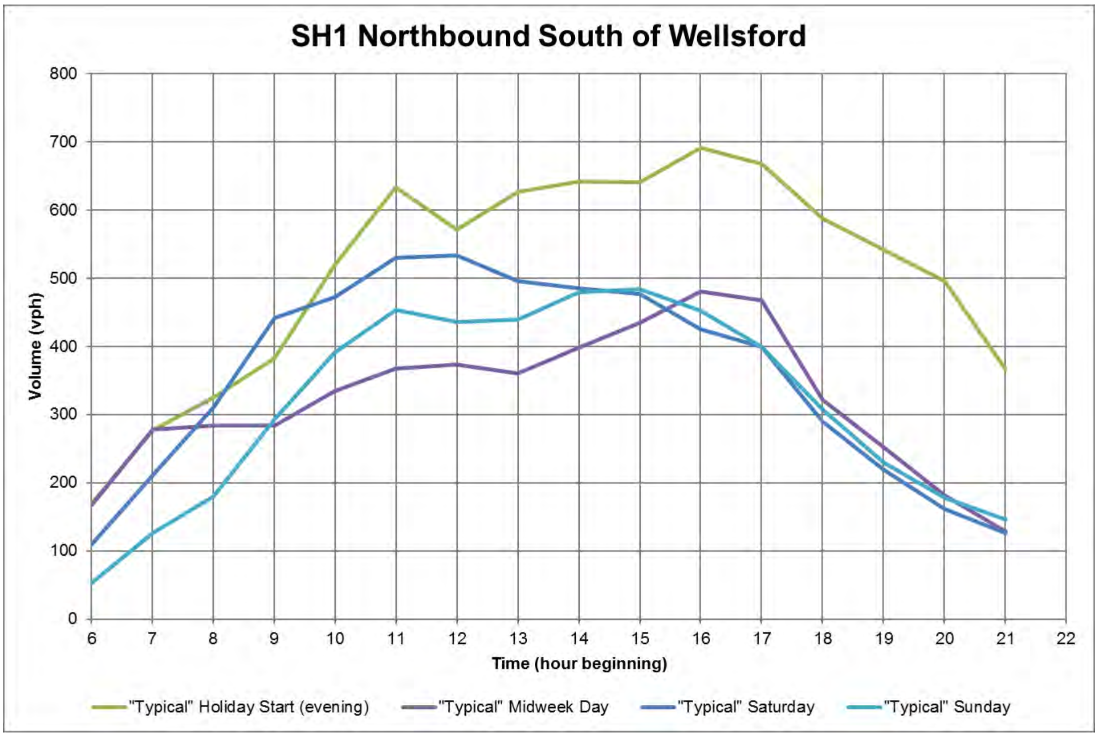


Figure 8 – Traffic profile at holiday start, northbound on SH1 south of Wellsford, compared to typical days

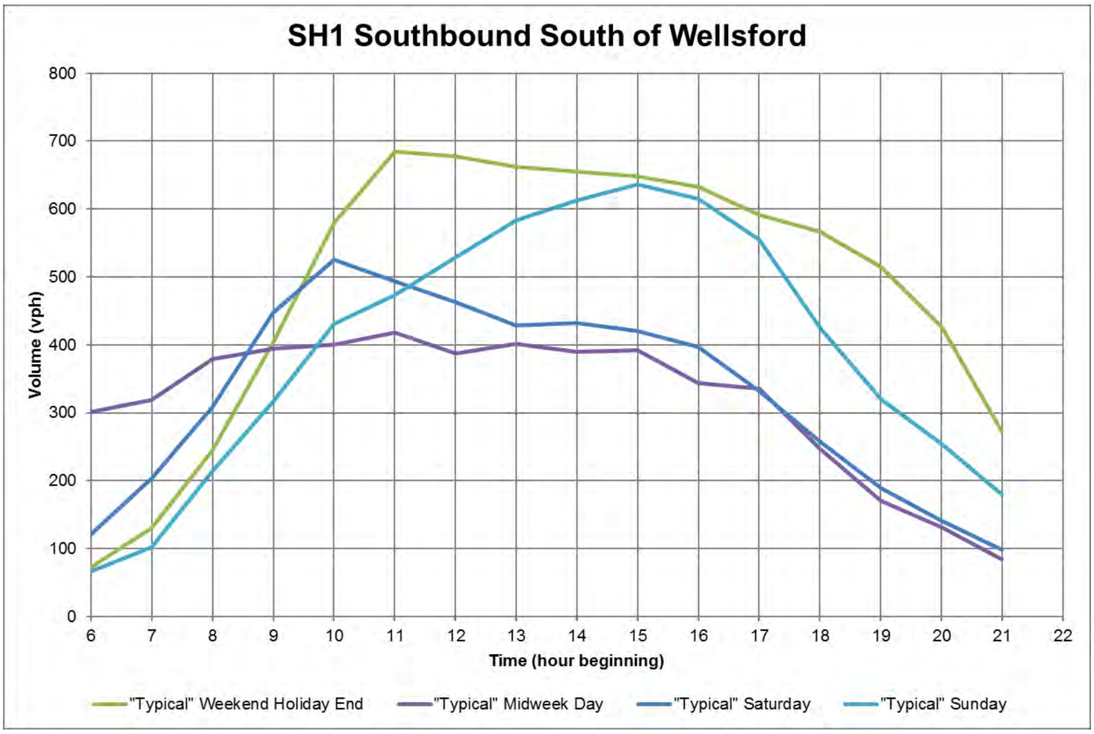


Figure 9 – Traffic profile at holiday end, southbound on SH1 south of Wellsford, compared to typical days

Total traffic flows on holiday days are higher than those experienced on a typical Saturday or Sunday, and significantly higher than those experienced on a typical weekday. The typical holiday end AADT on SH1 is on average 47% greater than the weekday AADT in the southbound direction (the direction in which most traffic is travelling at holiday end) and 19% greater than the weekday AADT in both directions. The higher traffic volumes exist over many hours, potentially indicating an element of holiday peak spreading that may consolidate should network capacity allow. The level of peak consolidation is very difficult to measure and to forecast. It is difficult to measure because the count data available indicates only the quantum of traffic which is able to pass through a particular location, and it does not indicate the current level of peak demand. Peak forecasts are difficult to derive, as it is difficult to ascertain the extent to which travellers currently time their journeys to avoid congestion, and therefore the extent to which they may retime their trips in the future, as congestion worsens.

3.5 Travel times

The existing Warkworth to Te Hana section of SH1 is currently subject to congestion. The most regular congestion currently occurs through Warkworth, at the southern end of the Project, and southbound queues extend back several kilometres. This congestion results in increased travel times, not only through Warkworth but also through Wellsford and at various locations along the route, such as at the end of passing lanes. Congestion is known to be extensive at peak periods, such as at weekends over the summer, and particularly around weekends which coincide with public holidays. Travel times for northbound traffic are significantly higher at the start of a holiday weekend, and for southbound traffic at the end of a holiday weekend. In addition, severe congestion can occur as a result of unexpected incidents (such as crashes, slips, etc.).

Existing travel times on SH1 have been obtained from automatic number plate recognition data[19] to get an average journey time for the weekday morning peak, inter peak, and evening peak periods on a weekday (data collected on a Wednesday 7:00 am to 9:00 am, 11:00 am to 1:00 pm, and 4:00 pm to 6:00 pm), and for a holiday end day (Labour Day from 10:00 am to 6:00 pm). Figure 10 shows the numbered locations of the sites where travel times were recorded and Table 1 shows the distance between each of those sites.

[19] Automatic Number Plate Recognition (ANPR) data was provided by Team Traffic on behalf of the Transport Agency in order to inform the calibration of the P2T model. The data was collected in October 2016.

Figure 10 – Travel time recording sites

Table 1 – Distances between the travel time recording sites

Distances	
Site 1 to Site 2	13 km
Site 2 to Site 3	3.5 km
Site 3 to Site 4	4 km

Figure 11 shows the average journey times for each period in each direction on SH1 between the southernmost Site 1 and northernmost Site 4. The higher journey time for traffic travelling southbound at the holiday end indicates that there is some congestion on this section of SH1. The northbound travel time is relatively consistent, indicating that any congestion along SH1 occurs south of Site 1. These results are consistent with site observations, which have shown that the SH1 intersections through Warkworth (and bottlenecks further south) act as a throttle point for traffic travelling further north. Also, Warkworth acts as a distribution point where a reasonable proportion of traffic diverts to the eastern beaches via Sandspit Road and Matakana Road.

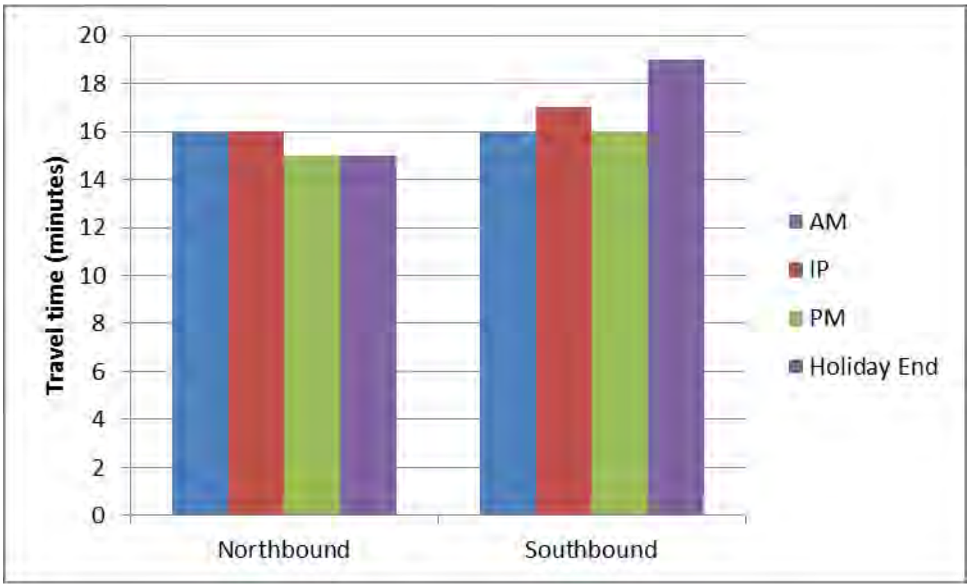


Figure 11 – Comparison of holiday and typical day travel times between Site 1 and Site 4

3.6 Travel time reliability

Travel time reliability[20] affects both individuals and businesses. At higher levels of traffic demand, congestion increases, travel times become more variable, and travel time reliability is reduced. Under such conditions, the consequences of any incidents or disruptions to traffic flow are magnified, with greatly increased travel times. If there is a high degree of inconsistency of travel times, people are not able to plan their travel with certainty. People therefore need to allow longer periods of time for their travel to ensure they arrive at their destination by a specific time. If travel times are not reliable, commercial traffic (including freight) needs to allow longer times in journey planning, therefore reducing the number of movements that can be made by each driver and vehicle. This reduction in movements increases fleet requirements and therefore freight costs.

The variability or uncertainty of travel times along the Warkworth to Te Hana section of SH1 is likely to become more pronounced in the future. This more pronounced uncertainty is due to the increased travel demand expected in the future, which will increase pressure on the existing network, leading to increased congestion, travel times, and peak spreading.

Automatic number plate recognition data[21] has been used to analyse the travel time reliability along SH1 during a weekday morning peak (7:00 am to 9:00 am), evening peak (4:00 pm to 6:00 pm) and a Monday at holiday end (10:00 am to 6:00 pm). The data was collected on SH1 between Goatley Road in Warkworth and just north of Mangawhai Road (Sites 1 to 4 on Figure 10). Between 300 and 900 vehicles were sampled, depending on time period and segment.

Table 2 and Table 3 show the travel time reliability results for the morning and evening peaks. The relative standard deviation is a standardised measure of dispersion, indicating the spread of travel times[22]. The 5th percentile and 95th percentile journey times (in minutes

[20] Travel time reliability is often referred to as travel time variability, travel time consistency, or journey time reliability. As the Project objectives refer to "travel time reliability" this term has been used throughout this Report.

[21] Automatic Number Plate Recognition (ANPR) data was provided by Team Traffic on behalf of the Transport Agency in order to inform the calibration of the P2T model.

[22] The RSD was calculated by dividing the standard deviation of the journey times by the mean.

and seconds) show the range of travel times without outliers. The tables show that the southbound trip from Site 4 to Site 3 has the most variability in both peaks.

Table 2 – Travel time reliability at weekday morning peak

Direction	Segment	Relative standard deviation	5th Percentile	Mean	95th Percentile
Northbound	Site 1 to Site 2	8%	0:08:22	0:09:19	0:10:36
	Site 2 to Site 3	11%	0:02:15	0:02:38	0:03:12
	Site 3 to Site 4	7%	0:03:38	0:04:20	0:04:41
Southbound	Site 4 to Site 3	27%	0:02:46	0:03:31	0:05:57
	Site 3 to Site 2	6%	0:03:02	0:03:19	0:03:42
	Site 2 to Site 1	8%	0:08:52	0:09:56	0:11:22
Northbound (Site 1 to Site 4) Range (5th to 95th percentile)			0:14:15	0:16:17	0:18:29
Southbound (Site 4 to Site 1) Range (5th to 95th percentile)			0:14:40	0:16:46	0:21:01

Table 3 – Travel time reliability at evening peak

Direction	Segment	Relative standard deviation	5th Percentile	Mean	95th Percentile
Northbound	Site 1 to Site 2	6%	0:08:21	0:09:08	0:10:10
	Site 2 to Site 3	9%	0:02:13	0:02:32	0:02:53
	Site 3 to Site 4	9%	0:03:48	0:04:16	0:04:50
Southbound	Site 4 to Site 3	11%	0:03:48	0:04:17	0:05:04
	Site 3 to Site 2	10%	0:02:00	0:02:17	0:02:36
	Site 2 to Site 1	8%	0:08:42	0:09:46	0:11:02
Northbound (Site 1 to Site 4) Range (5th to 95th percentile)			0:14:22	0:15:56	0:17:53
Southbound (Site 4 to Site 1) Range (5th to 95th percentile)			0:14:30	0:16:20	0:18:42

Figure 12 shows the distribution of journey times for the most variable segment, Site 4 to Site 3 southbound through Wellsford, during the morning peak. 92% of these trips have a journey time between 2 and 5 minutes.

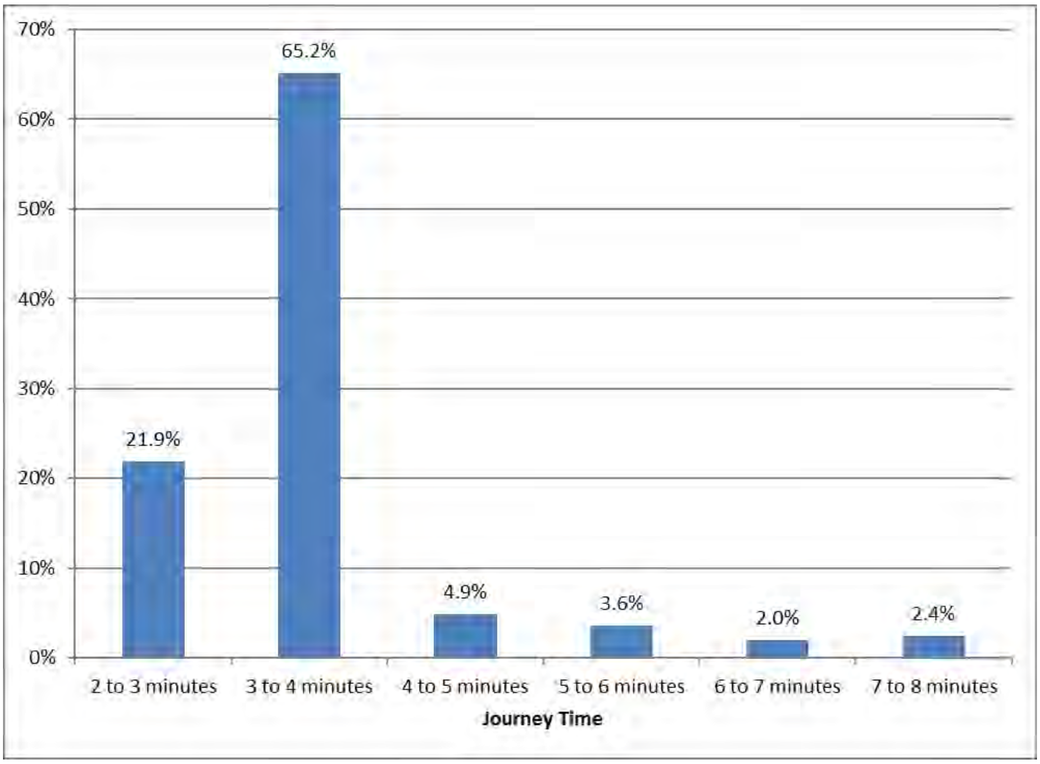


Figure 12 – Distribution of morning peak journey times from Site 4 to Site 3

Table 4 below shows the travel time reliability results for the holiday end. The segment with the most variability is Site 4 to Site 3 southbound through Wellsford.

Table 4 – Travel time reliability at holiday end

Direction	Segment	Relative standard deviation	5th Percentile	Mean	95th Percentile
Northbound	Site 1 to Site 2	10%	0:07:39	0:08:36	0:10:27
	Site 2 to Site 3	8%	0:02:09	0:02:26	0:02:46
	Site 3 to Site 4	7%	0:03:49	0:04:16	0:04:48
Southbound	Site 4 to Site 3	28%	0:04:09	0:08:07	0:10:54
	Site 3 to Site 2	7%	0:02:08	0:02:23	0:02:41
	Site 2 to Site 1	6%	0:08:35	0:09:18	0:10:23
Northbound Range (5th to 95th percentile)			0:13:37	0:15:17	0:18:01
Southbound Range (5th to 95th percentile)			0:14:52	0:19:48	0:23:58

Figure 13 shows the distribution of journey times for the holiday end for the segment with greatest variability between Warkworth and Te Hana, namely Site 4 to Site 3 Southbound through Wellsford. The graph highlights that only about 31% of southbound trips from Site 4 to Site 3 have a journey time between 3 and 5 minutes during the holiday end period.

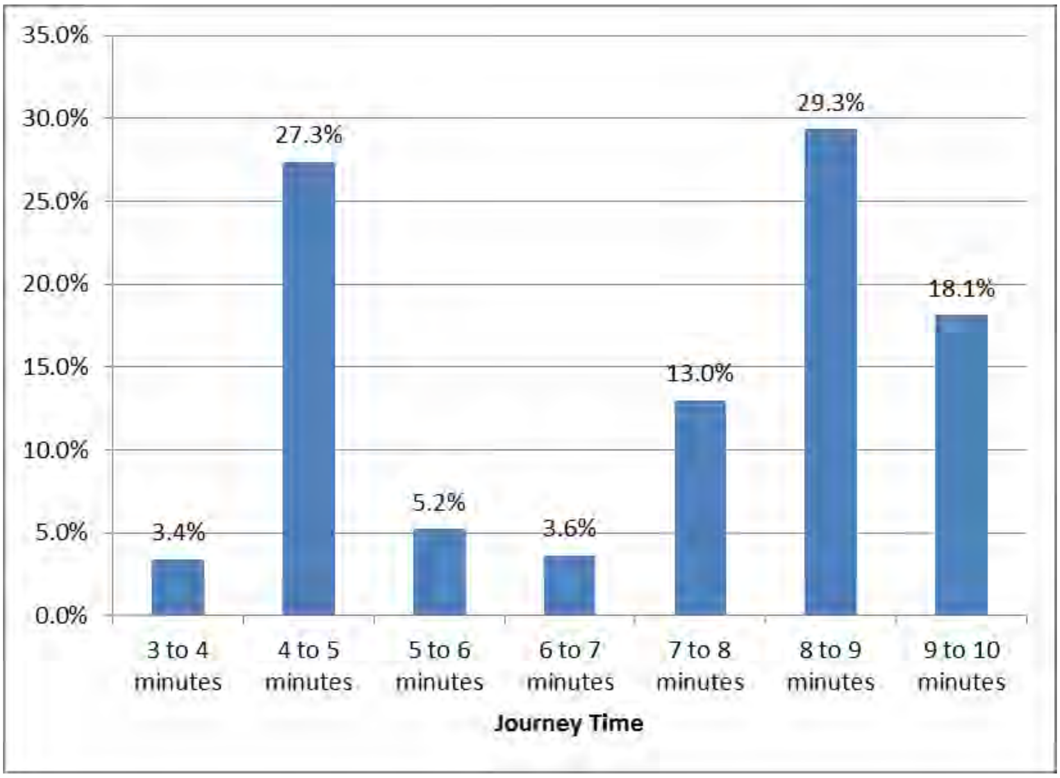


Figure 13 – Distribution of holiday end journey times from Site 4 to Site 3

This analysis shows that travel time variability on SH1 between Warkworth and Te Hana is mainly an issue during holidays, particularly through Wellsford, with a standard deviation of about 2 minutes (28% of the mean) and the majority of journeys (5^{th} to 95^{th} percentile) only varying by up to 7 minutes in this section.

3.7 Route resilience

SH1 between Auckland and Whangārei is of nationally strategic significance as it provides the primary inter-regional transport route between the Auckland and Northland regions.[23] However, the Warkworth to Te Hana section of SH1 is currently closed on average 5 times per year for an average of 3 hours as a result of events such as crashes, flooding or slips blocking the road.[24] This section of SH1 is vulnerable to long-term closure after a major natural event such as major slips and flooding.

Movement by road is the main means of transport for freight in the region, with the volumes moved by rail and coastal shipping being small, as discussed in Section 4.7. Freight lines, and the activities they support, are therefore highly dependent on the speed, safety, and reliability of SH1.

[23] Transit NZ. National State Highway Strategy. June 2007. http://www.nzta.govt.nz/assets/resources/national-state-highway-strategy/docs/national-state-highway-strategy-2007.pdf

[24] NZ Transport Agency. Warkworth to Wellsford: The Indicative Route Fact Sheet 2017. http://www.nzta.govt.nz/assets/projects/ara-tuhono-warkworth-to-wellsford/ww2w-the-indicative-route-2017-factsheet.pdf

SH16 provides the only available alternative route between Wellsford and Auckland in the event that SH1 through the Dome Valley is closed. While SH16 provides an additional connection between Auckland and Wellsford, that route does not provide a viable long-term national strategic connection to the same standard as SH1. The volumes of longer distance traffic using the SH16 route are small because it is significantly longer than SH1[25], does not provide connections to more highly populated areas on the east coast, does not provide as high a level of safety and mobility as SH1, and the topography is not as well suited as SH1 for the purpose of a nationally strategic state highway. The Transport Agency's SH1/SH16 Auckland to Wellsford Strategic Study (2008) recommended that SH16 should be maintained as a regional connection, while SH1 will remain a nationally strategic route. Increases in inter-regional road network capacity will therefore be concentrated on the SH1 corridor only.[26]

3.8 Safety

Between Warkworth and Te Hana, SH1 is a single carriageway that follows the undulating landform with restricted sightlines and steep grades in some locations. This landform presents limited opportunities for overtaking safely in congested conditions. Generally, the carriageway has shoulder widths of 1.5 m to 2 m[27] allowing for limited stopping for emergency or other reasons. SH1 intersects with local roads between Warkworth and Te Hana, with relatively few intersections providing adequate acceleration and deceleration lanes on SH1, which increases the potential for conflicts between state highway traffic and local traffic. These conflicts, coupled with the grades, tight corners and restricted sightlines along SH1, along a route with relatively high vehicle speeds, contribute to a significant number of crashes, particularly through the Dome Valley.

The Transport Agency's Crash Analysis System (CAS) database has been interrogated for records of crashes along SH1 between Warkworth and Te Hana, during the five-year period from 1 January 2012 to 31 December 2016. The table below provides a breakdown of the reported crashes in terms of crash severity.

Table 5 - Reported crashes on SH1 between Warkworth and Te Hana (2012 to 2016)

Crash type	Number of crashes
Fatal Injury Crash	4
Serious Injury Crash	17
Minor Injury Crash	46
Non-injury Crash	137
Total	**204**

A total of 204 crashes were reported, of which 46 involved minor injuries, 17 involved serious injuries, and 4 were fatal crashes. Based on the reported crashes, the Warkworth to Te Hana section of SH1 has a fatal/serious crash density of 0.17 per kilometre per year, which is a "Medium-High" collective risk rating based on the Transport Agency's High Risk

[25] The distance between Auckland and Wellsford is approximately 77 km on the existing SH1 and 96 km using SH16 and Kaipara Flats Road.

[26] Recommendation taken from SH1/16 Strategy Study, NZ Transport Agency, 2006 to 2008.

[27] Shoulder width varies and frequently narrows to less than 1 m in many locations. NZ Transport Agency Warkworth to Wellsford Scheme Assessment Report, Jacobs, dated 16 September 2016.

Rural Roads Guide (2011), published by KiwiRAP[28]. This is at the upper end of the "Medium-High" rating, with "High" being above 0.19 per kilometre per year.

According to the KiwiRAP Risk Maps released in 2012, 22% of the state highway in the Northland/Auckland region had a Medium-High collective risk rating and 10% of the state highway network had a High collective risk rating during the time period between 2006 and 2011. To put this another way, 68% of the network in Northland/Auckland has a lower risk rating. This Project seeks to address these identified safety issues in this network.

Figure 14 below highlights the sections of SH1 between Warkworth and Te Hana with a "High" or "Medium-High" collective risk ratings, based on the process set out in the High Risk Rural Roads Guide.

[28] New Zealand Road Assessment Programme (2012).

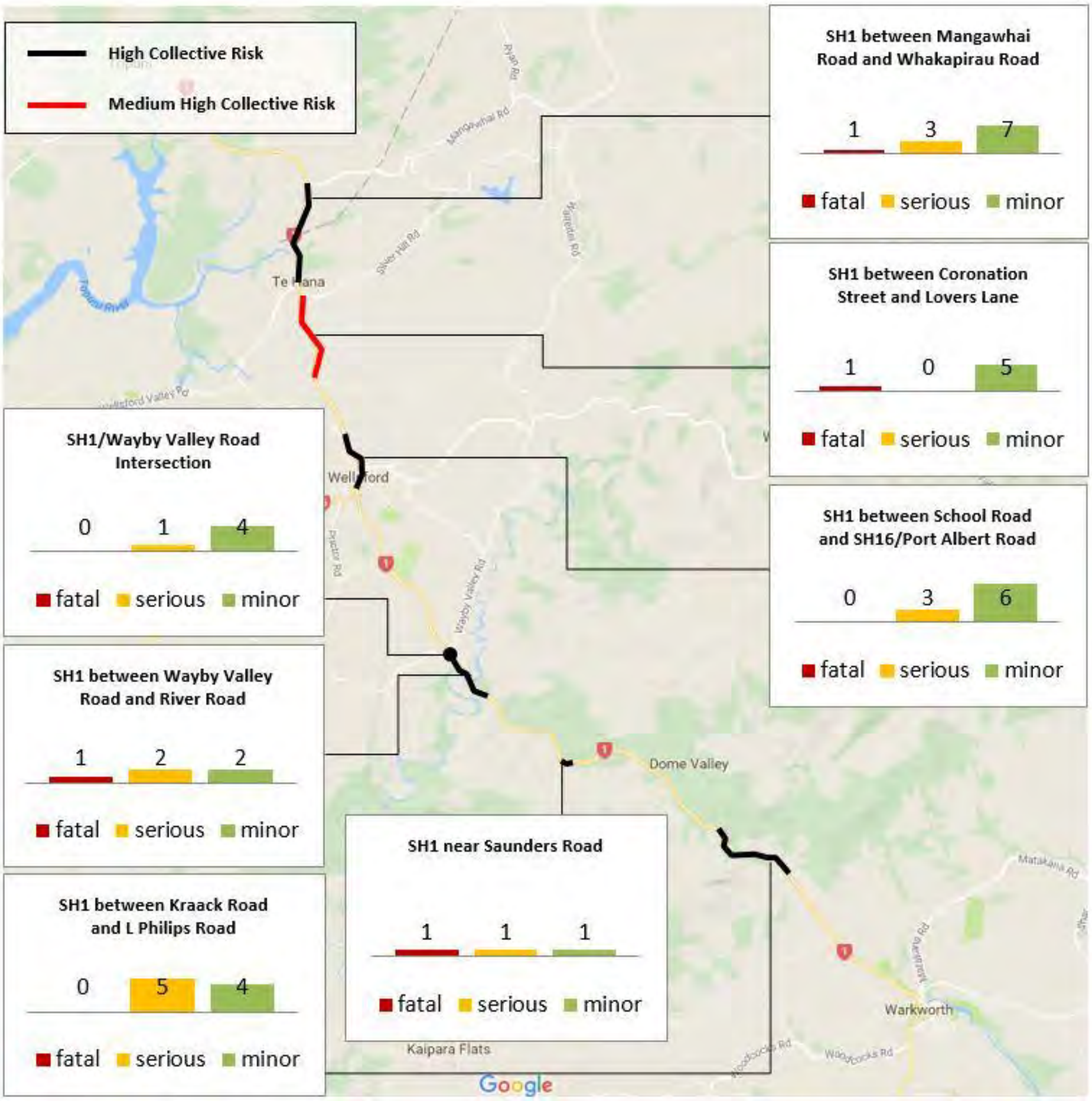


Figure 14 - Sections of SH1 with a High or Medium-High Crash Risk Ranking[29]

Figure 14 above indicates that the following sections of the route have a high crash rating (from south to north):

- Between Kraack Road and L Philips Road;
- Near Saunders Road;
- Between Wayby Valley Road and River Road;
- At the Wayby Valley intersection;

[29] Table 5 indicates seventeen serious injury crashes have occurred along the route, but only fifteen are shown in Figure 14 – this is because Figure 14 only identifies the sections with high or medium-high crash ratings, and two other serious injury crashes have occurred within the other sections

- Between School Road and Port Albert Road; and
- Between Mangawhai Road and Whakapirau Road.

