WAKA KOTAHI
NZ TRANSPORT AGENCY

ADDITIONAL WAITEMATĀ HARBOUR CONNECTIONS

Business Case

AWHC PROJECT TEAM

6 NOVEMBER 2020

New Zealand Government

More information

NZ Transport Agency
Published November 2020

If you have further queries, call our contact centre on 0800 699 000 or write to us:

NZ Transport Agency
Private Bag 6995
Wellington 6141

This document is available on the NZ Transport Agency's website at http://www.nzta.govt.nz

Document Version History

DATE	VERSION	AUTHOR	APPROVAL
6 NOVEMBER 2020	1.0	AWHC PROJECT TEAM	AWHC PROJECT SPONSOR

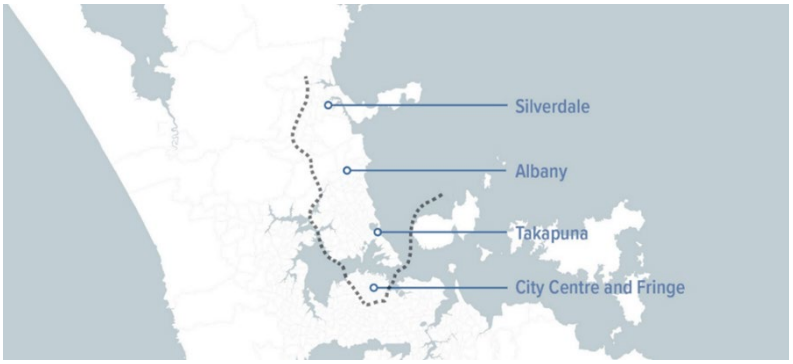
Contents

1. EXECUTIVE SUMMARY

1.1. Introduction

The growth of Auckland's North Shore is placing increasing pressure on key parts of Auckland's transport system. This pressure is being particularly felt on the strategic transport corridor, made up of State Highway 1 and the Northern Busway. This is a nationally significant corridor, providing access within the North Shore, from the North Shore to the Auckland isthmus, and acting as the most direct link between Northland, Auckland and the rest of New Zealand. The corridor is already under severe pressure and faces some unique resilience challenges, which are forecast to increase further as population and employment continues to grow.

The Auckland Harbour Bridge is an iconic structure and the corridor passes through extremely sensitive and significant environmental and cultural areas, especially between Takapuna and the city centre. The Waitematā Harbour has a special status with iwi.



The study area for this Business Case includes the entire North Shore area from Silverdale to the city centre and fringe.

A key section of this corridor is the Auckland Harbour Bridge (the 'harbour bridge'), a nationally significant component of New Zealand's transport system. The harbour bridge is the most travelled route in New Zealand, carrying on average around 235,000 people a day, including around 30,000 public transport trips and in the order of 12,000 freight (HCV) trips[1]. It has been in operation for over 60 years and will be nearing its 100th anniversary within the 30-year planning horizon of this business case.

The need for improved connectivity between the North Shore and the central isthmus has been anticipated for several decades and many studies have been undertaken into possible options. Recent work dates back to a study in 2008, which recommended a preferred route for a new road and rail crossing between the central city area and Esmonde Road on the North Shore.

Previous studies have largely focused on options analysis, rather than defining the problem to be solved or outlining a case for investment. In 2016, Auckland Transport developed a Programme Business Case for the development of rapid transit to the North Shore. This business case has built from this previous work and has undertaken updated investigations with the most recent demands and policy expectations.

Specifically, this business case responds to direction in the 2018 Auckland Transport Alignment Project (ATAP), which outlined the "urgent need" to "*confirm the rapid transit corridor's future mode and alignment, including how it integrates with a potential future road crossing*". ATAP also noted "*the*

[1] 171,000 vehicles per day in 2018 (around 205,000 people assuming an occupancy of 1.2 people per vehicle)

need to provide more certainty about the optimal timing, modal mix, configuration and operation" of any future crossing.[2]

This business case is a joint study between Auckland Council (AC), Auckland Transport (AT) and Waka Kotahi NZ Transport Agency (Waka Kotahi). It has analysed the current and future problems faced in the corridor, assessed a number of options for addressing these problems, and recommended a way forward to provide a comprehensive and long-lasting response. While there have been a number of previous studies into improved connections across the Waitematā Harbour, this business case is the first to establish the problems and benefits for investment and take a fully mode neutral approach in determining the preferred response. This is consistent with business case principles and includes consideration of the wider transport system

1.2. Summary of findings and next steps

The business case focuses on 'programme level' issues and conclusions – outlining the following high-level series of interventions to be progressed further:

- Further investigate the potential for land-use planning and demand management (e.g. road pricing) to optimise existing infrastructure and delay the need for major investment.
- Urgently upgrade the Northern Busway to increase its capacity, reliability and overall service quality.
- Develop an additional rapid transit connection for the North Shore (including across the Waitematā Harbour to the city centre), that integrates with the upgraded busway and the wider public transport network to provide high quality access to opportunities and travel choice.
- Improve roading connectivity in the corridor in a way that addresses resilience issues in the corridor (including the Auckland Harbour Bridge).

This work has confirmed the urgent need to enhance the existing busway, which is now being progressed through a Detailed Business Case. The scale, complexity and multiple interdependencies of the indicative rapid transit and road improvements identified means that more detailed analysis is required before their exact form, function and timing can be confirmed.

Indicative rapid transit and road options were looked at to better understand some of their key issues and guide where further detailed analysis is needed.

[2] Auckland Transport Alignment Project (2018), pages 25 and 32.

1.3. Current and Future Problems in the Corridor

This nationally significant corridor faces several key problems now and into the future. Addressing these problems and enabling the corridor to function effectively will have substantial local, regional and national benefits. The key issues are:

- Population and employment growth are leading to an increased demand for travel, which will increasingly exceed the existing network's capacity. As capacity is reached and exceeded across more modes of transport and across more of the day, there will be significant detrimental effects on access, travel choice and the efficient movement of goods and services.
- The very high and growing dependency on the corridor, particularly for cross-harbour travel, means that its vulnerabilities have increasingly significant impacts on Auckland and New Zealand if service levels are compromised. While the Harbour Bridge is in good condition, it is an ageing structure with growing maintenance needs and will require increasing traffic management restrictions to protect its ongoing structural integrity.

These issues are discussed further below.

Current and future growth is placing growing pressure on the corridor, including impacting on the efficient movement of goods and services

The North Shore's population is projected to grow from 337,000 to around 500,000 by the late 2040s, with most of this growth forecast to occur north of Albany. The city centre and fringe is the largest and most productive employment centre in New Zealand, with employment in this area expected to grow from 125,000 to 212,000 over the next 30 years. The North Shore is a major part of the city centre's labour pool.

The Northern Motorway has been congested at peak times for many decades now, resulting in long and unreliable travel times. Since the Northern Busway opened in 2008, commuters have had the option to avoid this congestion by using public transport – and ridership has increased dramatically from approximately 800,000 trips a year to over 6,000,000 trips annually, when traffic growth in this period has largely stayed static.

Continued public transport growth will push parts of the busway to its capacity limits, firstly in the city centre and then at key stations. This will result in slower and less reliable bus journeys, leading to severe access and travel choice issues for the corridor. Moving more people by public transport will enable access to employment (and the wider productivity and prosperity benefits that will bring) to grow in a way that realises the vision of Auckland Council's City Centre Master Plan.

Because the corridor has long been congested for general traffic at peak times, growth in vehicle demand has been accommodated through a lengthening of the traditional 'peaks', a process that is forecast to continue across much of Auckland's motorway network in the future. A lack of alternative routes across the Waitematā Harbour, combined with the important role the corridor plays in

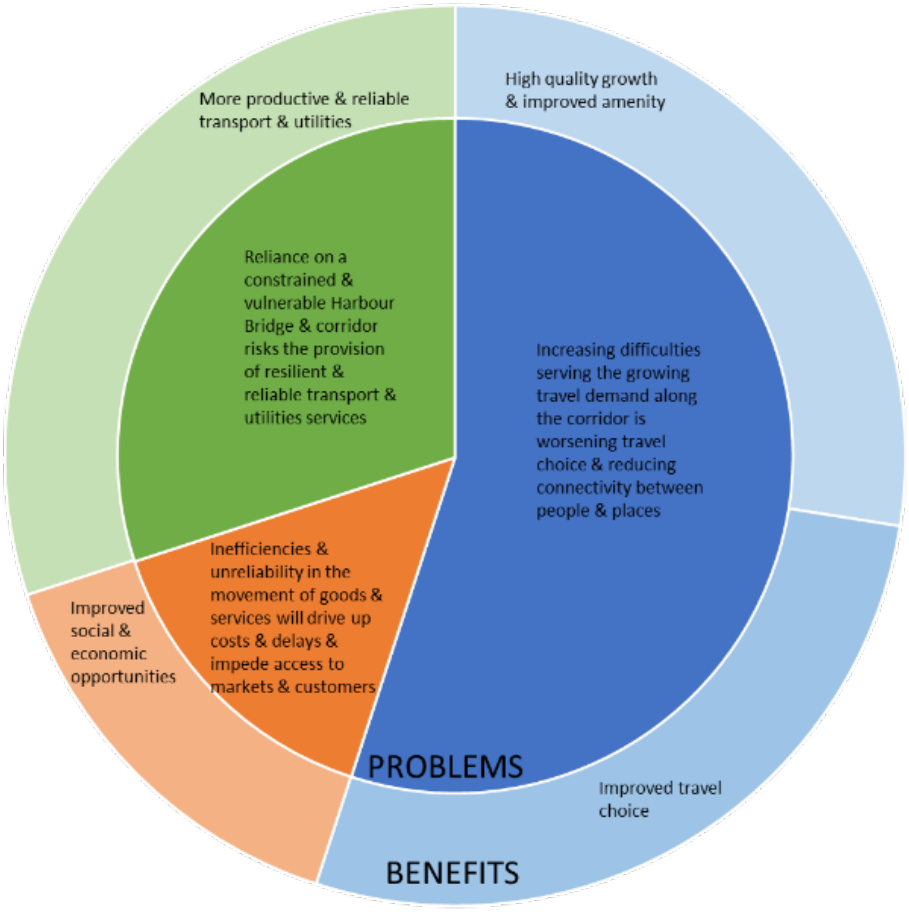
Auckland's freight network, means that all day congestion in this corridor would have widespread effects on economic productivity and prosperity at a local, regional and national level if not addressed.

Access in this corridor is highly dependent on a single route with several vulnerabilities

The high level of reliance on a single corridor and bridge means that various vulnerabilities could have significant impacts on Auckland and New Zealand if service levels were compromised. These include:

- While the harbour bridge has been strengthened on several occasions in the past, further strengthening is no longer possible. This means that maintaining the structural integrity of the bridge is likely to require some restrictions on heavy vehicles in the future, such as limiting the lanes they can use, the number of heavy vehicles allowed on the bridge at any one time, or the time of day they are able to travel on the bridge.
- Increasing seawater inundation due to storm surges and sea level rise, especially between the Onewa Road and Akoranga Drive interchanges.
- The restrictive ability to manage and recover from around 2,000 traffic incidents per year.
- The harbour bridge is over 60 years old and will require increasingly significant maintenance over time to protect its structural integrity.

These issues have been summarised in the business case problem statements and investment objectives outlined below. The access and travel choice problem is considered to be the most significant, reflecting the critical role the corridor plays in Auckland's transport system (including its public transport network).



IO 1 : Enable Auckland to Achieve quality, compact growth & improved amenity

IO 2 : Provide improved travel choices and access to employment, education and social opportunities

IO 3 : Improve the productivity, resilience & reliability of Auckland's transport networks

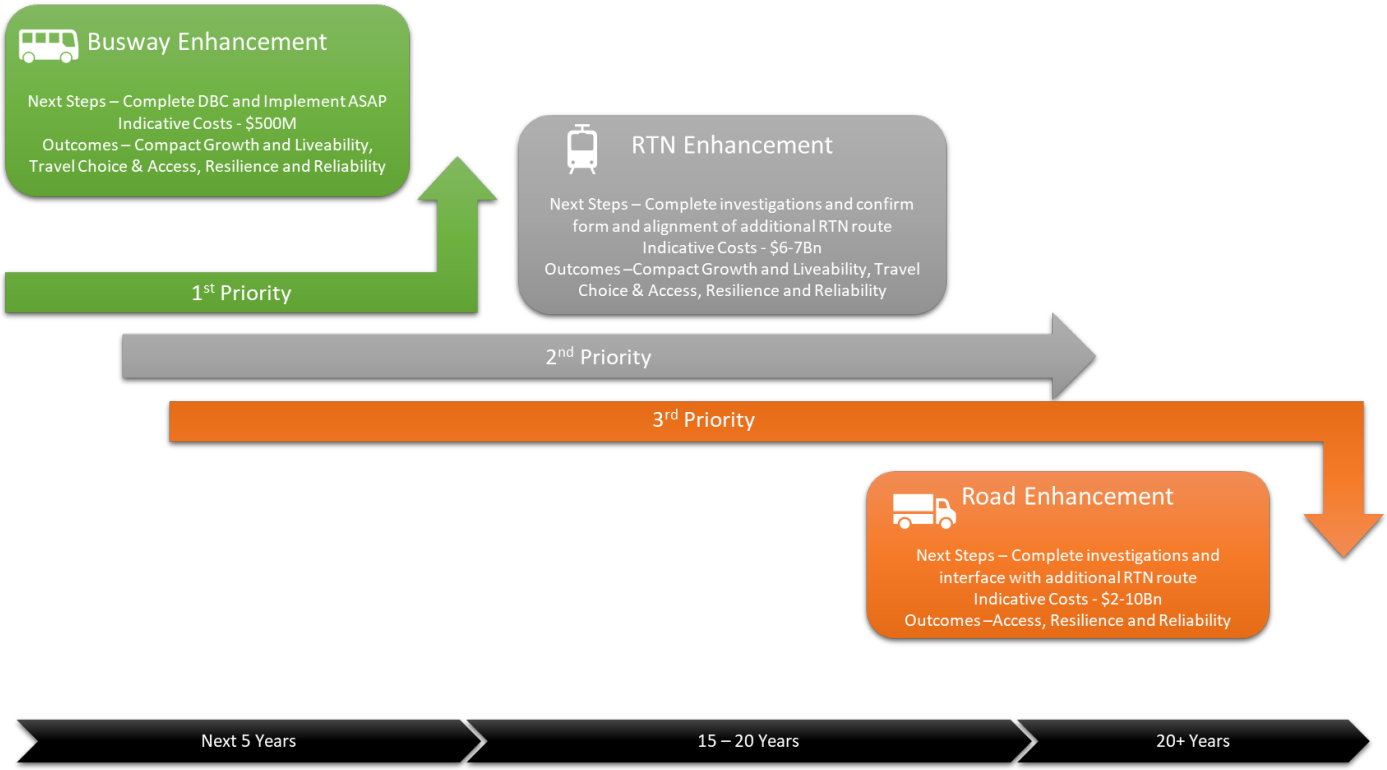
1.4. Programme level assessment and findings

Given the scale and complexity of the problems faced in the corridor, a variety of interventions over a number of decades are likely to be required. Following Waka Kotahi's 'intervention hierarchy' approach, land-use planning, demand management, network optimisation and new infrastructure initiatives were all considered as part of undertaking the programme-level analysis. A number of options were tested and considered.

The outcomes of this analysis are summarised in the table below:

Intervention Stage	Key findings
Integrated planning	• The timing, location and scale of growth on the North Shore is a key driver of the timing of investment. There is an important link between the timing of greenfield urbanisation around Dairy Flat and the need for high-cost rapid transit and road investment. • Focusing growth in and around major centres (especially Takapuna and Albany) will help reduce travel demand and support mode shift to public transport. • Employment growth on the North Shore will ease pressure on the harbour crossing part of the corridor and potentially delay the need for major investments.
Demand management	• Road pricing can help reduce congestion on the corridor, potentially delaying the need for road investment. However, it will increase public transport demand and potentially bring forward the need for rapid transit upgrades. Legislative change is required to enable road pricing. • City centre plans will reduce road capacity, discourage people from driving there, and increase public transport demand.
Best use of existing network	• Filling gaps in the Northern Busway (i.e. sections without a dedicated corridor), expanding busway stations and resolving city centre constraints can unlock spare capacity in other parts of the busway, realising the full potential of existing infrastructure. • Increasing non-peak direction road capacity (rather than peak direction capacity) across the harbour will help unlock spare capacity on the existing motorway network. • Protecting the ongoing functionality of the Auckland Harbour Bridge will mean this critical asset continues to provide value to Auckland and New Zealand.
New infrastructure	• An upgraded busway will not have sufficient capacity to meet medium-long term public transport demand. An additional rapid transit connection is therefore required to ensure public transport remains an attractive travel option and to retain resilient cross-harbour access. • The additional rapid transit connection should directly serve Takapuna and Smales Farm from the north and south, as well as integrate with the busway and the wider public transport network. Two rapid transit crossings of the harbour (i.e. the busway over the Harbour Bridge and an additional rapid transit crossing on a separate alignment) are required to meet forecast demand. • In the longer-term, improved road connectivity is required in the Albany to city centre corridor to address projected all-day congestion, protect the motorway from increasingly frequent flooding and to preserve the long-term structural integrity of the Harbour Bridge.

These outcomes indicate a programme of significant investment in the strategic spine of the North Shore transport system as follows:



1.5. Rapid Transit and Road Options Assessment and Findings

Following these programme level findings, further analysis was undertaken to understand the outcomes and impacts of the additional rapid transit and road options. The options considered are summarised in the table below. These options included road pricing (and the resultant effects) in the analysis.

Rapid transit options	Road options
A number of options (and sensitivities) were considered including: • Conversion of busway to LRT • Additional heavy rail rapid transit routes • Additional light rail rapid transit routes • Stations at Takapuna, Smales Farm and sensitivity test of Albany	• An upgrade to the existing harbour crossing to allow 10 lanes of traffic (5 in each direction) • A new 6 lane road tunnel under the harbour between the city centre and Akoranga • Widening of the Northern Motorway between Akoranga and Constellation

This business case originally sought to identify the preferred form, function and timing of a preferred new cross harbour alignment of all future improvements in the corridor. However, careful and more detailed investigation to understand the wider implications on the transport system of the additional

rapid transit connection and the road improvements is required before their exact form, function and timing can be confirmed. This is because of the complexity of the issues faced in the corridor, the scale of future investment to address these issues, and the strong interdependencies of the corridor with wider policy and planning (e.g. road pricing, wider rapid transit network planning).

Further investigation of the busway enhancements is being progressed already through a Detailed Business Case. The extent to which the busway enhancement ultimately enhances public transport capacity will impact the timing and nature of subsequent investments. Therefore, this business case only undertook an initial assessment of the rapid transit and road elements of the programme, with a focus on helping to define where future effort needs to be focused.

Key findings from this initial assessment are outlined below:

Rapid Transit Key Findings

- An Additional Rapid Transit Connection would make the most significant contribution to achieving the investment objectives outlined in this business case.
- While the programme-level work is clear that two rapid transit connections between Smales Farm/Takapuna and the city centre are required to meet forecast demand, it is not yet clear what the best approach is north of Smales Farm/Takapuna. Key findings to inform future work are:
    - If the Additional Rapid Transit Connection terminates at Smales Farm/Takapuna, it is unlikely to generate sufficient ridership to be cost effective and would only carry around 15% of cross-harbour peak time public transport trips (with 85% of trips still on the busway).
    - Extending the Additional Rapid Transit Connection to Albany (or even further to Silverdale/Orewa) results in the new connection playing a much greater role in meeting demand. However, complex issues still need to be resolved in terms of how this is done. In particular:
        - Upgrading the busway between Smales Farm and Albany to a rail-based mode will be the least costly option but means potentially significant disruption to passengers during construction.
        - Providing a second rapid transit corridor (either next to the motorway at grade or away from the motorway in a tunnel) will be much more expensive but would have less disruption and may open up new rapid transit catchments.
- Finalising the mode of this new rapid transit connection (i.e. light-rail, light-metro or heavy rail) should be done through a region-wide network planning process because of significant interdependencies with other rapid transit corridors – especially on the isthmus.
- The busway cannot be upgraded to heavy rail without significant works (major tunnelling etc.) and the resultant disruption to the operation of the existing busway.

- The alignment and mode of the Additional Rapid Transit Connection will have important land-use implications, with a potentially substantial refocusing of growth around stations required to maximise benefits from the investment.

Roading Key Findings

- There is a significant difference in cost (around $8 billion) between upgrading the Auckland Harbour Bridge corridor (for example via a parallel structure) and constructing new road tunnels under the harbour between the city centre and Akoranga.
- However, upgrading the Auckland Harbour Bridge corridor is likely to have significant environmental, cultural and social impacts. While the consentability of such works would not be fully understood until tested through normal processes, advice informing the business case has suggested it would be unlikely under current legislation.
- Neither road option analysed would eliminate congestion in the corridor at peak or interpeak times. Most interpeak trips between the North Shore and the isthmus would be 1-3 minutes faster in 2048 due to the road investments (compared to only investing in public transport improvements).
- Any road option would likely need to be accompanied by widening on upstream and downstream elements of the motorway and local network in order to achieve tangible benefits, and the costs and implications of these works need to be understood as part of any decision on additional cross-harbour roading capacity.
- The Northern Motorway needs to be raised between the Onewa Road and Esmonde Road interchanges to reduce flooding risk.
- A new crossing would ease pressure on the Auckland Harbour Bridge to a greater extent than an upgrade in the immediate vicinity of the bridge, assisting with enabling maintenance of the structure and providing a level of improved resilience (noting the corridors merge back together north of the crossing).
- Further work is required in the next phase of work to ensure longer term roading improvements effectively target the key problems in a way that supports wider transport and urban outcomes, in particular:
    - The improvements need to sufficiently ease pressure on the existing Auckland Harbour Bridge so that major maintenance activities can be undertaken to preserve its long-term structural integrity.
    - Detailed design and operational needs to ensure peak direction traffic volumes:
        - between the North Shore and the city centre decrease in line with City Centre Masterplan aspirations
        - travelling past the city centre does not unreasonably exacerbate congestion in other parts of the network
    - The merits and complications of combined or separate road and rapid transit connections needs to be considered in more detail, including when they are needed and whether the

optimal design is consistent with a combined crossing, as well as cost and environmental impact considerations.

- The size and timing of investment needs to be carefully considered, to ensure value for money.