The most common type of crash along this section of SH1 was cornering crashes (Type D), with head-on (Type B) and rear-end (Type F) crashes being the second and third most common type of crash, respectively. The crash types of the 21 fatal and serious injury crashes were as follows:

- There was one resulting from overtaking
- There were five loss of control/head on crashes on sections of road described as "straight"
- There were eleven loss of control/head on crashes on bends, with two of these being fatal incidents
- There was one fatal crash involving a rear end collision or obstruction
- There were two crashes involving crossing or turning, with one of these being a fatal incident
- There was one serious injury involving a pedestrian, who was hit while on a footpath, within Wellsford.

A plot showing the location and type of crashes is provided at Appendix D. It is noted that the serious injury at the SH1/Wayby Valley Road intersection occurred in December 2012, prior to the intersection upgrade.

3.9 Road freight performance

The SH1 corridor has an important freight function, providing freight access between Auckland and Whangārei. SH1 currently carries a significant volume of freight traffic. An average of just under 10% of vehicles travelling on SH1 between Pūhoi and Whangārei are HCVs, with the figure being higher, at 12%, between Warkworth and Wellsford. This proportion of freight traffic is similar to that seen on Auckland's SH1 Southern Motorway between Manukau and the SH2 interchange[30].

The geometry of the Warkworth to Te Hana section of SH1 presents difficulties for heavy vehicles, particularly through the Dome Valley. SH1 is a single carriageway with tight horizontal curves and steep grades in some locations, both of which force heavy vehicles to reduce speed. The alignment presents limited opportunities for overtaking safely in congested conditions, and as noted in Section 3.2, the passing lanes do not meet the Transport Agency's current standard requirements.

A review of the crash data described in Section 3.8 indicates that HCVs were involved in approximately 12% of injury crashes and 20% of fatal and serious injury crashes on SH1 between Warkworth and Te Hana. As HCVs make up about 12% of the current traffic volumes on this section of SH1,[31] they are not over represented in crashes overall, but are over represented in fatal and serious injury crashes along this SH1 corridor.

30 HCV volumes taken from NZ Transport Agency's Traffic Monitoring System (TMS) database.

31 Transport Agency TMS counts south of Centennial Park Rd, 2013-2016.

3.10 Public transport network performance

There are currently limited public transport services in the Project Area. There are about eight regular buses that run along the SH1 corridor between Warkworth and Te Hana, daily, operated by various bus companies.[32] There are also regular bus services between Auckland and Warkworth. Buses are subject to many of the same issues of geometry and safety as those encountered by HCVs discussed in the previous section.

In Wellsford, stops for these buses are located on SH1, on both sides of the road. There is currently no pedestrian crossing between these stops. The nearest crossing point is an uncontrolled crosswalk about 380 m north of the northbound bus stop. This distance, along with the high volume of traffic on SH1, makes it difficult for pedestrians to cross to the bus stop on the opposite side.

3.11 Pedestrian and cycle network performance

There are currently no pedestrian or cycle facilities along the majority of SH1 between Warkworth and Te Hana, and accordingly the levels of pedestrians and cyclists travelling along or across the route are very low.

There is a greater level of pedestrian activity within Wellsford, both along and across SH1. The section of SH1 through the Wellsford township generally has footpaths on both sides, but formal crossing opportunities are limited.

No pedestrian or cycle crashes were reported in the CAS database for the section of SH1 analysed in Section 3.8.

[32] There is an InterCity bus between Auckland and Whangarei 3 to 4 times per day. ManaBus goes between Auckland and Whangarei 3 times per day. NakedBus goes between Auckland and Paihia twice per day.

4 FUTURE REFERENCE CASE TRANSPORT ENVIRONMENT

Section summary

This section summarises the transport conditions in the Project Area in the Future Reference Case Scenario (without the Project).

Under the Future Reference Case Scenario, traffic volumes on SH1 are forecast to increase from about 14,000 vpd in 2016 to around 29,000 vpd in 2046 (north of Kaipara Flats Road).

A number of key transport issues in the corridor are expected to worsen over time as traffic volumes increase:

i. Travel time reliability and safety

Without the Project in place, travel times between Warkworth and Wellsford are forecast to increase by 2 to 3 minutes on a "normal" weekday between 2016 and 2036 (up to a 16% increase in the evening peak). The increasing volume of traffic will adversely affect safety by increasing the potential for conflict. Although the crash rate along the section of SH1 through the Dome Valley can be expected to decrease as a result of the safety improvements proposed on existing SH1, this is material and does not do enough. The increases in forecast traffic demands will adversely impact the travel time reliability of general traffic and freight movements in the corridor by increasing congestion.

ii. Freight performance and safety

The 2014 National Freight Demands Study (NFDS) forecasts that freight movements in the corridor are likely to grow by 68% by 2042. There may be limited potential for alternative modes to accommodate anticipated growth in freight transport demand based on the current level of investment in them. Therefore, the volumes of freight on the road are likely to continue to grow, although this report notes the intentions set out in the draft Government Policy Statement, to investigate opportunities to move more freight by rail or coastal shipping. HCVs are over represented in fatal and serious injury crashes on the corridor, and serious crashes may increase as a result of this growth. However, these risks may be reduced by safety improvements on existing SH1, referred to above.

4.1 Future reference case scenario network

Details of the transport modelling carried out to assess the Future Reference Case Scenario were provided within Section 2.3 of this report.

4.2 Traffic volumes

Figure 15 shows the forecast hourly traffic volumes on SH1 between Warkworth and Wellsford and between Wellsford and Te Hana. The Figure shows the existing (2016) flows, along with forecasts for 2036 and 2046, for the Future Reference Case scenario, for the weekday morning peak, inter peak and evening peak. The Figure indicates that the evening peak flows are the highest, and there is more traffic in the inter peak than in the morning peak. This pattern is consistent in all three model years, becoming more pronounced as overall volumes increase.

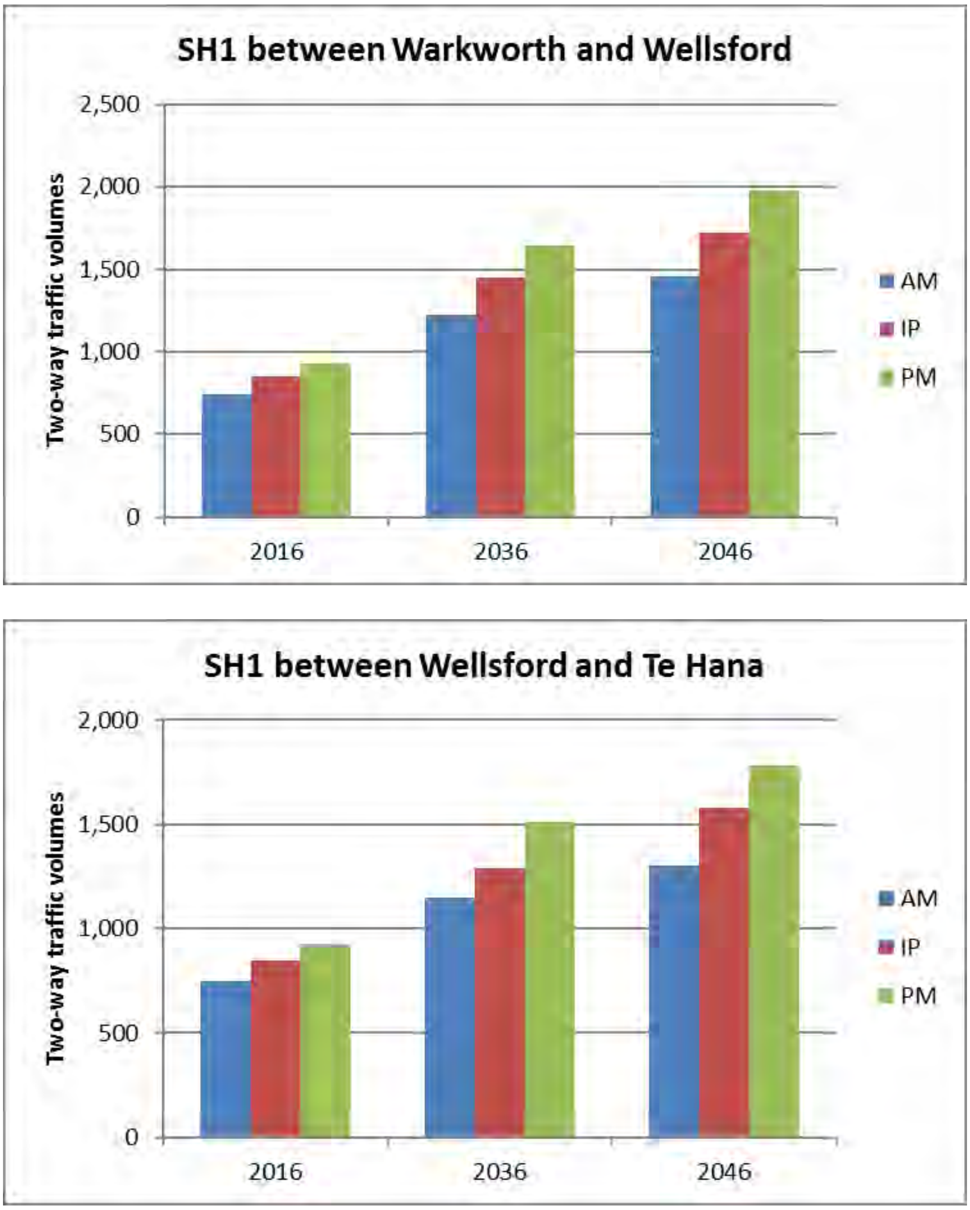
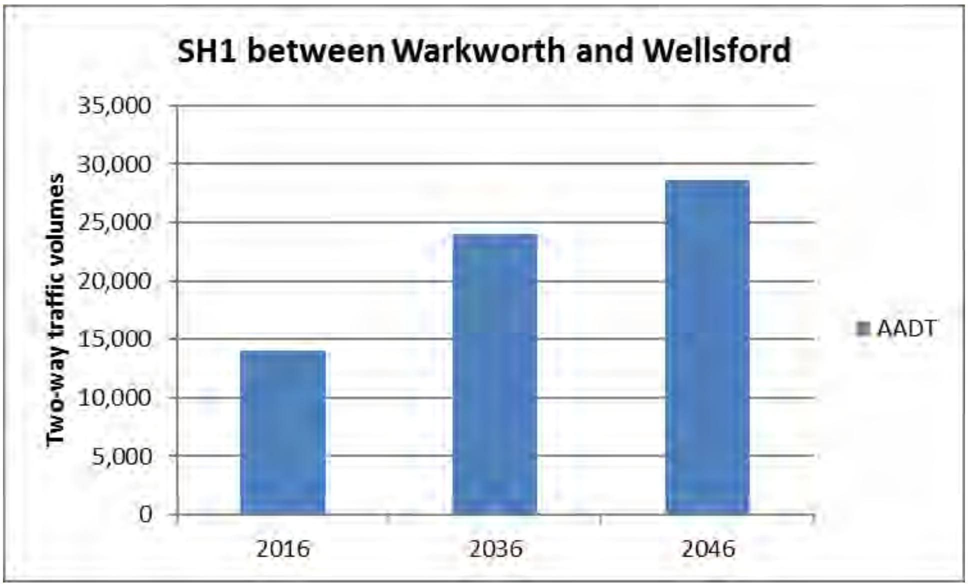


Figure 15 – Future reference case scenario traffic volumes by time period

Figure 16 indicates that daily traffic volumes on SH1 are predicted to grow at a rate of approximately 3.4% per annum between 2016 and 2046 between Warkworth and Wellsford, increasing by 71% between 2016 and 2036, without the Project in place.[33] This growth rate means that daily traffic volumes on SH1 are expected to be in the order of 29,000 vpd in 2046. This forecast growth rate is consistent with the 3.7% per annum growth rate observed over the last five years at this section of SH1.[34]

[33] AADT calculated from the base and forecast models, as reported in Section 2.2.

[34] Growth rates calculated using historic counts from 2011 to 2015 from the Transport Agency's TMS, site ID:01N00352, SH1 South of Wayby Station Rd.



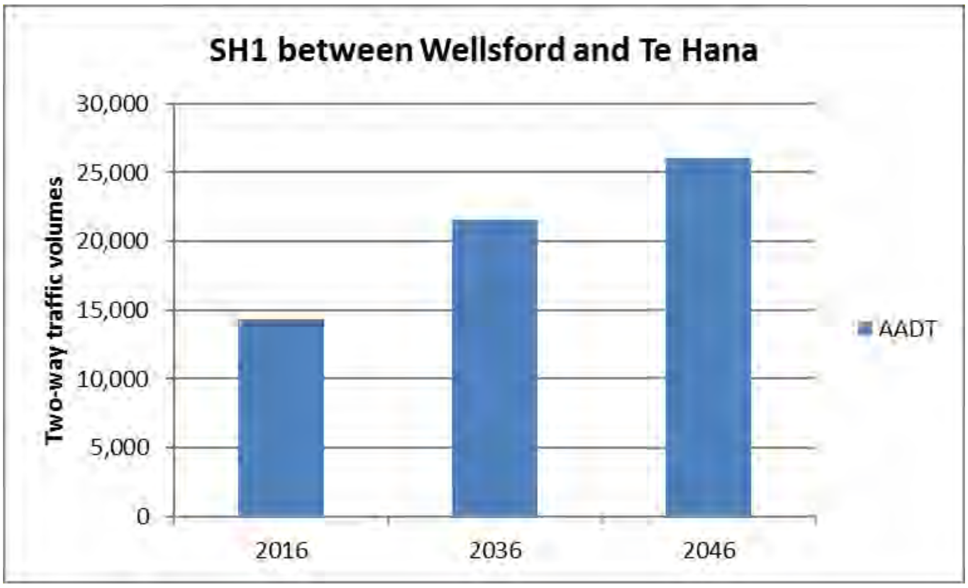


Figure 16 – Future reference case scenario traffic volumes by year

Figure 17 and Figure 18 show the forecast daily traffic volumes on key parts of the network for the Future Reference Case Scenario in 2016, 2036, and 2046. The Figures show that traffic is predicted to grow on most parts of the network, with the exception of Mangawhai Road and Whangapiro Valley Road (see Appendix E for a full table of modelled traffic volumes.)

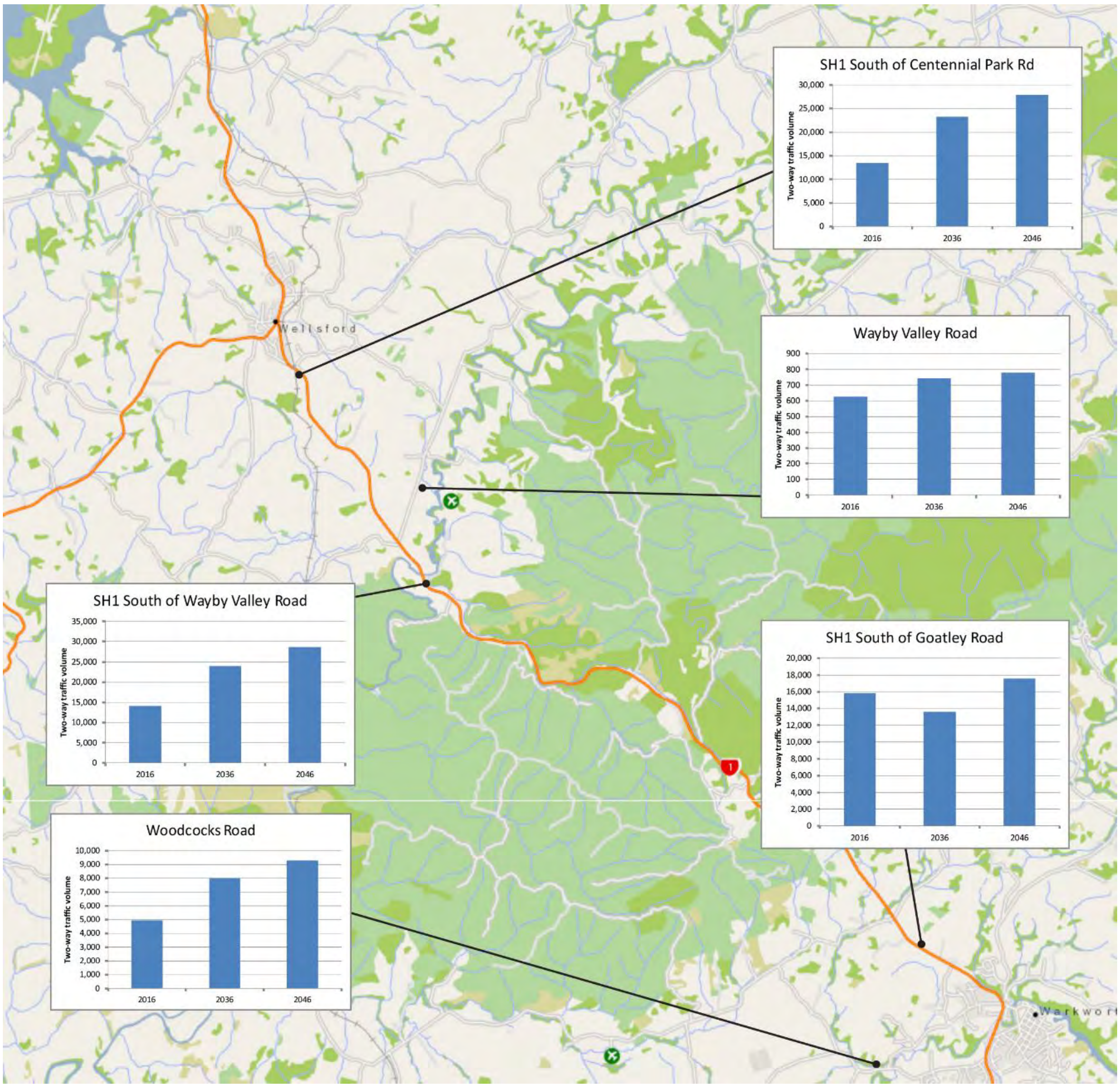


Figure 17 – Forecast daily traffic volumes on key parts of the network south of Wellsford

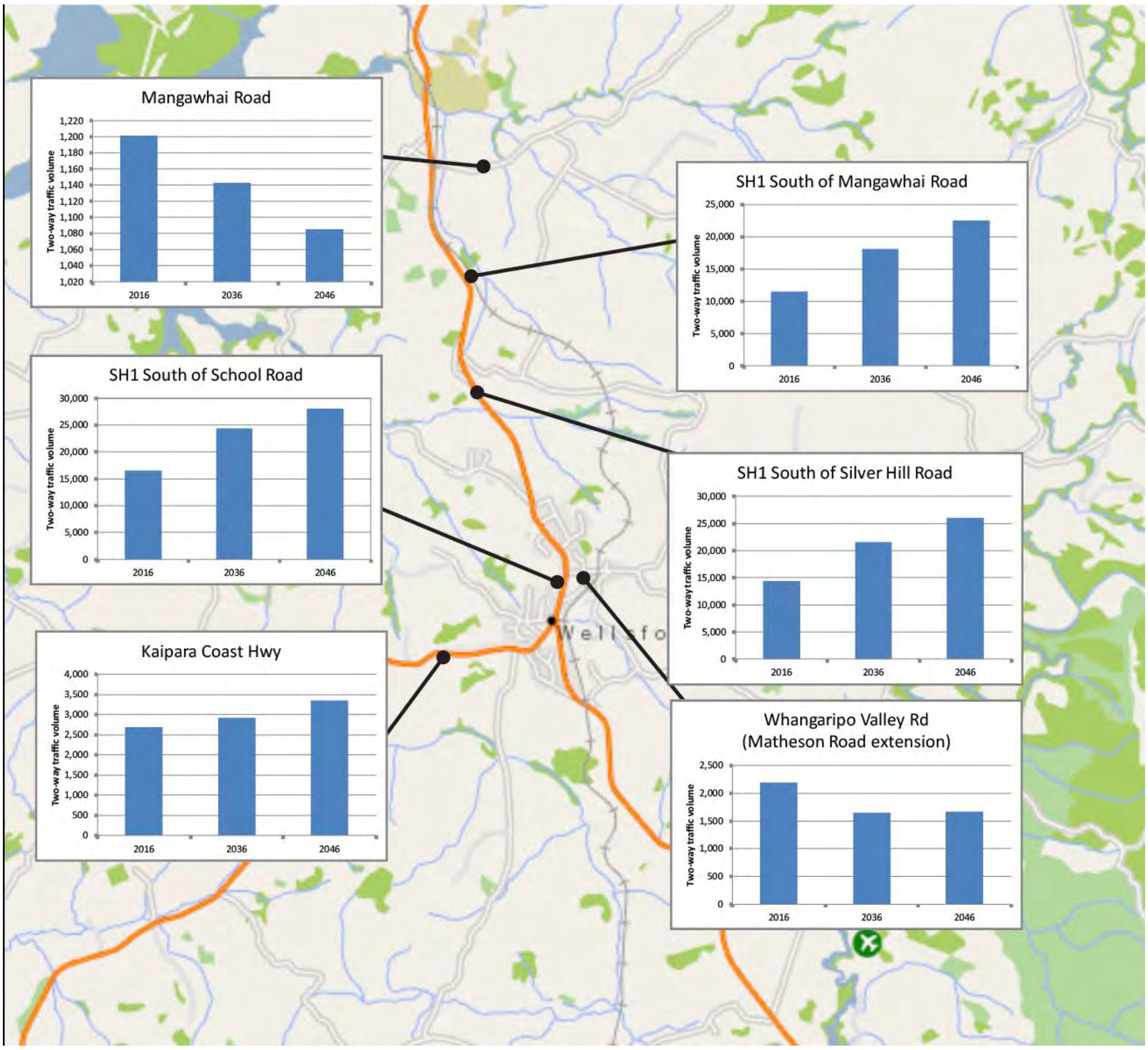


Figure 18 – Forecast daily traffic volumes on key parts of the network around Wellsford

4.3 Travel times

Travel times in 2016 have been compared against those forecast in the 2046 Future Reference Case Scenario along SH1 between Warkworth and Wellsford. The assessment has not looked at the change in travel times along the entire modelled area from Pūhoi to Te Hana because the Pūhoi to Warkworth section was not completed in 2016. To measure the impact on through traffic, travel times on the full Pūhoi to Te Hana route with and without the Project are compared in Section 5.2.

Table 6 shows the modelled 2016 and forecast 2036 and 2046 travel times along SH1 between Warkworth and Wellsford on a "normal" weekday. The table indicates that there is not expected to be significant increases in travel time between 2016 and 2046 in the Future Reference Case. This may seem surprising, given the significant forecast increases in demand. However, it should be noted that the Future Reference Case includes improvements to the wider road network, particularly within Warkworth, and these improvements can be expected to significantly relieve the queues that currently extend north from Warkworth at peak times. For example, the P-Wk project will allow traffic to bypass Warkworth centre, the location where the most significant queuing currently occurs.

Table 6 – Travel times on SH1 between Warkworth and Wellsford (minutes)

Direction	Segment	Period	2016	2036	2046	Change 2016 to 2046	
						Absolute	%
Northbound	Warkworth to Wellsford	Morning	17	18	18	2	10%
		Inter peak	17	18	19	2	12%
		Evening	18	19	21	3	16%
Southbound	Wellsford to Warkworth	Morning	18	18	19	1	8%
		Inter peak	17	19	20	2	13%
		Evening	19	19	21	2	10%

4.4 Travel time reliability

With the increased traffic volumes on SH1, shown in Figure 16, travel time reliability is likely to decrease on the Warkworth to Te Hana section of SH1 in the Future Reference Case Scenario. In congested conditions, small disturbances in flow are more likely to result in delays and queuing. The SATURN traffic model, used to inform this assessment, does not specifically address the matter of reliability. However, the model does indicate that sections of the route, particularly through the Wellsford township, are likely to be operating very close to the theoretical capacity during a normal weekday, indicating that issues relating to travel time reliability are likely to become more regular. That is to say, SATURN only predicts queues to build up when the flow exceeds the assumed theoretical capacity (i.e. a volume to capacity ratio of greater than 100%). Traffic conditions tend to deteriorate at values of less than 100% capacity, and a figure of about 85% to 90% is often termed "practical capacity" of a road.

4.5 Safety

Figure 16 above indicates that traffic volumes on SH1 between Warkworth and Wellsford are predicted to increase from some 14,000 vpd to approximately 29,000 vpd in 2046, if the Project does not proceed. The increases in travel times predicted in Section 4.3 above indicate that more congestion and queuing is expected in future. This congestion and queuing is predicted to increase the rate of rear-end crashes and may also increase the number of head-on crashes due to increases in two-way traffic demands. These increased demands will reduce the margin for error (i.e. it will increase the possibility of there being an oncoming vehicle if a vehicle accidentally crosses the centre line) and it will reduce the possibility of safe overtaking manoeuvres.

It is expected, however, that the slower travel speeds along the existing SH1 may reduce the severity of crashes during busy time periods. In addition, as noted in Section 2.5, there are plans by the Safe Roads Alliance to introduce safety improvements along the existing SH1 through the Dome Valley. These safety improvements will include wide medians and flexible barriers to separate traffic going opposite directions, to reduce the risk of head-on crashes. Shoulders are to be widened as well, to provide space for turning vehicles and improve safety for cyclists.[35] Fundamentally, however, the Future Reference Case Scenario will be based on SH1 continuing to operate along an undulating (predominantly) two lane

[35] NZ Transport Agency. Work planned to improve safety on SH1 through Dome Valley. 20 July 2017. http://nzta.govt.nz/media-releases/work-planned-to-improve-safety-on-sh1-through-dome-valley/

road with speed management. The route will therefore generally retain its existing inherent risks, although these will be reduced by the safety works that are proposed to be carried out by the Safe Roads Alliance.

Table 7 below provides an estimate of the expected crash rate reductions as a result of the SH1 Dome Valley safety improvements, based on the proposed treatment plan provided on that project's website. It is assumed that the proposed wide median and flexible barriers treatment will be applied to approximately 50% of the section of SH1 between Kaipara Flats Road and Wayby Station Road and new flexible centre barriers will be applied to 90% of the section of SH1 between Wayby Station Road and Wellsford.

Table 7 – SH1 Dome Valley Crash reduction prediction – 2036 (crashes per year)

	Expected crash rate without treatment	Proposed treatment	Predicted crash reduction	Total crash rate reduction	Future reference case crash rate
Between Kaipara Flats Road and Wayby Station Road	7.9	Wide median	15% (on 50% of the section)	1.8	6.1
		Flexible barriers	30% (on 50% of the section)		
Between Wayby Station Road and Wellsford	5.3	Flexible barriers	30% (on 90% of the section)	1.4	3.9

4.6 Route resilience

With the increased traffic volumes on the Warkworth to Te Hana section of SH1 shown in section 4.2, it will be increasingly important to have alternative routes available in the case of closure on SH1. For the reasons set out in the previous chapter, SH16 will not be adequate to meet demand if traffic must be rerouted from SH1.

4.7 Road freight performance

The NFDS 2014[36] forecasts that freight movements between Auckland and Northland are likely to grow significantly by 2042.

In terms of freight tonnage, the mode shares in 2012 between Auckland and Northland were 3% by rail, 21% by coastal shipping and 76% by road. The NFDS expects that by 2042, freight volumes between Northland and Auckland will increase by 68% from 2.8 to 4.7 million tonnes.[37] It also predicts that freight movements originating or terminating in Northland will increase by 38% from 30.2 to 41.6 million tonnes.[38] Not all Northland freight is destined for, or produced in, Auckland, which explains the difference in these numbers. The NFDS concludes that truck movements are likely to grow significantly in the future, particularly given the current (low) level of investment in non-road based modes. The NFDS

36 Ministry of Transport, et al 2014.

37 Figures adapted from Table 4.4-4.7 and 7.32 of the NFDS.

38 Figures adapted from Table 4. 4-4.7 and 7.32 of the NFDS (includes movements originating and terminating within Northland).

does not forecast freight modal share by region, but its forecast for New Zealand overall remains stable at about 91% of freight tonnage moved by road in 2012 and 2042.

Even if investment levels were to change, there is limited potential for a modal shift away from road based freight. Coastal shipping primarily serves specialist products (cement and petroleum only). There are presently no coastal shipping services for general cargo. If additional support was given to coastal shipping, the main impact is likely to be a transfer of freight from rail, for which shipping provides a closer alternative, rather than from road.

Additional investment in rail could provide the opportunity for some transfer of freight from road. The rail line north of Auckland is currently constrained in capacity due to its single track and limited passing loops.[39] Early work by the Project team indicated that upgrading the line would be difficult to achieve and that it would be likely to be expensive, given the condition of the track and the number of significant constraints, particularly existing tunnel sizes. However, the recent Draft Government Policy Statement indicates the Government's commitment to investigate moving more freight by rail or coastal shipping[40].

At 3%, the freight mode share of rail by volume is currently very low, so a doubling or trebling of the volumes of freight moved by rail would not have a significant effect on the overall traffic volumes, and therefore would not impact the need for improvements to SH1.

The Auckland to Whangārei Strategic Assessment[41] concluded that there was limited potential for alternative modes to accommodate anticipated growth in freight transport demand based on the current and proposed investment in those modes.

As noted in Section 3.9, the geometry along SH1 between Warkworth and Te Hana presents difficulties for HCVs. Tight horizontal curves and steep grades in some locations force HCVs to lose speed. As traffic increases on SH1, HCVs will be particularly impacted by slower speeds as they have a reduced ability to pass, and travel time reliability will decrease.

As reported in Section 3.9, HCVs are over represented in fatal and serious injury crashes on SH1 between Warkworth and Te Hana. HCVs are not forecast to grow as a percentage of overall traffic on SH1 in the Future Reference Case Scenario. However, HCV flows are forecast to grow in absolute terms and serious crashes may increase as a result. Forecast freight volumes are based on ART forecast demands, which have been factored as described in Section 2.2.[42]

4.8 Public transport network performance

Increased traffic on SH1 will cause longer travel times and decreased travel time reliability for the existing bus services between Auckland and Whangārei. These effects will be particularly pronounced on holidays, when bus services are likely to be more heavily utilised and traffic flows on SH1 are highest. The increase in traffic will also increase the difficulty of crossing SH1 to access the bus stops in Wellsford.

[39] National Freight Demand Study (Ministry of Transport, et al 2008).

[40] Draft Government Policy Statement on Land Transport 2018/19 – 2027/28 (New Zealand Government, 14 March 2018)

[41] NZ Transport Agency. Auckland to Whangarei Strategic Assessment. SKM, 2009 to 2010.

[42] HCV factors differed from LCV factors in the model matrix estimation process. For details, see the Pūhoi to Te Hana Forecasting Report, Jacobs, dated 9 June 2017.

4.9 Pedestrian and cycle network performance

Increases in traffic demands along SH1 could present an increased risk of conflict for recreational cyclists in the Project Area and for pedestrians and cyclists within Wellsford.

In terms of its initiatives for walking and cycling, AT has advised that it is working with the Rodney Local Board to support development of their two greenway initiatives and is developing a new region wide approach to secure high quality cycle facilities through the structure planning process in new growth areas that include Warkworth.

5 ASSESSMENT OF TRANSPORT EFFECTS OF PROJECT

Section summary

This section summarises the transport conditions in the Project Area in the Project Scenario. It compares the Project Scenario with the Future Reference Case Scenario to assess the transport effects of the Project.

The Project will provide a new four lane dual carriageway road, designed and constructed to the Transport Agency's design standards. We predict that the Project will significantly reduce daily traffic volumes on the existing SH1, due to traffic electing to use the new Project route. The daily traffic volumes on the existing SH1 between Warkworth and Te Hana in 2046 are predicted to be 24,500 vpd (or 86%) lower than in the Future Reference Case.

The previous section identified a number of transport issues that are forecast to increase with the growth of traffic in the Future Reference Case. This section sets out the forecast performance of the transport network under the Project Scenario, addressing each of these issues. This scenario is then compared against the Future Reference Case Scenario to identify the transport effects of the Project.

i. Travel times and congestion

The provision of a new standard four-lane dual carriageway alignment will reduce travel times and allow journeys to be planned with a greater level of certainty around travel times. The Project will reduce congestion and travel times between Warkworth and Te Hana during typical peak periods. This benefit will be experienced by both general and freight traffic. The Project will also improve travel times during the holiday periods, when large delays are currently experienced. These delays are expected to worsen in the Future Reference Case.

Travel times on both the existing SH1 and on the Project to and from the north of Warkworth will be faster than the Future Reference Case travel time on existing SH1. For example, we forecast travel times from Wellsford to Warkworth in the PM peak southbound on the Project in 2046 to be 4 minutes (24%) faster than the Base Case travel time on SH1.

ii. Consistency of journey times

Reductions in regular congestion and the effects of random incidents mean that the Project will reduce travel time variability for travel between Warkworth and north of Te Hana. This consistency is an important benefit of the Project, enabling individuals and businesses to plan their travel with a greater degree of certainty. Consequently, the Project will provide a more robust network that can cater for some disruption without significant increases in travel time.

Travel time consistency will improve for general and freight traffic as a result of reduced congestion, improved geometric alignment, and improved passing opportunities.

By reducing travel times and improving travel time consistency during all time periods, the Project will remove deterrents to travel in the corridor. The Project will consequently improve predictable journeys and accessibility between Auckland, Wellsford, and Northland.

iii. Crashes

In the Project scenario, the majority of trips in the corridor will use the Project rather than the existing SH1. The Project will have an improved crash performance when compared with the existing SH1 due to the higher standard of design. This improved crash performance means that the number and severity of crashes will be reduced when compared to the Future Reference Case, resulting in the Project having an improved road safety effect. In addition, the average annual number of crashes on the existing SH1 is forecast to be less in the 2046 Project scenario than in the 2046 Future Reference Case scenario because fewer vehicles are predicted to use the existing SH1 route once the Project is in place. There may be an increase in the proportion of more severe crashes on the existing SH1, as average speeds will increase as a result of the diversion of most traffic from the existing to the new route; however, the absolute number of crashes causing deaths or serious injuries is expected to reduce significantly, overall, due to the safety features included within the design of the Project.

iv. Route resilience

The introduction of a high quality, parallel alternative route to the existing SH1 route between Warkworth and Te Hana will reduce the effects of incidents (crashes and natural events such as slips and flooding) on travel between Northland and Auckland.

v. Freight movement

The Project will improve freight performance in a number of ways. HCVs will be able to bypass the Dome Valley using the Project, which will have grades and alignment more favourable to HCVs than the existing SH1, therefore improving travel times and vehicle operating costs. The indicative design has four lanes as well as a northbound crawler lane on the southern side of Kraack Hill, which will improve safety by eliminating the need for passing lanes and risky overtaking manoeuvres. Freight traffic will also gain the same benefits as general traffic in terms of travel time savings, safety improvements, and increased travel time reliability.

vi. Public transport network

The same performance improvements forecast for general traffic will be experienced by the regional bus services that run between Auckland and Whangārei as a result of the Project. The significant reduction in traffic on the existing SH1 will make it easier and safer for pedestrians in Wellsford to cross SH1 to access bus stops. The reduction in traffic could also facilitate the addition of more convenient crossings in the vicinity of the Wellsford bus stops in the future.

vii. Pedestrian and cycle network

Pedestrians and cyclists will be prohibited from using the mainline carriageway of the Project between Warkworth and Te Hana, including the Warkworth Interchange. However, some provisions have been made for pedestrians and cyclists on local roads in the indicative design of the Project. These provisions support the potential development of future walking and cycling infrastructure in the area.

The lower volumes of traffic along the existing SH1 will improve safety and amenity for pedestrians and cyclists using that route. In particular, the Project will improve the ease and safety of pedestrians crossing the existing SH1 route through Wellsford.

This section sets out the forecast performance of the transport network under the Project Scenario. This scenario is then compared against the Future Reference Case Scenario to identify the transport effects of the Project.

5.1 Traffic volumes

Figure 19 shows the forecast daily traffic volumes along the existing SH1 route and along the Project route between Warkworth and Wellsford, for both the Future Reference Case and Project scenarios. The "Corridor Total" is the combination of the volumes on the existing SH1 route (which will provide an alternative route once the Project is constructed) and the Project route.

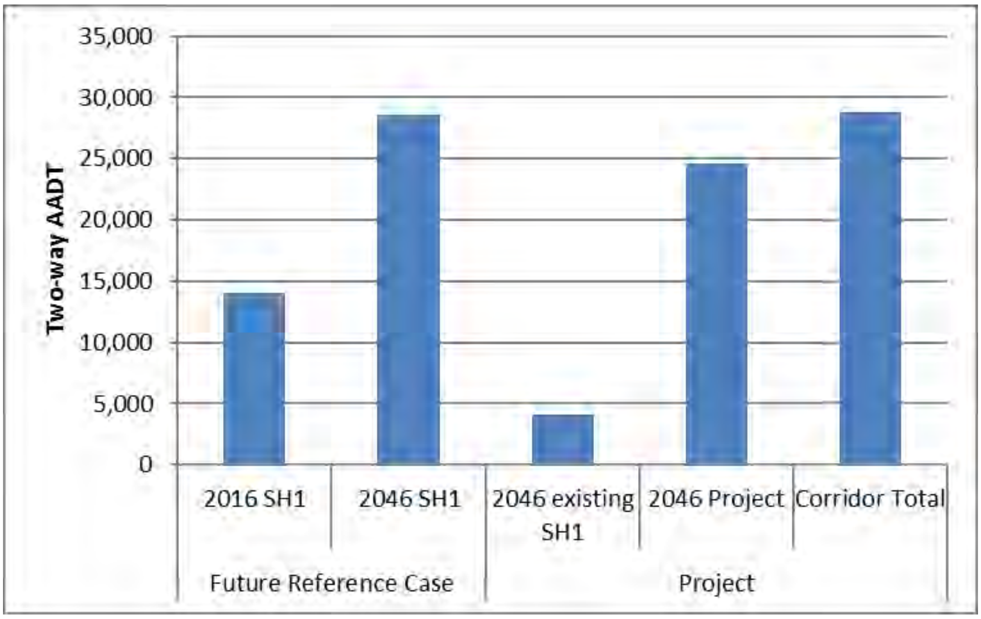


Figure 19 – Traffic volumes between Warkworth and Wellsford

Figure 19 indicates that traffic volumes on the existing SH1 route between Warkworth and Wellsford are expected to reduce significantly once the Project is constructed.[43] Daily traffic volumes on the existing SH1 route between Warkworth and Wellsford are expected to be in the order of 4,000 vpd in 2046 in the Project Scenario (24,500 fewer vpd, a decrease of 86%, compared to the Future Reference Case). The rate of diversion to the Project is relatively high because there is expected to be little local traffic needing to access destinations between Warkworth and Wellsford. In addition, the difference in speed between the Project and SH1 through the Dome Valley will offset the additional length along the Project route. Traffic volumes on the Project (between Warkworth and Wellsford) are expected to be in the order of 24,600 vpd in 2046.

[43] Modelled traffic volumes for SH1 and Project south of Wayby Valley Road. This location was chosen because it includes the section through the Dome Valley, covering the majority of the length of the Project, and traffic volumes are relatively constant through this section.

Figure 20 and Figure 21 show forecast traffic volumes on key parts of the network in the Future Reference Case Scenario and the Project Scenario in 2036 and 2046.

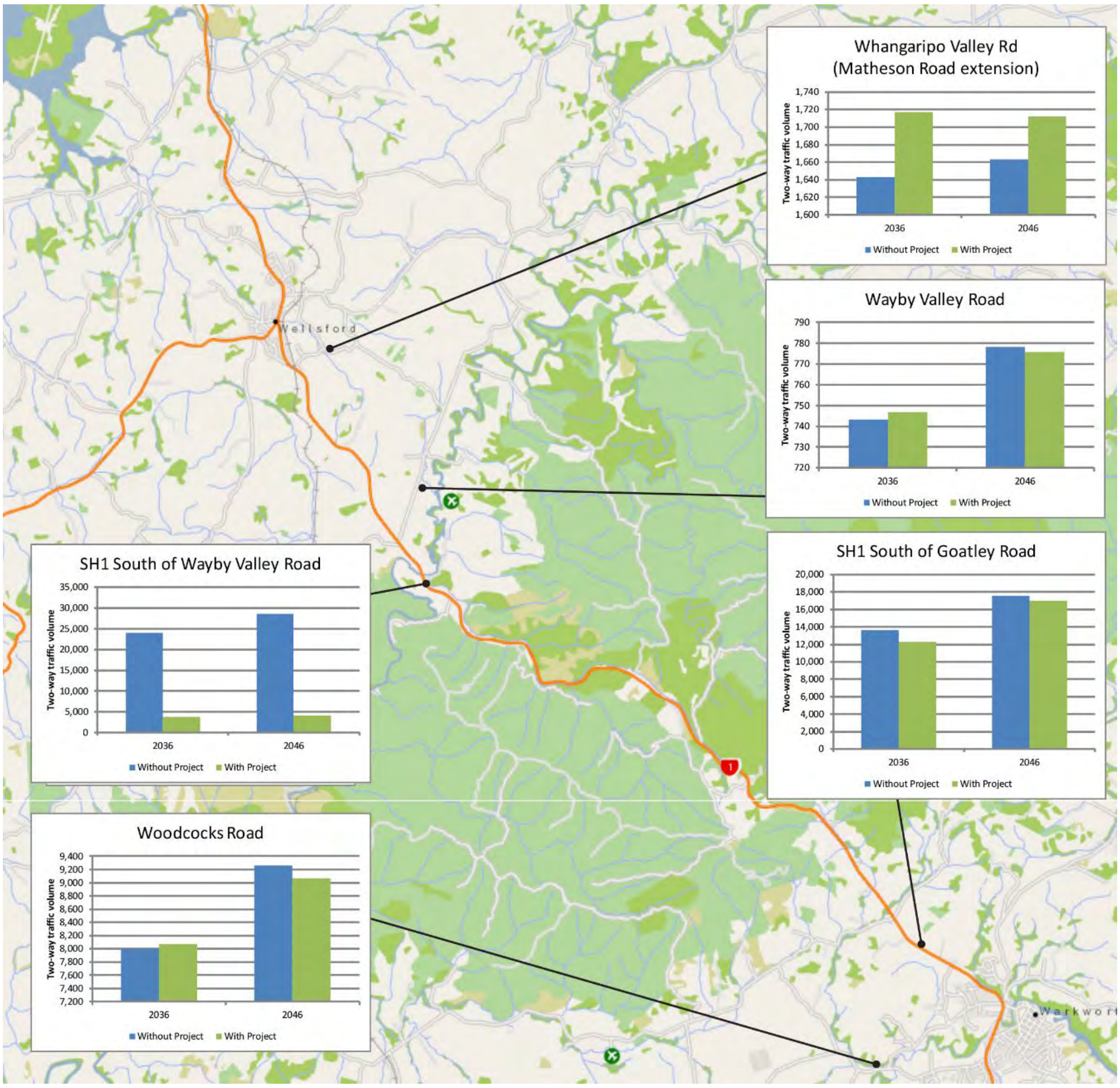


Figure 20 – Forecast traffic volumes (Future Reference Case Scenario and Project Scenario) south of Wellsford

Figure 21 – Forecast traffic volumes (Future Reference Case and Project Scenarios) around Wellsford

Traffic volumes are predicted to reduce on most parts of the existing transport network in the Project Area as a result of the Project. The key exception is Mangawhai Road, which is the location of the Te Hana interchange. However, most of the additional traffic will be between the existing SH1 and the interchange. Traffic on Mangawhai Road to the east of the interchange is only predicted to increase by about 100 vpd, and is unlikely to result in any adverse effects.

The models also show increases in traffic on Whangaripo Valley Road and the Kaipara Coast Highway (SH16), but these are very small changes of fewer than 100 vpd, and are therefore unlikely to result in any adverse effects.

5.2 Travel times

The travel time impact of the Project has been assessed on two routes with the potential to provide information on travel time changes:

- Between Pūhoi and Te Hana, to capture the effects on through traffic; and
- Between Warkworth and Wellsford, to capture local traffic.

The model has been used to calculate forecast travel times for these two trips in each direction using both the existing SH1 and the Project. Figure 22 and Figure 23 show the travel time routes.

Figure 22 - Travel time routes between Pūhoi and Te Hana

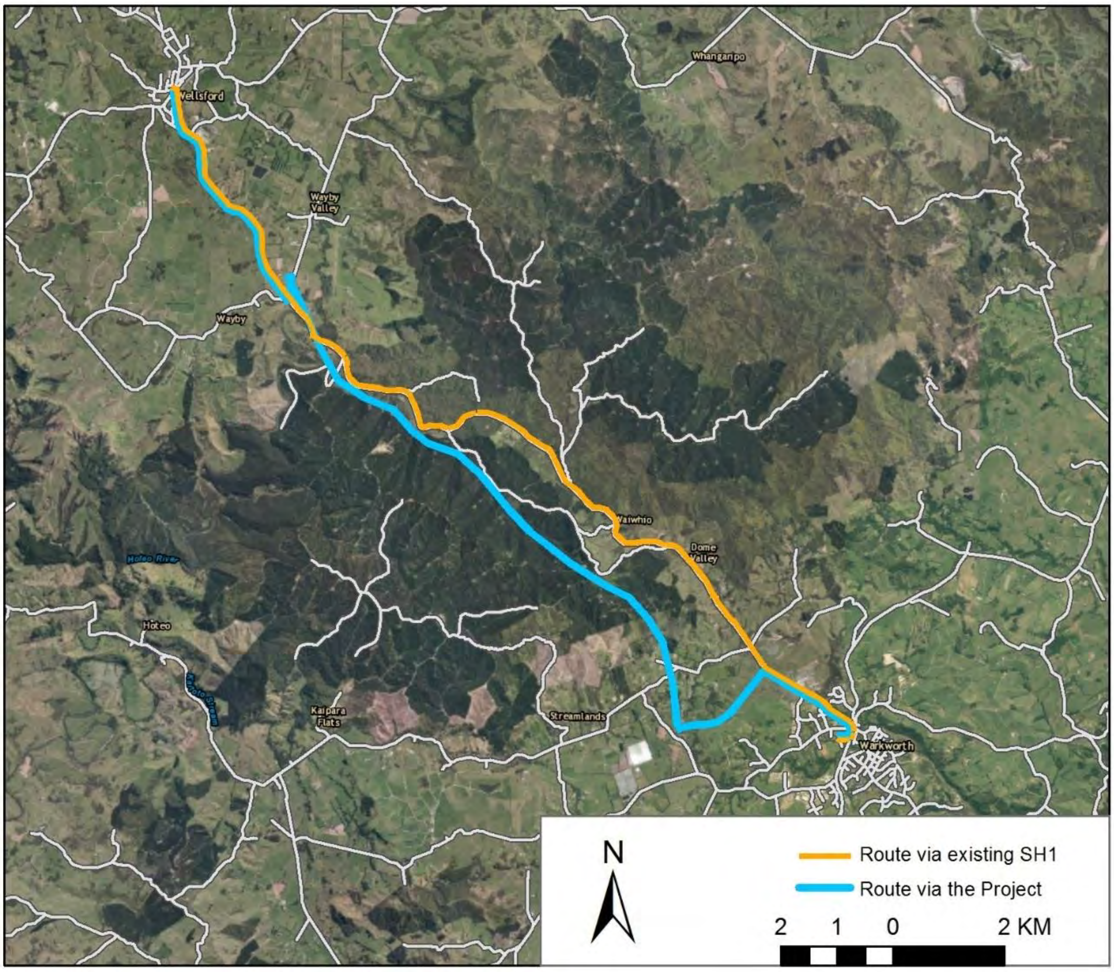


Figure 23 - Travel time routes between Warkworth and Wellsford

Figure 24 and Figure 25 below compare travel times on SH1 in the Future Reference Case Scenario and Project Scenario as well as travel times along the Project route.

Figure 24 shows travel times between Pūhoi Road in Pūhoi and Vipond Road in Te Hana, to assess the effects of the Project on through traffic. Through traffic using the existing SH1 route is assumed to use the P-Wk section of the P-W Project and then join the existing SH1 at Warkworth to continue north, and vice versa to go south. Through traffic using the Project route is on the P-W Project for the entire journey. The choice of the southern endpoint of the journey ensures that the impact of the P-Wk section of the P-W Project is constant for both scenarios.

Without the Project, travel times on the existing SH1 show delay in all periods, as indicated by the reduction in travel time when the Project is included. With the introduction of the Project, delays through Wellsford are predicted to reduce on both the main road (existing SH1) and side roads, as long distance travellers are using the Project route instead of going through Wellsford. The greatest improvement is in the evening peak northbound, where travel times on the existing SH1 reduce from 42 minutes to 32 minutes.

The results show a decrease in travel times for travellers on both SH1 and the Project as compared to the Base Reference Case. Travel times via the existing SH1 reduce between 6% and 24%, depending on time period travelled and direction. Travel times via the Project reduce between 36% and 48%. Travel times on the Project are consistent in both directions and all time periods, indicating that it is predicted to operate with free-flow conditions.

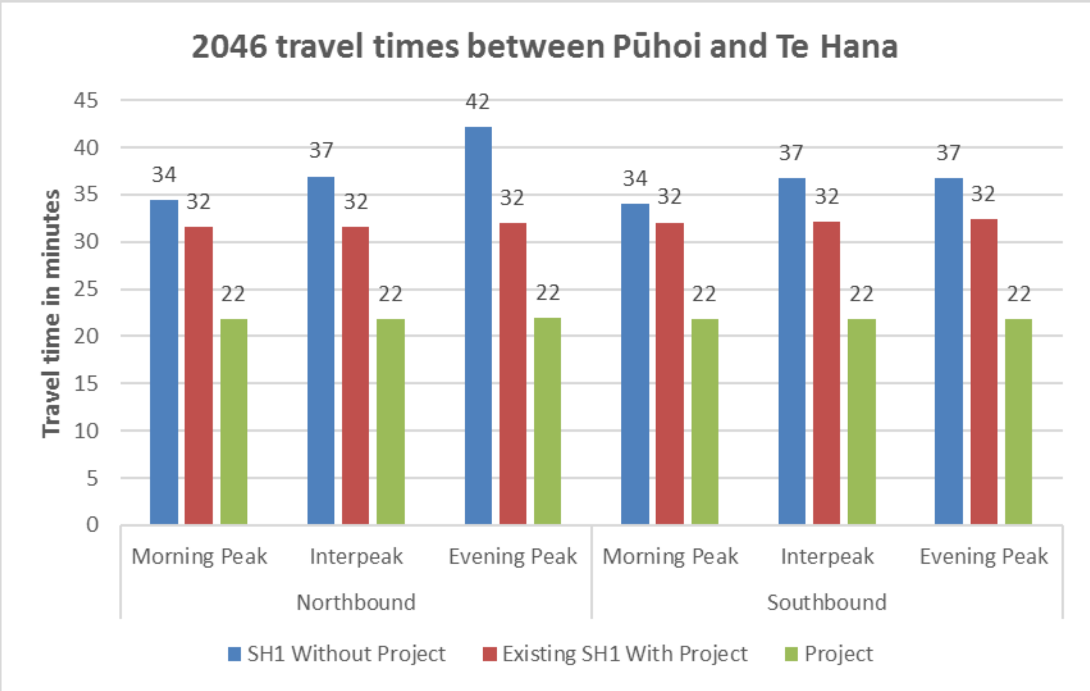


Figure 24 - Travel times between Pūhoi and Te Hana

Figure 25 shows travel times between Warkworth and Wellsford to assess the effects of the Project on local traffic. For the Project Scenario, traffic is assumed to use the Project route up to the interchange at Wayby Valley Road, and then use the existing SH1 into Wellsford township.

The results indicate that decreases in travel times are predicted for travellers on both the existing SH1 and the Project (labels on the figure are rounded to the nearest minute). The Project is predicted to have the lowest travel times overall, even though it will have a longer distance than the existing SH1 route. Travel times via SH1 reduce between 6% and 16%, depending on time period travelled and direction. Travel times via the Project reduce by between 9% and 19%. Travel times on the Project are predicted to be consistent in both directions and all time periods, indicating that it will be operating with free-flow conditions.