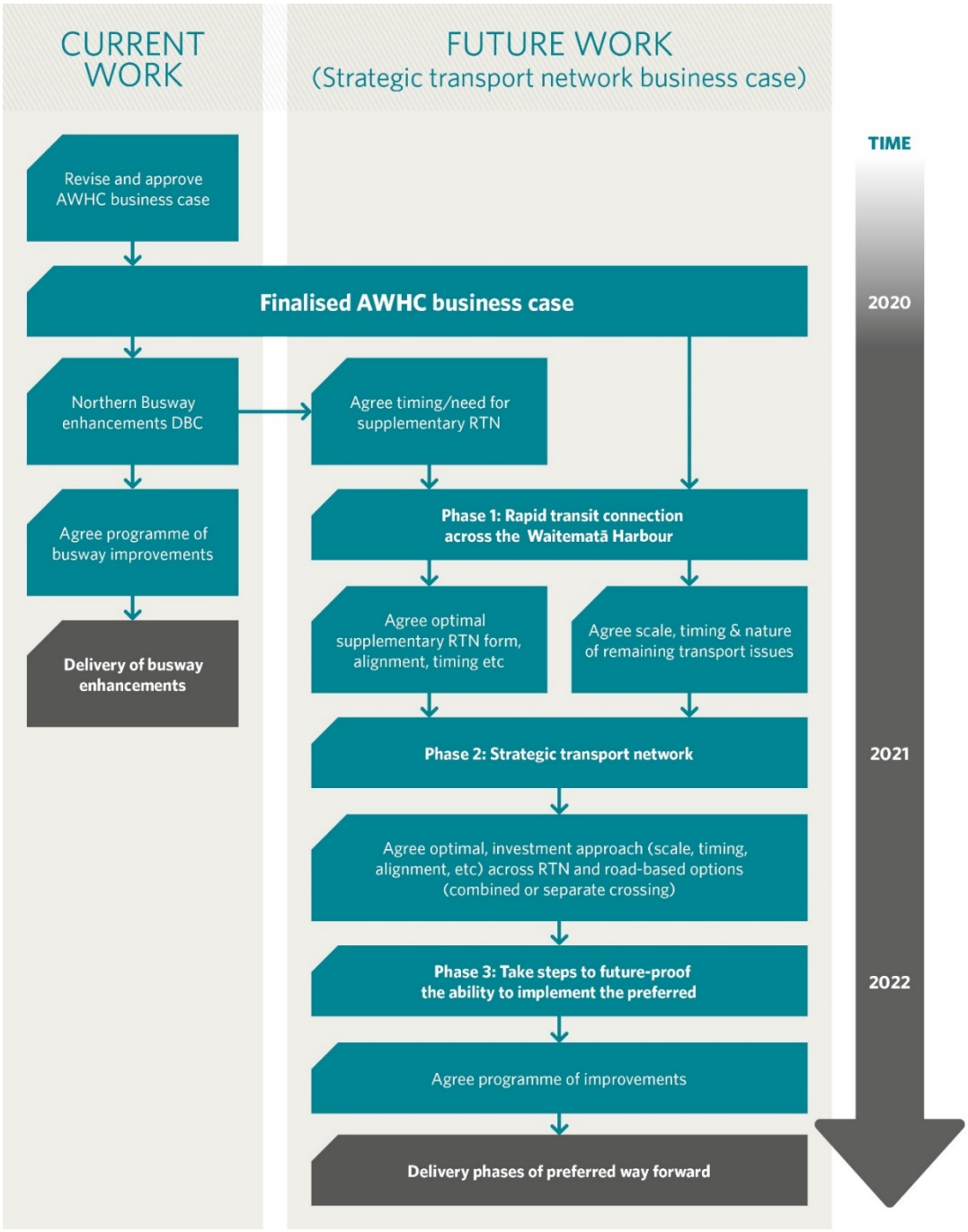
1.6. Next steps

This emerging programme has a forecast Investment Assessment Framework of **VERY HIGH** due to the scale of the significant access and public transport implications addressed which delivers the following outcomes.

Through this work, a number of areas have been highlighted where more detailed investigations are required to confirm the exact form of the future transport system. In the short term four key steps are proposed:

- **DBC for Busway improvements:** This will develop the exact form of the busway enhancements for early implementation. This work is urgent and has been commenced by Auckland Transport.
- **Strategic Transport Networks single-stage business case for:**
  - **An additional rapid transit connection across the Waitematā Harbour (Phase 1)** This phase will confirm the exact form (including mode) and alignment of the new cross harbour rapid transit connection, including an understanding of timing such that it may be in place prior to the enhanced busway reaching capacity
  - **Strategic transport networks (road and rapid transit) (Phase 2)** This phase confirms the wider rapid transit network on the North Shore and what additional roading network across the harbour should look like, when it is required and how any new road crossing would interact with Phase 1
  - **Future proofing and route protection (Phase 3)** This phase will seek to route protect the land required from Phases 1 & 2

The above workstreams will be heavily influenced by the wider transport system and these interdependencies need to be a key part of this further investigation.



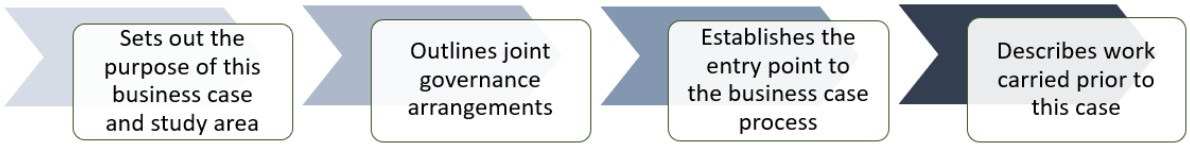
1.7. Governance

The recommended programme is large and complex, with many interactions and interdependencies. The successful delivery of the programme will require the continuation and evolution of the collaborative partnership and working arrangement between Waka Kotahi, Auckland Transport and Auckland Council that has been developed through this business case stage. It is proposed to continue the existing governance arrangements, with a vertically integrated approach proposed to drive effective project outcomes, delivery and monitoring of the programme.


Mandate
AT Board
NZTA Board
Council
ToR
Direction
Joint North Shore Strategic Governance Group
MoU or Agreement
Managment / Co-coordination
Joint Leadership Group

PART A STRATEGIC CASE

2. INTRODUCTION



2.1. Purpose

Waka Kotahi, AT and AC are working together to clearly outline the way forward in addressing key issues crossing the Waitematā harbour and beyond, affecting travel between the North Shore and the Auckland isthmus now and into the future.

The purpose of this business case is to understand the case for improved transport connections between the North Shore and Auckland Isthmus and is outlined in the Scoping Document[3] issued by Waka Kotahi in which the following questions are posed:

1. *"What are the problems?*
2. *What are the potential options to solve the problems?*
3. *What are the recommended options?*
4. *What is our recommended approach and next steps?"*

The scope of the business case is to include *"consideration of travel demands, options for serving these demands including the need, function, form and timing of new infrastructure".*

2.2. Defining the study area

The Additional Waitematā Harbour Connections (AWHC) study area is defined at its most broad level as the area extending from Silverdale to the city centre and fringe (see Figure 1).

[3] Scoping Document: North Shore to City Strategic Transport Business Case 23 November 2018

Figure 1: Project study area

2.3. Governance and Partners

A partnership between Waka Kotahi as lead partner, AT and AC has been established to develop the AWHC business case.

The partner organisations are working together in their respective roles, as outlined below:

Table 1: Partner Organisations

Project Partner Organisations		
WAKA KOTAHI NZ TRANSPORT AGENCY	AT	Auckland Council Te Kaunihera o Tāmaki Makaurau
Waka Kotahi is the Crown entity responsible for fulfilling the expectations of government as expressed in the Government Policy Statement on Land Transport. Particularly relevant functions of Waka Kotahi to this project include: - To plan, fund, design, supervise, construct and maintain rapid transit networks and/or projects, including light rail. - Manage regulatory requirements for land transport.	AT is a Council Controlled Organisation of AC. Functions of AT that are particularly relevant to this project include: - Planning, design, development, operation and maintenance of the majority of Auckland's transport infrastructure, including roads, wharves, cycleways and footpaths. - Planning and managing the delivery of bus, train and ferry services across Auckland.	AC is the local authority responsible for all local government decisions and responsibilities in Auckland. Functions of the Council that are particularly relevant to this project include: - Preparing and giving effect to the Auckland Plan, a long-term strategic document that guides the region's growth and development over the next 30 years and integrates social, economic and cultural objectives. - Regulatory functions relating to the Unitary Plan, which is the 'rulebook' that shapes growth under the Resource Management Act.

An integrated approach has been adopted by the project partners to help ensure that project planning and delivery is well aligned and coordinated to deliver the best outcomes for Auckland's future.

2.3.1. Key Stakeholders

There are many parties who have an interest in the outcomes of the project and a selection of partners and key stakeholders are in a position to influence the investment.

Table 2: Stakeholder table

Stakeholder	Interest
Mana Whenua and Iwi (partners)	Planning and decision-making Cultural, environmental, economic and social outcomes
Minister of Transport	National aspirations and policy objectives Political views
Members of Parliament	National, regional and local aspirations and views Political views
Councillors and the Mayor	Community aspirations and views Auckland Plan implementation Political views
Local Boards	Local issues and investment Community aspirations and views
Residents Groups	Local issues and connectivity Community aspirations and views
Business Associations	Risks and opportunities to local businesses
Transport Interest Groups	Needs and aspirations of transport users of all modes Road specific (freight and private vehicle) Public transport and active mode focus
Environmental Groups	Environmental risks, issues and opportunities GHG emission reduction and climate change Sustainability
KiwiRail	National rail operator
Community members	Community aspirations and views
Commuters and customers	Travelling public and couriers

2.4. Business Case Entry Point

The origin of this work is outlined in the Auckland Transport Alignment Project (ATAP), which forms the basis for transport investment in Auckland over the next decade and provides direction for the following two decades. ATAP specifically discusses both North Shore rapid transit and an additional Waitematā Harbour crossing.

ATAP states that *"Current investigation work into an additional Waitematā Harbour Crossing needs to be completed to provide more certainty on the optimal timing, modal mix, configuration and operation of the crossing."* In relation to the North Shore Corridor, ATAP highlights that '*There is an urgent need to confirm the rapid transit corridor's future mode and alignment, including how it integrates with a potential future road crossing.'*

The Strategic Case part of this business case was endorsed by Waka Kotahi on 2 August 2019. This confirmed that the appropriate level of detail for this work was a hybrid of a programme and indicative business case reflecting the complexity of the corridor and its many interdependencies with wider transport planning and policy framework. Firm conclusions can be reached at a programme-level, with the analysis undertaken at an 'indicative business case' level more focussed on scoping the next phase of work, including the potential options to be investigated further. The Management Case discusses next steps in more detail.

2.5. Previous Work

The need for additional transport connectivity between the North Shore and the city has been anticipated for several decades. Various studies have been undertaken over this period, with the most critical studies informing this work being:

- A 2008-2010 options analysis process led by Waka Kotahi into cross-harbour connections. This work considered 160 route options before identifying a preferred multi-modal crossing west of Wynyard Quarter comprising two tunnels for road traffic (each three lanes wide) and two tunnels for rail traffic (each for a single rail track). Notices of requirement for route protection were lodged as an outcome of this work, but they have not been progressed to notification.
- A Strategic Case and Programme Business Case (PBC) investigating North Shore Rapid Transit options, led by AT between 2016 and 2018. This work considered a broad range of programme options (e.g. demand management, land use responses and infrastructure upgrades) to address emerging issues from growing public transport demand. The work concluded that the existing busway would reach its effective capacity in the mid-2030s and a higher capacity system would be required after this. Being a Programme Case with a focus on rapid transit, this business case outlines a problem definition, case and likely timing for additional rapid transit capacity to the North Shore. However, the PBC does not detail form and feasibility of different rapid transit options and does not consider issues beyond public transport that face the corridor.

While these two studies are the most recent and specific to the issue, there have been many workstreams of relevance to the issue. Figure 2 shows in the last ten years, the policies and plans that have been prepared and investigations that have taken place.

This has resulted in the project being identified in the ATAP, the Regional Land Transport Plan (RLTP) and the National Land Transport Plan (NLTP).

Figure 2: Previous studies summary

3. STRATEGIC AND ORGANISATIONAL ALIGNMENT

This section outlines the project relationship with the Government Policy Statement on Land Transport (GPS), the Auckland Transport Alignment Project (ATAP), the Auckland Plan 2050 and other relevant documents. It also looks at organisational alignment with each of the project partners, Waka Kotahi, Auckland Transport and Auckland Council.

3.1. Government Policy Statement on Land Transport

The current 2018 GPS defines four strategic priorities for the land transport system, summarised in Table 3.

Table 3: GPS outcomes

GPS Strategic Priorities	Relevance to the North Shore connections
Safety: A land transport system that… Is a safe system, free of death and serious injury	While not a significant driver of this business case, reducing reliance on private vehicles for travel will contribute to improved safety outcomes.
Access: A land transport system that… Provides increased access to economic and social opportunities Enables transport choice and access Is resilient	Provision of quality of access and choices between the North Shore and key destinations, including the metropolitan centres and the City Centre will significantly contribute to providing access to economic and social opportunities for a large proportion of Auckland's population. There is a large reliance on the AWHC route for access to work, education and social opportunities for the residents of the North Shore. There is also a reliance from the city centre for access to an important pool of labour, students and visitors. Resilience of this connection is important to retaining the access function of the link.
Value for Money: A land transport system that… Delivers the right infrastructure and services to the right level at the best cost	Given the scale of the potential investment required to meet the access and resilience outcomes, value for money will be a key consideration as well as affordability.
Environment: A land transport system that… Reduces greenhouse gas emissions, as well adverse effects on the local environment and public health	There is an opportunity to improve efficiencies in the network, create mode shift and provide means of travel that reduce greenhouse emissions. Given the scale of potential infrastructure and the sensitive location, impacts on the environment, particularly the coastal environment could be significant.

3.2. Auckland Transport Alignment Project 2018

The Auckland Transport Alignment Project 2018 (ATAP) represents AC and the Government's agreement on transport priorities for Auckland and sets out a $28 billion programme of significant transport infrastructure projects for Auckland to 2028, as well as setting out "future priorities" for ensuing decades.

ATAP specifies a rapid transit connection from Orewa to the City, including an additional crossing of the Waitematā Harbour, as a *"future priority"* to be implemented beyond 2028. [4]

[4] ATAP 2018 p24

ATAP provides an acknowledgment that there is a need to investigate higher capacity modes, probably rail, to the North Shore in a manner cognisant of the rest of the rapid transit network being planned for the first decade. It also notes the need to consider integration with a potential future road crossing.

ATAP also specifically references the investigation of an additional road crossing of the Waitematā Harbour and acknowledges the importance of the Auckland Harbour Bridge in the national transport network, the risks associated with its longevity and notes that an additional crossing would improve resilience. ATAP suggests that while these issues exist, they need to be considered alongside the "very high" cost of a new crossing and that a multi-modal approach should be enabled with the ability to deliver road and rapid transit crossings separately.[5]

3.3. City Policy and Strategy

In this section, three key pillars of Auckland Council's strategy for the future development of Auckland are addressed.

3.3.1. The Auckland Plan 2050

The Auckland Plan 2050 is a key spatial plan that sets the direction for how Auckland will grow and develop over the next 30 years.

The Auckland Plan establishes three "key challenges", which are all relevant to this corridor.

Challenge 1 relates to **population growth and its implications** and **Challenge 2** relates to **sharing prosperity**. These are linked and provision of quality access to jobs, education and social activities is key to meeting growth objectives and ensuring that people have a good quality of life and can share in the prosperity that economic growth can provide. The consideration of additional connections to the North Shore responds to these challenges directly by considering improved access between an area planned for significant residential growth to locations for jobs, education and major cultural and social activities.

Challenge 3 relates to **reducing environmental degradation**. This is relevant to the AWHC issue in two main ways. Firstly, reducing car dependence on the North Shore and providing opportunities to travel by public transport, walking and cycling will reduce emissions and have other positive effects on the environment. However, the scale of potential solutions and the significance, sensitivity and uniqueness of the Waitematā Harbour mean that there is a need to carefully consider environmental and cultural effects of any future work.

'Transport and access' is one of the six key outcomes Auckland Plan 2050 aims to achieve, with the aim being for Aucklanders 'to get where they want to go more easily, safely and sustainably.'[6] This outcome is underpinned by three directions:

- Better connect people, places, goods and services
- Increase genuine travel choices for a healthy, vibrant and equitable Auckland
- Maximise safety and environmental protection

These directions have informed the problem and benefit statements for this work.

3.3.2. Auckland Development Strategy

The National Policy Statement on Urban Development Capacity 2016 requires councils experiencing high growth to prepare a Future Development Strategy. Auckland's Development Strategy is set out as part of the Auckland Plan 2050. The Development Strategy specifically references the importance of

[5] ATAP 2018 p32
[6] Auckland Plan 2050 p.114

the city centre, noting that it is "critical to the success of Auckland and New Zealand".[7] It also references the strategic role of Albany as the major centre ('node') in the North of Auckland.

The Development Strategy aims to achieve "quality and compactness" in urban form and sets out to achieve alignment in the timing, sequencing, capacities and design of infrastructure across all providers to ensure that these outcomes are met.

Given the scale and significance of the North Shore in Auckland's growth future and in supporting the development of the city, provision of appropriate form and capacity of access to the North Shore and supporting the city centre in a manner that is consistent with these outcomes is critical to Auckland's development.

The largest driver for the population growth in the northern suburbs is north of Albany, in the greenfield expansion of Dairy Flat and Warkworth. These areas account for up to two thirds of all the growth on the North Shore. The Future Urban Land Supply Strategy 2017 (FULSS) outlines the sequencing and timing of release of this future urban land for development over 30 years. The FULSS expands on the greenfield portion of the Auckland Plan Development Strategy.

Consideration of providing additional high quality, fast, reliable access to the city centre and wider Auckland from these greenfield growth areas north of Albany at the right time will be critical to enabling this growth to occur in the manner and at the timing desired.

Growth in Albany and further south is expected almost entirely to be absorbed within Takapuna, Northcote, Birkenhead, Sunnynook and Albany. This growth is enabled through the Unitary Plan.

3.3.3. The City Centre Masterplan

The city centre is the most valuable and most productive economic engine in New Zealand and a major destination for North Shore residents.

The City Centre Master Plan (CCMP) is a non-statutory supporting document to the Auckland Plan and an input to the Unitary Plan and supports other AC strategies.

The CCMP presents a vision of a city centre that is:

- more family-friendly;
- more pedestrian-friendly; and
- more environmentally-friendly.

The CCMP includes a new traffic circulation plan (Access for Everyone) requiring a 30% reduction in peak hour traffic in the city centre, along with significantly more use of public transport and active modes for access.

Growing the city centre while creating more space for people, making it family, pedestrian and environmentally friendly will require continued investment in more space-efficient access modes of transport like rapid transit. The provision of a transport connection to the North Shore that reduces the reliance on and delivery of private vehicles to the city centre will be supportive of achieving these objectives.

It is important to understand that achieving the CCMP outcomes involves a two-pronged approach – reduction in peak time private vehicle access; and significant increase in public transport capacity to accommodate those 'mode shifted' trips.

[7] Auckland Plan 2050 p.205

3.4. Organisational outcomes, impacts and objectives

3.4.1. Waka Kotahi NZ Transport Agency

Waka Kotahi has the following (relevant to this project) responsibilities under the Land Transport Management Act 2003 (amended 2008):

- Contribute to an effective, efficient and safe land transport system in the public interest.
- Manage the state highway system, including planning, funding, design, supervision, construction and maintenance operations.
- Manage funding of the land transport system, including auditing the performance of organisations receiving land transport funding.
- Cooperate with, provide advice and assist any government agency or local government agency at the request of the Minister of Transport.
- Provide the Minister of Transport with advice on our functions.

3.4.2. Auckland Council

AC's investments should act to plan for community needs (Local Governance Statement 2017). This is executed through strategic plans, like the Auckland Plan 2050, and flows through multiple operation plans, budgets, and regulation.

Realising the benefits of this investment in relation to high quality growth and urban amenity, improved travel choices (Auckland Plan outcome: Transport and Access) and improved access to economic and social opportunities (Belonging and Wellbeing, Homes and Places, and Opportunity and Prosperity) would directly support AC's organisational goals.

3.4.3. Auckland Transport

AT is a Council Controlled Organisation (CCO), responsible for managing the publicly owned transport assets of Auckland, and provision/operation of transport services. AT acts to deliver transport outcomes and activities that support AC's, and its mayor's, expectations for Auckland.

The AT Statement of Intent for 2019/20-2021/22 discusses the Auckland Plan 2050 as their core guiding document, in addition to delivering on the Regional Land Transport Plan 2018-2028.

This manifests itself in the following priorities:

- Help people to travel safely
- Improve access to frequent and attractive public transport
- Encourage walking and cycling
- Make the best use of existing transport networks
- Support growth, urban redevelopment and regeneration
- Manage the impacts of the transport system on the environment
- Ensure value for money

Realising the benefits of investing in the AWHC would support these priorities through supporting growth and urban development through high quality growth and urban amenity, as well as improved travel choices and improved access to social and economic opportunities. Realising these benefits is also likely to improve access to frequent and attractive public transport, which will contribute to reducing the transport impacts on the environment.

4. THE IMPORTANCE OF THE CORRIDOR

4.1. Strategic Context

The Auckland Plan[8] outlines Auckland's importance to New Zealand, as a whole in social and economic terms. The Auckland Plan notes that Auckland is home to one third of New Zealand's population and contributes 40% of its gross domestic product and states that *"Auckland's contribution to the economy lifts the standard of living for all new Zealanders. New Zealand needs Auckland to succeed, just as Auckland needs the rest of New Zealand."*

4.1.1. Social and Economic

Auckland is home to around 1.7 million people. From 2018 to 2048 Auckland's population is expected to increase from 1.7 million to 2.4 million[9]. The population of the North Shore is anticipated to increase from 337,000 to 497,000 by 2048.

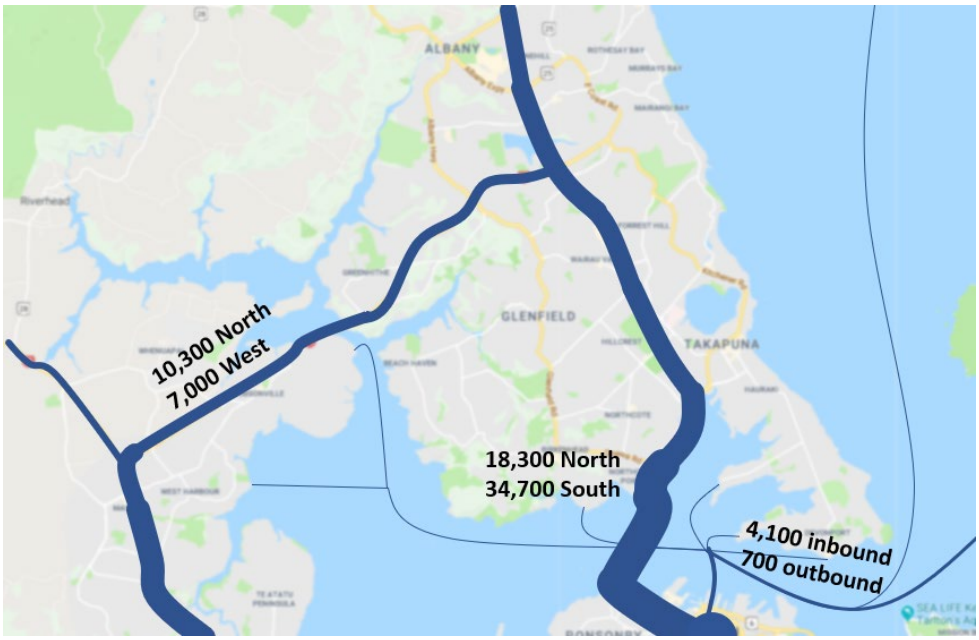
Key transport connections for the North Shore are:

- The Auckland Harbour Bridge, which is the most travelled route in New Zealand, carries on average around 171,000 vehicles per day in 2018[10] (around 205,000 people assuming an occupancy of 1.2 people per vehicle) and around 30,000 public transport trips per day. The bridge also carries important water and power utility connections.
- Ferry connections, which carry approximately 4,000 people in the AM peak.
- The Upper Harbour bridge, which carries around 55,000 vehicles a day.
- A proposed walking and cycling connection across the Auckland Harbour Bridge (this "Northern Pathway Westhaven to Akoranga" is expected to be consented by Waka Kotahi through the COVID-19 Recovery (Fast-track Consenting) Act 2020).