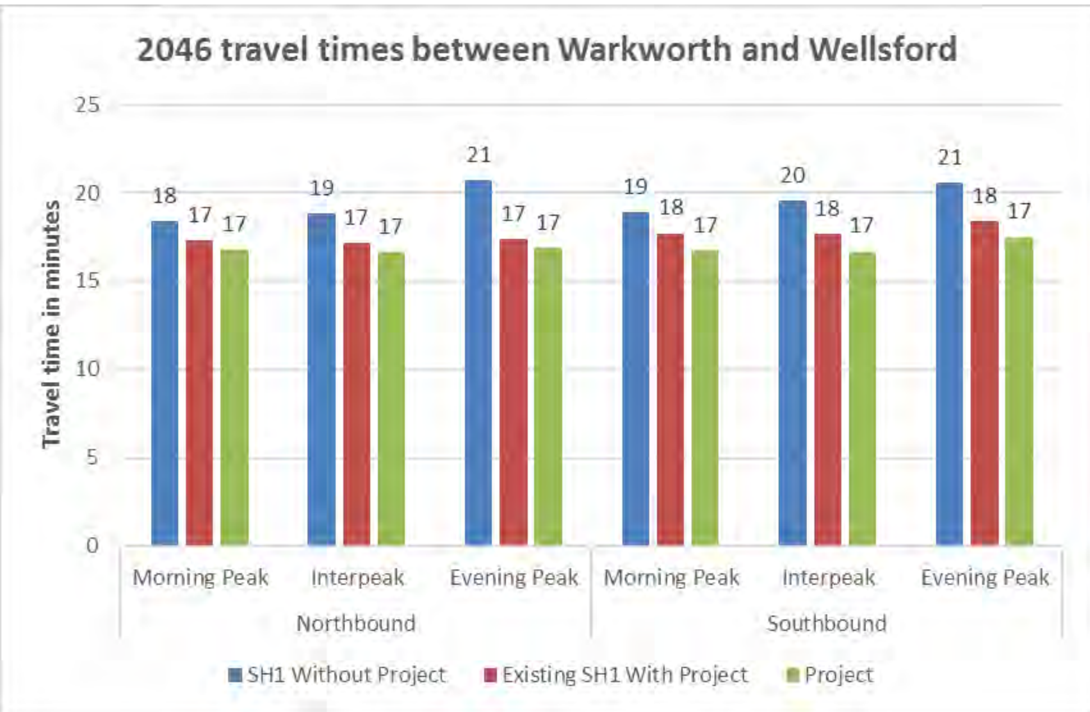


Figure 25 – Travel times between Warkworth and Wellsford (to the nearest minute)

5.3 Interchanges

We carried out an assessment of the Project's proposed interchanges at Te Hana, Wellsford, and Warkworth to consider their performance under the forecast traffic in the Project scenario. The analysis was carried out in SIDRA intersection modelling software, using forecast traffic volumes from the P2T model (see details in Section 2.2) for the year 2046.

The results of the analysis indicate that each of these interchanges, with their proposed layouts, will operate within their capacity, at level of service B or higher in 2046. In this case, level of Service B equates to average delays of less than 20 seconds.[44]

The full analysis, including modelled interchange layouts and detailed results, is in Appendix F.

5.4 Travel time reliability

Section 3.6 describes the current issues with travel time reliability along SH1, between Warkworth and Te Hana. Section 4.4 discusses why travel time reliability is expected to reduce in the Future Reference Case Scenario. Improvements in travel time reliability cannot be modelled, as the model predicts average travel times. However, in our experience we consider the Project will have a number of benefits that will improve travel time reliability, namely:

(a) The capacity along the corridor will increase significantly as a result of the Project. Trips to and from locations to the north of Wellsford will be faster along the Project route, while the reduction in traffic along the existing SH1 route will also reduce

[44] SIDRA Intersection 7 User Guide, Table 5.14.1 Delay (SIDRA) method for Level of Service definitions based on delay only (for vehicles). All intersections assessed are roundabouts. Level of service is a qualitative measure of the performance of the intersection. In this case, it is based on the amount of delay for each turn movement, as defined in the SIDRA user guide.

travel times for vehicles that remain on the existing SH1. Travel times and congestion are forecast to reduce compared to the Future Reference Case Scenario as described in Section 5.2. Given the relationship between traffic demand, congestion, and travel time variability discussed in Section 3.6, travel time reliability in the corridor is expected to improve as a result of the Project.

(b) There will be two traffic lanes in each direction along the Project route, whereas along the existing SH1 route there are limited passing opportunities. The improved passing opportunities provided by the Project will mean that general traffic will not be held up by slow moving vehicles (trucks or other vehicles), which will improve travel time reliability.

(c) Reduced traffic volumes along the existing SH1 route will allow light vehicles using that route to be less constrained by slow moving HCVs, particularly on the steeper graded sections.

(d) A shift of HCVs onto the Project route will provide greater travel time reliability for HCVs, due to the improved road geometry along this new route.

In summary, although not directly forecast by the models, travel time reliability generally decreases as traffic levels approach capacity. Therefore, the significant increase in capacity provided by the Project is expected to significantly improve travel time reliability.

The improvements in travel time reliability will be a significant benefit of the Project. It will enable individuals and businesses to plan their travel with a much greater degree of certainty. It will also provide for a much more resilient network that will be able to cater for some disruption without significant increases in travel time.

5.5 Safety

Section 3.8 describes the current safety issues along the existing SH1 route between Warkworth and Te Hana, and Section 4.5 discusses the likely changes in safety issues in the Future Reference Case Scenario.

As noted in Section 5.1, a large proportion of trips between Warkworth and north of Te Hana are expected to travel along the Project route. We predict that the AADT along the existing SH1 route will reduce from approximately 29,000 vpd in 2046, without the Project, to approximately 4,000 vpd, with the Project. The reduction in traffic on the existing SH1 section will have significant positive effects by reducing the number of crashes along that route.

In 2046, we predict that the AADT along the Project will be approximately 24,600 vpd. The Project is expected to have a significantly improved safety performance compared to the existing SH1, as it will be designed to the latest highway standards and will deliver a range of safety improvements, including:

- Providing a dual carriageway with separate north and southbound traffic, which will eliminate head-on crashes along the Project route;
- Removing through traffic from the local road network, especially freight;
- Providing free flow ramps at the SH1/Warkworth Interchange and therefore reducing intersection turning crashes;

- Reducing congestion and queuing on the existing SH1, thereby reducing the incidence of rear-end type crashes; and

- Reducing vehicle volumes along the existing SH1 and therefore improving safety for pedestrian and cyclists, particular through the Wellsford township.

Predictions of the crash rates along the existing SH1 (with and without the Project) and the Project in 2046 are provided in Table 8 below. Crash rates have been evaluated according to the procedures set out in the Economic Evaluation Manual. The crash rates include the predicted changes from the SH1 Dome Valley Safety Improvements project.

Table 8: Typical crash rates (crashes per Year) and site specific injury crash rates in 2036

Road sections	Future reference case scenario crash rate	Project Scenario crash rate	Change in crash rate
Existing SH1 route			
SH1 South of Kaipara Flats Road	0.18	0.07	-60%
SH1 Kaipara Flats Road to Wayby Station Road	6.11	0.98	-84%
SH1 Wayby Station Road to Davis Road	3.85	1.23	-68%
SH1 Davis Road to SH16	0.86	0.16	-82%
SH1 SH16 to School Road	2.03	0.84	-59%
SH1 School Road to Silver Hill Road	3.04	0.78	-74%
SH1 Silver Hill Road to Whakapirau Road	0.32	0.03	-89%
SH1 Whakapirau Road to Mangawhai Road	3.35	0.38	-89%
Total along existing SH1	**19.06**	**4.46**	**-77%**
Project route			
Warkworth Interchange	N/A	0.75	N/A
Warkworth Interchange to Wayby Valley Road Interchange	N/A	6.71	N/A
Wayby Valley Road Interchange	N/A	0.57	N/A
Wayby Valley Road to Mangawhai Road Interchange	N/A	4.60	N/A
Total along Project route	**N/A**	**12.63**	**N/A**
Total	**19.06**	**17.09**	**-10%**

The Project is predicted to result in a significant reduction in crashes along the existing SH1, primarily due to the diversion of the majority of vehicles from this existing route and onto the new route. The crash rates for the new route, and the interchanges, have been derived from the default rates for roads and interchanges of this type, as set out in the Economic Evaluation Manual. Table 8 indicates that the net effect of the Project is expected to be a reduction in annual injury crashes from 19 crashes to 17 crashes (a 10% reduction), along the existing SH1 and the Project route (i.e. combined), relative to the 2036 Future Reference Case Scenario. However, this 10% reduction significantly underplays the expected effects of the Project, which is expected to lead to a change in the level of injury incurred, namely a significant reduction in serious or fatal crashes in the Project area. The

Project may change the severity of crashes occurring on the existing SH1 as the predicted lower volumes may result in higher speeds (due to the reduction in congestion along the route) and therefore a higher proportion of high severity crashes. However, with the vast majority of vehicles predicted to divert to the new route, the total number of crashes involving deaths and serious injuries) is predicted to reduce significantly, as the new route will be designed to a high standard, in particular, being built on a good alignment with a dual carriageway, with median (and side barriers) and without regular intersections and accesses. The types of the serious and fatal crashes along the existing SH1 route were identified within Section 3.8 as predominantly involving manoeuvres such as overtaking, loss of control, head on and turning crashes. Such manoeuvres will all be very unlikely to lead to serious or fatal crashes along the new route.

The Project is therefore expected to deliver network safety benefits.

5.6 Route resilience

The introduction of a high quality, alternative route to the existing SH1 route between Warkworth and Te Hana will reduce the effects of incidents (crashes and natural events such as slips and flooding) on travel between Warkworth and Te Hana – which in turn will mean improved resilience for those travelling between Northland and Auckland.

The Project will improve route resilience between Northland and Auckland in a number of ways:

- Having another alternative route will provide a greater level of security and availability of travel routes between Auckland and Northland.

- The Project route will have four traffic lanes. This design will allow the route to be opened sooner following a crash than is currently possible along the existing SH1 route, which is primarily a single carriageway.

- As noted in Section 5.5 above, the number of serious or fatal injury crashes both along the existing SH1 route and in the Corridor overall is forecast to reduce significantly, which will consequently reduce the number of times the route is closed.

As a result of these factors, the resilience of the wider state highway network will be significantly improved by the Project.

5.7 Road freight performance

As noted in Section 4.7, freight volumes are expected to increase within the overall Project corridor and HCVs are expected to prefer to use the Project route. The reduced travel times, improved geometry, and improved predictable journeys on the Project will be more attractive to HCVs, as their values of time and desire for travel time certainty are higher than other vehicles. This will reduce the volume of HCVs on the existing SH1.

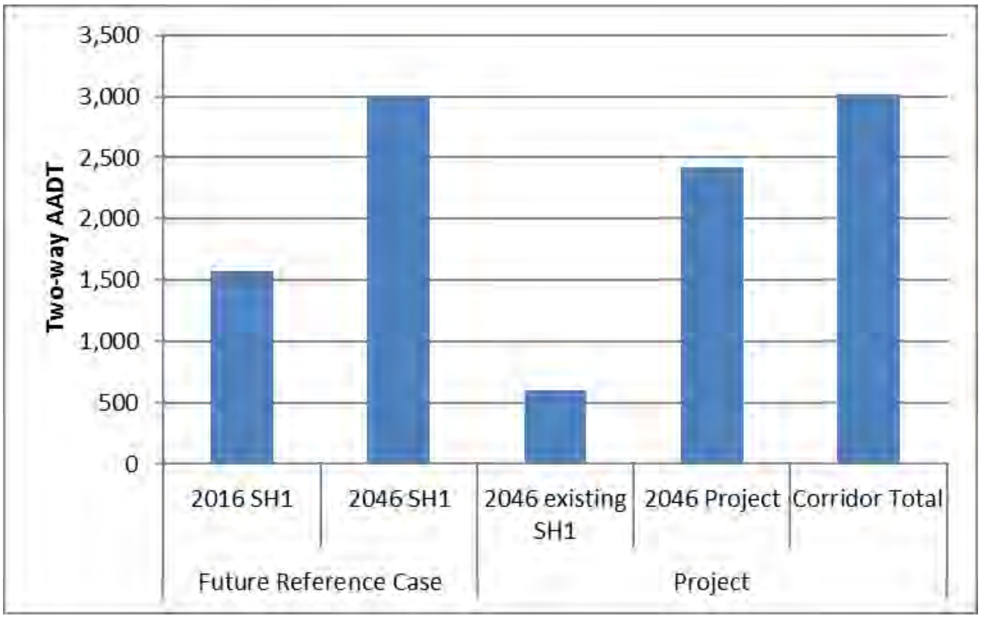


Figure 26 – HCV volumes along SH1 and the project

Figure 26 sets out the forecast HCV volumes along the existing SH1 route and the Project route in the Future Reference Case Scenario and Project Scenario. The numbers of HCVs using the existing SH1 route in 2046 are predicted to be 80% lower in the Project Scenario compared to the Future Reference Case Scenario. The model assumes that HCVs put a higher priority on distance than regular traffic, because they have higher operating costs. Because the Project route is longer for through traffic than the existing SH1 route, the model predicts that HCVs are slightly less likely than overall traffic (80% compared to 86%) to shift to the Project.

The Project will improve freight performance in a number of ways:

- The Project will be constructed to high design standards, with grades and alignment more favourable to HCVs. The Project will therefore improve travel times and vehicle operating costs for HCVs and increase travel time reliability for HCVs.
- Improved travel times for freight will improve opportunities for trade by effectively bringing freight destinations closer together.
- HCVs will be able to bypass the Dome Valley, which currently presents geometric challenges and safety risks for heavy vehicles.
- The indicative design has four lanes as well as a northbound crawler lane on the southern side of Kraack Hill, which will improve safety and travel times by eliminating the need for passing lanes and risky overtaking manoeuvres.
- Travel times and travel time reliability for HCVs will reduce in the same way as described for general traffic in Sections 5.2 and 5.4, as a result of the Project.
- Safety for HCVs will also improve as described for general traffic in Section 5.5
- Overall, the Project is expected to have a positive impact on the performance and safety of freight.

5.8 Public transport network performance

The Project will have a minimal impact on the performance for existing or potential public transport vehicles. The same performance improvements forecast above for general traffic will be experienced by the regional bus services that run between Auckland and Whangārei as a result of the Project.

The significant reduction in traffic on SH1 will make it easier and safer for pedestrians in Wellsford to cross SH1 to access bus stops. The reduction in traffic could also facilitate the addition of more convenient crossings between the Wellsford bus stops in the future.

5.9 Pedestrian and cycle network performance

Some provisions have been made for pedestrians and cyclists on local roads in the indicative design of the Project. Where local roads pass over the Project on bridges, a 1.8m wide footpath will be provided on one side for the length of the bridge. The exceptions are:

- Kaipara Flats Road, where footpaths will be on both sides of the bridge and extend along the approach embankments;
- Dibble Road (a private forestry road), where no footpath will be provided at the owner's request; however, the structure is wide enough to retrofit in the future; and
- Farmers Lime Road, where the footpath on the bridge will extend across the approach embankments.

Where local roads pass beneath the Project, the full reserve width of the local road will be preserved. While no footpaths will be constructed on these roads, maintaining the full reserve will not preclude future pedestrian or cycle improvements.

At the northern tie-in of the Project to the existing SH1, 3m wide shared path connections will be put in on both sides of the realigned SH1 to maintain connectivity between the local roads (Maeneene Road and Waimanu Road) and the existing SH1 north of the Project.

No provisions have been made at the rural interchanges of Wellsford and Te Hana, but future provisions are not precluded by the design.

We do not expect these provisions to increase walking or cycling in the area, as they are in isolated locations and do not improve the connectivity of walking and cycling networks. However, they support the potential development of future walking and cycling infrastructure in the area.

The lower volumes of traffic along the existing SH1 route between Warkworth and Te Hana will reduce the potential for conflicts between pedestrians and cyclists and vehicles using that route. In addition, the Project will significantly reduce traffic flows within Wellsford and Te Hana, which will improve safety and amenity for pedestrians and cyclists within those townships.

In the initial consultation with Auckland Transport they advised that they support measures to address existing safety hazards for pedestrians and cyclists on the old section of SH1 and would support initiatives for the future use of the existing SH1 and the wider area with respect to walking, cycling and recreational activities.

6 SENSITIVITY TESTING

In order to address the limitations and uncertainty of future traffic forecasting, a series of sensitivity tests have been carried out. These tests consider:

- The inclusion of only committed transport projects;
- A slower rate of growth (see section 6.2 for scenario description); and
- Higher traffic growth (see section 6.3 for scenario description) .

6.1 Committed projects only

6.1.1 Traffic volumes

Additional model runs have been carried out with only the currently committed projects included and all planned but uncommitted infrastructure removed from both the Future Reference Case Scenario and the Project Scenario. The only currently committed infrastructure projects are the Pūhoi to Warkworth Project and the Matakana link road.[45] Table 9 provides an overview of the planned and committed projects. These projects are shown spatially in Figure 4 earlier.

Table 9 – Description of committed and planned projects

Committed projects	Additional (planned but not yet committed) projects
• Pūhoi to Warkworth Project • Matakana link road	• Western Collector Full • Hauiti Drive–John Andrew new secondary arterial • Alnwick Street Connection • Matakana to SH1N inner link (i.e. Sandspit Link) • Matakana Rd to Sandspit realignment • Southern Network

All of the planned projects included in the Future Reference Case are in the vicinity of Warkworth township with the purpose of facilitating transport movements around Warkworth and away from the existing SH1. When these planned projects are removed from the model, the number of alternatives to SH1 are decreased, so there is an increase in traffic volumes in the southern end of SH1 in the Project Area. This increase is apparent from Figure 27 and Figure 28. These figures identify the change in traffic volumes on existing SH1 when all planned but uncommitted projects are excluded from the Future Reference Case Scenario models. There is a significant change in traffic volumes using the existing SH1 south of Woodcocks Road in Warkworth, but only a slight change in traffic at the other two locations, which are both north of the Dome Valley and therefore not strongly influenced by changes to the local Warkworth road network.

45 The SH1 Dome Valley improvements are also committed – but as noted earlier in the report, these are safety improvements which will not significantly affect the predicted travel times along the SH1 route.

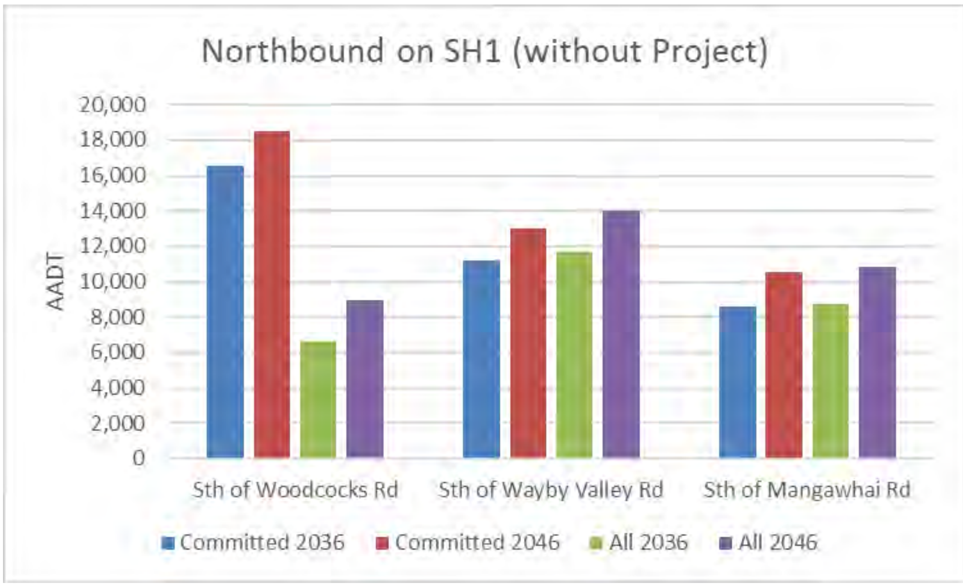


Figure 27 – Northbound traffic volumes on existing SH1 with committed only and all projects (Future Reference Case Scenario)

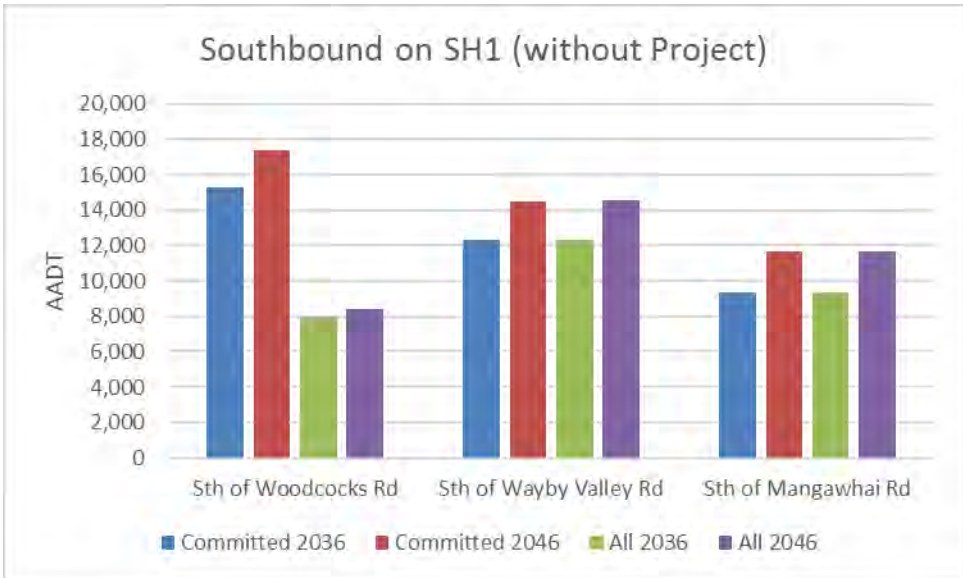


Figure 28 – Southbound traffic volumes on existing SH1 with committed and all projects (Future Reference Case Scenario)

Figure 29 and Figure 30 identify the change in traffic volumes on existing SH1 when only the committed projects are included (all planned but uncommitted projects are excluded) from the Project Scenario models. Again, the most noticeable change is south of Woodcocks Road in Warkworth. This is what is expected, since all of the additional projects are located in Warkworth, and would have little impact on SH1 further north.

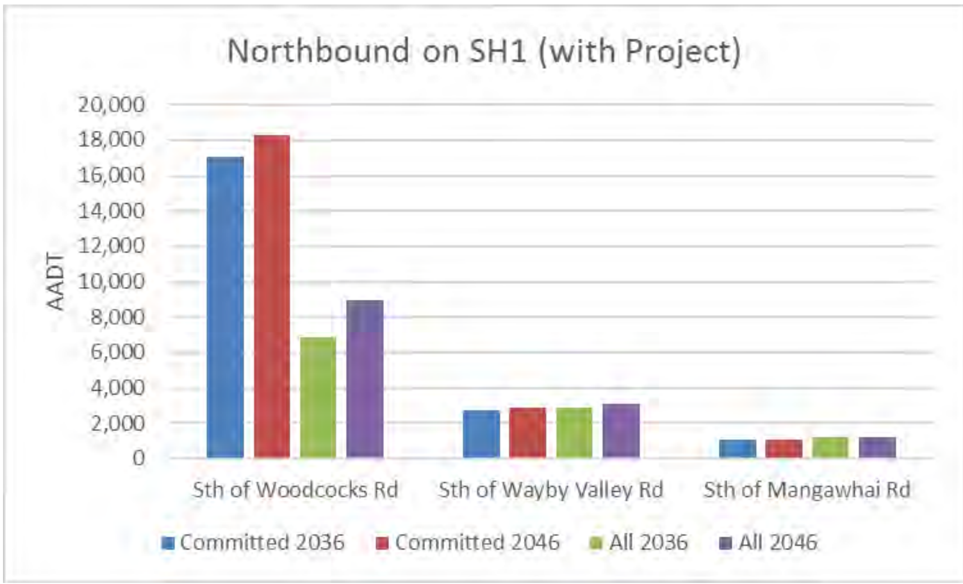


Figure 29 – Northbound traffic volumes on existing SH1 with committed and all projects (Project Scenario)

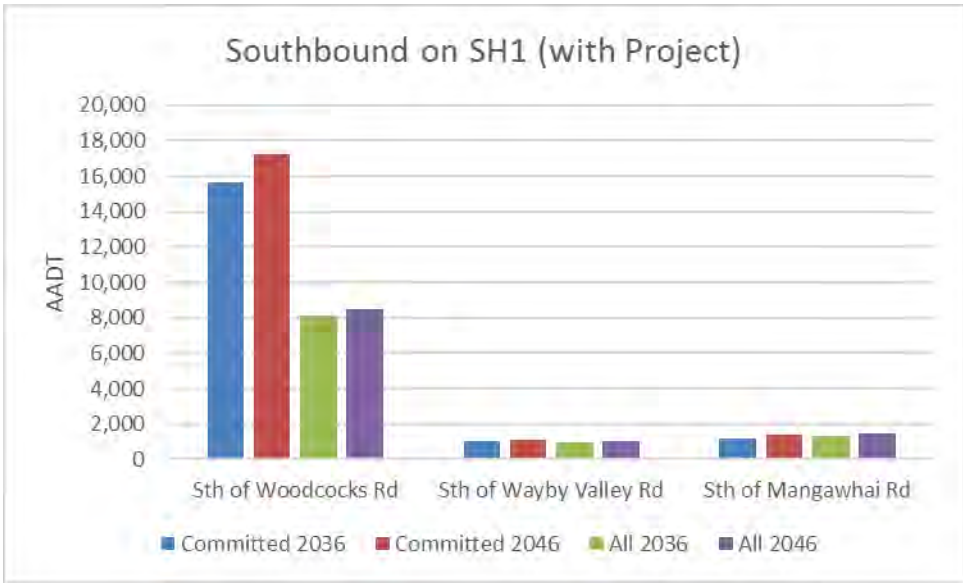


Figure 30 –Southbound traffic volumes on existing SH1 with committed and all projects (Project Scenario)

On the Project, northbound volumes (Figure 32) are predicted to remain consistent at the Warkworth Interchange, but slight variations in volumes are predicted near the Wellsford and Te Hana Interchanges. Traffic on the Project is slightly lower in these locations in the committed-only scenario because queuing in Warkworth prevents the full demand north of Warkworth from being realised. Southbound volumes are predicted to remain consistent across both models (Figure 31).

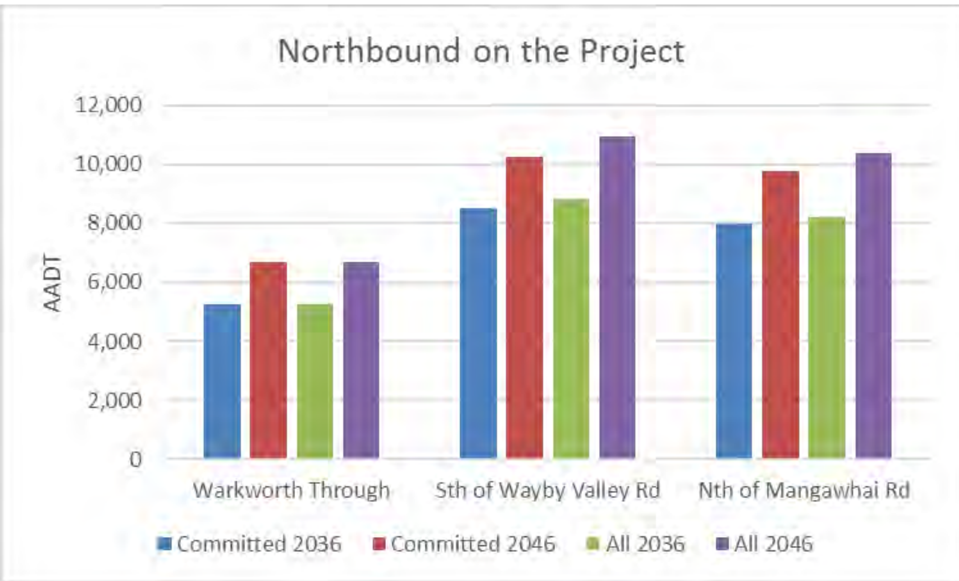


Figure 31 – Traffic volumes on the Project with committed and all projects (northbound)

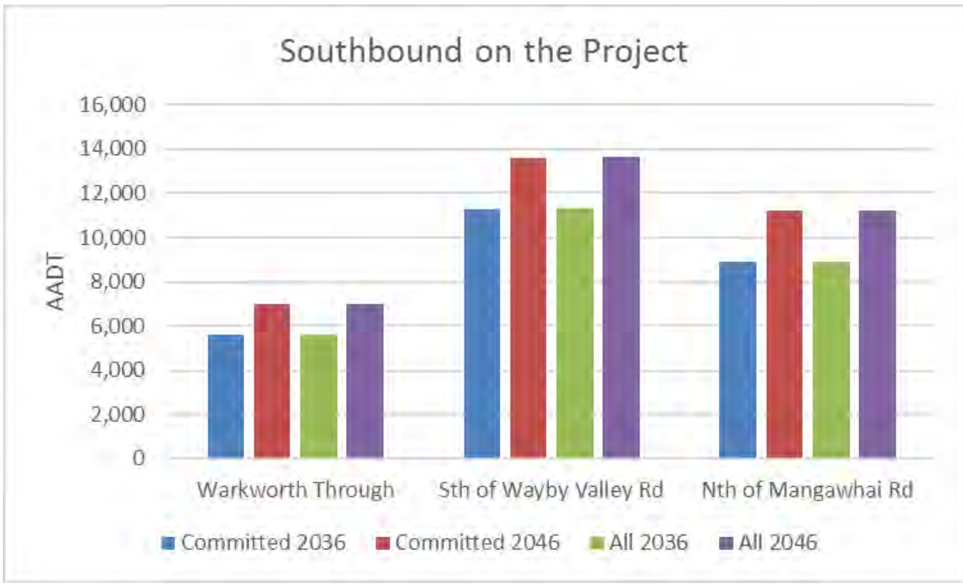


Figure 32 – Traffic volumes on the Project with committed and all projects (southbound)

6.1.2 2046 travel times

Travel time variations between the model scenarios with all planned projects and the model scenarios with committed projects only are shown in Table 10.