The Auckland Harbour Bridge is by far the most important of these connections and is arguably the single most important piece of land transport infrastructure in the entire country. It forms part of State Highway 1 and is a critical element in the national transport network. Unlike most other sections of the motorway network, the connection to the North Shore has a dual role, also carrying the North Shore's main public transport connection and forming part of the Northern Busway's route. The busway (and feeder services) between the North Shore and the City Centre is already Auckland's busiest bus route and is forecast to remain the highest demand public transport route in Auckland, with greater volumes than any other bus, rail or light rail corridors or ferry routes.

[8] Auckland Plan 2050 p 8 and 9
[9] Statistics New Zealand Subnational Population Estimates 2018 compared to i11-4 forecast
[10] Waka Kotahi's State Highway traffic counts

Figure 3 North Shore external travel volumes by corridor, all modes 2048 AM peak (source: AFC)



The Waitematā Harbour is a culturally significant area for Auckland. The Harbour plays many roles for Auckland; socially it is integral to Auckland's identity as the "City of Sails", providing a landscape for leisure and sports. Culturally, the harbour is significant to iwi and Tāmaki Makaurau's history, as well having an important role in freight, transport, and tourism.

4.1.2. Environmental

From an environmental perspective, any connection to the North Shore must interact with the Waitematā Harbour which is a highly valued and sensitive environment. In recognising the importance of coastal environments, the coastal marine area (CMA) and adjacent coastline is subject to tighter restrictions under the Resource Management Act. The coastal marine area within the Project area is largely classified under the AUP-OP as a Significant Ecological Area – Marine (SEA-Marine 1 and SEA-Marine 2) (as seen by the cross hatching in Figure 4), requiring greater levels of care and restriction.

SEA-Marine 1 are areas which, due to inherent value or physical form, are considered the most vulnerable to any adverse effects of development, while SEA-Marine 2 are regionally significant areas which are more robust. The presence of SEA-Marine 1 and 2 means that special consideration must be given to the management of the effects on the values of these areas by any development or use.

Figure 4 Significant Ecological Areas of the study area

4.1.3. Cultural

Coastal areas are significant taonga (treasure) to Māori; spiritually and functionally. The taonga status of water bodies means that Mana Whenua regard themselves as guardians for the water and its surrounding environment, imposing an obligation to protect and enhance the water's wellbeing for future generations[11].

Functionally, the harbour has been the main anchorage area for the Auckland region for centuries. The harbour is sheltered from many storms by the North Shore, resulting in slow currents. The harbour contains some deep channels for easy navigation, and the drowned valley system means the terraces on the shore have been convenient landing areas before the official ports were created. This sailing and trading heritage is enduring - today Ports of Auckland operates as the most efficient port in Australasia[12], and the Waitematā Harbour sees hundreds of ship movements every day.

Several sites of significance to Mana Whenua have been identified within or near to the AWHC corridor, including; Wai Kōkota and Te Tō - Victoria Park, Te Onewa (Stokes Point) pa, Te Rōutu o Ureia – Pt Erin, Motungaengae (Watchman Island) and Te Kōpua a Matakamo kamo – Tuff Crater

[11] https://www.epa.govt.nz/assets/FileAPI/proposal/NSP000038/Board-minutes-directions-and-correspondence-Correspondence-to-decision-maker/EWL-Resp-Min1-Cultural-Values-Report.pdf
[12] www.poal.co.nz/our-story/contribution

(subject of Plan Change 22 (PC22)13). The Onepoto explosion crater cliffs and the original shoreline and foreshore on both sides of the harbour (including the cliffs adjacent to the existing motorway between Northcote Point and Akoranga) are also noted.

[13] Plan Change 22: Additions to Schedule 12 Sites and Places of Significance to Mana Whenua, Schedule 6 Outstanding Natural Features Overlay, Schedule 14.1 Schedule of Historic Heritage (submissions closed on 24 May 2019).

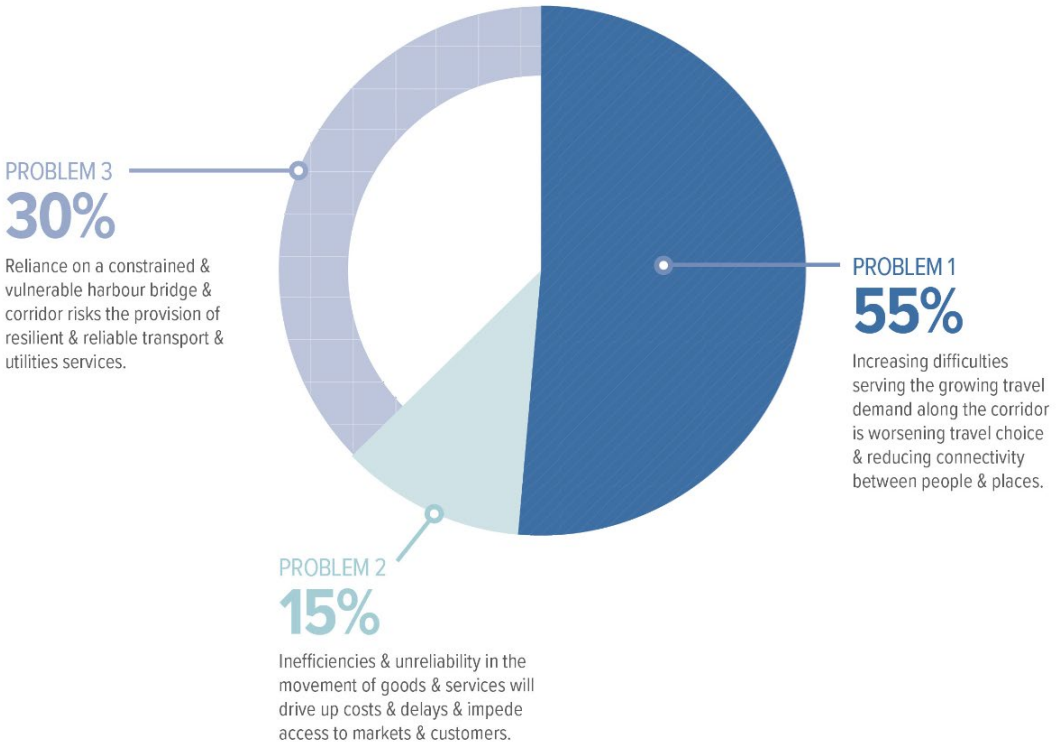
5. DEFINING THE PROBLEM

Investment logic map (ILM) workshops were held in February 2019 involving senior representatives from Waka Kotahi, AT, AC and KiwiRail, facilitated by an independent ILM facilitator.

The problems are based on the growth pattern (i.e. the location of future households, people and jobs) anticipated by the Auckland Plan and reflected in the regional land use and transport forecasting models *without* the investment considered here (i.e. the counter-factual) but including other reasonably foreseeable interventions in an agreed "do-minimum".

The following problems were identified by the project partners. The percentages are the weightings attributed by the Investment Logic Map Workshop.

Figure 5: Problem Statements



The full Investment Logic Map is included as Appendix A.

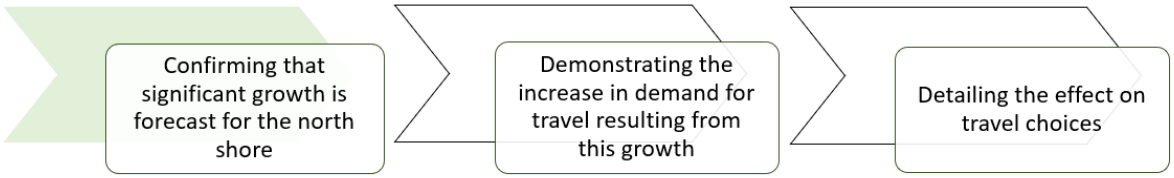
5.1. Problem 1 – Travel Choice and Connectivity

Increasing difficulties serving the growing travel demand along the corridor is worsening travel choice & reducing connectivity between people & places.

The evidence supporting Problem 1 is established here in using the following structure, based on the key elements of the problem statement:

- Confirming that significant growth is forecast for the north shore
- Demonstrating the increase in demand for travel resulting from this growth
- Detailing the effect on travel choices

5.1.1. Forecast Growth



From 2018 to 2048, Auckland's population is expected to increase from 1.7 million to 2.4 million people[14]. Accommodating this growth will require around 350,000 more homes over the next 30 years.

ATAP acknowledges the effects of Auckland's historic and forecast growth in stating *"Despite this progress [in previous investments] the sheer scale and pace of growth, a history of under-investment and insufficient housing construction means that Auckland still faces significant transport and housing challenges".*

The North Shore is currently home to around 20 per cent of the region's **residential population**. The population of the North Shore Corridor is forecast to increase by 160,000 from 337,000 to 497,000, (+48%) by 2048, maintaining the current share of around 20 per cent of the region's population.

The forecast growth pattern on the North Shore has an emphasis on greenfield growth on its northern edges with the area north of Albany forecast to grow by 103,000 people (+113%). Areas further south, from Albany to Devonport, are expected to grow through intensification by approximately 58,000 people. Most of the growth between Albany and Devonport is expected to occur within three areas – the Metropolitan Centres of Albany and Takapuna and the development area of Northcote. This overall growth pattern of largely greenfields growth is projected to drive increasing travel demand, especially for longer trips, placing pressure on existing networks and creating the need for investment in new capacity. This growth pattern could change given the National Policy Statement on Urban Development, which could see greater intensification of development around RTN corridors. This is particularly important for this corridor and this project given the RTN component.

In terms of **employment**, the study area, including the city centre, currently accounts for 250,000 (36%) of Auckland's 690,000 jobs. This is split between the North Shore with 135,000 jobs and the city centre (including the fringe) with 125,000 jobs. The jobs in the North Shore area are considerably more dispersed, across a large number of medium to relatively low-density employment areas, than jobs in the city centre, which is the densest employment location in New Zealand.

Overall, the North Shore's employment growth will not match the expected population growth, signalling a greater percentage of the future population travelling to work outside the North Shore. The city centre and fringe are the key destinations for work-based and education related trips from the North Shore.

Table 4: Employment and population forecast ratios (MSM)

	2016 Jobs/Population	2048 Jobs/Population
North Shore	0.4	0.37
City Centre including fringe	1.87	1.76
City Centre	2.35	2.68

[14] Statistics New Zealand Subnational Population Estimates 2018 compared to i11-4 forecast

According to growth forecasts, it is expected that by 2048:

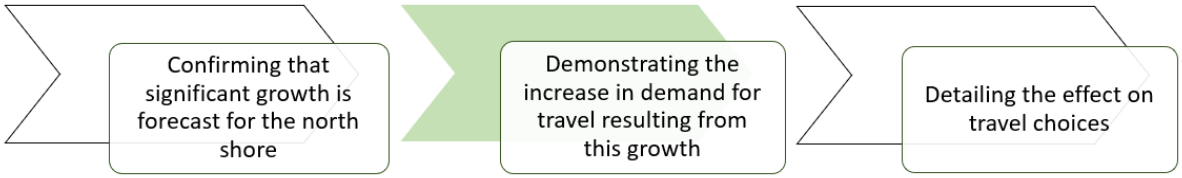
- The city centre and fringe area will remain Auckland's predominate high value, high density employment area with almost a quarter of all regional wide jobs. Employment is forecast to grow by an additional 87,000 jobs, increasing from 125,000 jobs to 212,000 or a 70% increase.
- Takapuna and Smales Farm will become the most significant employment zone on the North Shore with approximately 31,000 jobs in 2048, up from 18,000 now or a 71% increase.
- Existing industrial employment hubs in Wairau Valley and Rosedale are not forecasted to attract significant additional employment.

Education is a major source of travel demand, and access to education is an important component in people's ability to shape their future and fully contribute to the productivity of Auckland and New Zealand. Student trips will contribute to the changing level and nature of travel demand.

It is expected that the tertiary roll in the city centre will increase from 58,500 in 2016 to 96,000 by 2048, an increase of 64%. Meanwhile, the forecast tertiary roll on the North Shore is expected to increase from 14,500 in 2016 to 23,500 in 2048, an increase of 62%.

These forecasts were made pre-COVID-19 and the long-term effects of the pandemic will need to be considered as the project progresses through development.

5.1.2. Access to Opportunities: Increasing demand for travel and travel patterns



Based on the above growth expectations and the need for people to access employment, educational and social opportunities, demand for travel within, to and from the North Shore is expected to grow significantly. Travel external to the North Shore and in particular to the city centre is expected to grow at a significantly higher rate than internal travel.

Table 5 Increases in travel from the North Shore 2016 and 2048 (MSM i11)

	2016	2048
Total travel originating on the North Shore in the AM peak	145,000	190,000
	Increase of 31%	
Internal trips within the North Shore in the AM peak	116,000	145,000
	Increase of 25%	
Trips from the North Shore to the City Centre in the AM peak	17,000	24,500
	Increase of 44%	

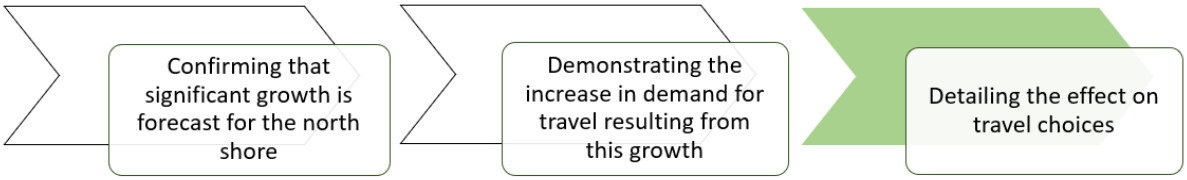
Travel patterns **within the North Shore** are complex as is typical of most urban areas, particularly given the relatively low-density employment, however there are some major east-west movements connecting residential catchments to employment centres in Wairau and Takapuna.

The majority of trips that leave the North Shore are expected to travel south across the Waitematā Harbour to access employment and other opportunities in the city centre and wider isthmus. The ART model shows that by 2048 around 32,000 trips from the North Shore are expected to cross the Waitematā Harbour in the AM peak, up from 22,500 in 2016. The 24,500 city centre bound journeys comprise 58% of all AM peak trips that originate in the North Shore and leave the North Shore

This illustrates that the people of North Shore, now and in the future, have a large reliance on the connection to the city centre and the remainder of the Auckland region for jobs, education and other opportunities.

The city centre also has a high and growing level of reliance on the North Shore's pool of labour. The North Shore contributes to 15% of the city centre's workforce today, and this is expected to increase to 19% by 2048; making the North Shore second only to the Isthmus in terms of labour contribution. This confirms that the North Shore's access to the city centre is important to its potential performance. This is significant in the strategic context given the productivity of the city centre and its important role in realising Auckland's land use objectives for a quality, compact city as expressed in the Auckland Plan.

5.1.3. Worsening Travel Choices

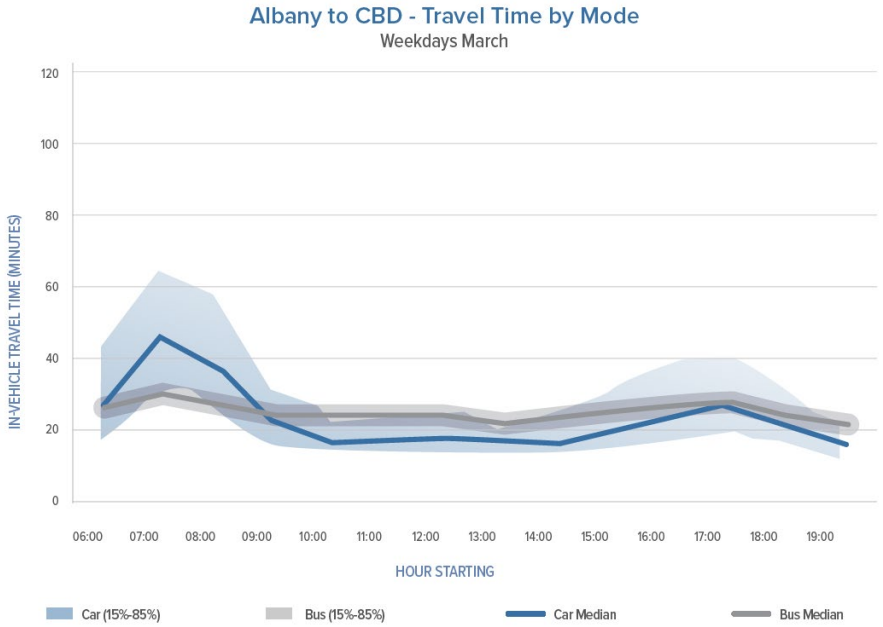


5.1.3.1. Current Situation – Access by public transport and road transport

Current peak hour travel times by road are highly variable and significantly longer than uncongested conditions. A journey by road from Albany to the city centre that takes around 20 minutes between peaks can take over an hour in peak times and travel times for this journey can vary by as much as 30 minutes at the same time of day.

Figure 6 shows that journeys by bus are comparatively more reliable than road journeys along the SH1 corridor, thereby providing a viable choice for many users. However, there will remain those for whom this will not be a viable alternative, particularly those accessing lower density employment destinations and goods and service vehicles. Goods and service traffic is dealt with specifically in Problem 2 and are subject to the same issues.

Figure 6: Observed travel times and variability between Albany and the City Centre, March 2019 *Source: AT*



The analysis of current travel times indicates not only a severe peak, but also a long peak period that commences as early as 6am with reliable journey times not occurring again until around 10am. The duration of these peaks is getting longer, for example, the 4am to 7am northbound vehicle flow has increased by over 50% in the last five years. These trends are projected to continue, with peak conditions continuing to spread to other times of the day. This will mean travel times and reliability can be expected to continue to deteriorate over a longer portion of the day as congestion spreads into the inter peak.

Due to its segregation from the southbound approaches to the Harbour Bridge, the Northern Busway currently provides good travel choice for a large proportion of North Shore customers, however given the growth in travel demand forecast, it will not remain this way.

The busway is not currently a complete system and for large sections buses must use unsegregated bus lanes or share road space with general traffic. Shared sections include the Harbour Bridge in both directions and parts of the route south of Akoranga in the northbound direction. As demand increases, elements of the busway are expected to become over capacity, resulting in reduced levels of service and an inability to meet demand. These issues are explored in detail in the North Shore Rapid Transit Programme Business Case[15] (PBC).

Some elements of the busway are already under pressure. Implementation of a new bus network on the North Shore in September 2018 highlighted some of the capacity limitations of the existing busway. Constellation Station in particular, experienced major operational issues with the network update, with up to 120 buses per hour scheduled to arrive at the existing two platforms. While this was the result of implementation issues with the bus network changes, it was illustrative of the limitations the busway will face as demand for travel increases. The long dwell times (Northern Busway dwell times range between 50 to 100 seconds per vehicle during AM and PM peaks) resulted in platooning of vehicles along the busway, which had a negative impact on the reliability of services, and customer journey times and experience.

The Northern Busway is being extended from Constellation Station to Albany Station as part of the Northern Corridor Improvements Project, which will also increase the capacity of Constellation Station and add a new Rosedale Station. This investment will help ease pressure on existing stations by diverting some local services away from Constellation and Albany Stations. While the busway extension will provide additional capacity in the short term, forecasted increased demand for travel requiring additional services will result in some elements exceeding capacity within the next decade[16].

A further key issue is that the Northern Busway bypasses Takapuna, with the street layout and harbour inlet forcing an awkward and indirect 1.7 km walk between Akoranga busway station and central Takapuna. Being a place of current and future density of residential population and employment, the lack of easy access to Takapuna from the rapid transit network (linking to areas both to the north and south) is likely to undermine its future success and the role this centre can play in supporting achievement of a “quality and compact” urban form.

[15] North Shore Rapid Transit Programme Business Case, Auckland Transport, 2017
[16] North Shore RTN Programme Business Case, 2016

Figure 7: Relationship of Akoranga busway station to Takapuna

The current extension and new Rosedale busway station address some of these issues, but other critical gaps remain, which can be summarised as follows:

- Northern motorway is highly congested at peak times, counter-peak and increasingly during the interpeak
- There is a lack of priority in some sections and in the city centre
- It does not directly service the important centre of Takapuna

5.1.3.2. The Customer's Lens on Existing Travel Choices

People who use the Auckland Harbour Bridge

People from the North Shore travel every day to access opportunities – jobs, education, retail, healthcare needs, recreation and many others. Auckland's transport system already impacts people's ability to meet their needs and for people and businesses on the North Shore, this is no different. Waka Kotahi and AT have carried out customer research to identify people's patterns and issues with the Auckland Harbour Bridge.

Journey purpose

Customer research from AT shows that two-thirds (66%) of people who use the Northern Busway in morning peak hours are commuting to work. Almost one-in-five (18%) are accessing tertiary education, while 16% are meeting other needs. Outside of peak hours, tertiary study is almost as high as employment as a reason for travelling across the harbour.

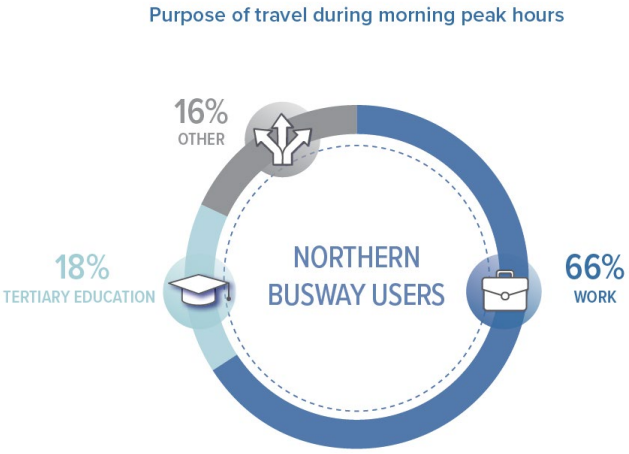


Figure 8: Northern Busway users' travel purposes

Behaviours and choice with transport modes

People who travel between the North Shore and the city centre on the SH1 route have a high rate of public transport usage at 39%.[17] This means that there is an opportunity to further promote travel choices that utilise public transport and active modes, noting that currently there is no connection for active modes (walking and cycling) across Auckland Harbour Bridge, although this is proposed.