For the full north-south route between Pūhoi and Te Hana (as described in Section 5.2), the sensitivity scenario with only committed projects is predicted to have lower travel times northbound than the Future Reference Case Scenario (up to 3 minutes faster in the evening peak). This difference is due to small decreases in delays distributed along the route. These decreases in delay are the result of increased congestion in Warkworth in the model with only committed projects. The increased congestion prevents the full modelled demand from leaving Warkworth, leading to reduced traffic upstream of Warkworth. Travel times are otherwise predicted to be similar for through traffic with and without the planned projects.

Between Warkworth and Wellsford (along SH1) in the Future Reference Case Scenario, the greatest changes between the Future Reference Case model and the sensitivity model are predicted in the evening peak southbound in 2046. The forecast travel time on SH1 is 7 minutes longer when only committed projects are included, due to additional congestion on the existing SH1 through Warkworth, south of the P-Wk Project northern roundabout.

In the Project Scenario the travel times (as shown in Table 10) are either the same or slightly higher if only the committed projects are included. The greatest increases in travel times are predicted on both existing SH1 and the Project southbound in the evening peak, when increases of about 10 minutes are predicted, due to additional congestion in Warkworth.

Table 10 – Travel times for planned and committed project models

		All planned projects						Committed projects					
	Scenario	Future reference case			Project			Future reference case			Project		
	Direction	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Pūhoi -Te Hana – SH1	NB	34	37	42	32	32	32	34	36	39	32	32	32
	SB	34	37	37	32	32	32	34	37	37	32	32	32
Pūhoi -Te Hana – Project	NB				22	22	22				22	22	22
	SB				22	22	22				22	22	22
Warkworth to Wellsford – SH1	NB	18	19	21	17	17	17	18	18	19	17	17	17
	SB	19	20	21	18	18	18	19	21	27	18	19	28
Warkworth to Wellsford – Project	NB				17	17	17				16	17	16
	SB				17	17	17				17	18	27

6.1.3 Conclusion for committed projects only test

The additional projects in the Future Reference Case scenario are located within Warkworth, and have the greatest impact on local Warkworth traffic. Therefore, whether or not these projects are constructed will have a minimal impact, if any, on the benefits of the Project. When only committed projects are included, travel times increase within Warkworth for both the Future Reference Case and Project scenarios.

6.2 Slower growth

This sensitivity test evaluates the traffic impacts if the growth in the P2T model area is slower than anticipated in the modelling. As a proxy for this slower growth, 2036 traffic flows and travel times can be thought of as those that may be experienced in 2046 with slower growth.[46]

6.2.1 Traffic volumes

Forecast flows on the existing SH1 route, north of Warkworth, under the Future Reference Case Scenario, are predicted to be around 29,000 vpd with the 2046 forecasts, compared with 24,000 vpd with the 2036 forecasts.

Traffic volumes along the existing SH1 route are predicted to reduce significantly following the completion of the Project. If traffic volumes in the Project Area grow at a slower rate, no negative impacts on the performance of the Project are expected, since forecast flows in 2036 are lower than 2046, as shown in Figure 33.

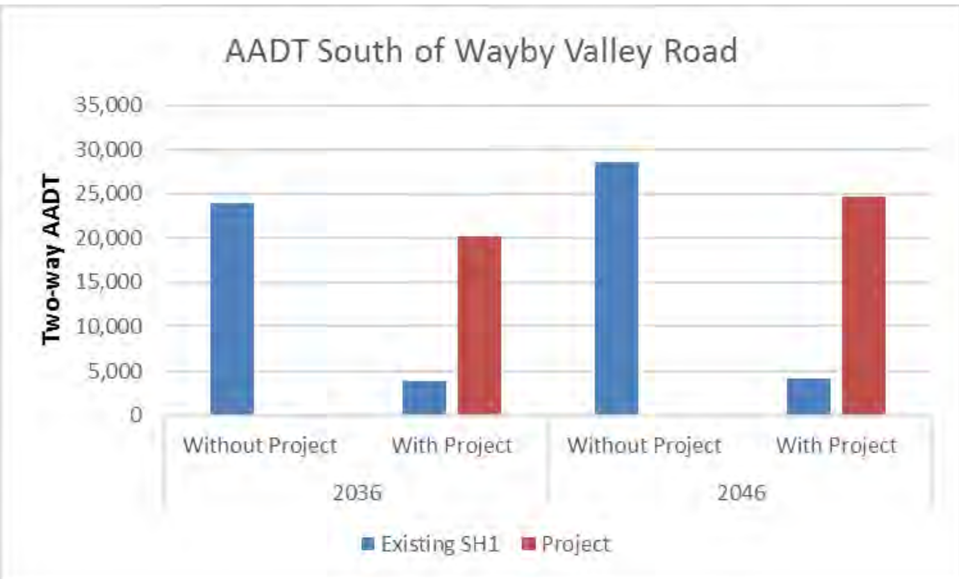


Figure 33 - Two-way traffic volumes on the SH1 route and the Project route in 2036 and 2046

6.2.2 Travel times

Table 11 shows the forecast travel times for 2036 and 2046 in the Future Reference Case Scenario and Project Scenario (including all planned projects). For the slower growth scenario, the 2036 travel times shown in Table 11 would be in fact the travel times predicted in 2046, i.e. due to slower growth it takes the extra 10 years to reach 2036 levels.

[46] Section 4.2 already illustrates the 2036 figures in comparison to the base and 2046.

Table 11 – 2036 and 2046 travel times for all planned projects

		2036						2046					
	Scenario	Future Reference Case			Project			Future Reference Case			Project		
	Direction	AM	IP	PM	AM	IP	PM	AM	IP	PM	AM	IP	PM
Pūhoi –Te Hana – SH1	NB	33	34	37	32	32	32	34	37	42	32	32	32
	SB	33	34	34	32	32	32	34	37	37	32	32	32
Pūhoi –Te Hana – Project	NB				22	22	22				22	22	22
	SB				22	22	22				22	22	22
Warkworth to Wellsford – SH1	NB	18	18	19	17	17	17	18	19	21	17	17	17
	SB	18	19	19	18	17	18	19	20	21	18	18	18
Warkworth to Wellsford – Project	NB				17	17	17				17	17	17
	SB				17	16	17				17	17	17

The 2036 travel times (proxy for slower growth) for both sets of routes are predicted to be the same or quicker than in 2046. This is the case for all time periods and routes, and for both the Future Reference Case Scenario and the Project Scenario.

6.2.3 Conclusion for slower growth test

Without the Project, travel times under the Future Reference Case Scenario are predicted to increase between 2036 and 2046. With the Project, the travel times are predicted to be roughly the same in 2036 and 2046. Therefore, the travel time savings resulting from the Project would be less both for those using the Project and those remaining on the existing SH1, since travel times are faster in the Future Reference Case with slower growth. This means that if growth is slower than predicted, the benefits of the project will be reduced. There will also be fewer people gaining the benefits of the Project, as AADTs would be lower on both the Project and the existing SH1 due to the reduced population growth.

6.3 Higher traffic growth

To test the impact of a higher growth scenario, a test was carried out using the P2T model with vehicle demands based on i9 land use assumptions. The i9 land use scenario concentrates employment growth in a few locations, and places future population growth throughout the Auckland urban area and major future urban growth areas.[47] The key difference between i9 and i11.4 is that the i11.4 scenario has higher employment growth forecast throughout the area between Pūhoi and Te Hana (particularly in Warkworth), resulting in fewer long distance trips to and from Auckland. (See Appendix B for a comparison of the input demographics in the two land use scenarios.) This change in trip distribution results in more traffic within Warkworth and in the Project Corridor in the i9 scenario., hence the use of the i9 scenario as a base for the higher traffic growth scenario.

[47] Auckland Transport Alignment Project Supporting Information, page 12. http://www.transport.govt.nz/assets/Uploads/Land/Documents/ATAP-Supporting-Information.pdf

6.3.1 Traffic volumes

In the higher traffic growth Scenario, traffic volumes along the existing SH1 route (without the Project) are predicted to reach 34,000 vpd in 2046, as shown in Figure 34. This volume can be compared to the 29,000 vpd volume in the Future Reference Case Scenario as described in Section 4.

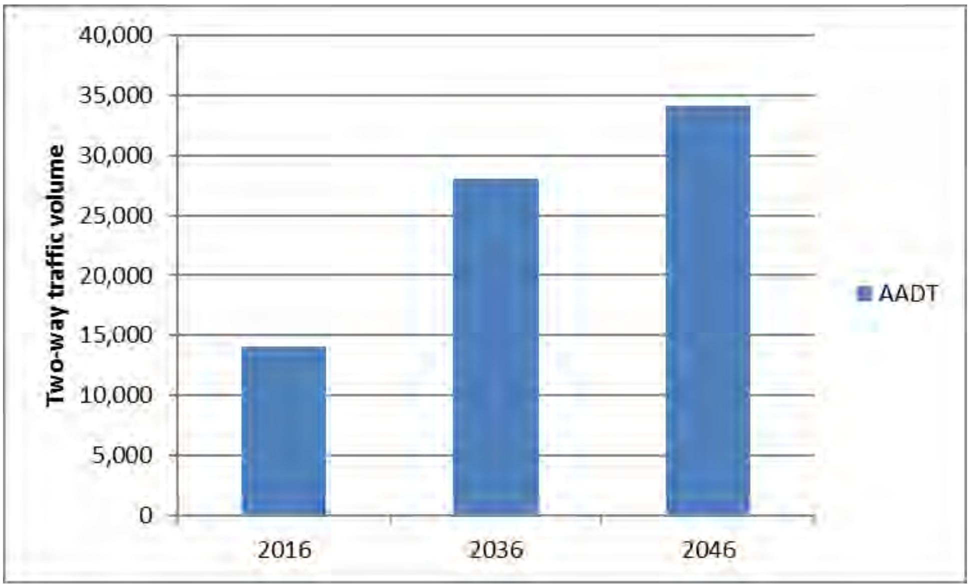


Figure 34 – Future reference case AADT by year, higher traffic growth scenario

In the higher traffic growth Project Scenario, the total amount of traffic in the Corridor is still predicted to be around 34,000 vpd, but about 85% of that traffic (about 29,000 vpd) is predicted to travel along the Project. This rate of diversion to the Project is consistent with that in the base assessment, which is about 86%. Only about 5,500 vpd are predicted to remain on the existing SH1 route, as shown in Figure 35. (In the base Project scenario, about 4,000 vpd remain on SH1.)

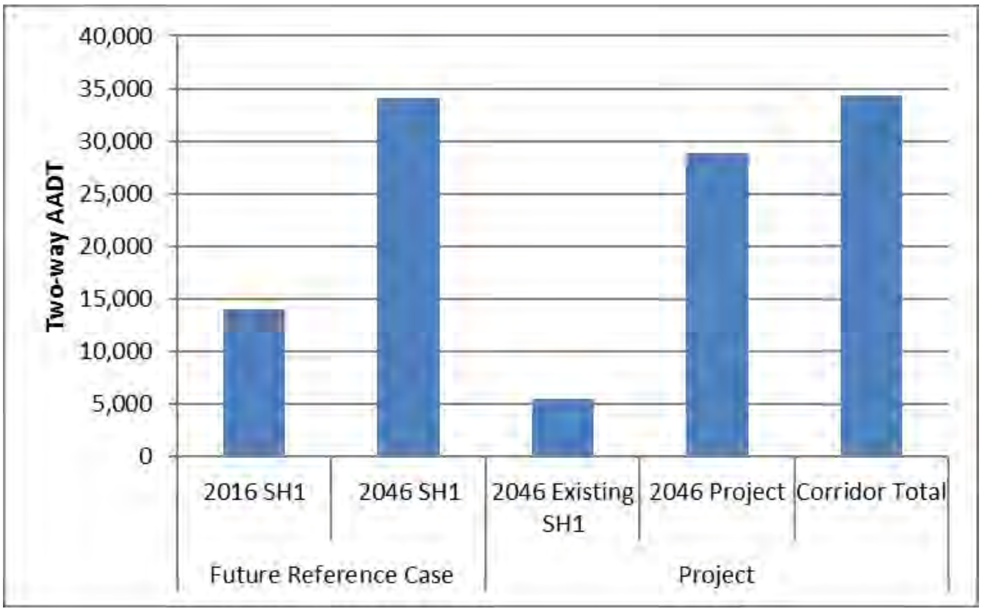


Figure 35 – Traffic volumes between Warkworth and Wellsford, higher traffic growth scenario

The higher traffic growth scenario has impacts on other parts of the network as well. On Kaipara Flats Road, traffic increases by about 250 vph in the evening peak period in 2046 in the higher growth Project Scenario (compared to the higher growth Future Reference Case Scenario). This increase is a result of southbound traffic from the Project that needs to access the southern part of Warkworth. In 2036, southbound traffic going to the southern part of Warkworth is able to go south through Warkworth using the existing SH1, but in 2046 congestion in Warkworth from the higher traffic growth scenario is predicted to lead to some vehicles taking a circuitous route using Kaipara Flats Road, Carran Road, and Woodcocks Road.

6.3.2 Travel times

Travel times in 2016 have been compared against those forecast in the 2046 higher growth Future Reference Case Scenario along the existing SH1 between Warkworth and Wellsford (as in Section 4.3). Table 12 shows the travel time in minutes on the existing SH1 between Warkworth and Wellsford in the higher traffic growth scenario. The greatest increase in travel time without the Project is southbound during the evening peak, where growth in traffic between 2016 and 2046 is predicted to add 13 minutes of delay. About 6 minutes of this increase is predicted to be a result of intersection delays in Warkworth. In particular, the new signalised intersection where the Matakana Link road joins SH1 is predicted to be over capacity in the evening peak and this is predicted to create a 4.5-minute delay for southbound through traffic. The remaining 7 minutes of additional delay relates to slower speeds distributed over the entire route.

Table 12 – Travel times on SH1 – higher traffic growth future reference case scenario

Direction	Segment	Period	2016	2036	2046	Change 2016 to 2046	
						Absolute	%
Northbound	Warkworth to Wellsford	AM	17	18	19	3	16%
		IP	17	19	20	3	20%
		PM	18	20	22	4	22%
Southbound	Wellsford to Warkworth	AM	18	19	19	1	7%
		IP	17	19	25	7	43%
		PM	19	22	32	13	70%

For the Project Scenario, the travel time impact of the in the higher traffic growth scenario has been assessed on two sets of routes (as in section 5.2):

- Between Pūhoi and Te Hana, to capture through traffic; and
- Between Warkworth and Wellsford, to capture local traffic

Figure 36 and Figure 37 show the predicted effect of the Project on travel times for each of these routes.

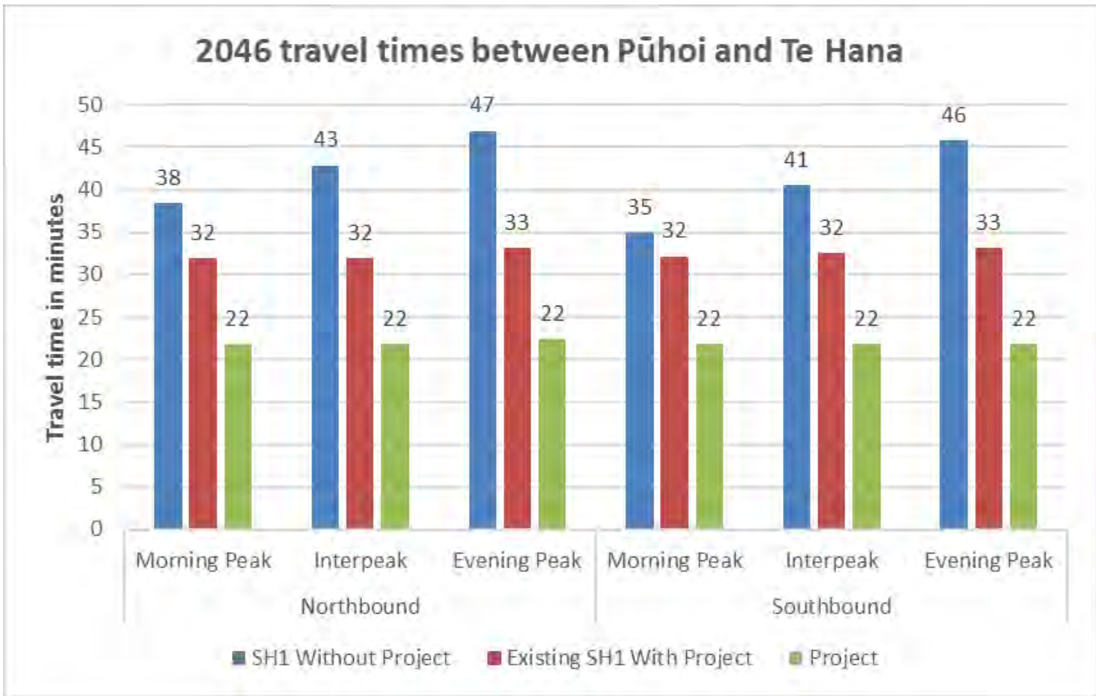


Figure 36 – Travel times between Pūhoi and Te Hana, higher traffic growth scenario

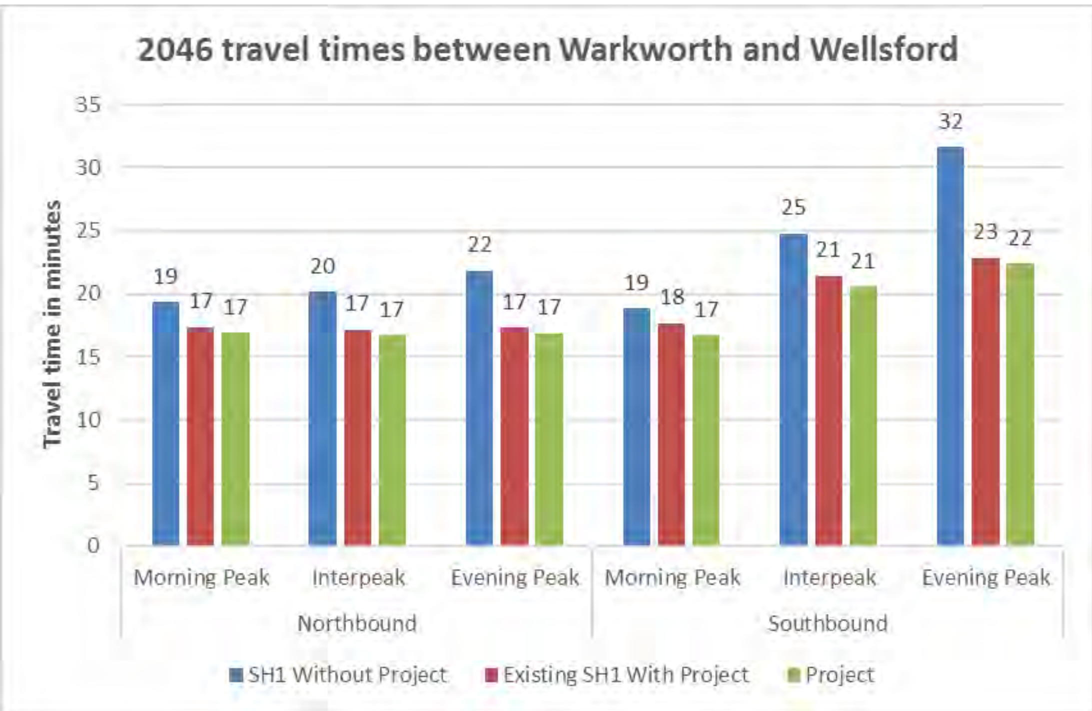


Figure 37 –Travel times between Warkworth and Wellsford, higher traffic growth scenario

Travel times on the Project in the higher traffic growth scenario between Pūhoi and Te Hana are predicted to be constant for all time periods and are predicted to be very similar to the travel times in the Future Reference Case (i11.4) scenario in the P2T model described in section 5.2. This outcome indicates that the performance of the Project for through traffic is not impacted by the higher growth, as both P-Wk and the Project have sufficient capacity to accommodate the increased traffic.

By comparison, travel times between Warkworth and Wellsford on the Project are predicted to be longer in the higher growth scenario than in the main Project scenario. Since travel times are constant for through traffic on the Project, this increased delay results from additional traffic within Warkworth and Wellsford on the local roads before and after connecting to the Project.

Travel times along the existing SH1 route in the higher traffic growth scenario without the Project are predicted to be higher than in the main Future Reference Case. Travel times along the existing SH1 route in the higher traffic growth scenario with the Project in place are only predicted to be slightly higher than in the main Project Scenario.

6.3.3 Conclusion for higher growth test

It is sensible (and indeed good practice) to carry out a sensitivity test using higher traffic forecasts than those predicted with the "core" scenario. This sensitivity test is considered to have merit in assessing the ability of the Project scenario to accommodate the higher demands. These higher demands may materialise, for example, if the distribution of trips to/from Warkworth changes, as a result of the Project itself or as a result of a change in future land use patterns (e.g. the employment changes made between the i9 and i11.4 land use scenarios).

The higher traffic growth test indicates that even with more traffic in the corridor, the rate of diversion to the Project is similar to the base assessment (about 85%). The increased demand in the model results in higher delays on the existing SH1 and within the local Warkworth network, therefore the Project shows increased travel time benefits in the higher growth scenario.

7 CONCLUSIONS

Section summary

The Project will increase capacity for travel between Warkworth and Te Hana, improving road safety, reducing journey times, and improving reliability of journey times for general traffic and freight. It will improve route security by providing an alternative route built to higher standards, which will be more resilient to incidents. Overall, the Project will meet the objectives identified by the Transport Agency and it will significantly improve the safety, reliability, and resilience of the route.

The Project will provide a new four lane route between Warkworth and north of Te Hana, which will be built to high design standards. It will significantly increase the capacity of the corridor. The transport benefits of the Project are predicted to be as follows:

- The Project will increase corridor capacity between Warkworth and the Northland Region providing an alternative route to the existing SH1. This will reduce congestion through Wellsford and the effects of planned events (such as road maintenance) and unplanned incidents (such as crashes).

- As a result of the increased capacity, the Project will improve travel time reliability for travel between Warkworth and north of Te Hana. The improved travel time reliability will enable individuals and businesses to plan their travel with a much greater degree of certainty and provide a much more resilient network that will be able to cater for some disruption without significant increases in travel time.

- The provision of a high quality four lane alignment will mean that the effects of incidents on travel between Warkworth and Wellsford (due to fatal or serious injury crashes and natural events such as slips and flooding) will be significantly reduced. The Project will also provide an alternative route to the existing SH1 route, improving the resilience of the state highway network.

- The majority of vehicles travelling between Warkworth and north of Wellsford are predicted to transfer from the existing SH1 route to the new, faster route. The new route will be constructed to high design standards and will have an improved crash performance, with a significant reduction in fatal and serious injury crashes, when compared with the existing SH1 route. In addition, the reduced traffic volume on the existing SH1 will reduce crashes on that road.

- All of the benefits detailed above for general traffic in terms of reduced travel times, improved route quality and safety, resilience, and travel time reliability will also be experienced by HCVs. Freight vehicles in particular will receive travel time reduction benefits because of the higher speed horizontal curves and reduced grades along the Project route.

The sensitivity tests carried out show that the benefits of the Project are dependent upon the amount of traffic growth that occurs in the Project Area, with higher growth resulting in more travel time savings compared to the alternative without the Project in place.

As a result of the above, the Project will meet the objectives identified by the Transport Agency and it will significantly improve the safety, reliability, and resilience of the route.

APPENDIX A: MEMORANDUM ON CALCULATION OF AADT

JACOBS

Memorandum

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Date	22 March 2017
Attention	Gavin Smith
From	Caleb Deverell
Subject	**Warkworth Model Study Area AADT Seasonal Adjustment Factors**
Copies to	**Gavin Smith**

1. Overview

The readily available Annual Average Daily Traffic (AADT) factors for Auckland road networks may not be appropriate for use in the Warkworth area covered by the P2T Saturn Model, as prepared by Jacobs. An investigation was performed using traffic counts from along State Highway 1 to determine the local AADT seasonal factors and to compare it to known AADT factors.

An investigation was also performed to determine appropriate factors for conversion of modelled AM, IP and PM peak periods to cover a full day.

In general, the results indicate that a rural urban fringe, as defined in AustRoads Part 3: Traffic Studies and Analysis (2013), is appropriate to represent the Warkworth study area, except for over a Friday to Sunday, where the published factors underestimate the volume of traffic over these days. It is important to note however that although the AustRoads report was published in 2013, the data used for the seasonal adjustment factors is from 2001.

2. Count Sites

Three count sites were used to determine the AADT seasonal adjustment factors. These sites were selected based on the availability of a continuous data set for a full year and their locations relative to the study area. Data was calculated using the 2015 calendar year as this provided a full year with all months included to gather a clear picture of the trends in traffic volumes.

The count sites selected were:

1. 01N00347 – SH1 South of Centennial Park Road (South of Wellsford)
2. 01N00369 – SH1 South of McKinney Road (South of Warkworth)
3. 01N00383 – SH1 South of Puhoi Road

3. Calculation of AADT

The AADT was calculated by summing the total daily count from each site over the entire year and dividing by the number of days the data was available for. Although the sites were active over the entire 2015 year, there are some cases where a few days had no counts recorded. This was likely due to a technical issue with the count equipment.

Table 3-1 presents the AADT for each site.

Table 3-1: AADT

SH1 Site	Southbound	Northbound	Total
South of Wellsford	5,400	5,400	10,800
South of Warkworth	10,500	10,500	21,000
South of Puhoi Road	10,700	10,700	21,400

4. Seasonal Adjustment Factor

The seasonal adjustment factors (SAF) were determined by taking an average of selected samples and comparing this to the AADT calculated for the appropriate site.

Several scenarios were considered, as follows:

- Monday to Sunday factors over the year (not including public holidays)
- Monday to Sunday factors for each month (not including public holidays)
- Part day factors for a typical weekday (Monday to Thursday) (not including public holidays)
- Public holiday factors (including denoting holiday start and holiday end)

4.1 Monday to Sunday factors over the year

The SAFs for Monday to Sunday are shown for each site in **Table 4-1** below. This demonstrates that between sites there is very limited variation (less than 5%) and therefore it is appropriate to use the weighted average values presented across all sites in this region.

Table 4-1: Daily Seasonal Adjustment Factors

Day	SH1 - South of Wellsford	SH1 - South of Warkworth	SH1 - South of Puhoi Road	Weighted Average
Monday	1.12	1.15	1.09	1.12
Tuesday	1.10	1.15	1.09	1.12

Day	SH1 - South of Wellsford	SH1 - South of Warkworth	SH1 - South of Puhoi Road	Weighted Average
Wednesday	1.09	1.13	1.07	1.10
Thursday	1.04	1.08	1.04	1.06
Friday	0.86	0.91	0.89	0.89
Saturday	1.00	0.97	0.96	0.97
Sunday	0.98	1.00	0.98	0.99

Table 4-2 below compares the calculated SAFs to those found in Transfund NZ (2001) as reported in AustRoads Part 3: Traffic Studies and Analysis (2013).