Bus use has increased markedly since 2015, while the volume of private vehicles has remained relatively static in peak periods. While North Shore residents are higher-than-average public transport users when accessing the city centre, their car use is much higher for trips that don't cross the Auckland Harbour Bridge than for those that do. Overall, people from the North Shore take fewer single occupant vehicle trips on their most frequent journey than Aucklanders as a whole.[18]

Journey reliability

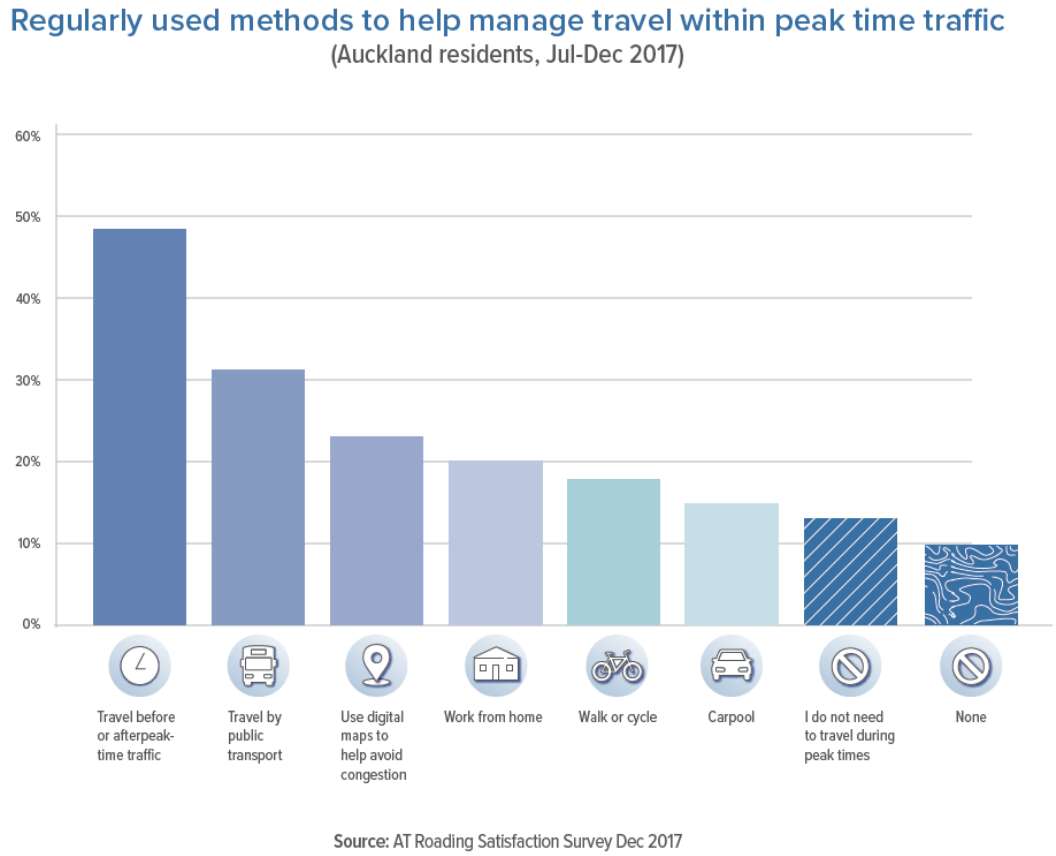
In AT's Roading Satisfaction survey, 60% of Aucklander drivers agreed with the statement that "I feel each day that I am battling the traffic." This is particularly high given the fact that 14% of drivers do not need to travel at peak.

Strategies used to manage travel needs

Aucklanders already use a range of strategies to manage congestion, most commonly by travelling earlier or later than peak or using public transport. 20% of people report that they work from home; and walking and cycling is also approaching 20%. For the North Shore context where several feeder roads to the bridge have transit lanes, 15% are carpooling, with 14% taking advantage of transit lanes to avoid congestion.

[17] AT Market Perceptions Research, March 2019.
[18] AT Market Perceptions Research, December 2018.

Figure 9: Methods to deal with peak times



Young people (15 to 24-year olds) are most likely to manage peak travel using public transport, walking, cycling or car-pooling, while those in self-employment are most likely to travel either side of peak time or work from home. However not all workers have this flexibility: 57% of Auckland commuters say they are unable to change their work hours.

Summary of customer insights

The input from users of the Auckland Harbour Bridge strongly supports the problem definition and supporting analysis, reflecting concern over reliability and delays in accessing jobs, education and other activities. People are concerned that this dynamic and a lack of alternatives for travel will impact on their opportunities for work and living.

5.1.3.3. Future Access - Traffic

Approaches to the Harbour Bridge have been at capacity for a number of decades at peak times, with additional demand taken up through growth in public transport use and a longer peak period. Figure 10 and

Figure 11 show that the Harbour Bridge corridor is currently at capacity in both northbound and south bound directions, during the AM and PM peaks. These trends are projected to continue, with peak conditions continuing to spread to other times of the day.

The capacity per direction changes over the day as the moveable barrier reassigns traffic lanes, also note that the southbound peak capacity is constrained by the three southbound lanes (plus busway lane) north of Onewa Road, so is lower than the northbound peak capacity.

Over the last five years, off-peak traffic has been steadily growing: inter peak flows across the Harbour Bridge have been observed to increase by approximately 1% per annum and pre-AM peak (4am to 7am) has increased by 53% across the five years.

By 2048 the Harbour Bridge flows are forecast to be within 90% of capacity for up to 12 hours of the day. This level of demand will impact on travel times and reliability for inter peak trips including freight,

business and commercial trips. Considering these reasons for travel demand, and that a high proportion of inter-peak trips are not to or from the city centre, these trips have limited ability to transfer to public transport compared to commuting trips to and from the city centre. Furthermore, because the Harbour Bridge is the only direct road link between the North Shore and the isthmus, congestion on the corridor affects a wide variety of trips and cannot easily be avoided by travelling via an alternative route.

Figure 10: Harbour Bridge Southbound Traffic Flow and Capacity 2018 and 2048 (MSM i11)

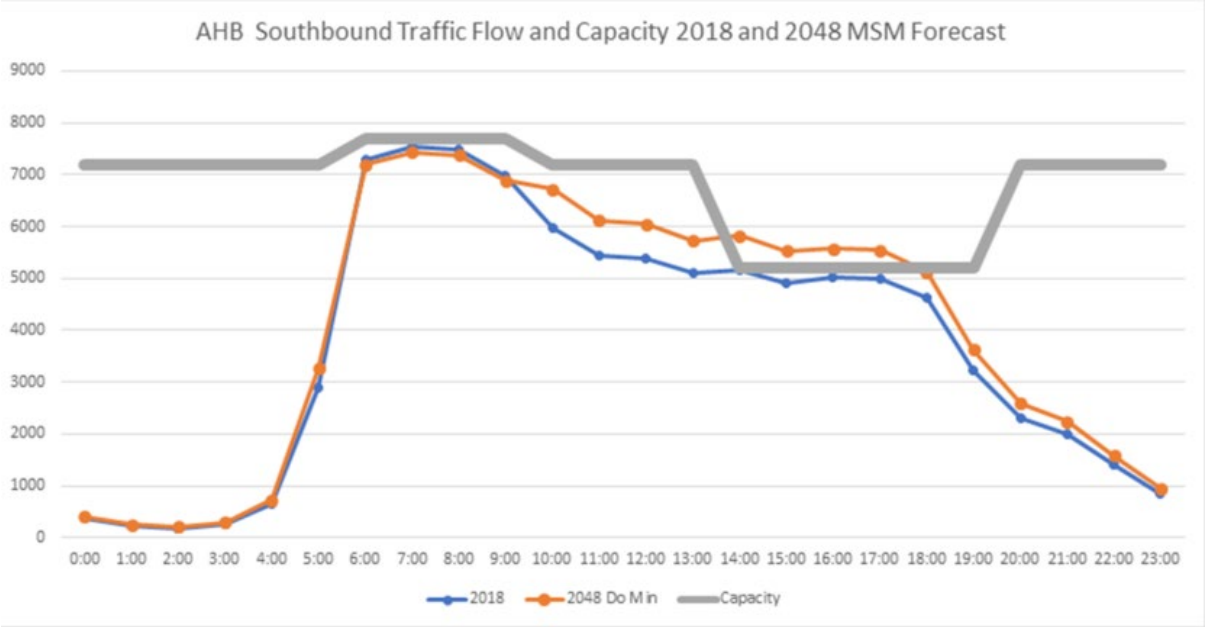
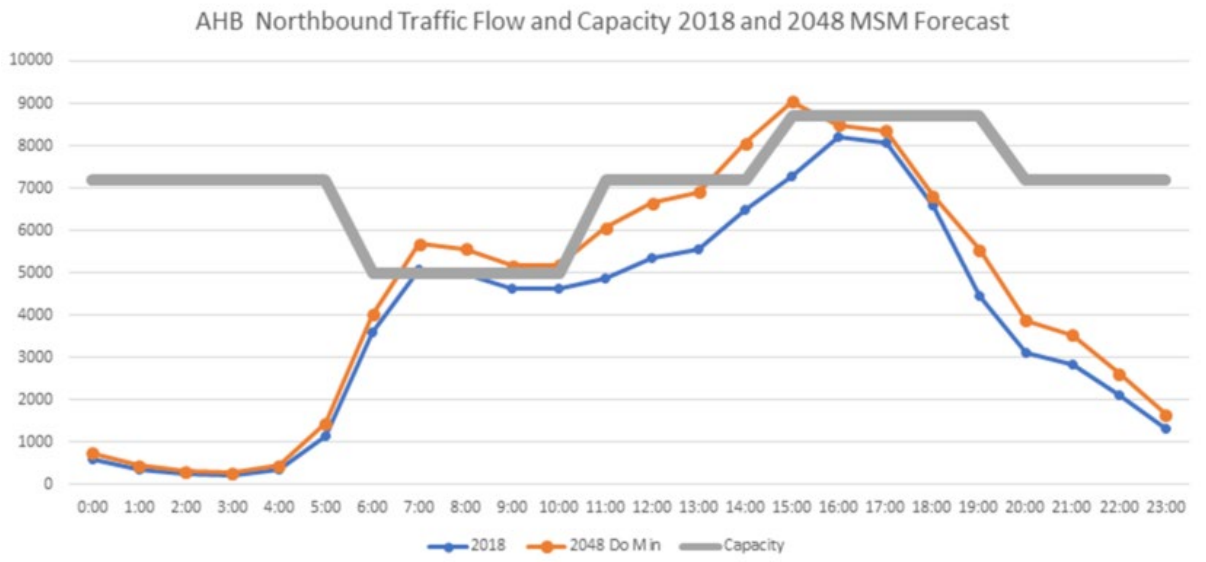
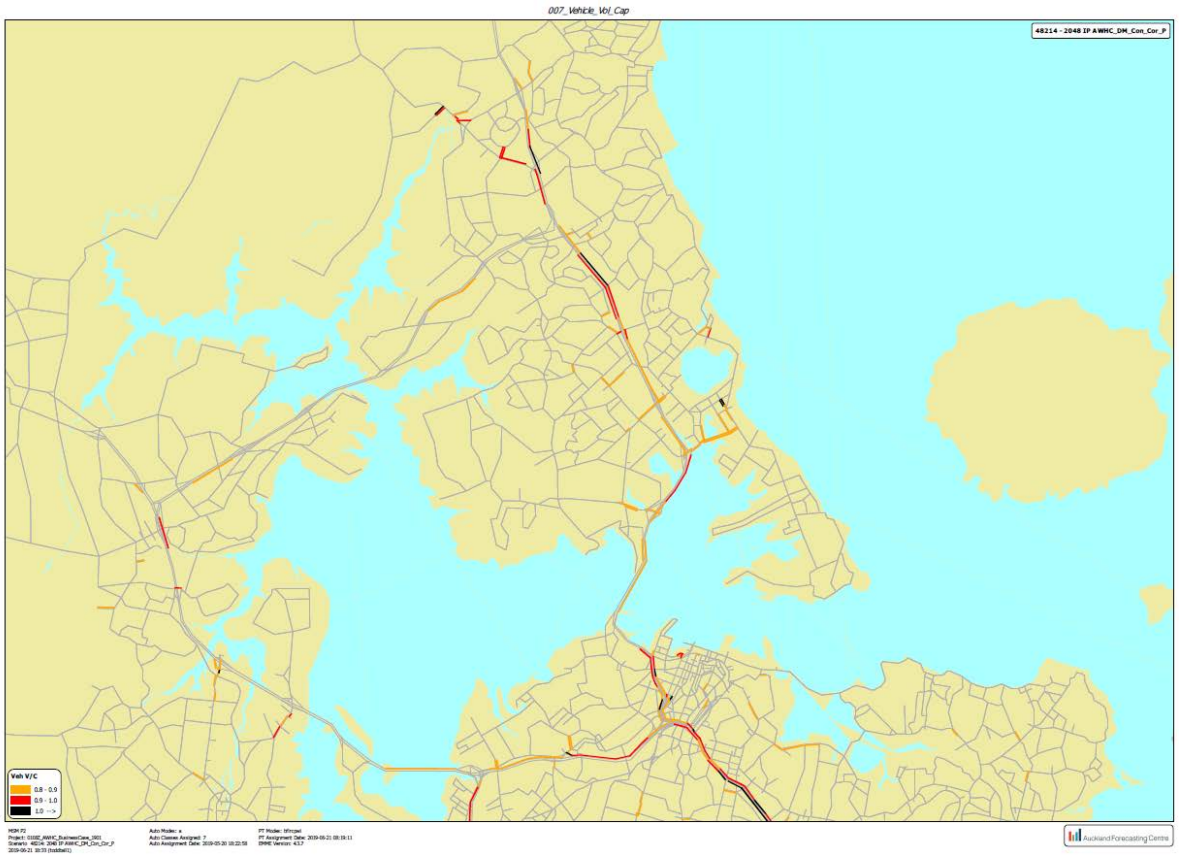


Figure 11: Harbour Bridge Northbound Traffic Flow and Capacity 2018 and 2048 (MSM i11)



By 2048 these key approaches are also forecast to be highly congested in the interpeak as well as shown in Figure 12 (red and black indicates areas of congestion).

Figure 12: 2048 Interpeak transport network performance



Careful consideration of these approaches will need to be made when developing responses to the cross-harbour traffic challenges in the future.

5.1.3.4. Future Access – Public transport

Due to the wider network capacity constraints on the road network, public transport needs to accommodate all peak direction, peak time additional cross-harbour travel in the future. This scale of demand growth means the Northern Busway (including its stations and key city centre bus routes) will become overwhelmed in the future, with the additional buses needed to meet demand placing pressure on stations and city centre streets, ultimately resulting in longer and less reliable trips.

Growing public transport demand[19] and increasing all-day congestion on the corridor will also mean that gaps in the Northern Busway system (i.e. a lack of bus priority in city centre streets, over the Harbour Bridge, northbound through St Mary's Bay and northbound between the Harbour Bridge and Akoranga Station) increasingly undermines performance and attractiveness of the public transport system.

A considerable amount of work has been carried out through several studies on the issue of addressing growing demands and worsening travel choices for access to the city centre, specifically:

- The City Centre Future Access Study, 2012
- The Bus Reference Case, 2016 and 2018 update
- The North Shore Rapid Transit Strategic Business Case, 2016

[19] Using unconstrained demand forecasts to determine the underlying demand for travel and identify any capacity deficiencies, the

These studies consistently show a significant issue in the ability of the existing transport system to cope for the forecast demands.

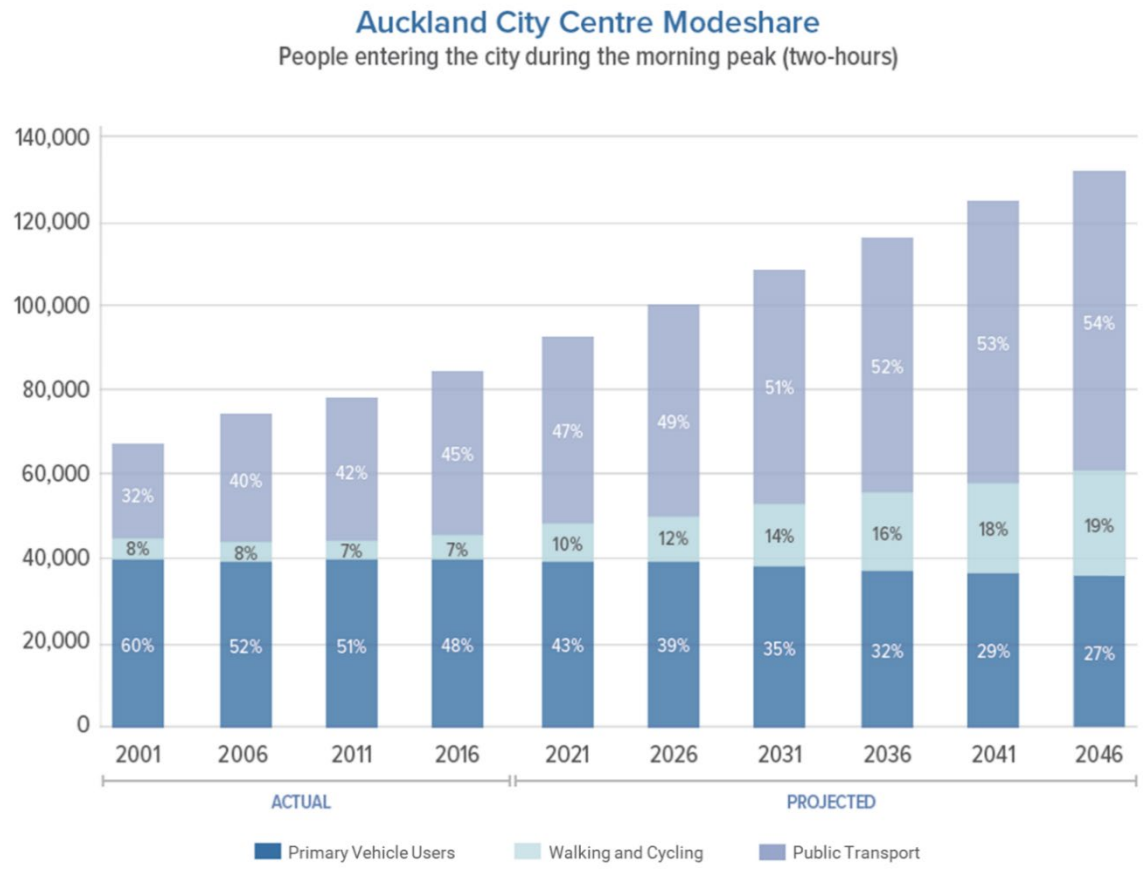
The Auckland Bus Reference Case concluded:

"Anticipated large volumes of buses, particularly from the North Shore, Northwest and Isthmus will be a challenge to accommodate given space constraints in the city centre, particularly along key bus corridors (e.g., Wellesley Street and Albert Street) and at city centre bus termini."[20]

A combination of increasing demands for additional capacity, a desire through the City Centre Masterplan to improve the liveability of the city centre by allocating more space to pedestrians, the limitations imposed by frequent intersections and crossings and the need for a large number of high-volume bus stops means that there are a limited range of options for improving the ability of the city centre to receive the forecast numbers of buses.

Given the net reduction in traffic capacity envisaged in the City Centre Masterplan, all growth (and more) in travel to the city centre over the next 30 years is expected to be accommodated by public transport, walking or cycling, as shown in Figure 13 below. This trend is already underway, as all travel growth to the city centre since 2001 has been via public transport and active modes. Further updates to these projections are expected following the completion of the Access for Everyone Programme Business Case in early 2021.

Figure 13: Auckland City Centre mode share, actual and projected



Based on these studies, it is clear that:

- Significant increases in demand for public transport can be expected between the North Shore and the city centre.

[20] Auckland Bus Reference Case

- It is critical for the growth in trips between the North Shore and the city centre to be via public transport and not general traffic.
- There is limited capacity for further growth in bus volumes from the North Shore to the city centre, without significantly degrading service speed and reliability.

What this means is that over time, public transport access to the North Shore will be increasingly crowded, less reliable and will eventually reach the point where the buses fail to provide an effective rapid transit service. An ineffective public transport system is likely to affect the quality of access for people to key metropolitan centres (such as Takapuna and Albany) and the city centre. This also means that people from the North Shore, an increasingly important contributor of skilled labour to the city centre, will be less able, or less inclined to use public transport. This will undermine the mode shift required for the city centre to reach its potential as a quality place and dense centre of highly productive business.

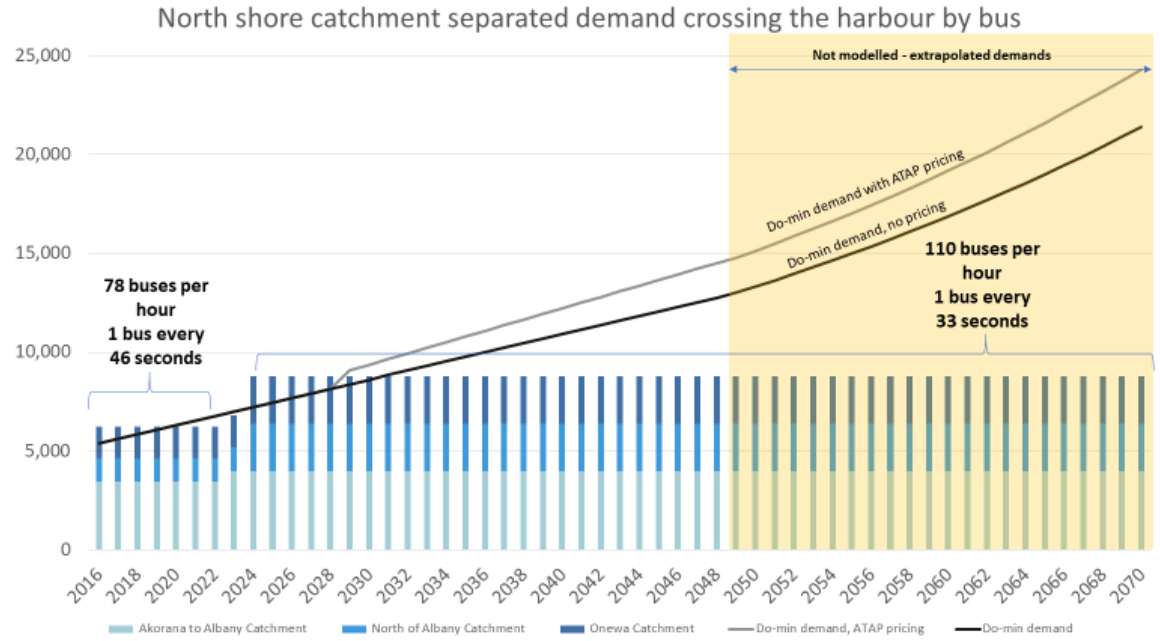
Figure 14 shows that even with busway enhancements enabling 110 double-decker buses an hour, the Northern Busway is forecast to reach its effective AM peak southbound capacity in the early 2030s.

Further, this figure shows that by the late 2040s the scale of the access deficit from the North Shore to Auckland's critical economic engine, the city centre will be about 4,000 people in the peak hour.

It is forecast that road pricing would reduce cross harbour traffic demand, with the degree of reduction dependent upon the charging system adopted. Any system would likely increase the demand for public transport and therefore the timing (bringing forward) of any required intervention. Shown using the light grey line in Figure 14, road pricing is expected to reduce the effective lifespan of the busway by 3-4 years almost immediately from introduction. If a pricing regime were implemented in the 2020s the busway capacity would be surpassed by demand in the late 2020s.

Figure 14 North Shore bus demand and capacity – do-minimum

Source: Demand – ATAP i11



5.1.3.5. Future Access - Ferry and Active Modes

The North Shore's connection to the city centre and isthmus is dominated by the Harbour Bridge and a distant supporting connection on SH18 to Hobsonville. The State Highway 1 link is a motorway and currently has no provision for walking or cycling. As travel conditions worsen on public transport and road, North Shore residents do not have a viable walking and cycling connection. A walking and

cycling connection across the harbour between Westhaven and Akoranga (known as the 'Northern Pathway') is proposed to be completed by 2024. This facility, once implemented, will provide a connection for walking and cycling between the North Shore and the existing shared path at Westhaven with Northcote Point. This connection will be implemented regardless of the outcome of this business case.

The Northern Pathway will enhance the choice available for travel between the North Shore and city centre and beyond due to the connection with the shared path and cycleway system on Auckland's waterfront and State Highway 16. Nevertheless, this is a single connection and its location and alignment may not be convenient for all users, depending on the origin or destination of the journey.

Ferry services operate from several locations on the North Shore and provide opportunities for travel choice for people with access to ferry wharves and destinations in the city centre. Ferry locations serve local catchments. Ferry services currently provide 5.1% of AM peak inbound mode share to the city centre or around 4,000 people per AM peak. This is expected to increase in the future retaining a 5.2% share in 2048. While an important component of access in the AWHC corridor of movement, it is unlikely that ferry transport will fully resolve the scale of the access problem likely to exist in the future. The North Shore RTN Programme Case considered an enhanced ferry option in its long list assessment as part of a programme alternative based around enhancing existing modes which was not recommended[21]. The conclusions of the business case did recommend that ferries are enhanced as part of the RTN-led recommended programme.