Table 4-2: Day Factor Comparison

Day	Warkworth observed (weighted average of the count sites)	Rural strategic 1	Rural urban fringe	Urban arterial 1 (non-Auckland)
Monday	1.12	1.05	1.14	1.01
Tuesday	1.12	1.01	1.14	0.98
Wednesday	1.10	0.99	1.10	0.95
Thursday	1.06	0.97	1.07	0.94
Friday	0.89	0.97	1.07	0.89
Saturday	0.97	1.09	0.94	1.09
Sunday	0.99	1.1	0.86	1.24

The Warkworth study factors line-up most closely with that of a rural urban fringe. This is indicative of the characteristics of the area, with interfaces between the Warkworth town centre and the rural surrounding area and destinations. This can be seen by the higher weekday factors, indicating lower than average weekday daily volumes, and lower weekend factors, indicating higher than average Saturday and Sunday daily volumes.

4.2 Monday to Sunday factors by month

Table 4-3 presents the weighted average results for each day, split over each month of the year. As could be reasonably expected, the factors presented indicate that during December and January the volumes of traffic are higher than that of the AADT, even when discounting for public holidays. August and September have the least amount of traffic, as indicated by the higher SAFs. In general, the days with the most traffic are Friday and Saturday, followed by Sunday. This is demonstrated by the lower SAFs over these days. Tuesdays have the least traffic volume in general.

Table 4-3: Daily SAFs by month

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Monday	1.03	1.05	1.11	1.04	1.22	1.19	1.22	1.24	1.17	1.27	1.07	0.86
Tuesday	1.04	1.09	1.12	1.04	1.24	1.21	1.21	1.56	1.18	1.32	1.08	0.90
Wednesday	0.93	1.03	1.08	1.06	1.18	1.20	1.19	1.53	1.33	1.33	1.05	0.86
Thursday	0.87	0.92	1.04	0.95	1.13	1.16	1.10	1.45	1.42	1.00	0.99	0.87
Friday	0.75	0.84	0.85	0.85	0.96	1.00	0.95	1.02	1.18	0.84	0.81	0.80
Saturday	0.79	0.89	0.99	0.96	1.09	1.13	1.07	1.12	1.03	0.99	0.95	0.83
Sunday	0.80	0.87	0.92	0.95	1.12	1.14	1.07	1.12	1.25	0.99	0.92	0.82

4.3 Part day factors for a typical midweek

Part day factors were prepared in the event that counts are only taken over a short period within a day. These values are for Monday to Thursday and they do not include public holidays that may fall on these days. **Table 4-4** shows the part day factors for four periods throughout a day. **Table 4-5** compares the values found in the Warkworth study to those reported in AustRoads.

Table 4-4: Part day factors for midweek

Site	7-9am	9am-12pm	1-4pm	4-6pm
SH1 - South of Wellsford	9.55	5.24	4.91	7.25
SH1 - South of Warkworth	8.71	5.51	5.20	6.89
SH1 - South of Puhoi Road	8.32	5.45	5.10	6.53
Weighted Average	8.72	5.43	5.10	6.82

Table 4-5: Part day factors for comparison

Site	7-9am	9am-12pm	1-4pm	4-6pm
Warkworth observed (weighted average of the count sites)	8.72	5.43	5.10	6.82
Rural strategic 1	8.40	4.74	4.41	5.99
Rural urban fringe	8.61	5.59	5.49	6.64

Site	7-9am	9am-12pm	1-4pm	4-6pm
Urban arterial (non-Auckland)	7.31	5.17	4.6	6.00

As with the full week factors, the rural urban fringe best represents the traffic volumes experienced in the Warkworth study.

4.4 Public holiday factors

Public holiday factors were prepared for completeness of the study and to give an indication of the level of demand experienced during these periods compared to the AADT.

Public holiday factors are shown in **Table 4-6**. These factors have been separated into their directional component in order to confirm the directional behaviour of the holidays. Holidays have been grouped into three categories, holiday start – evening, holiday start – day and holiday end. These groups' best defined the public holidays that occur throughout the year.

Both holiday start groups experience a high volume of northbound traffic, and hence a low SAF, while the holiday end experiences a high southbound volume and low SAF.

Table 4-6: Public Holiday SAFs

	Southbound	Northbound
Holiday Start - Evening	0.96	0.64
Holiday Start - Day	1.04	0.73
Holiday End	0.68	1.18

5. Modelled Period Factors

An investigation was performed in order to determine appropriate factors for the periods that have been defined in the P2T model as AM peak, IP and PM peak. The AM peak was modelled as 7-8am, IP as 12-1pm and PM as 4:30-5:30pm.

The AM and PM peak factors were determined in order to adjust the volumes to a two hour period, 7-9am for the AM and 4-6pm for the PM. The IP was then adjusted to ensure the total volume over the day was the same as the AADT values calculated.

Table 5-1 below shows the factors that are required. The AM peak value of 1.98 indicates that the modelled period hour has a higher single hour volume than the hourly volumes of the two hour period selected to represent the AM peak. This indicates that the peak hour selected is a good representation of the AM peak and covers the highest single hour demand during the AM.

The PM factor of 2.04 would suggest that there is a slightly higher volume outside of the hour selected in the model. However, due to the nature of the observed data, volumes were only available on the hour. So the observed data had to take volumes from 4-5pm, rather than the 4:30 to 5:30pm that has been modelled. Given that the factor is only slightly above two, it can be reasonably assumed that 4:30-5:30pm gives a good representation of the PM peak hour.

Table 5-1: Modelled period factors

Time period	AADT factor
AM	1.98
IP	12.58
PM	2.04

6. Conclusions

AADT values were calculated from three continuous count sites, SH1 South of Centennial Park Road (South of Wellsford), SH1 South of McKinney Road and SH1 South of McKinney Road. These sites were then used to determine the seasonal adjustment factors required to convert full day or part day counts in this region to an AADT volume.

The volumes during the week are generally lowest on a Tuesday, while Friday, Saturday and Sunday have the highest volumes of traffic, even when discounting public holidays. This is determined by the higher SAF factors for Tuesday's across over the year and lower factors for Friday to Sunday (as shown in **Table 4-3**.

The results indicate that the Warkworth study area best represents a rural urban fringe, as show in **Table 4-2** and **Table 4-5**. The variation between the study area and rural urban fringe is less than 5% for a full weekday count. For the part day factors, all periods except for 1-4pm are within 5%, while 1-4pm is within 10%. The rural urban fringe factor for 1-4pm is 5.49, while for the study area it is 5.10. This suggests that there is more traffic during this period than what is accounted for by a standard factor. Friday and Sunday have the least correlation, with close to 20% difference on Friday and 13% on Sunday.

It is therefore considered appropriate to use standard published factors for a rural urban fringe for part day counts, with care being taken for the 1-4pm period. For full day counts it is appropriate to use published values for Monday to Thursday, however over Friday to Sunday the seasonal adjustment factor should be carefully selected given that the findings of this study show higher volumes are experienced than what the rural urban fringe factors suggest.

APPENDIX B: COMPARISON OF FORECAST DEMAND, I9 AND I11.4

Table 13 shows a comparison of the input demographics in the ART i9 and i11.4 scenarios.[48]

Table 13 – ART input demographics, Warkworth growth area overview

Scenario I Modified	Scenario I MODIF				Scenario I MODIF				Scenario I MODIF			
	HOUSEHOLD FORECASTS				POPULATION FORECASTS				EMPLOYMENT FORECASTS			
ART 3.2A Zone	2013	2026	2036	2046	2013	2026	2036	2046	2013	2026	2036	2046
Version 9												
1	3,334	3,485	3,412	3,334	8,846	7,749	7,305	6,794	2,864	2,857	2,855	2,864
2	1,377	1,955	2,056	2,149	3,272	4,166	4,356	4,492	1,194	1,191	1,190	1,194
3	1,972	3,075	3,292	3,491	4,573	6,535	6,993	7,362	997	1,028	1,037	1,051
4	1,082	2,336	2,741	2,678	2,583	4,923	5,745	5,635	1,766	1,761	1,760	1,766
5	513	1,098	2,175	2,125	1,282	2,411	4,559	4,471	1,231	1,252	1,300	1,304
6	173	659	1,580	2,001	425	1,410	3,328	4,210	99	232	499	635
7	111	116	2,192	4,172	289	297	4,623	8,780	153	153	580	1,010
8	709	913	1,374	1,950	1,864	2,259	3,210	4,381	500	499	498	500
Total	9,270	13,635	18,821	21,900	23,135	29,751	40,119	46,126	8,804	8,972	9,718	10,324
Version 11.4												
1	3,334	3,564	3,564	3,564	8,846	8,946	8,540	8,159	2,864	3,355	3,324	3,241
2	1,377	1,925	2,033	2,137	3,272	4,338	4,382	4,411	1,194	1,429	1,416	1,381
3	1,972	3,024	3,247	3,463	4,573	6,717	6,978	7,212	997	1,113	1,115	1,099
4	1,082	2,312	2,761	2,757	2,583	5,235	5,985	5,732	1,766	2,199	2,307	2,249
5	513	1,073	2,094	2,091	1,282	2,539	4,729	4,512	1,231	1,726	3,569	3,920
6	173	664	1,591	2,031	425	1,543	3,532	4,307	99	128	127	124
7	111	115	1,837	3,505	289	285	4,333	7,899	153	115	593	2,014
8	709	900	1,352	1,924	1,864	2,239	3,210	4,363	500	503	515	523
Total	9,270	13,579	18,479	21,472	23,135	31,844	41,689	46,596	8,804	10,569	12,965	14,551
Difference												
1	-	79	152	230	-	1,197	1,235	1,365	-	498	469	377
2	-	-29	-24	-12	-	171	26	-81	-	239	226	187
3	-	-51	-45	-28	-	182	-15	-150	-	85	77	48
4	-	-23	20	80	-	313	240	97	-	438	547	484
5	-	-24	-80	-34	-	128	170	41	-	474	2,269	2,616
6	-	5	11	30	-	133	204	96	-	-104	-372	-511
7	-	-0	-355	-667	-	-12	-291	-880	-	-37	14	1,004
8	-	-12	-22	-27	-	-20	0	-18	-	4	16	23
Total	-	-56	-342	-428	-	2,093	1,570	470	-	1,597	3,247	4,227

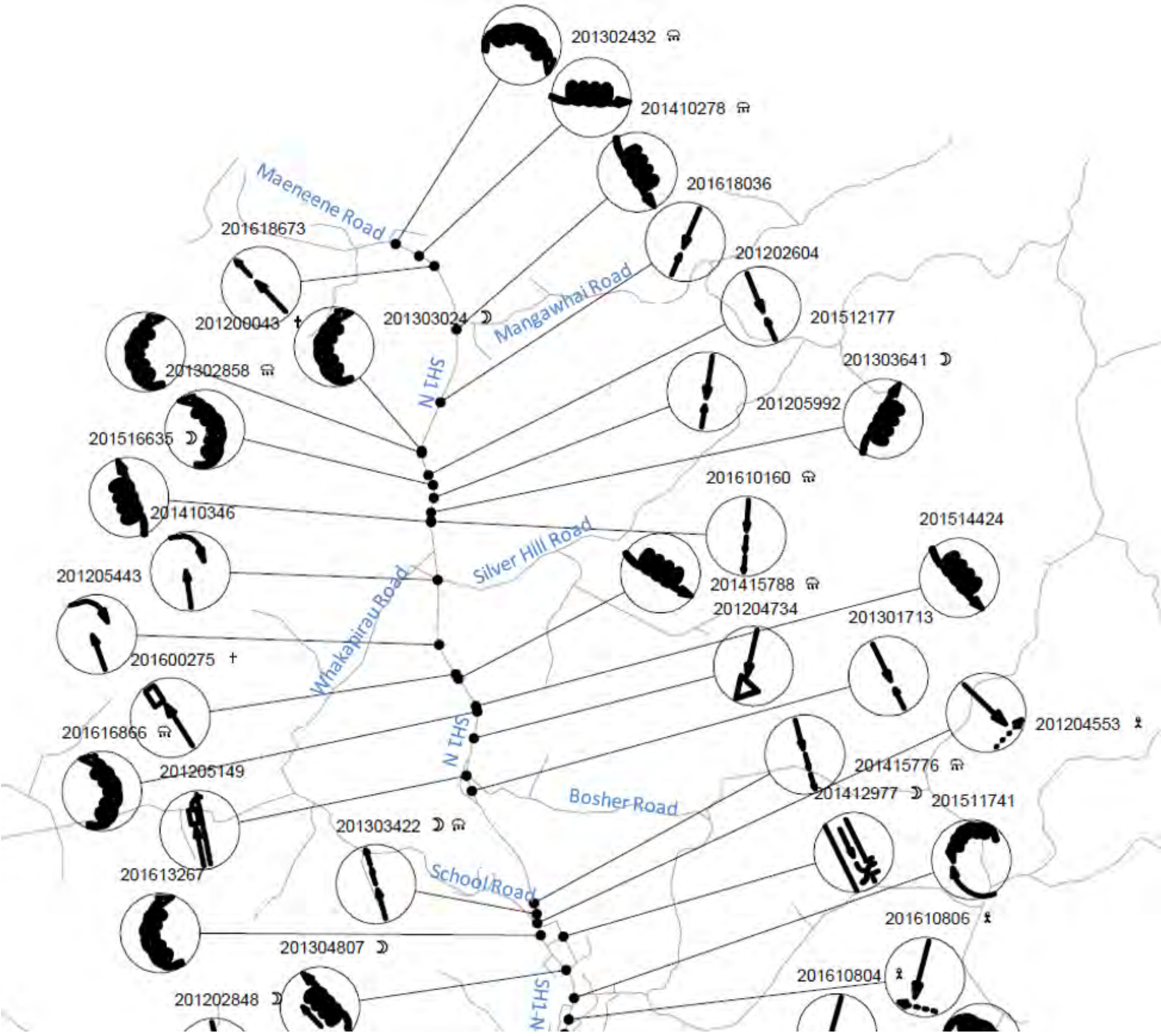
[48] Data provided by Auckland Forecasting Centre via email on 9 August 2017.

APPENDIX C: DETAILS OF ROAD NETWORK CHANGES INCLUDED IN FUTURE MODELS

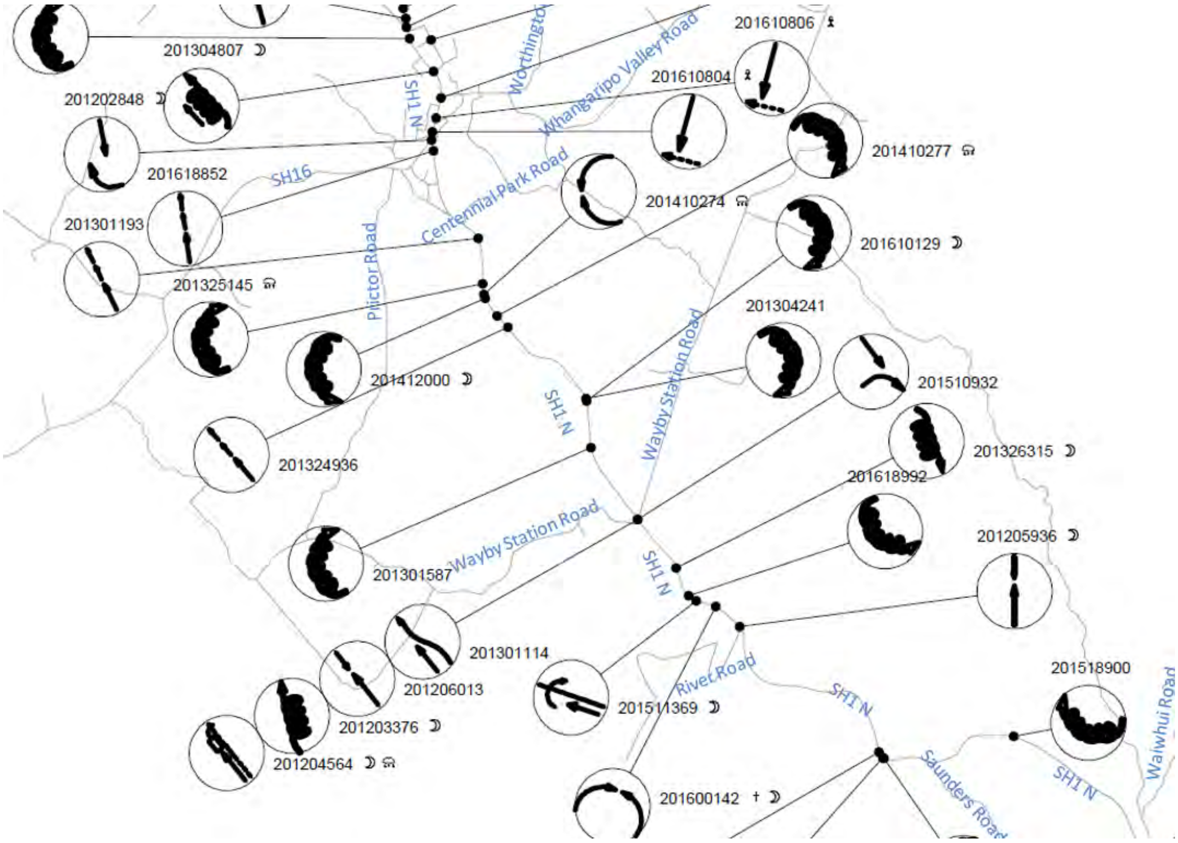
Do Minimum	Future Reference Case Scenario	Project Scenario
Pūhoi to Warkworth Project Matakana link road Western Collector Stage 1	Pūhoi to Warkworth Project Matakana link road Western Collector Full Hauiti Drive-John Andrew new secondary arterial Alnwick Street Connection Matakana to SH1N inner link (i.e. Sandspit Link) Matakana Rd to Sandspit realignment Southern Network	Pūhoi to Warkworth Project Matakana link road Western Collector Full Hauiti Drive-John Andrew new secondary arterial Alnwick Street Connection Matakana to SH1N inner link (i.e. Sandspit Link) Matakana Rd to Sandspit realignment Southern Network Warkworth to Wellsford Project

APPENDIX D: SH1 INJURY CRASH DIAGRAM (2012 – 2016)

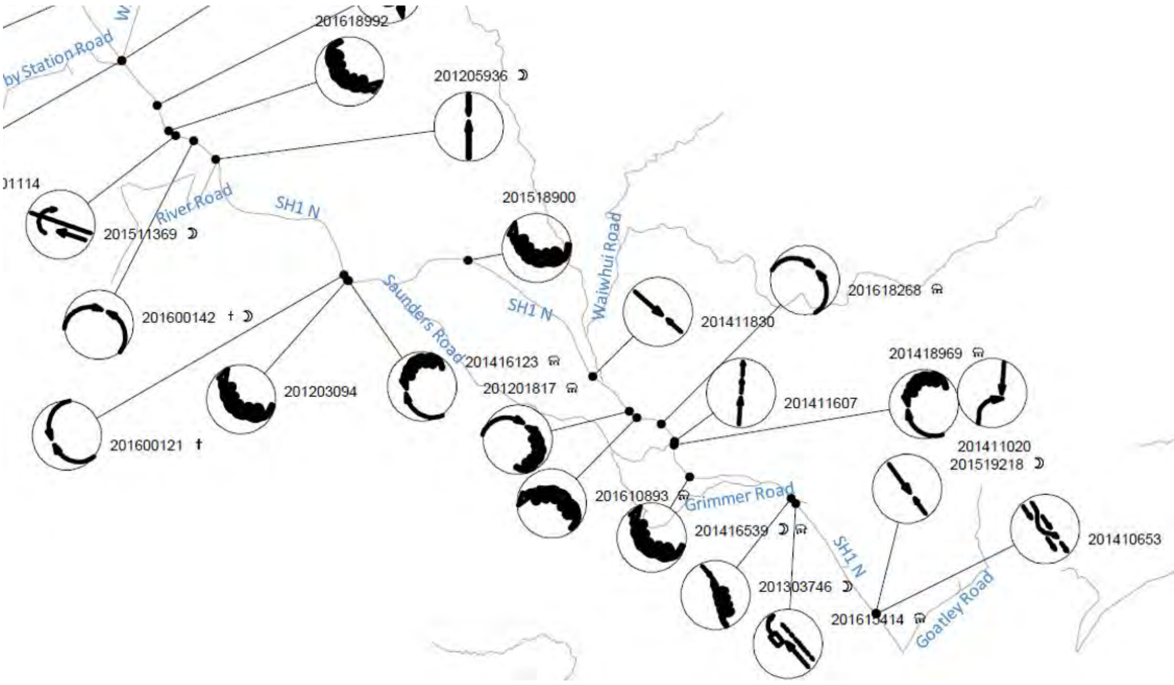
Between north of Mangawhai Road and Wellsford



Between Wellsford and River Road



Between River Road and North of Warkworth (Kaipara Flats Road)



APPENDIX E: TRAFFIC VOLUMES

			Actual Flows			Actual Flows			Actual Flows			Actual Flows		
			Future Reference Case			Project Scenario			Future Reference Case			Project Scenario		
			2036			2036			2046			2046		
Location		**Direction**	Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total	Light	Heavy	Total
SH1 South of Goatley Road	AM	NB	1944	515	68	1966	150	16	1944	631	76	1966	160	17
		SB	1949	572	72	1971	35	9	1949	668	80	1971	34	9
SH1 South of Goatley Road	IP	NB	1944	613	79	1966	150	20	1944	747	88	1966	165	21
		SB	1949	661	93	1971	43	17	1949	787	101	1971	46	17
SH1 South of Goatley Road	PM	NB	1944	820	70	1966	178	18	1944	972	78	1966	181	19
		SB	1949	686	70	1971	58	13	1949	852	78	1971	61	13
SH1 South of Wayby Valley Road	AM	NB	515	68	583	150	16	166	631	76	708	160	17	177
		SB	572	72	644	35	9	44	668	80	748	34	9	43
SH1 South of Wayby Valley Road	IP	NB	613	79	692	150	20	170	747	88	835	165	21	187
		SB	661	93	754	43	17	60	787	101	888	46	17	63
SH1 South of Wayby Valley Road	PM	NB	820	70	890	178	18	196	972	78	1050	181	19	200
		SB	686	70	757	58	13	71	852	78	930	61	13	74
SH1 South of Centennial Park Rd	AM	NB	504	60	563	188	13	201	619	68	686	207	14	222
		SB	546	65	612	189	9	198	642	73	715	193	10	203
SH1 South of Centennial Park Rd	IP	NB	599	73	671	205	14	219	731	82	813	219	15	235
		SB	646	90	736	216	17	233	771	97	868	229	18	246
SH1 South of Centennial Park Rd	PM	NB	784	61	845	259	16	275	934	69	1002	260	17	277
		SB	666	63	729	246	13	259	830	71	901	277	13	290
SH1 South of School Road	AM	NB	597	62	660	288	12	300	673	68	741	268	11	279
		SB	592	70	661	243	13	256	660	76	736	220	12	232
SH1 South of School Road	IP	NB	622	82	703	235	19	254	751	86	837	255	18	273
		SB	664	90	754	244	18	262	763	95	858	273	16	290
SH1 South of School Road	PM	NB	807	57	864	329	13	342	917	63	980	313	12	325
		SB	727	63	790	365	14	379	796	69	865	368	12	381
SH1 South of Silver Hill Road	AM	NB	493	64	556	173	17	190	567	69	636	152	16	167
		SB	516	76	592	154	20	174	586	83	669	133	19	152
SH1 South of Silver Hill Road	IP	NB	534	84	619	138	25	163	681	93	775	151	24	175
		SB	575	97	672	142	25	167	699	103	802	165	23	188
SH1 South of Silver Hill Road	PM	NB	737	62	798	193	17	210	885	75	960	178	16	194
		SB	640	75	715	220	20	239	743	80	824	218	18	237
SH1 South of Mangawhai Road	AM	NB	395	55	450	81	9	89	469	62	530	58	8	66
		SB	435	76	511	77	20	98	507	83	591	59	20	78
SH1 South of Mangawhai Road	IP	NB	439	81	520	47	22	69	565	86	651	56	22	77
		SB	478	94	572	49	21	70	618	102	720	68	21	88
SH1 South of Mangawhai Road	PM	NB	593	51	644	69	7	76	733	58	791	57	7	64
		SB	520	65	585	91	14	106	652	73	725	88	14	102
Woodcocks Road	AM	WB	169	214	42	169	325	39	169	405	62	169	365	59
		EB	156	236	65	156	211	61	156	244	77	156	222	73
Woodcocks Road	IP	WB	1944	613	79	1966	150	20	1944	747	88	1966	165	21
		EB	1949	661	93	1971	43	17	1949	787	101	1971	46	17
Woodcocks Road	PM	WB	1944	820	70	1966	178	18	1944	972	78	1966	181	19
		EB	1949	686	70	1971	58	13	1949	852	78	1971	61	13
Wayby Valley Road	AM	WB	1944	515	68	1966	150	16	1944	631	76	1966	160	17
		EB	1949	572	72	1971	35	9	1949	668	80	1971	34	9
Wayby Valley Road	IP	WB	1920	599	73	1942	205	14	1920	731	82	1942	219	15
		EB	1921	646	90	1943	216	17	1921	771	97	1943	229	18
Wayby Valley Road	PM	WB	1920	784	61	1942	259	16	1920	934	69	1942	260	17
		EB	1921	666	63	1943	246	13	1921	830	71	1943	277	13
Kaipara Coast Hwy	AM	WB	1920	504	60	1942	188	13	1920	619	68	1942	207	14
		EB	1921	546	65	1943	189	9	1921	642	73	1943	193	10
Kaipara Coast Hwy	IP	WB	1900	622	82	1922	235	19	1900	751	86	1922	255	18
		EB	1901	664	90	1923	244	18	1901	763	95	1923	273	16
Kaipara Coast Hwy	PM	WB	1900	807	57	1922	329	13	1900	917	63	1922	313	12
		EB	1901	727	63	1923	365	14	1901	796	69	1923	368	12
Whangaripo Valley Rd (Matheson Road extension)	AM	WB	1900	597	62	1922	288	12	1900	673	68	1922	268	11
		EB	1901	592	70	1923	243	13	1901	660	76	1923	220	12
Whangaripo Valley Rd (Matheson Road extension)	IP	WB	1824	534	84	1846	138	25	1824	681	93	1846	151	24
		EB	1969	575	97	1991	142	25	1969	699	103	1991	165	23
Whangaripo Valley Rd (Matheson Road extension)	PM	WB	1824	737	62	1846	193	17	1824	885	75	1846	178	16
		EB	1969	640	75	1991	220	20	1969	743	80	1991	218	18
Mangawhai Road	AM	WB	1824	493	64	1846	173	17	1824	567	69	1846	152	16
		EB	1969	516	76	1991	154	20	1969	586	83	1991	133	19
Mangawhai Road	IP	WB	1649	439	81	1648	47	22	1649	565	86	1648	56	22
		EB	1650	478	94	1649	49	21	1650	618	102	1649	68	21
Mangawhai Road	PM	WB	1649	593	51	1648	69	7	1649	733	58	1648	57	7
		EB	1650	520	65	1649	91	14	1650	652	73	1649	88	14

APPENDIX F: INTERCHANGE ANALYSIS

technical note

PROJECT	**WARKWORTH TO WELLSFORD PROJECT**
SUBJECT	**FORECAST OPERATION OF TE HANA, WELLSFORD INTERCHANGE AND WARKWORTH TERMINATION ROUNDABOUT**
TO	**PROJECT TEAM**
FROM	JULIE LIU/QING LI
REVIEWED BY	IAN CLARK
DATE	30 OCTOBER 2017

1 INTRODUCTION

This section of the report summarises the results of SIDRA tests which consider the forecast operation of seven roundabouts, at or near to the three interchanges proposed along the Wellsford to Warkworth project, namely at Te Hana, Wellsford, and Warkworth.

The forecast flows have been taken from the latest SATURN model (see details at Section 2.2 of this report). The SATURN model provides forecasts in terms of passenger car units (or PCUs), so in using these flows, the HCV percentages have been set to zero in SIDRA.

The layouts assumed in SIDRA are shown in the figures for each roundabout.

The analysis focuses on the predicted performance of the roundabouts in the year 2046, for the weekday morning peak, inter peak and evening peak time periods.

2 TE HANA INTERCHANGE

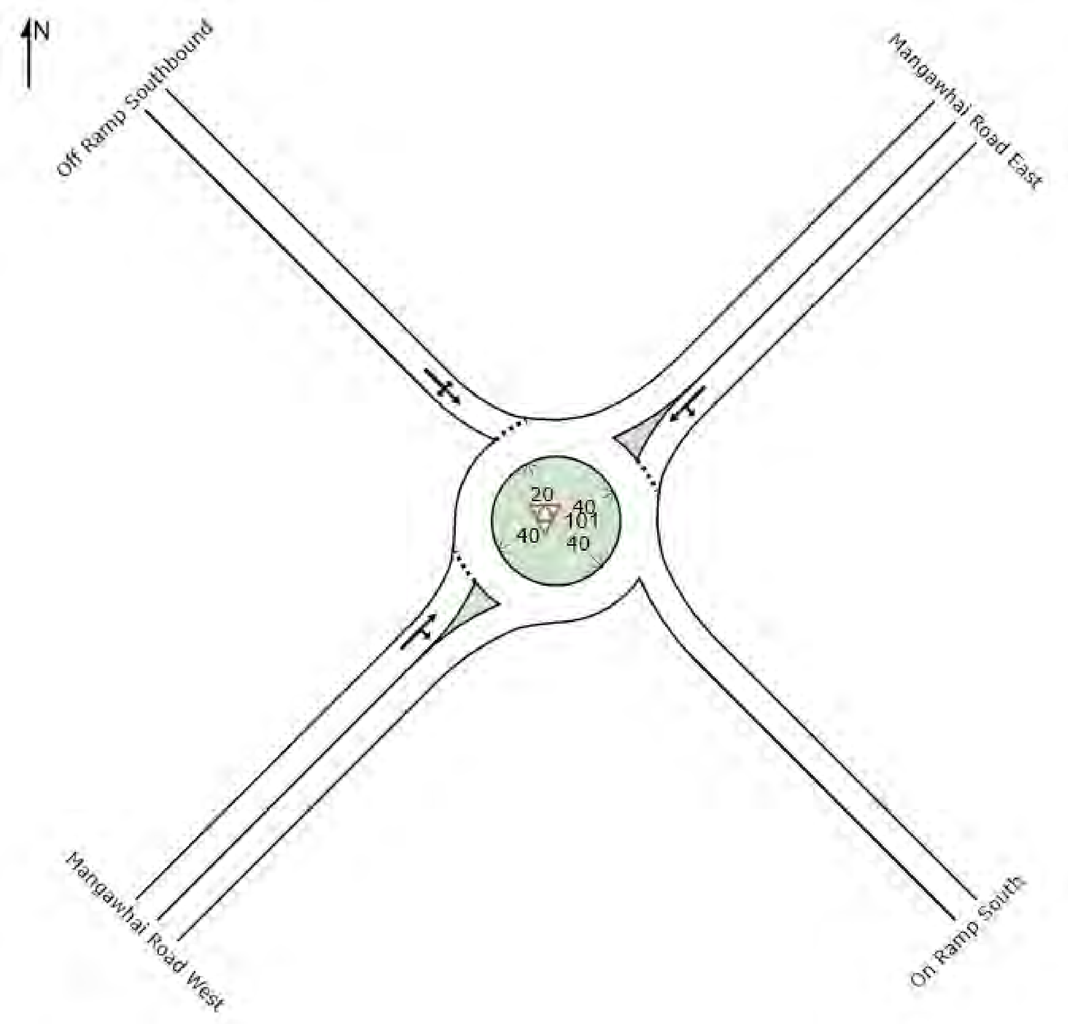
This interchange will include three roundabouts as shown within Plan ??:

- A roundabout at the intersection of Mangawhai Road with the southbound off and on ramps
- A roundabout at the intersection of Mangawhai Road with the northbound off and on ramps
- A roundabout at the intersection of Mangawhai Road with the existing SH1 (i.e. providing a connection between the existing SH1, and the proposed expressway interchange).

2.1 Roundabout of Mangawhai Road and the southbound off and on ramps

The modelled layout for the roundabout at the intersection of Mangawhai Road with the southbound off and on ramps is shown in Figure 1. The plan indicates single lane entries on each of the three approaches (with the southbound on ramp being a single lane exit).

Figure 1: Modelled Layout of Mangawhai Road/Southbound Ramps Intersection



The predicted performance of the roundabout in 2046 is summarised in Figures 2 to 4, for the weekday morning, inter peak and evening peaks.

Figure 2: Predicted Performance of Mangawhai Road/Southbound Ramps Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 2-node 675 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Mangawhai Road East											
24	L2	1	0.0	0.034	3.0	LOS A	0.2	1.1	0.03	0.28	57.6
25	T1	58	0.0	0.034	2.7	LOS A	0.2	1.1	0.03	0.28	59.8
Approach		59	0.0	0.034	2.7	LOS A	0.2	1.1	0.03	0.28	59.8
NorthWest: Off Ramp Southbound											
27	L2	1	0.0	0.002	4.0	LOS A	0.0	0.1	0.11	0.48	54.0
28	T1	1	0.0	0.002	3.5	LOS A	0.0	0.1	0.11	0.48	56.2
29	R2	1	0.0	0.002	9.4	LOS A	0.0	0.1	0.11	0.48	57.0
Approach		3	0.0	0.002	5.6	LOS A	0.0	0.1	0.11	0.48	55.7
SouthWest: Mangawhai Road West											
31	T1	28	0.0	0.016	3.4	LOS A	0.0	0.0	0.00	0.36	58.3
32	R2	1	0.0	0.016	9.2	LOS A	0.0	0.0	0.00	0.36	59.1
Approach		29	0.0	0.016	3.6	LOS A	0.0	0.0	0.00	0.36	58.3
All Vehicles		92	0.0	0.034	3.1	LOS A	0.2	1.1	0.02	0.31	59.2

Figure 3: Predicted Performance of Mangawhai Road/SH1 Southbound Ramps Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 2-node 675 IP]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Mangawhai Road East											
24	L2	1	0.0	0.033	3.0	LOS A	0.2	1.1	0.03	0.28	57.6
25	T1	56	0.0	0.033	2.7	LOS A	0.2	1.1	0.03	0.28	59.8
Approach		57	0.0	0.033	2.7	LOS A	0.2	1.1	0.03	0.28	59.8
NorthWest: Off Ramp Southbound											
27	L2	1	0.0	0.002	4.1	LOS A	0.0	0.1	0.17	0.47	53.8
28	T1	1	0.0	0.002	3.7	LOS A	0.0	0.1	0.17	0.47	56.0
29	R2	1	0.0	0.002	9.5	LOS A	0.0	0.1	0.17	0.47	56.7
Approach		3	0.0	0.002	5.8	LOS A	0.0	0.1	0.17	0.47	55.5
SouthWest: Mangawhai Road West											
31	T1	61	0.0	0.034	3.4	LOS A	0.0	0.0	0.00	0.35	58.4
32	R2	1	0.0	0.034	9.2	LOS A	0.0	0.0	0.00	0.35	59.2
Approach		62	0.0	0.034	3.5	LOS A	0.0	0.0	0.00	0.35	58.4
All Vehicles		122	0.0	0.034	3.2	LOS A	0.2	1.1	0.02	0.32	59.0

Figure 4: Predicted Performance of Mangawhai Road/Southbound Ramps Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 2-node 675 PM]

New Site
Roundabout

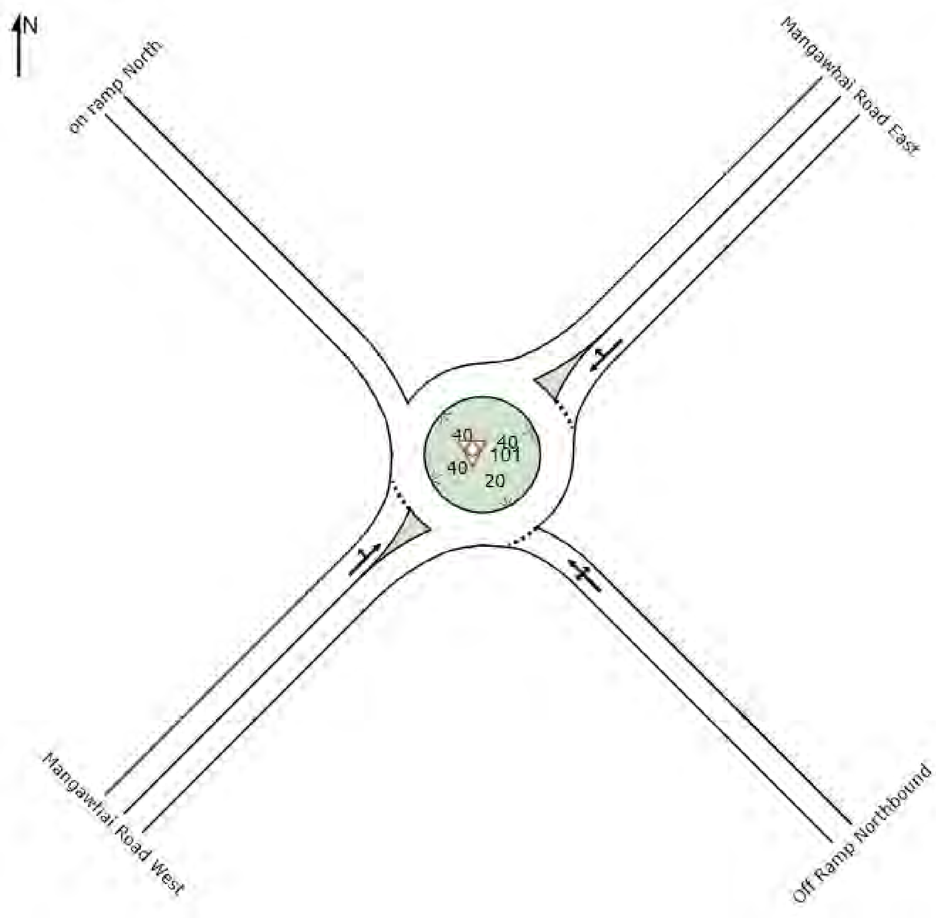
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Mangawhai Road East											
24	L2	1	0.0	0.024	3.0	LOS A	0.1	0.8	0.03	0.28	57.6
25	T1	40	0.0	0.024	2.7	LOS A	0.1	0.8	0.03	0.28	59.8
Approach		41	0.0	0.024	2.7	LOS A	0.1	0.8	0.03	0.28	59.7
NorthWest: Off Ramp Southbound											
27	L2	1	0.0	0.002	4.0	LOS A	0.0	0.1	0.12	0.48	54.0
28	T1	1	0.0	0.002	3.5	LOS A	0.0	0.1	0.12	0.48	56.2
29	R2	1	0.0	0.002	9.4	LOS A	0.0	0.1	0.12	0.48	57.0
Approach		3	0.0	0.002	5.6	LOS A	0.0	0.1	0.12	0.48	55.7
SouthWest: Mangawhai Road West											
31	T1	31	0.0	0.017	3.4	LOS A	0.0	0.0	0.00	0.36	58.3
32	R2	1	0.0	0.017	9.2	LOS A	0.0	0.0	0.00	0.36	59.1
Approach		32	0.0	0.017	3.6	LOS A	0.0	0.0	0.00	0.36	58.3
All Vehicles		76	0.0	0.024	3.2	LOS A	0.1	0.8	0.02	0.32	59.0

It is predicted that the intersection will operate well within its capacity with the forecast 2046 volumes.

2.2 Roundabout of Mangawhai Road and the northbound off and on ramps

The modelled layout for the roundabout at the intersection of Mangawhai Road with the northbound off and on ramps is shown in Figure 5. The plan indicates single lane entries on each of the three approaches (with the northbound on ramp being a single lane exit).

Figure 5: Modelled Layout of Mangawhai Road/Northbound Ramps Intersection



The predicted performance of the roundabout in 2046 is summarised in Figures 6 to 8, for the weekday morning, inter peak and evening peaks.

Figure 6: Predicted Performance of Mangawhai Road/Northbound Ramps Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 1-node 674 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp Northbound											
21	L2	1	0.0	0.002	4.3	LOS A	0.0	0.1	0.23	0.47	53.6
22	T1	1	0.0	0.002	3.8	LOS A	0.0	0.1	0.23	0.47	55.7
23	R2	1	0.0	0.002	9.6	LOS A	0.0	0.1	0.23	0.47	56.5
Approach		3	0.0	0.002	5.9	LOS A	0.0	0.1	0.23	0.47	55.3
NorthEast: Mangawhai Road East											
25	T1	103	0.0	0.057	3.4	LOS A	0.0	0.0	0.00	0.35	58.4
26	R2	1	0.0	0.057	9.2	LOS A	0.0	0.0	0.00	0.35	59.3
Approach		104	0.0	0.057	3.5	LOS A	0.0	0.0	0.00	0.35	58.4
SouthWest: Mangawhai Road West											
30	L2	51	0.0	0.045	3.0	LOS A	0.2	1.5	0.03	0.34	57.5
31	T1	28	0.0	0.045	2.7	LOS A	0.2	1.5	0.03	0.34	59.7
Approach		79	0.0	0.045	2.9	LOS A	0.2	1.5	0.03	0.34	58.2
All Vehicles		186	0.0	0.057	3.3	LOS A	0.2	1.5	0.02	0.35	58.3

Figure 7: Predicted Performance of Mangawhai Road/Northbound Ramps Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 1-node 674 IP]

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp Northbound											
21	L2	1	0.0	0.002	4.3	LOS A	0.0	0.1	0.24	0.47	53.6
22	T1	1	0.0	0.002	3.9	LOS A	0.0	0.1	0.24	0.47	55.7
23	R2	1	0.0	0.002	9.7	LOS A	0.0	0.1	0.24	0.47	56.4
Approach		3	0.0	0.002	6.0	LOS A	0.0	0.1	0.24	0.47	55.2
NorthEast: Whangawhai Road East											
25	T1	115	0.0	0.064	3.4	LOS A	0.0	0.0	0.00	0.35	58.4
26	R2	1	0.0	0.064	9.2	LOS A	0.0	0.0	0.00	0.35	59.3
Approach		116	0.0	0.064	3.5	LOS A	0.0	0.0	0.00	0.35	58.4
SouthWest: Mangawhai Road West											
30	L2	43	0.0	0.060	3.0	LOS A	0.3	2.1	0.03	0.32	57.5
31	T1	61	0.0	0.060	2.7	LOS A	0.3	2.1	0.03	0.32	59.7
Approach		104	0.0	0.060	2.9	LOS A	0.3	2.1	0.03	0.32	58.8
All Vehicles		223	0.0	0.064	3.2	LOS A	0.3	2.1	0.02	0.34	58.6

Figure 8: Predicted Performance of Mangawhai Road/Northbound Ramps Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 1-node 674 PM]

New Site
Roundabout

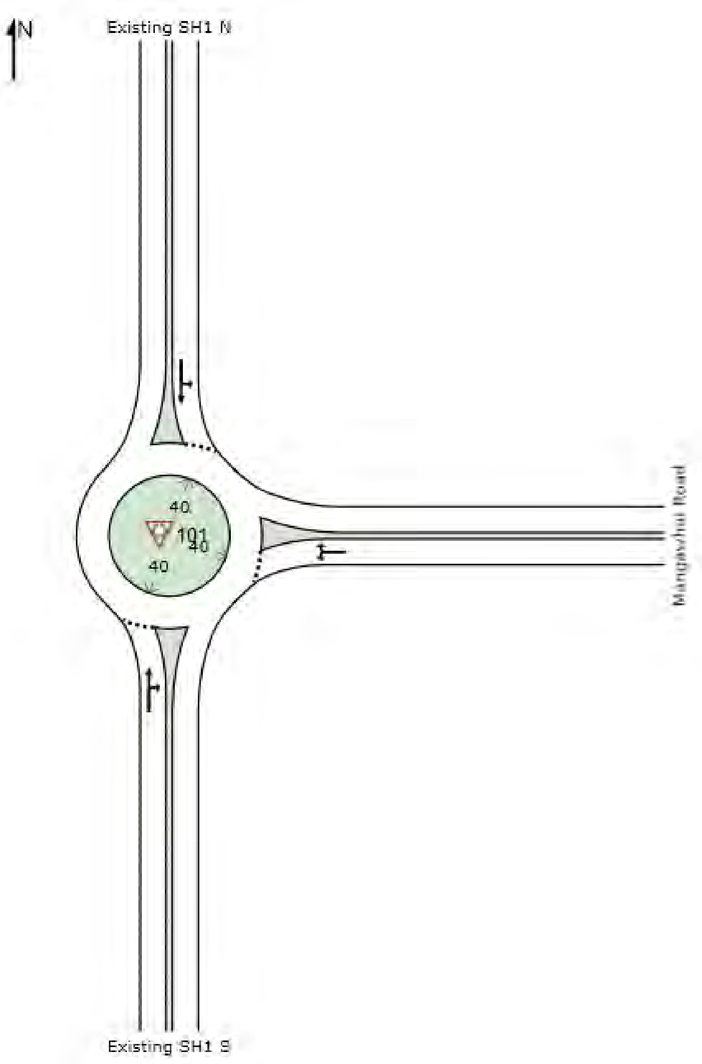
Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp Northbound											
21	L2	1	0.0	0.003	4.4	LOS A	0.0	0.1	0.25	0.47	53.5
22	T1	1	0.0	0.003	3.9	LOS A	0.0	0.1	0.25	0.47	55.6
23	R2	1	0.0	0.003	9.7	LOS A	0.0	0.1	0.25	0.47	56.4
Approach		3	0.0	0.003	6.0	LOS A	0.0	0.1	0.25	0.47	55.2
NorthEast: Whangawhai Road East											
25	T1	122	0.0	0.068	3.4	LOS A	0.0	0.0	0.00	0.35	58.4
26	R2	2	0.0	0.068	9.2	LOS A	0.0	0.0	0.00	0.35	59.2
Approach		124	0.0	0.068	3.5	LOS A	0.0	0.0	0.00	0.35	58.4
SouthWest: Mangawhai Road West											
30	L2	43	0.0	0.043	3.0	LOS A	0.2	1.4	0.03	0.33	57.4
31	T1	31	0.0	0.043	2.7	LOS A	0.2	1.4	0.03	0.33	59.6
Approach		74	0.0	0.043	2.9	LOS A	0.2	1.4	0.03	0.33	58.3
All Vehicles		201	0.0	0.068	3.3	LOS A	0.2	1.4	0.02	0.35	58.3

The above results indicate that the intersection will operate well within capacity with the forecast traffic volumes in 2046.

2.3 Intersection of Existing SH1/Mangawhai Road

The modelled layout for the roundabout at the intersection of the existing SH1 with Mangawhai Road (ie the road leading to the Te Hana interchange) is shown in Figure 9. The plan indicates single lane entries on each of the three approaches.

Figure 9: Modelled Layout at Intersection of Existing SH1/Mangawhai Road



The predicted performance of the roundabout in 2046 is summarised in Figures 10 to 12, for the weekday morning, inter peak and evening peaks.

Figure 10: Predicted Performance of Existing SH1/Mangawhai Road Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 3-node 551 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South: Existing SH1 S											
2	T1	11	0.0	0.054	2.8	LOS A	0.2	1.7	0.06	0.60	54.8
3	R2	79	0.0	0.054	9.4	LOS A	0.2	1.7	0.06	0.60	55.5
Approach		89	0.0	0.054	8.7	LOS A	0.2	1.7	0.06	0.60	55.5
East: Mangawhai Road											
4	L2	103	0.0	0.063	3.0	LOS A	0.3	2.2	0.01	0.41	56.9
6	R2	11	0.0	0.063	9.4	LOS A	0.3	2.2	0.01	0.41	60.0
Approach		114	0.0	0.063	3.6	LOS A	0.3	2.2	0.01	0.41	57.2
North: Existing SH1 N											
7	L2	1	0.0	0.001	3.3	LOS A	0.0	0.0	0.19	0.32	56.7
8	T1	1	0.0	0.001	3.0	LOS A	0.0	0.0	0.19	0.32	58.8
Approach		2	0.0	0.001	3.1	LOS A	0.0	0.0	0.19	0.32	57.7
All Vehicles		205	0.0	0.063	5.8	LOS A	0.3	2.2	0.04	0.49	56.4

Figure 11: Predicted Performance of Existing SH1/Mangawhai Road Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 3-node 551 IP]

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South: Existing SH1 S											
2	T1	11	0.0	0.068	2.8	LOS A	0.3	2.2	0.06	0.60	54.7
3	R2	104	0.0	0.068	9.4	LOS A	0.3	2.2	0.06	0.60	55.4
Approach		115	0.0	0.068	8.8	LOS A	0.3	2.2	0.06	0.60	55.3
East: Mangawhai Road											
4	L2	115	0.0	0.069	3.0	LOS A	0.4	2.5	0.02	0.41	57.0
6	R2	11	0.0	0.069	9.4	LOS A	0.4	2.5	0.02	0.41	60.0
Approach		125	0.0	0.069	3.6	LOS A	0.4	2.5	0.02	0.41	57.2
North: Existing SH1 N											
7	L2	1	0.0	0.001	3.3	LOS A	0.0	0.0	0.22	0.32	56.5
8	T1	1	0.0	0.001	3.1	LOS A	0.0	0.0	0.22	0.32	58.6
Approach		2	0.0	0.001	3.2	LOS A	0.0	0.0	0.22	0.32	57.6
All Vehicles		242	0.0	0.069	6.0	LOS A	0.4	2.5	0.04	0.50	56.3

Figure 12: Predicted Performance of Existing SH1/Mangawhai Road Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 3-node 551 PM]

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop Queued	Effective Stop Rate per veh	Average Speed km/h
South: Existing SH1 S											
2	T1	11	0.0	0.051	2.8	LOS A	0.2	1.6	0.06	0.60	54.8
3	R2	74	0.0	0.051	9.4	LOS A	0.2	1.6	0.06	0.60	55.6
Approach		84	0.0	0.051	8.6	LOS A	0.2	1.6	0.06	0.60	55.5
East: Mangawhai Road											
4	L2	122	0.0	0.073	3.0	LOS A	0.4	2.6	0.02	0.41	57.0
6	R2	11	0.0	0.073	9.4	LOS A	0.4	2.6	0.02	0.41	60.1
Approach		133	0.0	0.073	3.5	LOS A	0.4	2.6	0.02	0.41	57.2
North: Existing SH1 N											
7	L2	1	0.0	0.001	3.2	LOS A	0.0	0.0	0.18	0.32	56.7
8	T1	1	0.0	0.001	3.0	LOS A	0.0	0.0	0.18	0.32	58.9
Approach		2	0.0	0.001	3.1	LOS A	0.0	0.0	0.18	0.32	57.8
All Vehicles		219	0.0	0.073	5.5	LOS A	0.4	2.6	0.03	0.48	56.5

It is predicted that the intersection will operate well within its capacity with the forecast 2046 volumes.

3 WELLSFORD INTERCHANGE

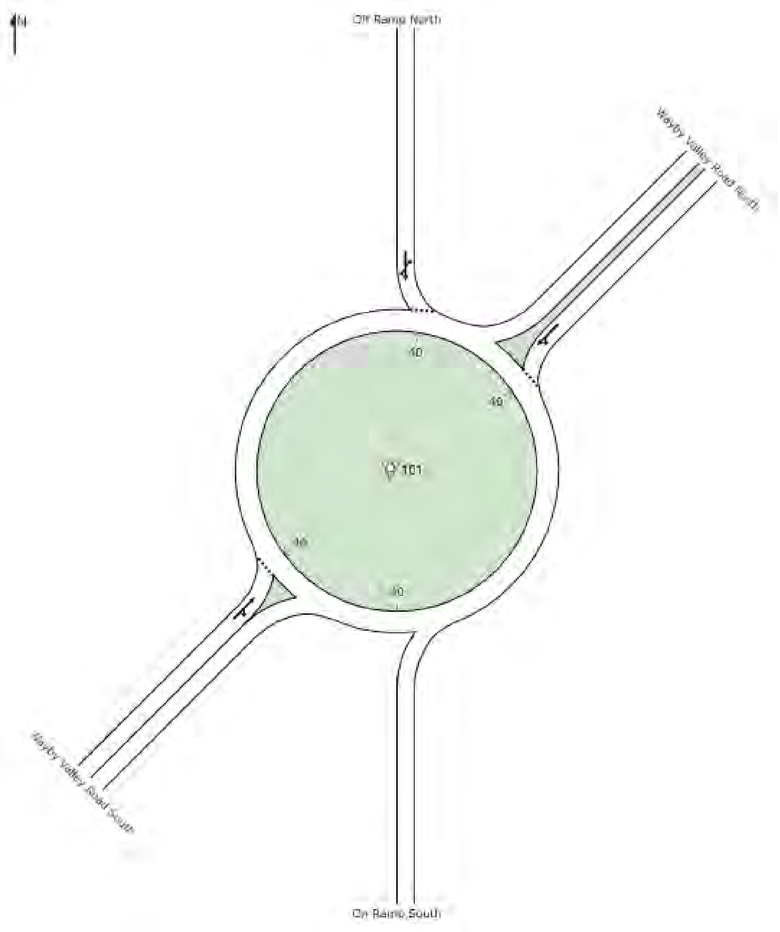
This interchange will include three roundabouts as shown within Plan ??:

- A roundabout at the intersection of Wayby Valley Road with the southbound off and on ramps
- A roundabout at the intersection of Wayby Valley Road with the northbound off and on ramps
- A roundabout at the intersection of Wayby Valley Road with the existing SH1 (i.e. providing a connection between the existing ShH, and the proposed expressway interchange).

3.1 Roundabout of Wayby Valley Road and the southbound off and on ramps

The modelled layout for the roundabout at the intersection of Wayby Valley Road with the southbound off and on ramps is shown in Figure 13. The plan indicates single lane entries on each of the three approaches (with the southbound on ramp being a single lane exit).

Figure 13: Modelled Layout of Wayby Valley Road /Southbound Ramps Intersection



The predicted performance of the roundabout in 2046 is summarised in Figures 14 to 16, for the weekday morning, inter peak and evening peaks.