A limiting factor in the potential effectiveness of ferries in this situation is the land use forecast for the North Shore which envisages significant growth on the northern edge of the urban area which is not well located for active modes (other than active mode arrivals at RTN stations) or ferries to deliver trips external to the North Shore.

5.1.4. Status of the Evidence Base for Problem 1

The evidence for Problem 1 is considered **strong**. There is a large body of evidence that points to this problem:

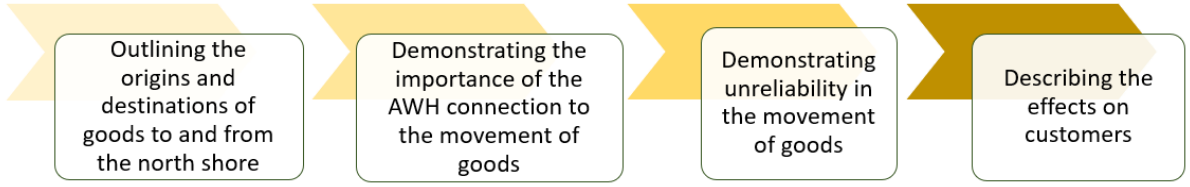
- Having a **clear cause** in large scale land use growth and increasing demand for travel resulting in reducing access and choice of access as do-minimum networks become congested and unreliable.
- Having a **clear time** that the problem will manifest itself as the road network is already operating at peak capacity for long periods of the day and this period is lengthening, while demand for public transport connection is expected to exceed capacity in the early-2030s or potentially late 2020s.
- Having a **clear scale** with the deficiency of AM peak access to the city centre being specifically defined and the growth and travel demand estimates being clearly defined.
- Being **specific** to the investment being considered as the AWHC corridor is the only direct connection between the North Shore, the city centre and isthmus, acknowledging that there are also broader network impacts (such as impacts on CMJ).
- Having no significant **gaps** in the evidence base are limited from a public transport and city centre access and peak period perspective. There are some gaps in knowledge in respect of interpeak and counter peak demands and potential issues, particularly in respect of road transport.

[21] North Shore RTN Strategic Case, Auckland Transport 2016 section 6.3

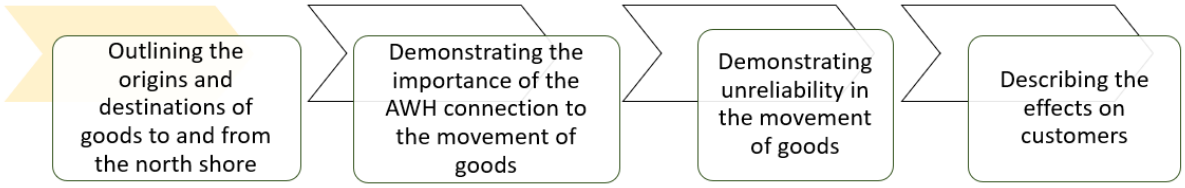
5.2. Problem 2 – Freight Productivity

Inefficiencies & unreliability in the movement of goods & services will drive up costs & delays & impede access to markets & customers.

The evidence supporting Problem 2 is established here in using the following structure, based on the key elements of the problem statement:



5.2.1. Origins and Destinations for Heavy Vehicle Trips



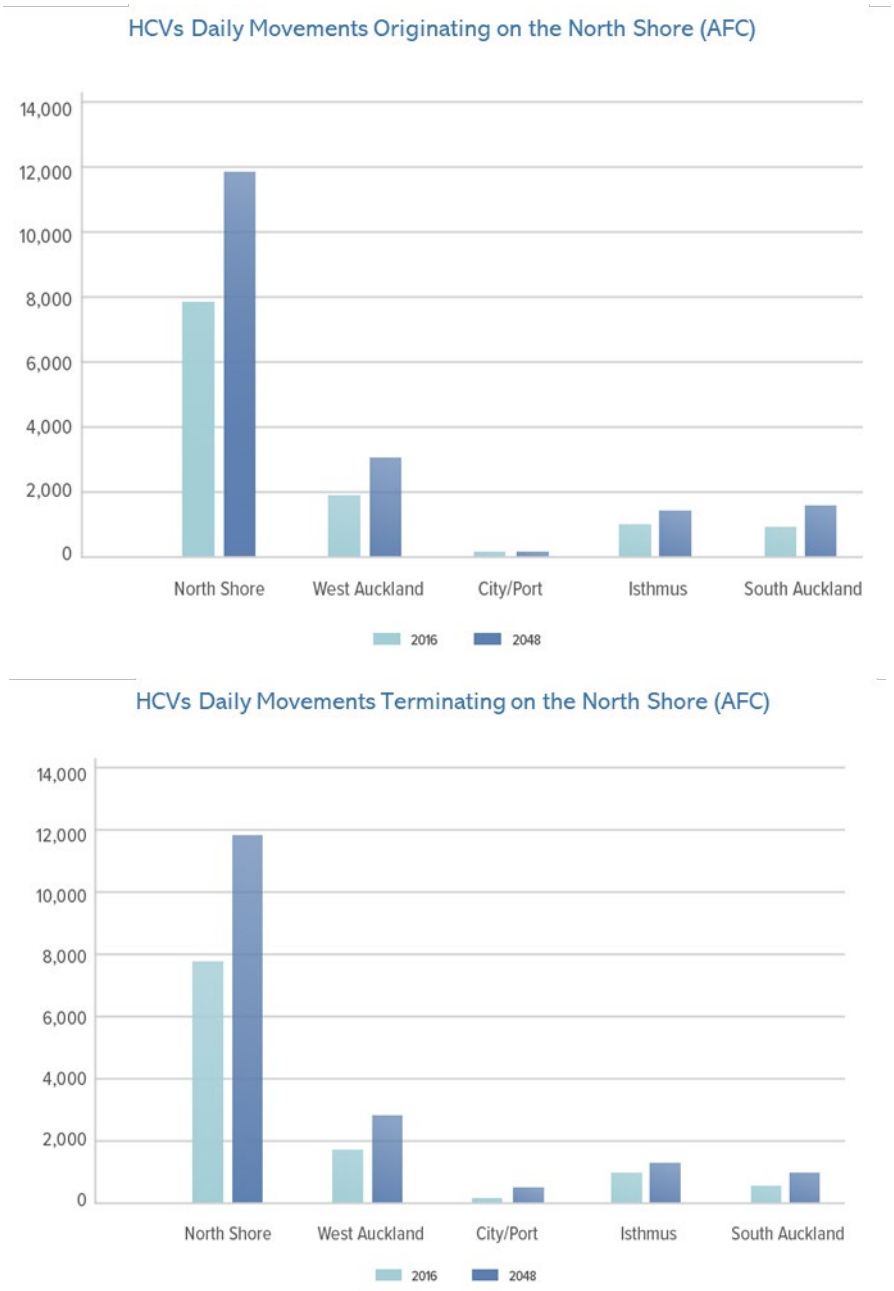
The movement of goods and services around Auckland covers a wide variety of different trips, including freight, deliveries and services (e.g. electricians and plumbers). In this analysis, Heavy Commercial Vehicles (HCVs) have been used to proxy goods and services movement as this is a class included in transport modelling forecasts.

Most HCV traffic that travels on the North Shore originates and terminates on the North Shore (Figure 15). The dominant destinations and origins of freight trips to/from outside the North Shore are in West Auckland, South Auckland and the Isthmus. A breakdown of the primary destinations and origins on the "Isthmus" indicates that these are on its southern edges in the vicinity of Penrose and Mt Wellington.

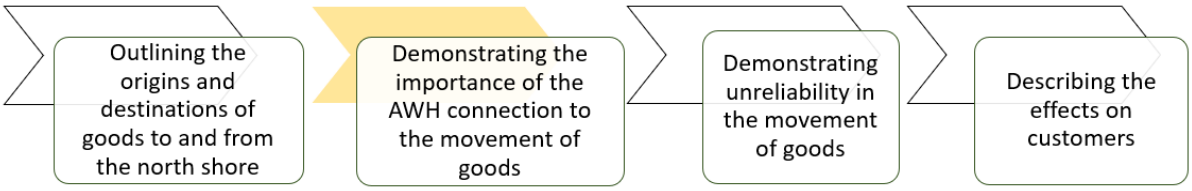
Most trips are internal to the North Shore in which case the reliability of the connection between the North Shore and the city is relevant to the extent that any congestion or unreliability on the cross-harbour connection impacts on movements across the state highway or intra-North Shore movements using the state highway. The second greatest movement is going to and from West Auckland, in which case the SH18 – SH16 route would appear to be a viable, if not preferred route.

Of note is that the port area, while strategically important, is a relatively minor origin/destination for HCV trips to and from the North Shore. Similarly, inter-regional connections to Northland make up only a small proportion of the total HCV movements in the AWHC corridor. Daily HCV volumes at Puhoi for example, are 1,400 per day, many of which are likely to have originated north of the Harbour Bridge.

Figure 15: Origins and destinations of HCVs to and from the North Shore (MSM i11)



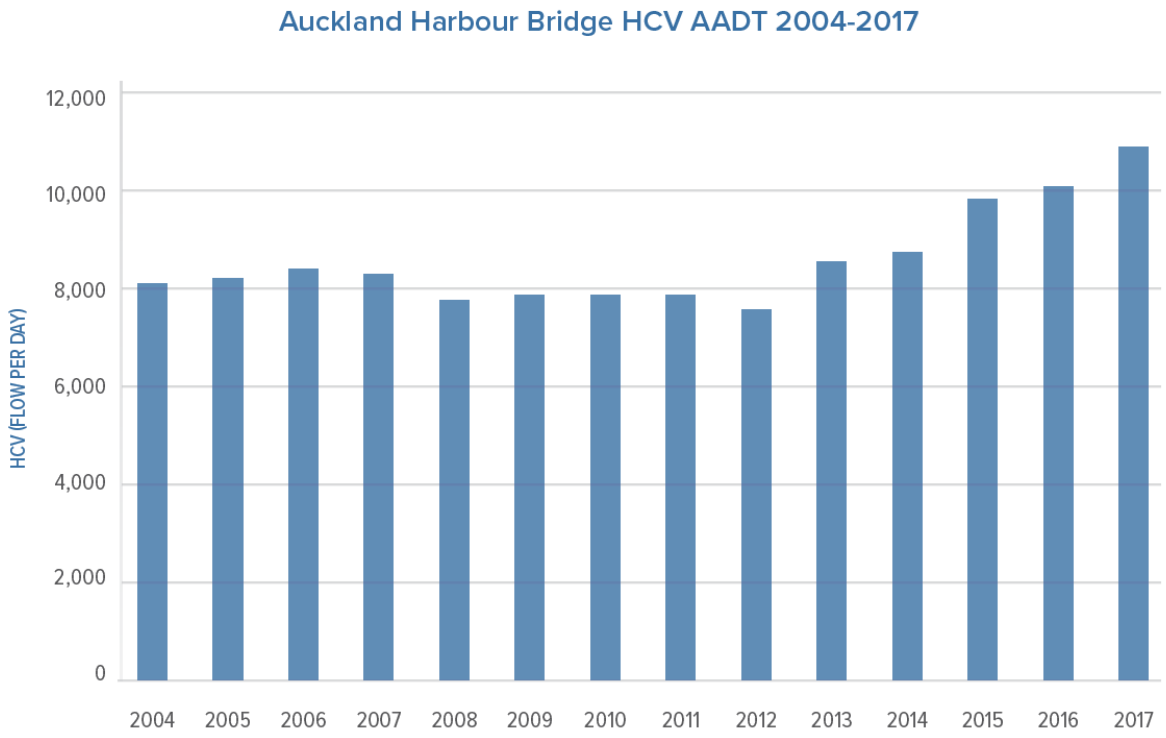
5.2.2. The Importance of the AWHC to the Movement of Goods



The connection to the North Shore is a major component of Auckland's goods and services movement network. The Harbour Bridge currently carries around 11,000 HCV movements per day. In 2017 the Northbound and Southbound links across the Harbour Bridge were the 8th and 10th busiest links in New Zealand for HCVs respectively. HCVs as a percentage of the total traffic volume on the AHB corridor is not high at 6.4% when compared to other strategic routes in Auckland.

Volumes of freight have been increasing in recent years on the Harbour Bridge, following more than a decade of remaining relatively stable (Figure 16).

Figure 16: Harbour Bridge Heavy Vehicle Volumes - 2001-2017 (ATOC)



As the North Shore and the wider Auckland Region grows, volumes of heavy vehicle trips are also forecast to grow.

An alternative route exists for goods and services movement to and from the North Shore in the Western Ring Route via SH18 and 16, including major demands to/from West Auckland and South Auckland. Provision of an alternative to the SH1 route through Auckland City and the Harbour Bridge was a core part of the case for the Western Ring Route, including from the North to the Southern Isthmus[22]. As a result, this role is included in the Objectives for the corridor in Concept of Operations for the Western Ring Route. As part of a suite of objectives in this Concept of Operations, the following are included[23] (emphasis added):

- *"To deliver improved trip reliability from the west to the south, from the **north to the southern isthmus** and in particular from the CBD to the southern Auckland isthmus and airport;*
- ***To provide an alternative route through the region that reduces dependency on SH1 and the Auckland Harbour Bridge** and unlocks the growth potential of development nodes along the length of the corridor."*

Forecasts based on 2048 land use indicate that for HCV trips) originating on the North Shore that leave the North Shore, around 60% are expected to use the Harbour Bridge, while around 40% will likely use SH18 (see Figure 17 and Figure 18 below).

[22] Waka Kotahi evidence to Waterview Connection Project Board of Enquiry November 2010
[23] Western Ring Route Concept of Operations, August 2016

Figure 17: HCV Select Link on SH18, SB Interpeak, 2048. 833 shown in red section

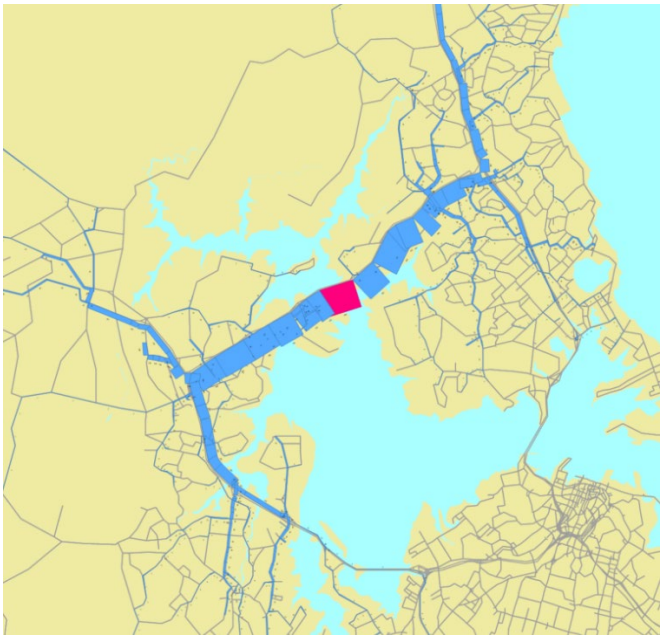
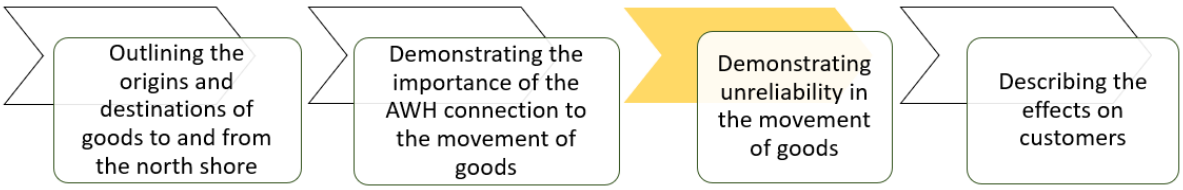


Figure 18: HCV Select Link on SH18, SB Interpeak, 2048. 1,225 shown in red section

This information indicates that while the Western Ring Route is intended to and is expected to cater for a significant proportion of HCV trips originating from the North Shore and destinations further north, the SH1 route is still expected to be the preferred route for most trips.

5.2.3. Unreliability in Movement of Goods and Services



The bulk of heavy and commercial travel in Auckland is by medium and small size vehicles distributing goods to retailers or to homes and by service workers such as plumbers or electricians[24]. Transport modelling outputs provide limited specific information on this class of user, however much of the information underpinning Problem 1 insofar as it discussed road network performance and capacity would also apply to these trips.

This means that for a large part of the day, poor travel times and reliability exist for goods and services trips between the North Shore and Auckland City (refer to Problem 1). Given forecast growth in both goods' movement and other demand for travel, it is expected that this situation will worsen significantly in the future. By 2048 much of the corridor is projected to face congestion throughout the day (as identified in Figure 12) if improvements or wider policy initiatives (e.g. road pricing) are not in place. This level of saturation will impact on travel times and reliability for inter peak trips including freight, business and commercial trips.

Modelling also indicates that while public transport ridership and mode share in both peak and interpeak travel is expected to increase substantially over time as improvements are made, this does not result in a reduction in traffic volumes – instead allowing more people to travel across the harbour. Therefore, as traffic volumes approach capacity limits throughout more of the day, travel times are projected to worsen through the interpeak periods. This will impact on the ability for goods and services to be delivered efficiently and reliably.

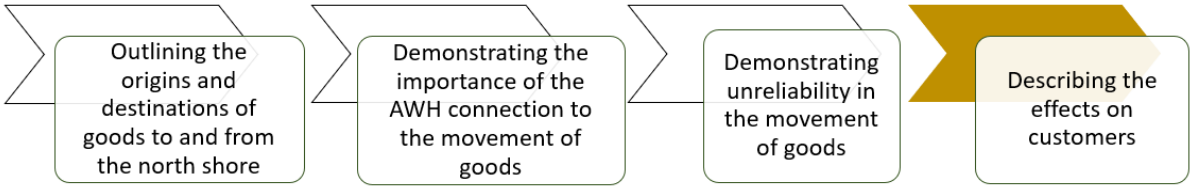
Table 6 shows that all routes are expected to worsen in the future, noting that some of the variability evident in empirical data is not easily replicated by a strategic modelling tool. This trend is similar for all periods of the day. Analysis of the AM shows clearly that some longer journeys connecting Northland with the key destinations on the southern Isthmus around Mt Wellington and Manukau are similar via the Western Ring Route and the Harbour Bridge. The difference in travel time is more significant for shorter journeys.

Table 6: Existing and forecast travel times for key goods routes (2019 Google; 2048 MSM do-min AM peak)

ROUTE	2019 GOOGLE MAPS AM PEAK	2048 DO-MINIMUM AM PEAK
Wairau - City Centre AHB	18-40	32.2
Onewa - City Centre AHB	17-40	32.9
Wairau - Mt Wellington AHB	26-46	45.6
Wairau - Mt Wellington WRR	45-80	69.8
Warkworth - Manukau AHB	70-110	95.8
Warkworth - Manukau WRR	75-110	101.4

[24] Auckland Council, Auckland Plan 2050 Direction 1 Better connecting people, places, goods and services

5.2.4. The Potential Effects on Markets and Customers



Efficient movement of goods and services is important to Auckland by helping to keep prices down. Congestion and longer journeys (forecast at over a 12% increase in travel time alone in the interpeak) mean that businesses must take extra steps to enable deliveries to be made. This is effectively leading to more vehicles on the road, reduced efficiency and increases costs to the customer.

A higher cost of moving goods also restricts the competitiveness of manufacturers.

In the context of this problem, commercial vehicles movement within the North Shore are being negatively impacted through the network wide issue of congestion on key arterial roads, originating from the Harbour Bridge corridor.

Equally, commercial vehicles travelling over the Harbour Bridge are facing the same economic cost of delays and constrained productivity as private vehicles, but this is causing knock on effects to the supply chain and wider economy, further than just the city centre.

Increased congestion has reduced average speeds that trucks can travel at along key freight routes. Whilst freight makes up a relatively small proportion of road users, the reliance of many other sectors on transport means that travel time delays have implications across the supply chain[25].

5.2.5. Status of the Evidence Base for Problem 2

The evidence for Problem 2 is considered **moderately strong**. Much of the evidence supporting Problem 1 in relation to the road network performance relates to this problem. The evidence points to the problem:

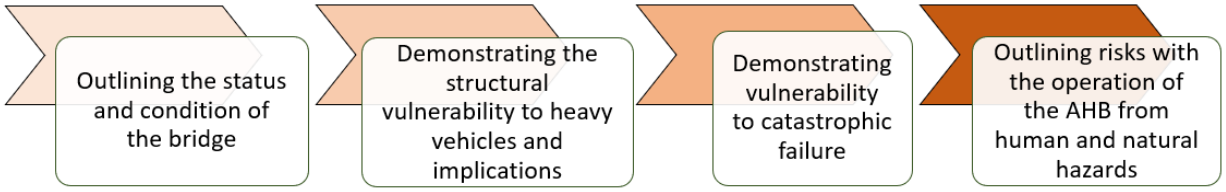
- Having a **clear cause** in increasing demand for commercial travel resulting in greater demand for movement on increasingly unreliable corridors.
- Having a **timing and scale** that is reasonably clear in that the problem exists today and is likely to worsen. The evidence does not provide particularly specific indications of scale or timing of this degradation at this time, however the observed patterns and know future forecasts suggest that the scale could be significant with development of further information.
- Being reasonably **specific** to this investment. While evidence shows that the corridor is a significant route for heavy and commercial traffic, the patterns of movement from the North Shore indicate that some alternatives do exist for many journeys. A network approach to resolving this problem is expected to be required.
- Having **gaps** exist in the evidence base in relation to the detailed make up and patterns for commercial traffic in the service sector which includes tradespeople, deliveries and other small commercial vehicles. Gaps also exist in the detailed understanding of the future operation of the wider road network, particularly in the interpeak periods.

[25] NZIER report – Benefits from Auckland road decongestion, July 2017

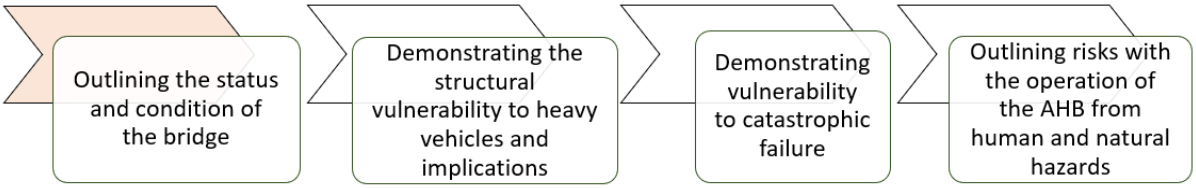
5.3. Problem 3 – Vulnerability and Resilience

Reliance on a constrained & vulnerable Harbour Bridge & corridor risks the provision of resilient & reliable transport & utilities services.

The evidence supporting Problem 3 is established here in using the following structure, based on the key elements of the problem statement:



5.3.1. Status and Condition of the Harbour Bridge



The Harbour Bridge carries State Highway 1 over the Waitematā Harbour and is essential to the safe and efficient movement of people and goods. The bridge also forms a major part of Auckland's public transport network, connecting Auckland City to the Northern Busway, although no specific priority is provided for buses.

The Harbour Bridge is the most travelled route in New Zealand, moving over 230,000 people a day. It provides the most direct road connection between the North Shore and the Auckland Isthmus. While the Western Ring Route functions as an alternative, it is a much longer route for many journeys and at peak times in particular has little spare capacity to handle diverted trips from the Harbour Bridge.