Figure 14: Predicted Performance of Wayby Valley Road/SH1 Southbound Ramps Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 4-node 688 AM]

New Site
Roundabout

Movement Performance - Vehicles												
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Wayby Valley Road North											
24a	L1	2	0.0	0.030	3.0	LOS A	0.1	1.0	0.29	0.34	57.4
25	T1	39	0.0	0.030	3.3	LOS A	0.1	1.0	0.29	0.34	58.2
Approach		41	0.0	0.030	3.3	LOS A	0.1	1.0	0.29	0.34	58.1
North: Off Ramp North											
7b	L3	1	0.0	0.002	3.8	LOS A	0.0	0.1	0.31	0.44	54.1
8	T1	1	0.0	0.002	3.4	LOS A	0.0	0.1	0.31	0.44	56.8
9a	R1	1	0.0	0.002	8.8	LOS A	0.0	0.1	0.31	0.44	56.7
Approach		3	0.0	0.002	5.3	LOS A	0.0	0.1	0.31	0.44	55.8
SouthWest: Wayby Valley Road South											
31	T1	32	0.0	0.111	2.7	LOS A	0.0	0.0	0.00	0.65	54.5
32b	R3	172	0.0	0.111	10.7	LOS B	0.0	0.0	0.00	0.65	56.0
Approach		203	0.0	0.111	9.4	LOS A	0.0	0.0	0.00	0.65	55.8
All Vehicles		247	0.0	0.111	8.4	LOS A	0.1	1.0	0.05	0.59	56.1

Figure 15: Predicted Performance of Wayby Valley Road/SH1 Southbound Ramps Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 4-node 688 IP]

New Site
Roundabout

Movement Performance - Vehicles											
Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Wayby Valley Road North											
24a	L1	2	0.0	0.017	3.1	LOS A	0.1	0.6	0.31	0.34	57.3
25	T1	21	0.0	0.017	3.4	LOS A	0.1	0.6	0.31	0.34	58.1
Approach		23	0.0	0.017	3.4	LOS A	0.1	0.6	0.31	0.34	58.0
North: Off Ramp North											
7b	L3	1	0.0	0.002	3.9	LOS A	0.0	0.1	0.33	0.45	54.0
8	T1	1	0.0	0.002	3.5	LOS A	0.0	0.1	0.33	0.45	56.8
9a	R1	1	0.0	0.002	8.9	LOS A	0.0	0.1	0.33	0.45	56.6
Approach		3	0.0	0.002	5.4	LOS A	0.0	0.1	0.33	0.45	55.8
SouthWest: Wayby Valley Road South											
31	T1	29	0.0	0.124	2.7	LOS A	0.0	0.0	0.00	0.65	54.3
32b	R3	197	0.0	0.124	10.7	LOS B	0.0	0.0	0.00	0.65	55.9
Approach		226	0.0	0.124	9.6	LOS A	0.0	0.0	0.00	0.65	55.7
All Vehicles		253	0.0	0.124	9.0	LOS A	0.1	0.6	0.03	0.62	55.9

Figure 16: Predicted Performance of Wayby Valley Road/SH1 Southbound Ramps Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 4-node 688 PM]

New Site
Roundabout

Movement Performance - Vehicles

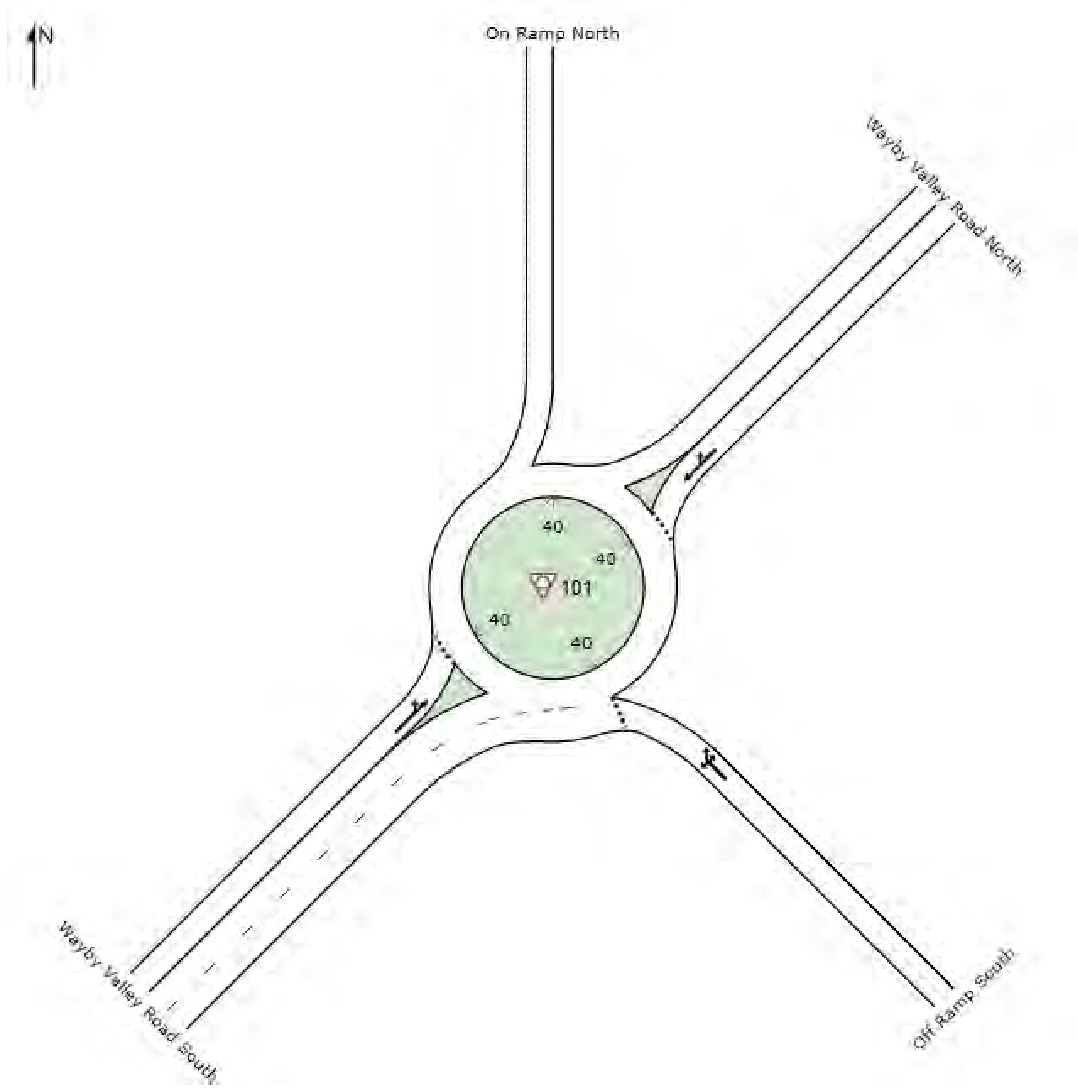
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
NorthEast: Wayby Valley Road North											
24a	L1	3	0.0	0.030	3.3	LOS A	0.1	1.0	0.34	0.36	57.2
25	T1	37	0.0	0.030	3.6	LOS A	0.1	1.0	0.34	0.36	57.9
Approach		40	0.0	0.030	3.5	LOS A	0.1	1.0	0.34	0.36	57.8
North: Off Ramp North											
7b	L3	1	0.0	0.002	4.2	LOS A	0.0	0.1	0.38	0.45	53.8
8	T1	1	0.0	0.002	3.7	LOS A	0.0	0.1	0.38	0.45	56.6
9a	R1	1	0.0	0.002	9.1	LOS A	0.0	0.1	0.38	0.45	56.4
Approach		3	0.0	0.002	5.7	LOS A	0.0	0.1	0.38	0.45	55.6
SouthWest: Wayby Valley Road South											
31	T1	59	0.0	0.159	2.7	LOS A	0.0	0.0	0.00	0.64	54.7
32b	R3	232	0.0	0.159	10.7	LOS B	0.0	0.0	0.00	0.64	56.3
Approach		291	0.0	0.159	9.1	LOS A	0.0	0.0	0.00	0.64	56.0
All Vehicles		334	0.0	0.159	8.4	LOS A	0.1	1.0	0.04	0.60	56.2

It is predicted that the intersection will operate well within its capacity with the forecast 2046 volumes.

3.2 Roundabout of Wayby Valley Road and the northbound off and on ramps

The modelled layout for the roundabout at the intersection of Wayby Valley Road with the northbound off and on ramps is shown in Figure 17. The plan indicates single lane entries on each of the three approaches (with the northbound on ramp being a single lane exit).

Figure 17: Modelled Layout of Wayby Valley Road /Southbound Ramps Intersection- node 689



The predicted performance of the roundabout in 2046 is summarised in Figures 18 to 20, for the weekday morning, inter peak and evening peaks.

Figure 18: Predicted Performance of Wayby Valley Road/SH1 Northbound Ramps Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 5-node 689 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp South											
21	L2	55	0.0	0.048	3.0	LOS A	0.2	1.5	0.03	0.49	55.6
23a	R1	1	0.0	0.048	8.1	LOS A	0.2	1.5	0.03	0.49	57.5
23	R2	27	0.0	0.048	9.4	LOS A	0.2	1.5	0.03	0.49	58.5
Approach		83	0.0	0.048	5.2	LOS A	0.2	1.5	0.03	0.49	56.5
NorthEast: Wayby Valley Road North											
25	T1	2	0.0	0.002	2.7	LOS A	0.0	0.0	0.00	0.47	57.6
26b	R3	1	0.0	0.002	10.7	LOS B	0.0	0.0	0.00	0.47	59.4
Approach		3	0.0	0.002	5.4	LOS A	0.0	0.0	0.00	0.47	58.2
SouthWest: Wayby Valley Road South											
30a	L1	6	0.0	0.113	2.5	LOS A	0.6	3.9	0.11	0.28	58.5
31	T1	176	0.0	0.113	2.8	LOS A	0.6	3.9	0.11	0.28	59.3
Approach		182	0.0	0.113	2.8	LOS A	0.6	3.9	0.11	0.28	59.3
All Vehicles		268	0.0	0.113	3.6	LOS A	0.6	3.9	0.08	0.35	58.4

Figure 19: Predicted Performance of Wayby Valley Road/SH1 Northbound Ramps Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 5-node 689 IP]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp South											
21	L2	61	0.0	0.050	3.0	LOS A	0.2	1.6	0.03	0.47	55.8
23a	R1	1	0.0	0.050	8.1	LOS A	0.2	1.6	0.03	0.47	57.7
23	R2	24	0.0	0.050	9.4	LOS A	0.2	1.6	0.03	0.47	58.7
Approach		86	0.0	0.050	4.9	LOS A	0.2	1.6	0.03	0.47	56.6
NorthEast: Wayby Valley Road North											
25	T1	3	0.0	0.002	2.7	LOS A	0.0	0.0	0.00	0.43	58.2
26b	R3	1	0.0	0.002	10.7	LOS B	0.0	0.0	0.00	0.43	60.0
Approach		4	0.0	0.002	4.7	LOS A	0.0	0.0	0.00	0.43	58.6
SouthWest: Wayby Valley Road South											
30a	L1	12	0.0	0.131	2.5	LOS A	0.7	4.6	0.11	0.28	58.6
31	T1	202	0.0	0.131	2.8	LOS A	0.7	4.6	0.11	0.28	59.3
Approach		214	0.0	0.131	2.8	LOS A	0.7	4.6	0.11	0.28	59.3
All Vehicles		304	0.0	0.131	3.4	LOS A	0.7	4.6	0.08	0.34	58.5

Figure 20: Predicted Performance of Wayby Valley Road/SH1 Northbound Ramps Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 5-node 689 PM]

New Site
Roundabout

Movement Performance - Vehicles

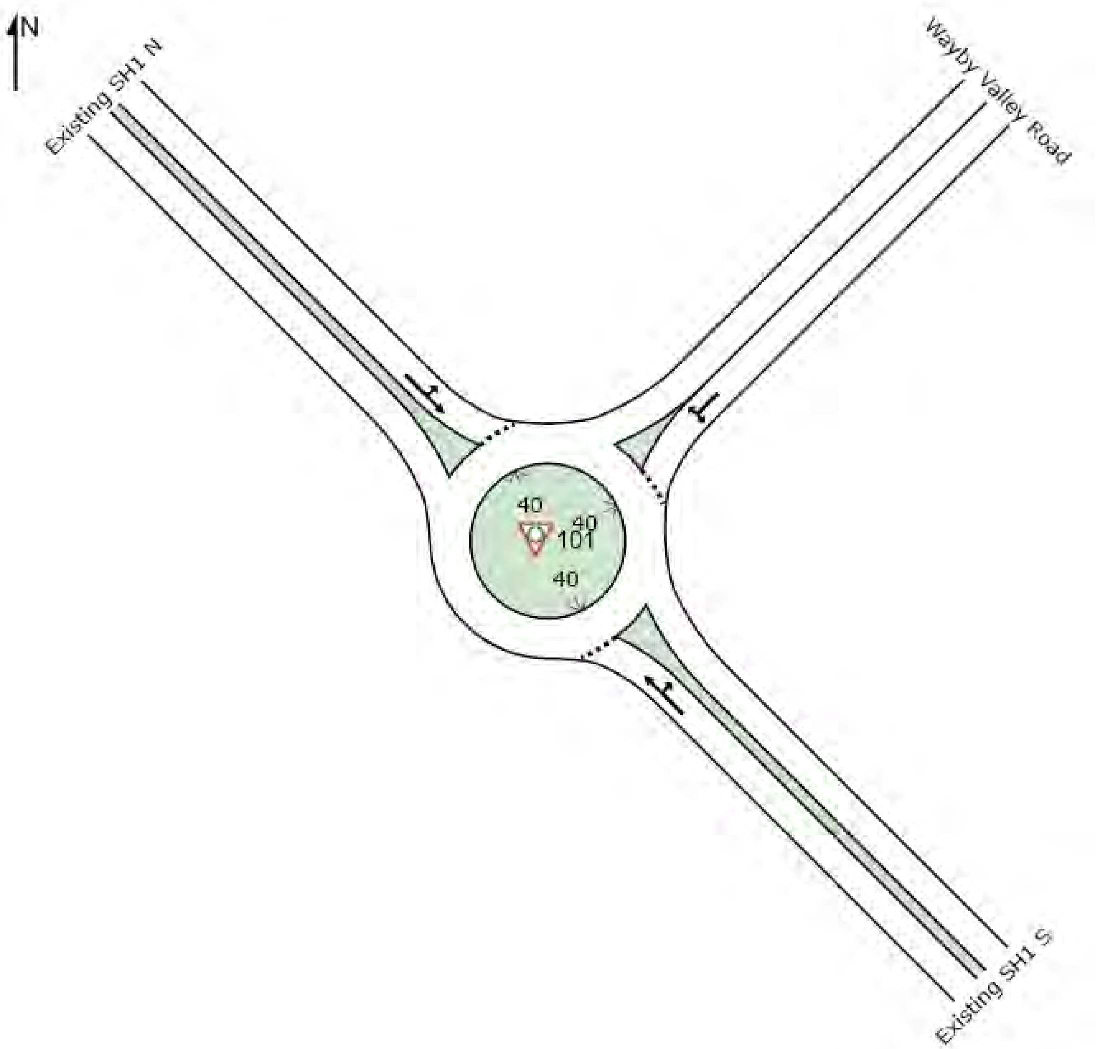
Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Off Ramp South											
21	L2	89	0.0	0.083	3.0	LOS A	0.4	2.7	0.04	0.50	55.4
23a	R1	1	0.0	0.083	8.1	LOS A	0.4	2.7	0.04	0.50	57.2
23	R2	54	0.0	0.083	9.4	LOS A	0.4	2.7	0.04	0.50	58.2
Approach		144	0.0	0.083	5.4	LOS A	0.4	2.7	0.04	0.50	56.4
NorthEast: Wayby Valley Road North											
25	T1	4	0.0	0.003	2.7	LOS A	0.0	0.0	0.00	0.40	58.5
26b	R3	1	0.0	0.003	10.7	LOS B	0.0	0.0	0.00	0.40	60.4
Approach		5	0.0	0.003	4.3	LOS A	0.0	0.0	0.00	0.40	58.9
SouthWest: Wayby Valley Road South											
30a	L1	5	0.0	0.155	2.6	LOS A	0.8	5.6	0.17	0.30	58.2
31	T1	237	0.0	0.155	2.9	LOS A	0.8	5.6	0.17	0.30	58.9
Approach		242	0.0	0.155	2.9	LOS A	0.8	5.6	0.17	0.30	58.9
All Vehicles		392	0.0	0.155	3.9	LOS A	0.8	5.6	0.12	0.37	57.9

It is predicted that the intersection will operate well within its capacity with the forecast 2046 volumes.

3.3 Roundabout at the intersection of the existing SH1 and Wayby Valley Road

The modelled layout for the roundabout at the intersection of the existing SH1 with Wayby Valley Road is shown in Figure 21. The plan indicates single lane entries on each of the three approaches.

Figure 21: Modelled Layout at Intersection of Existing SH1/Wayby Valley Road



The predicted performance of the roundabout in 2046 is summarised in Figures 22 to 24, for the weekday morning, inter peak and evening peaks.

Figure 22: Predicted Performance of Existing SH1/Wayby Valley Road Intersection: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 6-node 632 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Existing SH1 S											
22	T1	196	0.0	0.133	2.9	LOS A	0.7	4.9	0.17	0.32	58.6
23	R2	11	0.0	0.133	9.6	LOS A	0.7	4.9	0.17	0.32	59.5
Approach		206	0.0	0.133	3.3	LOS A	0.7	4.9	0.17	0.32	58.7
NorthEast: Wayby Valley Road											
24	L2	2	0.0	0.038	3.2	LOS A	0.2	1.2	0.15	0.59	52.3
26	R2	55	0.0	0.038	9.6	LOS A	0.2	1.2	0.15	0.59	54.7
Approach		57	0.0	0.038	9.3	LOS A	0.2	1.2	0.15	0.59	54.6
NorthWest: Existing SH1 N											
27	L2	172	0.0	0.131	3.0	LOS A	0.7	4.8	0.06	0.35	57.3
28	T1	53	0.0	0.131	2.8	LOS A	0.7	4.8	0.06	0.35	59.5
Approach		224	0.0	0.131	3.0	LOS A	0.7	4.8	0.06	0.35	57.8
All Vehicles		487	0.0	0.133	3.8	LOS A	0.7	4.9	0.12	0.36	57.7

Figure 23: Predicted Performance of Existing SH1/Wayby Valley Road Intersection: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 6-node 632 IP]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Existing SH1 S											
22	T1	203	0.0	0.143	3.0	LOS A	0.8	5.4	0.19	0.33	58.4
23	R2	17	0.0	0.143	9.6	LOS A	0.8	5.4	0.19	0.33	59.2
Approach		220	0.0	0.143	3.5	LOS A	0.8	5.4	0.19	0.33	58.4
NorthEast: Wayby Valley Road											
24	L2	3	0.0	0.044	3.3	LOS A	0.2	1.5	0.20	0.58	52.2
26	R2	61	0.0	0.044	9.7	LOS A	0.2	1.5	0.20	0.58	54.6
Approach		64	0.0	0.044	9.4	LOS A	0.2	1.5	0.20	0.58	54.5
NorthWest: Existing SH1 N											
27	L2	197	0.0	0.164	3.1	LOS A	0.9	6.3	0.09	0.34	57.1
28	T1	81	0.0	0.164	2.8	LOS A	0.9	6.3	0.09	0.34	59.3
Approach		278	0.0	0.164	3.0	LOS A	0.9	6.3	0.09	0.34	57.8
All Vehicles		562	0.0	0.164	3.9	LOS A	0.9	6.3	0.14	0.37	57.6

Figure 24: Predicted Performance of Existing SH1/Wayby Valley Road Intersection: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 6-node 632 PM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Existing SH1 S											
22	T1	224	0.0	0.158	3.1	LOS A	0.9	6.0	0.24	0.34	58.2
23	R2	11	0.0	0.158	9.8	LOS A	0.9	6.0	0.24	0.34	59.1
Approach		235	0.0	0.158	3.4	LOS A	0.9	6.0	0.24	0.34	58.3
NorthEast: Wayby Valley Road											
24	L2	4	0.0	0.065	3.3	LOS A	0.3	2.2	0.21	0.59	52.1
26	R2	89	0.0	0.065	9.7	LOS A	0.3	2.2	0.21	0.59	54.5
Approach		94	0.0	0.065	9.4	LOS A	0.3	2.2	0.21	0.59	54.4
NorthWest: Existing SH1 N											
27	L2	232	0.0	0.184	3.0	LOS A	1.1	7.4	0.07	0.34	57.2
28	T1	88	0.0	0.184	2.8	LOS A	1.1	7.4	0.07	0.34	59.4
Approach		320	0.0	0.184	3.0	LOS A	1.1	7.4	0.07	0.34	57.8
All Vehicles		648	0.0	0.184	4.1	LOS A	1.1	7.4	0.15	0.38	57.5

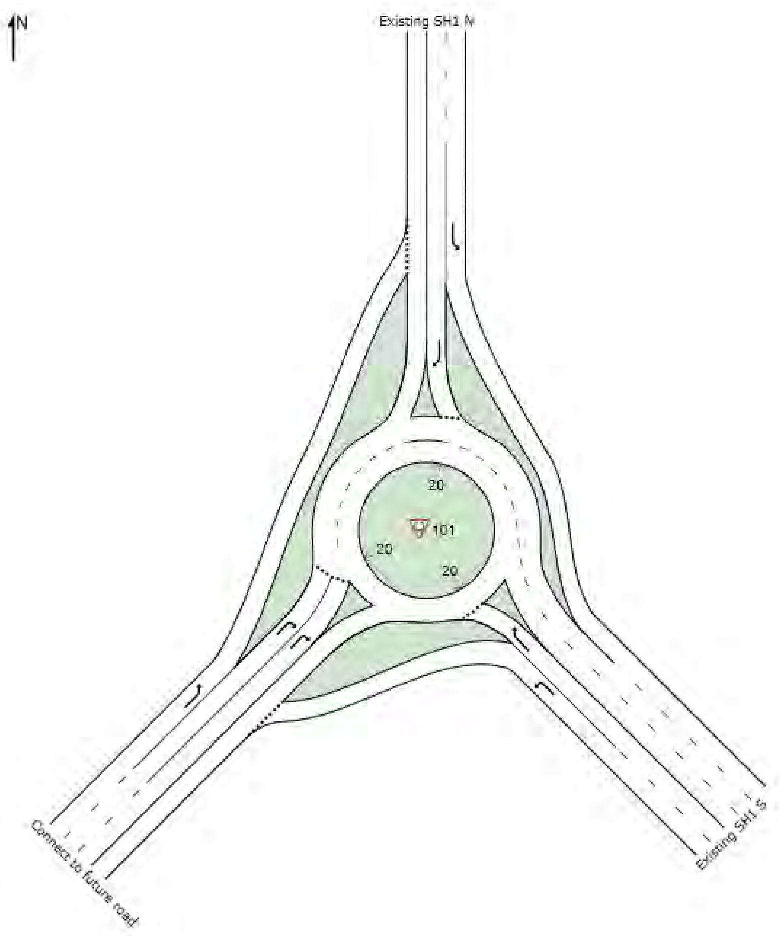
It is predicted that the intersection will operate well within its capacity with the forecast 2046 volumes.

4 WARKWORTH INTERCHANGE

This interchange will include free flow connections to and from the expressway, both to/from the south and north. Therefore, this interchange will operate without delay. However, the Warkworth interchange will lead traffic travelling between the Expressway and Warkworth into the roundabout at the northern termination of the Puhoi to Warkworth project, just to the north of Warkworth itself.

The modelled layout for the Warkworth termination roundabout is shown in Figure 25. The plan indicates free flow left turn lanes on each of the three approaches (meaning that this traffic will not incur delay at the roundabout. Single lane approaches are assumed for the other (through or right turn movements) on two of the three approaches, with a two lane right turn (meaning two circulating lanes on the roundabout for traffic travelling from the future Warkworth interchange toward Warkworth itself.

Figure 25: Modelled layout of Existing SH1/Future Connection from Expressway Intersection: node 126



The predicted performance of the roundabout in 2046 is summarised in Figures 26 to 28, for the weekday morning, inter peak and evening peaks.

Figure 26: Predicted Performance of Warkworth Termination Roundabout: 2046 AM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 7-node 126 AM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: Existing SH1 S											
21	L2	976	0.0	0.552	2.9	LOS A	5.7	40.2	0.16	0.39	47.7
23a	R1	380	0.0	0.221	6.4	LOS A	1.5	10.3	0.11	0.56	46.4
Approach		1356	0.0	0.552	3.9	LOS A	5.7	40.2	0.14	0.44	47.3
North: Existing SH1 N											
7a	L1	257	0.0	0.130	2.5	LOS A	0.0	0.0	0.00	0.31	49.3
9a	R1	17	0.0	0.019	8.1	LOS A	0.1	0.5	0.56	0.67	45.5
Approach		274	0.0	0.130	2.9	LOS A	0.1	0.5	0.03	0.34	49.0
SouthWest: Connect to future road											
30a	L1	23	0.0	0.019	3.7	LOS A	0.1	0.7	0.45	0.43	47.6
32	R2	845	0.0	0.373	9.5	LOS A	2.4	17.0	0.58	0.71	45.3
Approach		868	0.0	0.373	9.3	LOS A	2.4	17.0	0.58	0.70	45.4
All Vehicles		2498	0.0	0.552	5.6	LOS A	5.7	40.2	0.28	0.52	46.8

Figure 27: Predicted Performance of Warkworth Termination Roundabout: 2046 Inter Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 7-node 126 IP]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: RoadName											
21	L2	989	0.0	0.556	2.9	LOS A	6.0	42.2	0.15	0.39	47.7
23a	R1	346	0.0	0.200	6.4	LOS A	1.4	9.5	0.09	0.56	46.5
Approach		1336	0.0	0.556	3.8	LOS A	6.0	42.2	0.13	0.43	47.4
North: RoadName											
7a	L1	215	0.0	0.108	2.5	LOS A	0.0	0.0	0.00	0.31	49.3
9a	R1	14	0.0	0.018	8.8	LOS A	0.1	0.6	0.65	0.71	45.2
Approach		228	0.0	0.108	2.9	LOS A	0.1	0.6	0.04	0.34	49.0
SouthWest: RoadName											
30a	L1	29	0.0	0.024	3.6	LOS A	0.1	0.8	0.43	0.43	47.7
32	R2	1158	0.0	0.495	9.5	LOS A	3.6	25.2	0.62	0.72	45.2
Approach		1187	0.0	0.495	9.4	LOS A	3.6	25.2	0.61	0.71	45.3
All Vehicles		2752	0.0	0.556	6.1	LOS A	6.0	42.2	0.33	0.54	46.6

Figure 28: Predicted Performance of Warkworth Termination Roundabout: 2046 PM Peak

MOVEMENT SUMMARY

Site: 101 [Roundabout 7-node 126 PM]

New Site
Roundabout

Movement Performance - Vehicles

Mov ID	OD Mov	Demand Flows Total veh/h	Demand Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	95% Back of Queue Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
SouthEast: RoadName											
21	L2	1100	0.0	0.631	2.9	LOS A	8.3	58.0	0.24	0.38	47.5
23a	R1	484	0.0	0.284	6.4	LOS A	2.2	15.7	0.15	0.55	46.3
Approach		1584	0.0	0.631	4.0	LOS A	8.3	58.0	0.21	0.43	47.1
North: RoadName											
7a	L1	240	0.0	0.121	2.5	LOS A	0.0	0.0	0.00	0.31	49.3
9a	R1	23	0.0	0.055	12.5	LOS B	0.3	2.1	0.86	0.87	43.5
Approach		263	0.0	0.121	3.4	LOS A	0.3	2.1	0.08	0.36	48.7
SouthWest: RoadName											
30a	L1	131	0.0	0.115	4.4	LOS A	0.6	4.5	0.54	0.54	47.4
32	R2	1772	0.0	0.842	19.0	LOS B	15.9	111.2	0.98	1.19	40.8
Approach		1902	0.0	0.842	18.0	LOS B	15.9	111.2	0.95	1.15	41.2
All Vehicles		3749	0.0	0.842	11.1	LOS B	15.9	111.2	0.58	0.79	44.0

The above results indicate that the roundabout will operate satisfactorily during the weekday morning and inter peak in 2046, but that it will be approaching capacity in the weekday evening peak, with a maximum degree of saturation of 84% on the right turn on the approach from the Expressway. This is considered satisfactory, given the long horizon (between now and 2046) and due to the fact that the models include substantial land use change within Warkworth. Also, it is noted that this situation will be significantly better than the performance of the roundabout without the Warkworth to Wellsford project.

Reference: P:\NZTA\131 wark to wells\reporting\TN8A171024.docx - Julie Liu