In addition to its main function of carrying traffic and public transport, the Harbour Bridge provides a land-based route across the Waitematā Harbour for utilities. Presently, the bridge carries two water mains, a gas main, telecommunications cables and a high voltage power link.

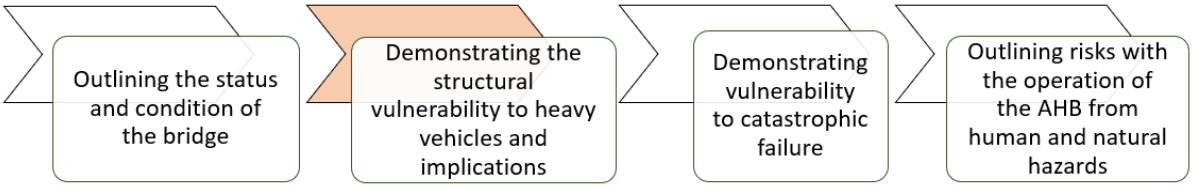
While the Harbour Bridge is often seen as one structure, it is actually a collection of bridges which includes:

- 1km long truss bridge opened in 1959, which is a four-lane steel box girder structure.
- Two two-lane extension bridges (known colloquially as the 'clip ons') that were opened in 1969 and are essentially widened extensions of the approach viaducts.
- A further 600 metres of steel and concrete approach viaducts.

The Harbour Bridge is generally in good condition.[26] There are however, a number of defects that require attention in the coming years. These include steel fatigue cracking, corrosion, concrete cracking and stringer debonding. There are also several fatigue prone areas that require ongoing monitoring. There are increasing risks to the Harbour Bridge's condition and Waka Kotahi is bound to retain the condition of the bridge as a key part of the nation's transport network. These risks relate to increasing volumes of HCVs creating stress on the bridge. This will require management in order to retain its good condition. This management is expected to take longer and be more disruptive the longer the bridge remains a heavily trafficked connection. For example, major pavement overhauls will need to be undertaken in the future.

[26] HARBOUR BRIDGE Life Cycle Management Plan, 2017

5.3.2. Managing Heavy Vehicles



The Harbour Bridge was opened in 1959 and in its lifetime has seen average daily traffic increase from 15,000 to 171,000. The Harbour Bridge is currently available to all legal loads, 50max permit vehicles, double decker buses, and overweight vehicles by permit in the four centre lanes. It is not available to High Productivity Motor Vehicles.

The Auckland Harbour Bridge Long Term Strategy (May 2019 draft) sets out a long-term plan for the management of the bridge. The Long Term Strategy outlines the potential need to manage heavy vehicle volumes, so the Harbour Bridge's structural integrity is protected into the future:

"The key structural capacity issue is the density of heavy vehicles on both the truss bridge and the box girder bridges. A significant increase in the density of heavy vehicles may result in the safe live load capacity of the bridge being exceeded in very extreme circumstances."[27]

The strategy for maintaining, operating and managing the Harbour Bridge will vary depending on its future function and whether any future investments take pressure off it. In the absence of future investments that may reduce pressure on the Harbour Bridge, the asset management strategy focuses on continuing the current programme of strengthening and associated works. Some restrictive management may be required, including limiting the lanes heavy trucks can use and/or the times of day at which they can use the bridge. Table 7 outlines potential responses.

Advice from Waka Kotahi is that a range of scenarios exist for potential restrictions and that more work would be required to accurately predict future load scenarios.[28]

The effects of such a management strategy, if implemented, would be that vehicles prevented from using the Harbour Bridge will be required to travel longer distances in many cases via the Western Ring Route.

Table 7: Long term strategy draft maintenance plans under different alternative Waitematā Harbour crossing assumptions

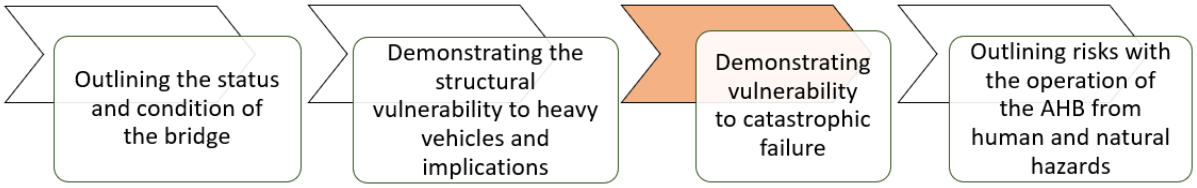
Crossing assumptions	Maintenance descriptors	Closure estimate	Timing
Pre-AWHC	Strengthening works Stringer half joints Barrier upgrades Pier patch repair Minor structural works	Nights A few weeks per lane Nights or 1 lane closure N/A Nights or Christmas break	5-20 years 10-30 years 1-2 years 5-15 years As required
AWHC road crossing	Concrete deck replacement Major repairs, recoating, surface replacement	1-2 years >6 months	30-60 years After AWHC built
No AWHC or public transport only	Load management Concrete deck major repairs Major recoating Strengthening works and string half joints as above	N/A Nights or Christmas break Nights	>20 years 30-60 years As required

While heavy vehicles make up only 6% of the total traffic on the bridge and these changes are unlikely to impact on the majority of customers, these trips have an effect on Auckland's supply chain.

[27] HARBOUR BRIDGE Long Term Strategy 2019, NZTA
[28] Memo from HARBOUR BRIDGE team to James Kaye 31 May 2019

Management of heavy vehicles on the “clip-on” structures may create some inefficiencies by requiring trucks to travel at particular times of day or requiring active operational management to limit the number of vehicles on the bridge at any one time.

5.3.3. Vulnerability to Failure



Following a detailed seismic assessment, the Harbour Bridge and approach structures underwent a seismic retrofit over several years from 1997.

Bridge components were retrofitted to the adopted performance standard of immediate access to 4 lanes of traffic after a 2000-year return period event and a low risk of collapse during an MCE (maximum credible earthquake).

This means that the Harbour Bridge is expected to retain half of its current capacity in the event of a major (2,000-year return) earthquake event. Given the reliance on the Harbour Bridge and evidence presented in Problem 1, that the bridge operates at or close to its current capacity for long periods of the day, this would present a significant degradation in its role providing a strategic access route. A major event would cause this degradation in access for a long time, potentially years, although no specific assessment has been done on the potential recovery periods.

5.3.3.1. Structural Risks

As noted above, the condition of the Harbour Bridge is generally good,[29] however, there are fatigue prone areas that require ongoing monitoring. The Harbour Bridge Asset Management Plan notes structural risks that need to be considered in the maintenance of the structural asset.

Of the 16 live threats that are rated “high”, the following seven threats have the potential to lead to partial or full closure of the Harbour Bridge to traffic, potentially for extended periods.

- **Bolidt failure** - Bolidt is a synthetic wear layer used for bridges and viaducts. It is a material that provides elasticity, crack bridging, and chemical resistance. A failure in the Bolidt would cause vehicles to contact the steel deck and it would need to be replaced, requiring emergency closure for an extended period.
- **Stringer fatigue** - The stringers are beams in the steel deck, the fatigue of the stringer would be a structural failure which may close multiple lanes or close the entire Harbour Bridge.
- **Edge Barrier Failure** -The edge barrier protects vehicles from falling from the Harbour Bridge. Failure of the edge barrier would be a serious safety risk which would require at least a partial closure of the bridge.
- **Significant Natural Event** – A significant natural event such as an earthquake, volcanic activity or tsunami could cause the bridge to be closed for an extended period.
- **Ship Strike** - A ship strike to the Auckland Harbour piers could cause structural damage to the bridge and the extent of the damage will need to be inspected. If the damage is severe, it may require immediate repairs and a possible closure /part closure of the bridge.
- **Inadequate Evacuation Warning** - Similar to the significant natural event, inadequate evacuation warning would cause journey planning to be compromised.
- **Explosive gases & chemical spills** - The spillage of explosive gases and chemicals on the Harbour Bridge could cause some lane closures and possibly the whole bridge to be out of use until the spill is cleared.

[29] HARBOUR BRIDGE Life Cycle Management Plan, 2017

Of the 21 live threats that are rated “moderate”, the following five threats have the potential to lead to partial or full closure of the Harbour Bridge to traffic, potentially for extended periods.

- **Brittle Failure Pier Bracket -** The brittle failure of the pier bracket could cause a collapse in the bridge if not replaced. The replacement may require closing multiple lanes.
- **High live loads** - The critical loading scenario for the box girder extension bridges is an early morning incident that results in blocked lanes and a queue of fully laden heavy vehicles. Incident response is required to mitigate the risk of this scenario eventuating.
- **Fatigue cracking** - Similar to stringer fatigue, the fatigue cracking in the other members of the bridge could cause structural failure in the bridge requiring closure or part closure or restrictions for repairs.
- **Fire underside of bridge** - In the case there is a fire that spreads from under the bridge to the bridge truss or bridge deck, the bridge may need to be closed until extinguished.
- **Side truss gusset failure** - A failure in the side truss gusset would be similar to a member failure in the bridge. It could cause failure in the overall structure and could cause the bridge to be closed.

While some of these risks can be, to some extent predicted or managed, others for example ship strike, natural events, spills and explosions are almost completely outside reasonable control and cannot be easily predicted, while the potential effects on the Harbour Bridge and its function are likely to be significant.

Failures outlined here have a range of likelihood and consequence. While some of the more severe risks are unlikely, the importance of the bridge in the transport network (it is New Zealand’s busiest transport link) and the reliance on the bridge by a large population connecting New Zealand’s largest city centre means that the effects could be significant.

5.3.3.2. Effects of failure

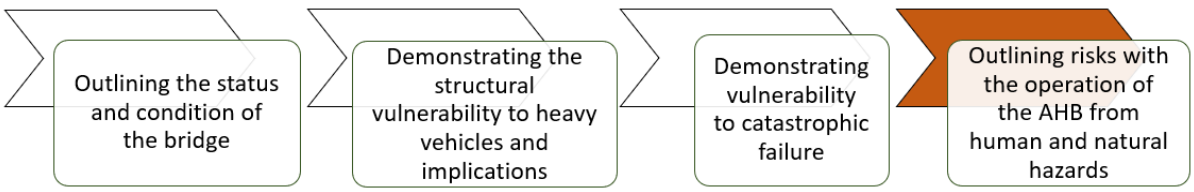
To illustrate this reliance, a MSM model run was carried out that reduced the capacity of the Harbour Bridge to six lanes from eight that it currently has in a 2048 AM peak do-minimum scenario (more detail in Appendix F). This was intended to replicate the closure of one of the “clip-on” bridges. The output from this run indicated that:

- Total public transport person throughput across the Harbour Bridge would reduce by 6,200 from 19,700 to 13,500 in the AM peak.
- Private vehicles crossing the Harbour Bridge southbound would reduce by 2,800 from 15,100 to 12,300 in the PM peak.

This represents a significant reduction in access for people from the North Shore, in the vicinity of 10,000 people in a single peak period, assuming an occupancy of 1.2 people per vehicle. The model output indicated that while some reassignment of trips to the Western Ring Route could be expected, this was around 250 for public transport and 500 vehicles. There are numerous potential scenarios that could eventuate, all with different degrees of capacity loss.

This analysis reinforces the reliance on and lack of resilience to a major event affecting the Harbour Bridge by indicated large increases in travel time.

5.3.4. Risks with Operation, Human and Natural Hazards



5.3.4.1. Unplanned Operational Incidents

Unplanned incidents on the Harbour Bridge and its approaches can have a major impact on the wider network. The Harbour Bridge Control Centre Incident Logging System records all reported incidents on the Harbour Bridge and approaches. These include crashes, breakdowns and a range of other incidents.

The Harbour Bridge is particularly sensitive to incidents because of its high traffic flows over long periods of the day, the lack of shoulders on the bridge, the long gradient and the relatively long spacing between off ramps.

In the 2018 calendar year, 2,198 incidents were recorded by the system covering a wide range of event types, from driving complaints to serious crashes, essentially around six incidents per day on average of any scale and a “significant” or “serious” incident every second day.

The incidents are allocated to four levels, Admin, Minor, Significant and Serious. The number of incidents in each level is summarised in Table 8.

Table 8: Harbour Bridge Incident Logging System Incident Levels 2018

Incident level	Number of Incidents ’18-’19
0- Admin	54
1- Minor	1,970
2- Significant	167
3- Serious	7
Total	**2,198**

The majority of the recorded incidents are minor incidents, however many of these have the potential to cause delays and/or safety issues caused by braking or weaving and slowing to look.

These incidents can often result in lengthy delays and wide spread media attention as outlined in Figure 19.

Figure 19: Example media report of Harbour Bridge incident


NEW ZEALAND

Harbour Bridge traffic chaos: Motorists were delayed by 90 minutes

12:43 pm on 2 September 2019 Share this

A truck fire near the Auckland Harbour Bridge closed multiple southbound lanes this morning, causing major traffic delays.


NEW ZEALAND

Auckland Harbour Bridge back at 100 per cent capacity

There will be reduced capacity on the bridge to allow the work to be carried out. Video / NZTA

Incident data provided by ATOC shows that Incident effects are largely dependent to the time of day, number of lanes closed, and duration of closure respectively. The largest effects observed were for incidents with two or more lane closures for longer than 30 minutes during the PM peak.

Delay for vehicles calculated from volume across the Harbour Bridge shows that there were 9,700 and 9,000 of total delay hours respectively arising from the incidents in the figures above. This is measured against the days with least variation.

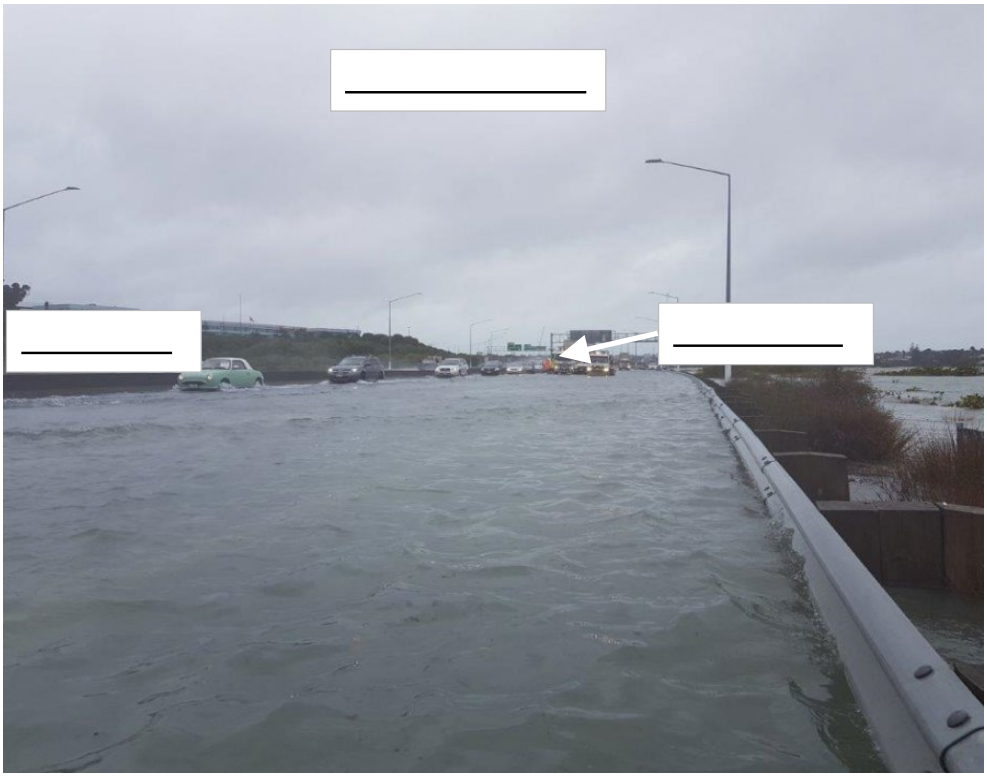
5.3.4.2. Inundation of the Motorway

The northern approach to the Harbour Bridge is subject to flooding from coastal inundation. The section between the Esmonde Road Interchange and the Onewa Road Interchange has the highest risk due to the lowest ground levels in this section. In the past 10 years, four major inundation incidents were recorded by the Auckland Motorway Alliance (AMA) resulting in lane closures and deposition of debris on the carriageway areas. The inundation is caused by a combination of high tide levels during poor weather (lower barometric pressure) where actual maximum sea level is elevated by storm surge, wind and wave set up. AMA also states the coastal storm tide inundation occurs on the busway lane approximately once per year and four-five times per year on the Northern Busway shoulder.

Figure 20: Road Surface Levels (AVD-1946) from DEM 2016

The present inundation causes safety risks which most likely will be exacerbated by sea-level rise, continued differential settlement of the causeway since construction and continued pressure from vehicle movements and impacts of adjacent coastal processes. The present inundation results in traffic delays, congestion as well as leaving debris after the flooding subsides which itself poses safety risk. Figure 21 illustrates the coastal inundation that occurred on 5th January 2018.

Figure 21: Incident on 5th January 2018 (Photo Taken by AMA)



It is predicted that coastal inundation will continue to increase into the future, as sea levels rise due to climate change.

Sea level rise is presented as an Average Recurrence Interval (ARI) which is a measure of probability and is not a predicted frequency of occurrence. Using the Auckland Region guidance, the sea level is predicted to rise into the future. It is predicted that there is a 99% chance that the section between Esmonde Rd and Onewa Rd interchanges will experience at least a 2-year ARI storm surge by 2030, with a maximum level of 2.25m RL, and has likelihood of 86% and 39% to have a 5-year and 20-year storm surge by 2030 with corresponding maximum level of 2.33m RL and 2.44m RL. Comparing these levels with the level of the motorway in this area between 2.03 and 2.8 m RL – all these events will result in motorway flooding to some extent as illustrated in Figure 22.

Figure 22: Coastal Inundation Extent in 2030s

The latest Ministry for the Environment (MfE) guidance (2017) advocates for planning for the long term and recognition of the relative uncertainty about the speed of sea level rise and corresponding impact on coastal areas. More recently, the MfE's National Climate Change Risk Assessment for New Zealand (2020) recognises the risk that ongoing sea-level rise (as well as other climate change effects) has on the New Zealand road transport network, including risks of disruption, temporary or permanent damage, and the need for relocation from at-risk locations. It specifically recognises the constraints on cost-effective adaptation of road infrastructure (given its long design life and the costs of interruption) and recognises the benefits of locating new infrastructure away from risk areas or otherwise accommodating climate change risk assessment in infrastructure design.[30]

5.3.5. Status of the Evidence Base for Problem 3

The evidence for Problem 3 is considered **strong**. There is a large body of evidence that points to this problem:

- Having a **clear cause** in the reliance on the Harbour Bridge as a connection between major and growing urban areas with few alternatives and being responsible for both public transport and road transport, with walking and cycling proposed. Causes of potential failures are numerous and specifically identified.
- Having relatively unclear **timing** the nature of resilience issues in that identifying a clear time is not always possible. The timing of the existence of the resilience risk is clear in that is exists now, however the timing of some of the potentially major outages is less clear and hard to predict.
- Having a moderately **clear scale** with a range of scales possible depending on the cause. Lesser scale occurrences are generally more likely.
- Is **specific** to the investment being considered as the corridor is the only connection between the North Shore, the city centre and isthmus and has specific vulnerabilities.

[30] Ministry for the Environment. 2020. National Climate Change Risk Assessment for Aotearoa New Zealand: Main report – Arotakenga

- **Gaps** in the evidence base relate to the likely recovery periods from various events detailed analysis of the network or user effects of ongoing management of the Harbour Bridge for heavy vehicles.

6. THE BENEFITS OF INVESTMENT

The Benefits identified that can be achieved by investing in this problem as identified by the Project Partners are:

High quality growth and urban amenity

Achievement of the outcomes in the Auckland Plan is dependent on not only achieving the scale of growth sought, but also the quality of growth. In the study area, this means a compact urban form and high levels of urban amenity, particularly in the city centre and metropolitan centres at Takapuna and Albany, as well as improving urban outcomes in the peripheral growth areas. Providing appropriate transport access and connectivity is a key element of achieving these outcomes.

Achievement of this benefit is aligned with the outcomes sought in the Auckland Plan and given the significance and scale of the North Shore and Auckland City, realising this benefit will play an important role in achieving the Auckland Plan's outcomes.

The GPS refers to *"liveable cities"* as a priority, including improving the integration between transport and land use. With specific reference to Auckland, the GPS states that "*There is an intention to support all metropolitan and high growth areas*"[31] which would include Takapuna, Albany, the growth areas north of Albany and the city centre, all of which are core elements in the AWHC study area. Achievement of this benefit through improving the quality of growth and urban amenity will support the GPS through creating the *"inviting spaces"* referred to and in particular.

"Well designed, attractive public spaces provide residents with places to gather, and attract people to frequent local businesses, connect with their neighbours and partake in recreational and cultural activities."[32]

Improved travel choices

Quality of access to urban centres is key to their ability to achieve density, be economically effective and meet the Auckland Plan's land use objectives. The quality of travel choices in terms of mode choice availability is key to quality choice of access for people to meet their needs, which is part of the GPS's 'access' strategic priority.

In the North Shore connections context, this means provision of fast, reliable options for access to the places and opportunities people need to get to, enabling mode share increases for travellers to the city centre (and beyond) and choices and reliability for interpeak and peak journeys. Multiple strategic documents emphasise the need to create a shift in mode from reliance on private cars to public transport and active modes. Investing in achieving this benefit will be highly aligned with this outcome.

Improved access to social and economic opportunities

Providing access to economic and social opportunities is a core element of the GPS and a fundamental role of the transport system in people's lives. Indeed, *"A land transport system that provides increased access to economic and social opportunities"*[33] is a specific Objective of the GPS.

With the scale of growth planned on the North Shore, metropolitan centres at Albany and Takapuna and the connection with the city centre, investment in this benefit would be effective in achieving the objectives of the GPS.

In the context of the North Shore connections, this means access to jobs, educational places and cultural activities in the city centre, metropolitan centres and wider Auckland area as well as access to markets and labour for businesses.

This benefit is also well aligned with the ATAP outcome of "Easily connects people, goods and services to where they need to go".

[31] Para 63, GPS, 2018
[32] Para 70, GPS, 2018
[33] Para 56, GPS, 2018

More productive and reliable transport system and utilities

Auckland is New Zealand's largest city and the most significant contributor to the New Zealand economy. Ensuring the efficient movement of goods and services is vital to the continued performance of the economy of the country's largest city. Goods and services require reliable transport linkages. This provides confidence in travel times and allows productivity of supply chains to be enhanced.

In the context of the North Shore connections, moving goods from suppliers to customers and the movement of service providers to meet the needs to their customers is a key function of the transport system in enabling the economic prosperity of Auckland. This is also related to people's ability to meet their economic needs through employment and access to goods and services required to business to function.

Enhancing the corridor's resilience by reducing the pressure and level of reliance on existing infrastructure, especially the Auckland Harbour Bridge, is also a key part of making it more productive and reliable. A more resilient corridor will help minimise the wider impacts on Auckland and New Zealand from disruptions.

6.1. Investment Objectives and KPIs

The Assessment Framework is a product of the problem definition and has been created to reflect the Investment Objectives (IO) developed for each problem statement. The Framework connects Problems, Benefits and Objectives as displayed in Figure 23 to a suite of KPIs and measures against which all options are tested to allow a transparent assessment of effectiveness of options in solving the problems identified.

Many of the KPIs can be derived using the Auckland Forecasting Centre's MSM model runs for developed options, which will form the basis of assessment for the quantitative measures. The evidence base judgement of subject matter specialists, previous studies as well as strategic model outputs, will allow the assessment of the qualitative measures.

Figure 23: Relationship between ILM Benefits, Investment Objectives, KPI Categories

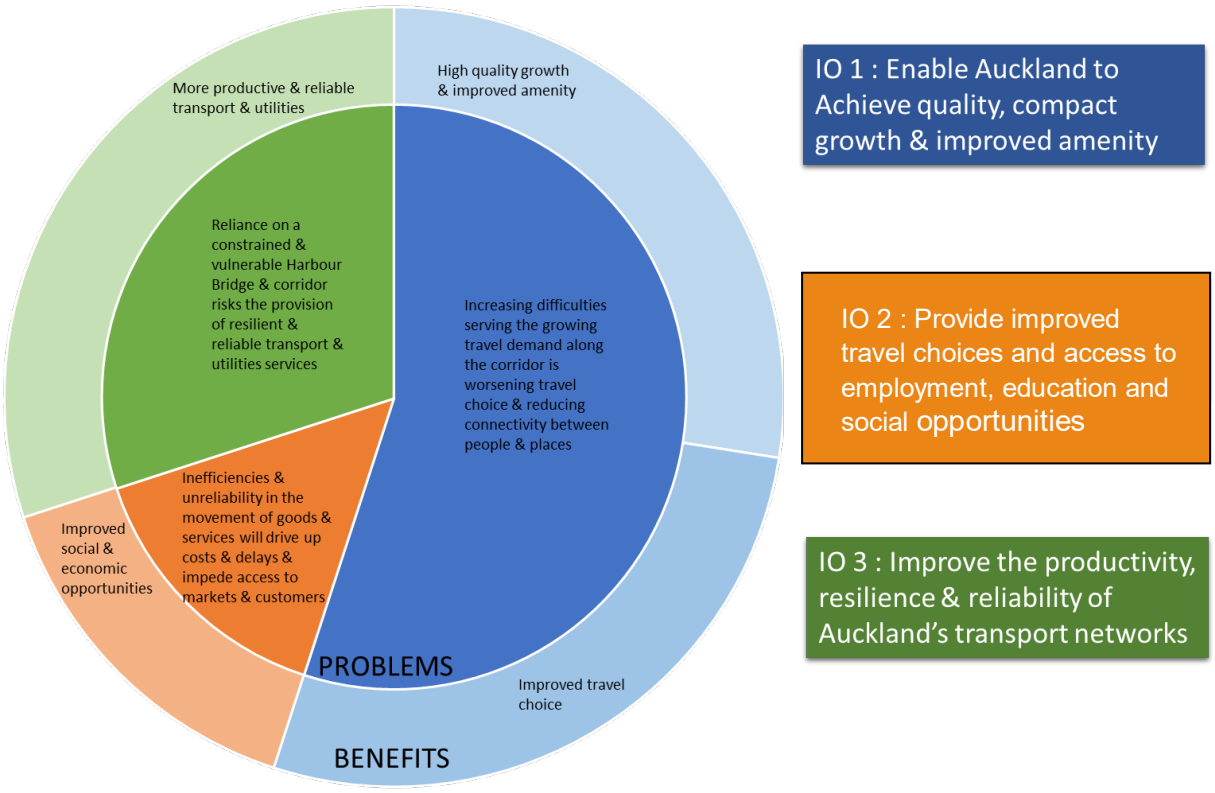


Table 9: KPI Table

	Investment Objective		KPI
	Enable Auckland to achieve **quality, compact growth and improved amenity**	KPI 1.1	Greater density close to high frequency public transport routes (and key locations)
		KPI 1.2	Improved amenity for city centre & metropolitan centres
		KPI 1.3	Reduced impact of transport on Auckland's environment
	Provide improved travel **choices and access** to employment, education and social opportunities	KPI 2.1	Increased use of public transport (during AM, IP and PM peak periods)
		KPI 2.2	Improved access to rapid transit.
		KPI 2.3	Improved capacity in the transport system to better serve travel demand
		KPI 2.4	Improved accessibility of key destinations & centres for people by public transport
		KPI 2.5	Increased access to employment for North Shore residents. By public transport
		KPI 2.6	Improved accessibility of key destinations & centres for people by private vehicle
		KPI 2.7	Increased access to employment for North Shore residents by private vehicle
	Improve the **productivity, resilience and reliability** of Auckland's transport networks	KPI 3.1	Improved recovery from incidents
		KPI 3.2	Reduced vulnerability to natural and human induced events
		KPI 3.3	Improved reliability of key journeys by user type & time of day
		KPI 3.4	Reduced risk to key utilities

The KPIs listed here have been used in the Multi-Criteria Analysis (MCA) framework against which all options have been tested in this business case. A suite of specific measures has been developed to allow assessment of the effectiveness of options against the KPIs.

7. SUMMARY OF THE STRATEGIC CASE AND ASSESSMENT PROFILE

7.1. Assessment of Alignment

Assessment of alignment considers how the problems identified in the strategic case align with the results sought under the GPS in terms of safety, access and environment. Assessment uses the **Investment Assessment Framework (IAF)** and considers criteria that align to the GPS results, rating the alignment from Low to Very High.

Results alignment focuses on the problem, issue or opportunity being considered without regard to the possible solution, based on the evidence provided in the strategic case.

Considered against the IAF criteria for Results Alignment for public transport improvement activities, the problem being addressed by the proposal is considered to be of **VERY HIGH** Results Alignment and a **HIGH** results alignment for road improvement activities. These directly link to specific priority results sought in the GPS, specifically as follows:

Access – liveable cities

Investment in the benefits would:

- Address a significant level of service gap in the major route accessing social or economic opportunities for a major urban area forecast to accommodate around 500,000 people by 2048.
- Address a significant gap in the level of service for the city centre and fringe, which contains around 19% of workforce – the largest and most productive employment area in New Zealand.
- Allow a significantly higher mode share for the North Shore to city centre peak journeys – from around half of all trips currently to over three-quarters by 2048, providing transport choices and reducing reliance on private motor vehicles.
- Support quality and compact development in the Auckland City (and strongly supporting the Auckland Plan and City Centre Masterplan) by allowing a growth in city centre journeys from the North Shore from 17,000 to 26,000 in the AM peak while achieving a reduction in private vehicle numbers entering the city centre from the North Shore.
- Support quality and compact development in major metropolitan centres on the North Shore including Takapuna and Albany as well as supporting a major greenfield growth area.
- Significantly improve the resilience of the busiest section in NZ's transport network to climate change and major events.
- Allow faster recovery from incidents on the motorway, reducing the effects on Auckland's wider transport network.
- Allow more reliable distribution of goods and services between the North Shore and Auckland City and interpeak travel for a range of purposes.

Access – thriving regions

Investment in the benefits would:

- Improve access for freight, tourism and other travel between Northland and Auckland City, South Auckland and regions south of Auckland.

Safety

Investment in the benefits would:

- Improve network wide safety by reducing Vehicle Kilometres Travelled per capita by 16% and increasing use of public transport across the Auckland region.
- Enable safer urban areas by reducing vehicles entering the city centre, Takapuna and Albany.

Environment

Investment in the benefits would:

- Reduce Auckland's transport greenhouse emissions (CO2).
- Allow improved urban amenity and health in the city centre and metropolitan centres to support greater development densities.

7.2. Significance of Problems

The key findings and conclusions of this strategic case have been summarised in Table 10.

Table 10: Summary and Conclusions

Problems	Key findings in the strategic case	Conclusions
Problem 1: **Increasing difficulties serving the growing travel demand along the corridor is worsening travel choice & reducing connectivity between people & places.**	There is significant growth pressure for travel to and from the North Shore, particularly to the city centre. The city centre is New Zealand's most productive employment area and a major location for Auckland's employment growth and the North Shore is a major location for Auckland's existing population and future growth. There is strong evidence that the existing transport network connecting the North Shore with the Auckland City will not cope with the forecast demand. The road connection is already at capacity at peak times and the peak is lengthening. However, there are no proposed increases in capacity on the Isthmus to receive any more traffic. The public transport connection is likely to become over capacity in the mid-2030s and is expected to carry the majority of additional cross-harbour trips.	This is a nationally significant, serious issue which, given lead times for potential solutions has a high degree of urgency given potential lead times for solutions. There could be significant impacts on Auckland's growth, economic performance and prosperity aspirations.
Problem 2: **Inefficiencies & unreliability in the movement of goods & services will drive up costs & delays & impede access to markets & customers.**	The impacts of the issues resulting from Problem 1 will also affect the movement of goods and services in Auckland's supply chain. This will result in inefficiencies in the supply chain and added cost to business. At this stage, the evidence base supporting this problem is not strong in its own right in comparison to Problems 1 and 3.	This issue is connected to Problem 1, although the effects will be felt by a smaller number of high value freight trips. The problem does exist; however, the scale of this problem is not as well understood and does not appear as significant as Problem 1, and resolution

		of this problem may help resolve Problem 2.
Problem 3: **Reliance on a constrained & vulnerable Harbour Bridge & corridor risks the provision of resilient & reliable transport & utilities services.**	There is a high degree of reliance on the Harbour Bridge as a vital, nationally significant part of New Zealand's transport network. This creates a strategic risk for the national transport network. There is evidence of the approaches to the bridge being susceptible to inundation and sea level rise, while there is good evidence that recovery from incidents is difficult due to the location and distance to alternative routes. Structurally, the bridge can be maintained in perpetuity with restrictions that may create restrictions for a small proportion of users.	Evidence shows that this problem exists and is strategically significant. The problem is multi-faceted with varying degrees of likelihood and severity. Less severe, highly likely problems have a degree of immediacy, if not scale while there is insufficient evidence to indicate that severe aspects of the problem could be considered urgent.

PART B PROGRAMME DEVELOPMENT AND ASSESSMENT

This section documents the development and assessment of programme level options to address the problems in the corridor and wider study area identified in the previous section.

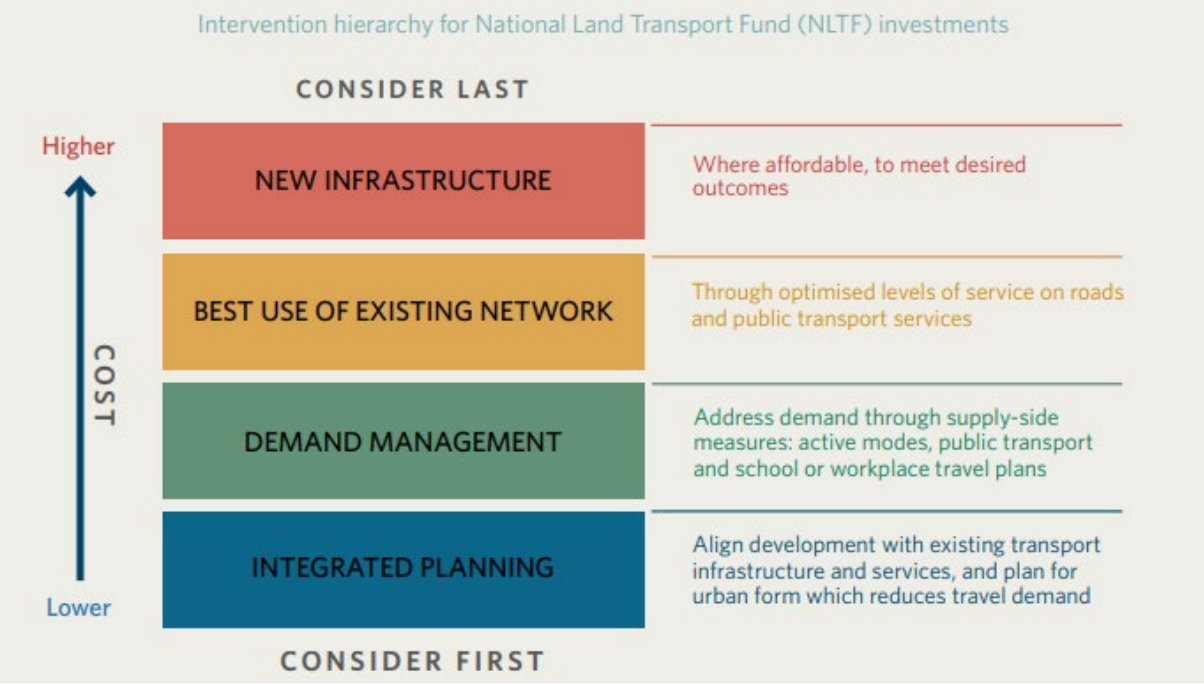
8. ASSESSMENT METHODOLOGY

8.1. Option Development Approach

To understand the impacts and potential solutions for the identified problems, options were developed and tested. The development of options has been based on the direction provided in ATAP and the previous studies as discussed earlier in this report. These, along with the scoping document for this business case, defined the parameters for the options development process and the geographical area considered.

The Waka Kotahi intervention hierarchy as outlined in Figure 24 formed the basis for the development of programme-level options to address the problems facing this area. This approach was particularly important given the number of previous studies and changes in constraints, land use and transport policy since these previous studies and the scale of the cost of new infrastructure across the harbour.

Figure 24: Intervention hierarchy



Integrated planning was an important consideration in the development and assessment of options, however detailed modelling of land use changes was not undertaken as part of this assessment. This was due to the recently completed North Shore Rapid Transport Programme Business Case considering this option and concluding that

"Demand management options including land-use change (an alternative land-use scenario with higher employment in Takapuna and Albany and lower employment in the city centre) or peak-period fare increases do not reduce public transport demand to a level that is within the capacity of the services and infrastructure".

Table 11 summarises the impacts from integrated planning and demand management interventions.

Table 11: Integrated Planning and Demand Management Outcomes

	Intervention	Likely impacts
Integrated planning	Focus and prioritise the release of more of the North Shore's residential growth around existing and planned rapid transit stations.	• Increased intensification around existing (and planned stations) • Increased number of public transport trips • Increased public transport mode share • Potential for greater proportion of trips in the southern part of the North Shore catchment (where there are more stations) compared to north of Albany • Delay development in large Greenfields areas north of Albany that are not around the proposed rapid transit stations
	Encourage more employment growth in Albany and Takapuna, rather than the city centre	• Reduced demand for cross harbour trips • Shorten overall trip lengths due to increased local employment for residents of the North Shore • Increased counter peak direction travel across the harbour
Demand management	Implement road pricing	• Reduction in vehicle trips across network • Increase in walking and cycling trips across network • Increase in public transport trips across network • Delays need for road-based intervention and increases need for public transport capacity
	Discourage vehicle travel to city centre through network changes, parking management, travel planning etc.	• Increases demand for public transport trips to and from the city centre • Reduces demand for private vehicle access to the city centre • Depending on the scheme, reduces peak period demand and increase off peak demand for private vehicle trips

All the interventions outlined above would make a positive contribution to the benefits and should be developed further in future work. In general, these interventions are likely to delay the need for road investment but bring forward the need for public transport investment. Encouraging appropriate employment in Albany and Takapuna would ease pressure on all modes crossing the harbour.

These interventions are important 'foundation' elements of the investment programme and will play an important role in the timing (both delaying and accelerating different capital investments) of more infrastructure focused investments.

8.2. Assessment tools

Where options were formally assessed against each other, a multi-criteria assessment approach was adopted. The MCA criteria used is consistent with Waka Kotahi MCA guidelines and can be found along with the definition of the adopted 7-point rating system in Appendix E.

A suite of appropriate technical analysis tools were used in the assessment of options (such as transport models) that are outlined in the appropriate Appendix of this report.

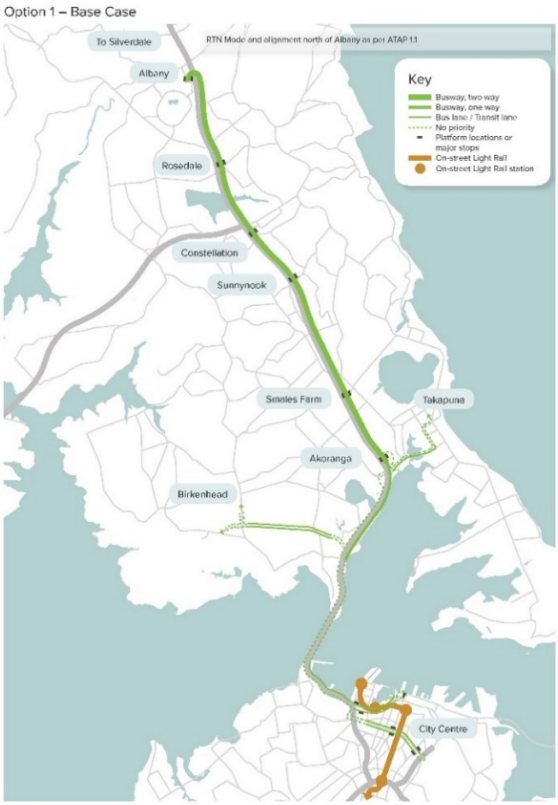
9. PROGRAMME ASSESSMENT

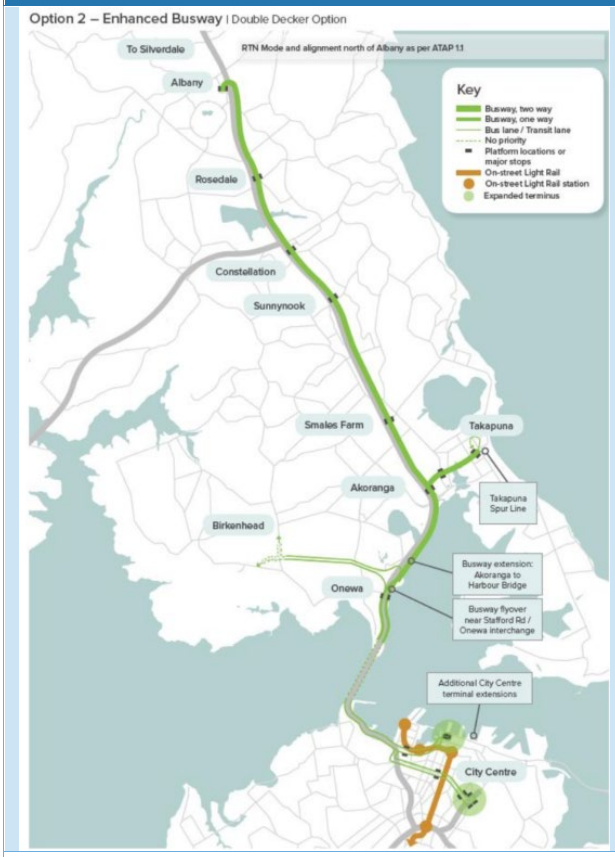
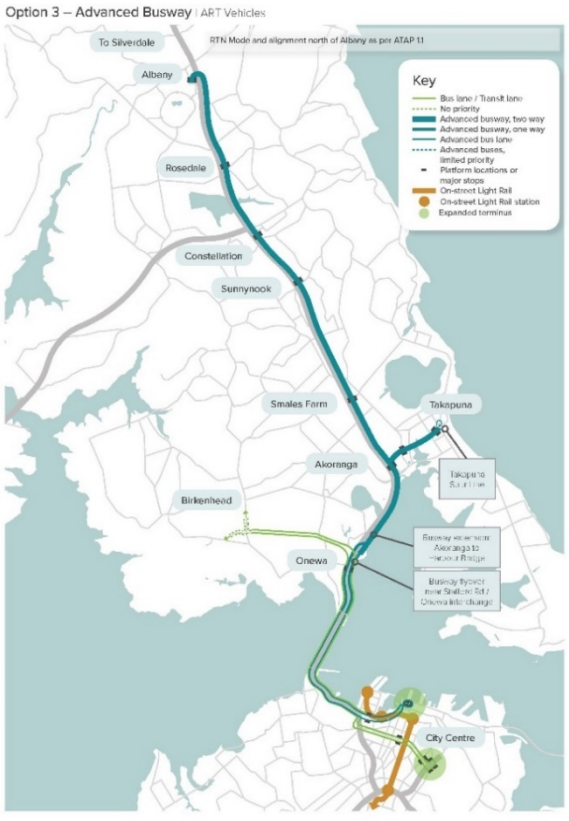
9.1. Programme options considered

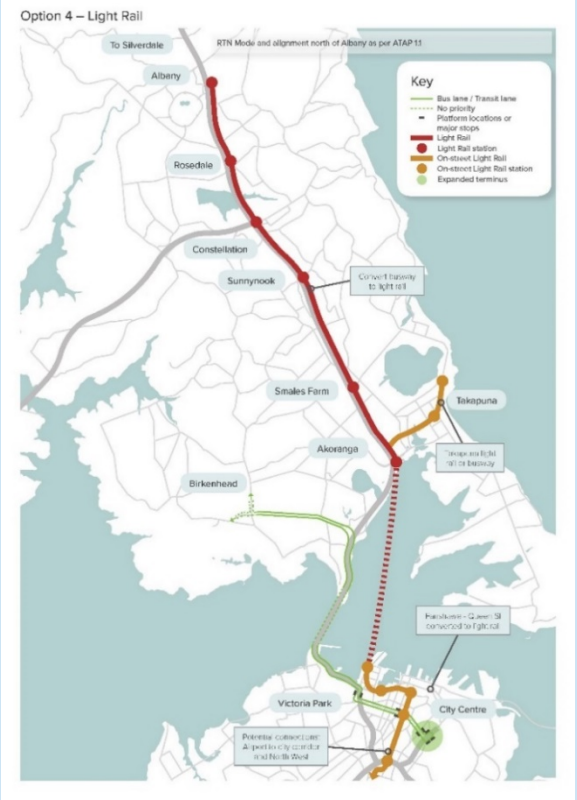
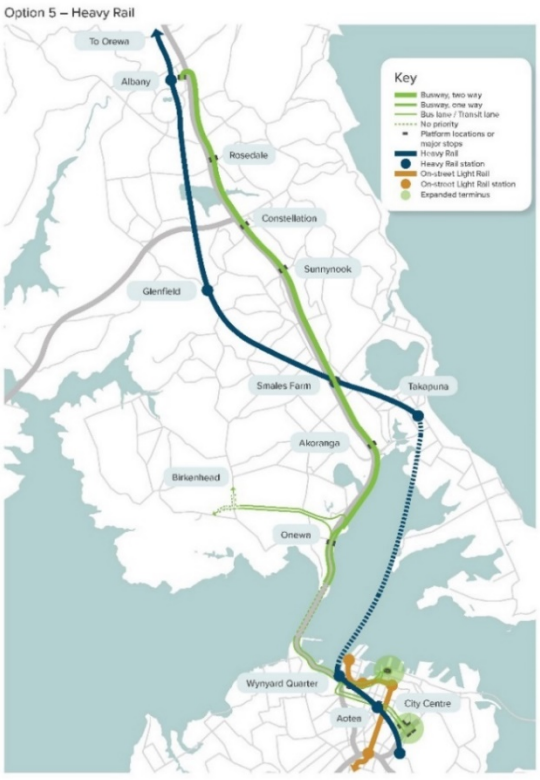
To understand the scale of the challenges in the study area at a programme level, nine illustrative options were developed. These options were developed to enable key programme-level issues to be explored (e.g. is there a case for any major infrastructure investment, is there a need for rapid transit investment beyond upgrading the busway, is heavy rail an option, can a road-only investment address the issues etc.) The findings from testing these illustrative options could then be refined to create the recommended way forward. These options were:

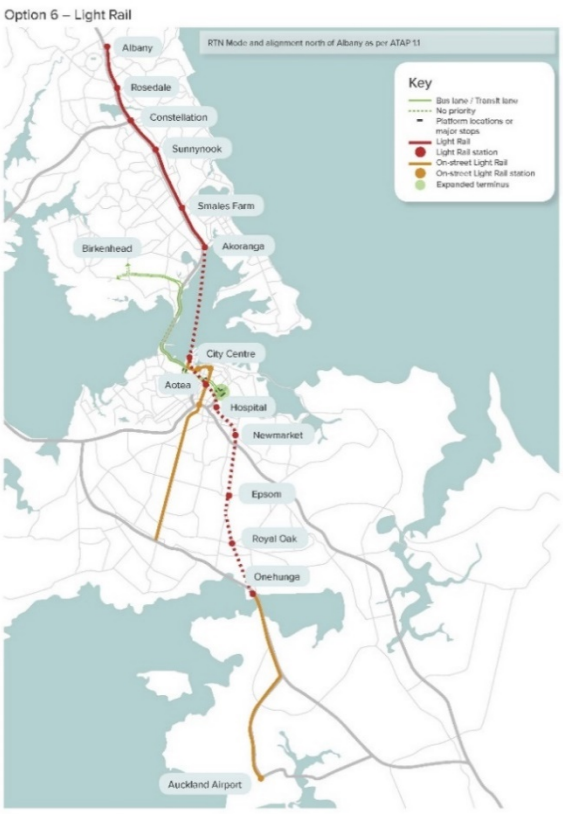
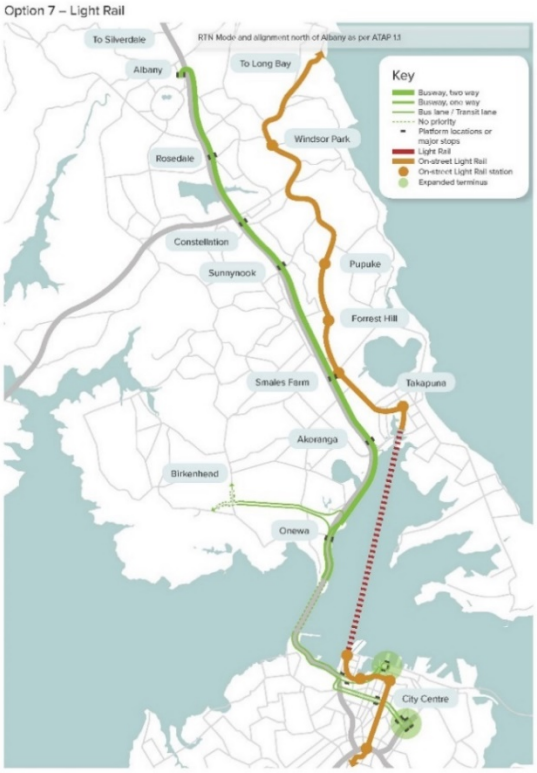
- Demand Management Only
- Enhanced Busway
- Advanced Busway
- Light Rail Busway Conversion
- Heavy Rail
- Light Rail Busway Conversion, with Isthmus Tunnel
- Light Rail On Street
- Road Only
- Combination of Road and Rail Crossings

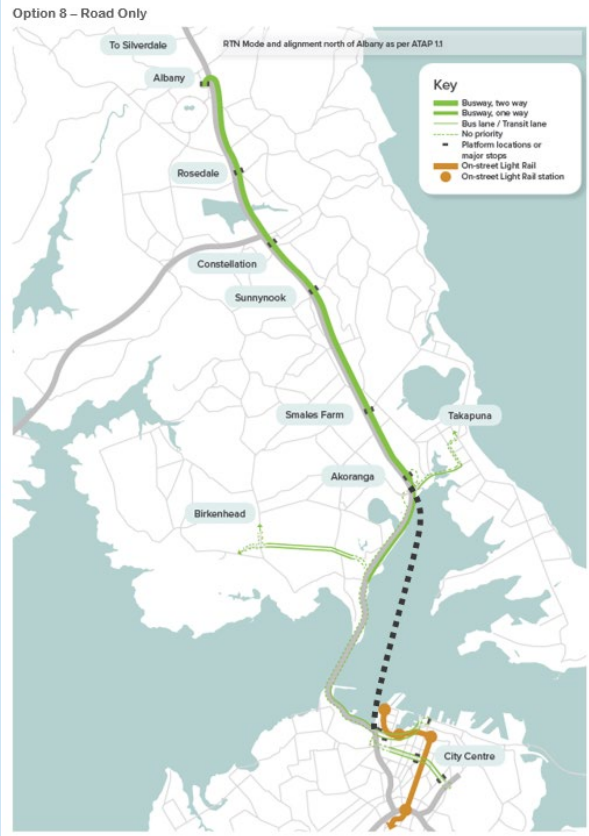
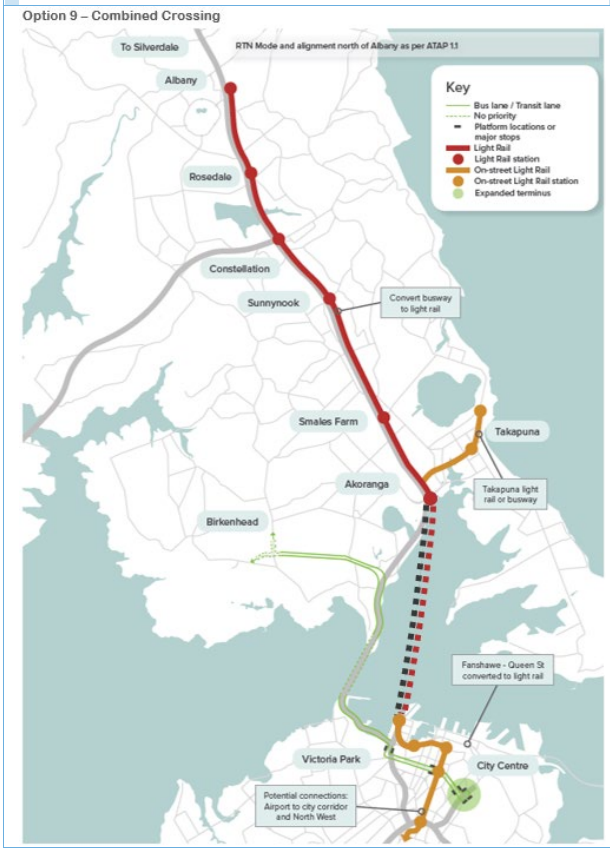
These options were compared against a Do Minimum. A description of these options and the Do Minimum are provided below.

Option Map	Description
	**Option 0 - Do Minimum** No infrastructure investments beyond committed 2018 levels, although key assumptions were made in regard to related networks and reasonably expected operational improvements. • The Rapid transit network alignment follows ATAP • City Centre to Mangere light rail (CC2M/ Isthmus surface running LRT) has been implemented and terminates at Wynyard Quarter • Bus frequency on the North Shore is globally uplifted by 50% • Northern Busway capacities are based on double deck buses • Fanshawe Street has inbound and outbound kerbside bus priority • No change to road provision
	**Option 1 - Demand Management** *Intent:* To provide an option that does not involve additional supply of capacity through major investment in infrastructure and services and instead addresses the problems through managing demand for travel. *Description:* • ATAP pricing for the whole of network strategic corridors. • Do-minimum public transport infrastructure and services • Do minimum road provision **NB** *This is the only option at the long list stage testing road pricing. All other options are unpriced.*

Option Map	Description
	**Option 2 - Enhanced Busway** *Intent:* To minimise cost, environmental effects and implementation risk through using the existing busway to its fullest extent with standard bus technology. *Description:* Do Minimum operational strategies, including frequencies, with the following infrastructure improvements: • Busway spur between Akoranga and Takapuna • Busway stations in Takapuna and on Onewa Road • Priority for buses in both directions up to the northern and southern extents of the Harbour Bridge, including bus northbound flyover at Onewa interchange • Do-minimum bus frequencies • Do minimum road provision
	**Option 3 - Advanced Busway** *Intent:* To provide an absolute maximum outcome using the existing busway as a base, thereby avoiding provision of a new corridor, including a new tunnel and mode. This option uses high capacity vehicles and additional infrastructure to represent the “maximum” non-rail option. *Description* Similar to Enhanced Busway (Option 2) with: • High capacity articulated vehicles between Orewa and the city centre with the option for multiple vehicle coupling • Replace “Orewa to City Centre” with ART vehicle: ART Vehicle capacity 170 per 32m set. Use coupled set (64m = 340 pax); 4 min frequency • Full bus priority lanes across the AHB - reduced road capacity to provide bus lanes on the Harbour Bridge

Option Map	Description
	**Option 4 - Light Rail – Busway Conversion** *Intent:* To test a higher capacity mode, light rail in this case, that: • Uses the existing busway alignment and stations so that a new corridor is not required • Is inter-operable with light-rail on the isthmus • Has its own tunnel across the harbour, not relying on the existing Harbour Bridge *Description:* • Conversion of the current Northern Busway to a light rail corridor with one physical line Southbound and one Northbound, allowing up to two-minute headways. Light rail is street-running within the city centre (connecting to the CC2M line) and on a Takapuna spur. • The Light Rail alignment necessitates a new piece of infrastructure crossing the harbour, which would be a dedicated Rapid Transit crossing. • Do minimum road provision.
	**Option 5 – Heavy Rail** *Intent:* To test a very high capacity mode that has fast travel times and long stop spacing and augments the busway and provides a new alignment to service additional areas, including Takapuna. *Description:* • Creation of a new harbour crossing that is a dedicated, fully grade-separated Heavy rail system • 6 car trains at 12 trains per hour • New stations at: Hospital, Aotea, Wynyard, Takapuna, Smales Farm, Sunset Rd / Albany Highway intersection, Albany • Local services connect to new stations • North of Albany, busway is converted to heavy rail • The busway would remain in service on its current alignment • Do minimum road provision

Option Map	Description
	**Option 6 – Light Rail Busway Conversion, with Isthmus Tunnel** *Intent:* To test a higher capacity mode, light rail in this case, that uses the existing busway alignment and stations so that a new corridor is not required and is not inter-operable with the assumed CC2M, which instead provides an additional alignment in a tunnel through the isthmus. *Description:* • Option 4 with supporting tunnelling infrastructure for through-running light rail to the Isthmus • North Shore LRT in a tunnel under Wynyard and city centre to Onehunga • Terminate Isthmus (CC2M) line at Mt Roskill • Stations: at Wynyard, Aotea, Hospital, Newmarket, Epsom, Royal Oak, and Onehunga • Feeder services to connect to stations • Do minimum road provision
	**Option 7 – Light Rail On-Street** *Intent:* To test an additional route using light rail that augments the busway and provides a new alignment to service additional areas, including Takapuna and as on-street, improving access to catchments, but slower and less reliable than a segregated alignment. *Description:* • Various new alignments of light rail on dedicated new crossings of the harbour, in addition to Option 2 busway enhancements. • These light rail alignments are street running and the five sub-variations have different lengths, traversing different suburbs to assess the catchment impacts. • Do minimum road provision.

Option Map	Description
	**Option 8 – Road Only** *Intent:* To test the provision of only additional road capacity to improve access and relying on the existing busway operation for public transport operation. *Description:* • A new vehicle only crossing of the harbour, connecting Akoranga and Central Motorway Junction at Victoria Park. • This option keeps the busway running on its current alignment with do-minimum frequencies and public transport infrastructure.
	**Option 9 – Combination of Road and Rail Crossings** *Intent:* To test the impact of adding both road capacity and a higher capacity public transport connection. *Description:* • The creation of a new combined rapid transit and private vehicle crossing(s). • For testing purposes, the rapid transit form has been assumed as the light rail busway conversion of Option 4 and the private vehicle crossing of Option 8. The MCA considered this as a combined tunnel.

9.2. Programme options assessment

Appendix D includes the detailed assessment of each option against the MCA criteria.

Figure 25 provides a visual summary of this assessment, with the effects aggregated to allow an easy visual comparison of the impacts of an option against the benefits of delivering against the investment objectives. This generally shows that the high capacity Rapid Transit options deliver best against the investment objectives. The roading options do not perform well against all objectives, but do deliver well against the productivity, resilience and reliability objective. This 'snapshot' also generally shows that the more significant the scale of the intervention, the greater the impact of implementation. There are important contextual issues (such as the timing of the need for the various interventions, or the magnitude of their cost) which need to be understood before firm preferences can be made.

The cost range provided indicates the expected (P50 cost) and the P95 cost for each option.

Figure 26 summarises the MCA scoring of the options.

Figure 25: Graphic for performance against Objectives

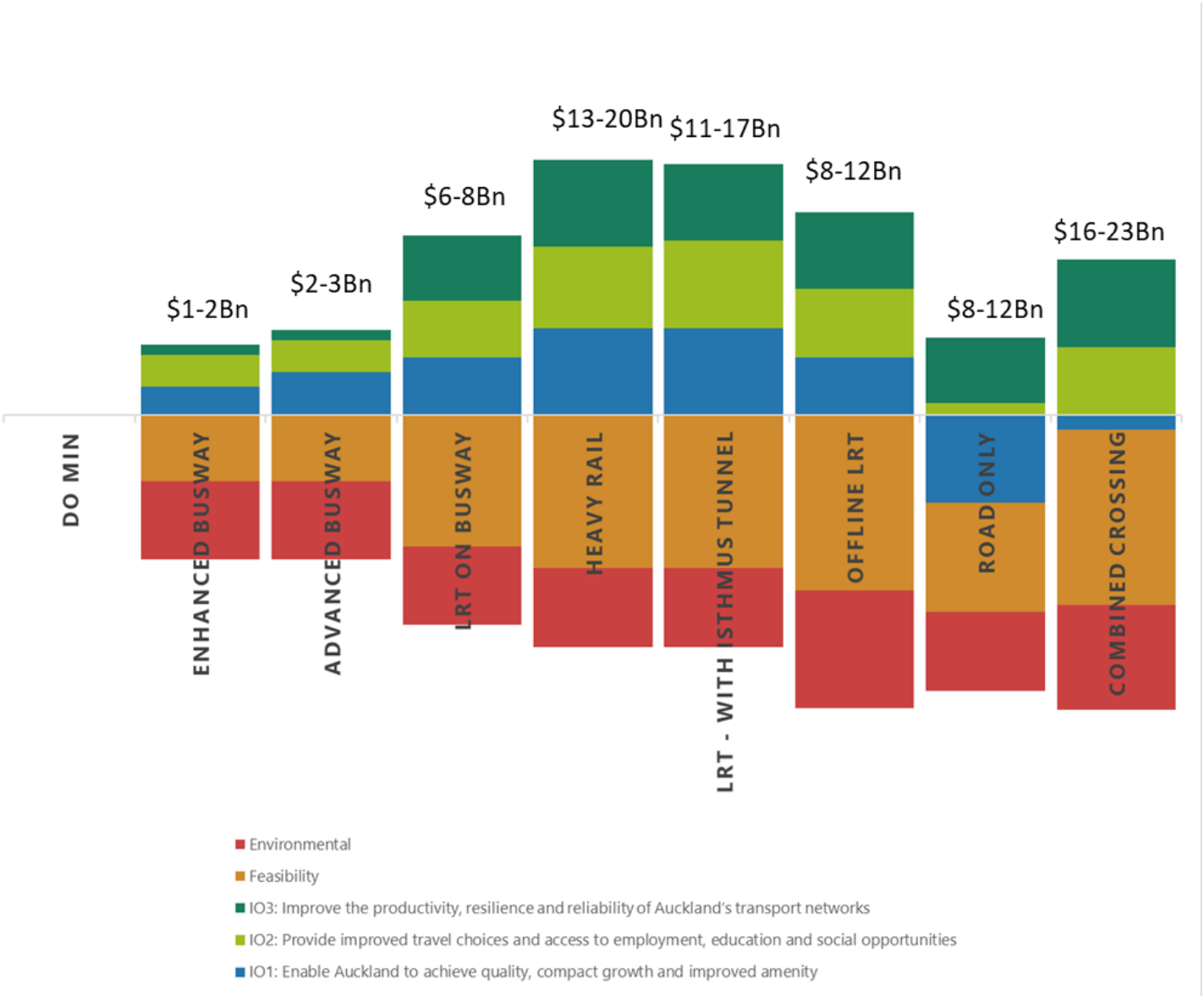


Figure 26: Multi-Criteria Analysis Scoring Summary (Options 0-9)

ILM Benefits	Investment Objectives (Strategic Merit Test)	KPI (MCA)		Option 0	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9
				Do Min	Enhanced Busway	Advanced Busway	LRT on Busway	Heavy Rail	LRT - With Isthmus Tunnel	Offline LRT	Road Only	Combined Crossing
High quality growth & improved amenity	Enable Auckland to achieve **quality, compact growth and improved amenity**	Greater density close to high frequency PT routes (and key locations)		0	1	1	2	**2**	3	**2**	-1	1
		Improved amenity for City Centre & Metropolitan Centres		0	0	1	0	2	1	**1**	-3	-3
		Reduced impact of transport on Auckland's environment		0	**1**	**1**	2	2	2	1	-2	**1**
Improved travel choice	Provide improved travel **choices and access** to employment, education and social opportunities	Increased use of public transport (during AM, IP and PM peak periods)		0	1	1	2	3	2	2	-3	-1
		Improved access to rapid transit.		0	1	1	1	2	3	2	0	1
		Improved capacity in the transport system to better serve travel demand		0	1	1	2	3	3	2	1	3
		Improved accessibility of key destinations & centres for people by PT		0	1	1	2	3	3	2	0	2
		Increased access to employment for North Shore residents. By PT		0	**1**	**1**	2	2	3	3	0	2
		Improved accessibility of key destinations & centres for people by private vehicle		0	0	0	0	0	0	0	**2**	**2**
		Increased access to employment for North Shore residents by private vehicle		0	0	0	0	0	0	0	**2**	**2**
More productive and reliable transport and utilities	Improve the **productivity, resilience and reliability** of Auckland's transport networks	Improved recovery from incidents		0	0	0	2	2	2	2	2	**3**
		Reduced vulnerability to natural and human induced events		0	0	0	1	2	1	2	1	1
		Improved reliability of key journeys by user type & time of day		0	1	1	1	2	2	1	**1**	**2**
		Reduced risk to key utilities		0	0	0	2	2	2	2	2	2

Feasibility			Do Min	Enhanced Busway	Advanced Busway	LRT on Busway	Heavy Rail	LRT - With Isthmus Tunnel	Offline LRT	Road Only	Combined Crossing
Feasibility	Affordability		0	-1	-1	-2	**-3**	**-3**	-3	-2	-3
	Engineering		0	-1	-1	-2	**-2**	**-2**	-2	-2	-3
	Consentability		0	-1	-1	-2	-2	-2	-3	-1	-2

Environmental			Do Min	Enhanced Busway	Advanced Busway	LRT on Busway	Heavy Rail	LRT - With Isthmus Tunnel	Offline LRT	Road Only	Combined Crossing
Environmental	Landscape visual (e.g. ONF's, ONL's, Volcanic viewshaft, Section 6A and B)		0	-1	-1	-1	-1	-1	-2	-2	-2
	Coastal Environment (e.g. CMAs / Maritime SEAs)		0	-2	-2	-2	-1	-2	-1	-1	-2
	Built heritage (Section 6F), Natural heritage & Archaeology (Section 6F))		0	-1	-1	-1	-1	-1	-2	-1	-1
	Ecology (e.g. SEA's, terrestrial, threatened- Section 6C)		0	-1	-1	-1	-1	-1	-1	-1	-1
	Social (e.g. recreational, severance, property, noise (Localised effects / Contsruction / road traffic) , Section 6D)		0	-1	-1	-1	-2	-1	-3	**-1**	**-2**

9.3. Summary of MCA Analysis

Based on this MCA assessment, Figure 25 presents the findings of the programme level option assessment and the relative merits of each option, as well as the decision to progress the options through to the next stage of refinement and assessment.

Programme level options conclusion

Option	Advantages	Disadvantages
Option 1 Pricing	• Reduces peak vehicles demand, delaying need for road-based intervention (exact timing depends on the form of the pricing model implemented) • Increases public transport and active mode demands • Low cost to implement	• Requires legislative change • Brings forward the need to spend on public transport infrastructure (indicates the acceleration of an additional rapid transit route by five years) • Does not meet the transport needs of the growth forecast
Option 2 Enhanced Busway	• Low cost and easy to implement • Low risk profile • Uses known technology • Can be implemented quickly	• Does not meet forecast demand level while operating effectively • Urban impacts on city centre • Lack of mode shift potential • Does not serve Takapuna • Does not meet objective of more reliable and productive goods and services
Option 3 Advanced Busway	• Low cost and easy to implement • Low risk profile • Can be implemented relatively quickly	• Does not meet forecast demand level while operating effectively • Lack of mode shift potential • Does not serve Takapuna • Does not meet objective of more reliable and productive goods and services
Option 4 Busway LRT	• Uses the existing busway corridor effectively • Meets forecast demand • Achieves mode shift in forecast period • Can connect with proposed isthmus light rail	• Risks with converting the busway while in operation • Limited spare capacity beyond 2040s • Requires a spur to Takapuna • Does not meet objective of more reliable and productive goods and services
Option 5 Heavy rail	• More than enough capacity for growth beyond 2040s • Achieves mode shift • Speed provides significant access outcomes • If Heavy rail, can connect with remainder of the Heavy rail network	• Very high cost • Large, complex project • Does not meet objective of more reliable and productive goods and services

Option 6 LRT with isthmus tunnel	• Enough capacity for growth beyond 2040s • Achieves mode shift • Speed provides significant access outcomes • Provides improved access to high density isthmus areas	• Very high cost • Large, complex project • Requires a spur to Takapuna • Does not meet objective of more reliable and productive goods and services
Option 7 Street running LRT	• Improved access to rapid transit and opportunities for urban renewal	• Very high cost • Large, complex project • Does not achieve mode shift as well as other options • Significant social impact • Does not meet objective of more reliable and productive goods and services
Option 8 Road Only	• Some improvement to car access and network resilience	• Provides generally negative outcomes for key objectives in relation to mode shift, travel choice and urban amenity and growth • Does not significantly impact on overall network capacity and resilience
Option 9 Combined	• Includes the benefits of public transport investment with the resilience and traffic benefits of the road option	• Very high cost • Small reduction in the benefit of the public transport investment • Potential to generate additional traffic demand into the city centre which needs to be mitigated

9.4. Programme level conclusions

Based on this assessment of the above options the following conclusions were drawn at a programme level:

- **A demand management approach (such as road pricing) alone was not sufficient to address the forecast increased demand and that a complete multi-modal transport approach is required.**

Road pricing is currently being investigated for Auckland with early findings indicating it could provide considerable benefits to the performance and outcomes of the transport system. Legislative change will be required to introduce road pricing.

This business case considered what impact on this programme road pricing could have. There are many different potential pricing models. For this programme the model most consistent with ATAP assumptions was adopting, being a cordon charge into the Auckland City centre and a network access charge.

In relation to this programme, this analysis showed:

- A general reduction in peak period private vehicle trips, with 500 fewer people travelling by private vehicle across the harbour in the AM peak period.

- An increase in public transport trips, with 1,300 more people travelling by public transport across the harbour in the AM peak period.
- Increase in public transport mode share (by people trips) across the harbour to 73%, from 70% without pricing in place.
- Private vehicle trips outside of peak periods increased marginally, within the order of 4,500 trips forecast to move from the peak period to 'non peak' times.

Road pricing therefore helps to address some of the problems identified for this programme, such as improved travel choice. The resultant attractiveness of public transport as a mode to the city centre and increase in demand does however result in an increased burden on the public transport system. The analysis indicates that this increase in demand results in the expedition of additional rapid transit capacity by in the order of five years.

This intervention increases public transport demand, resulting in additional public transport capacity being required. Whilst Road Pricing addresses some of the problems facing the corridor it does not address them all as it fails to address the resilience challenges in the corridor and fully address the road network challenges.

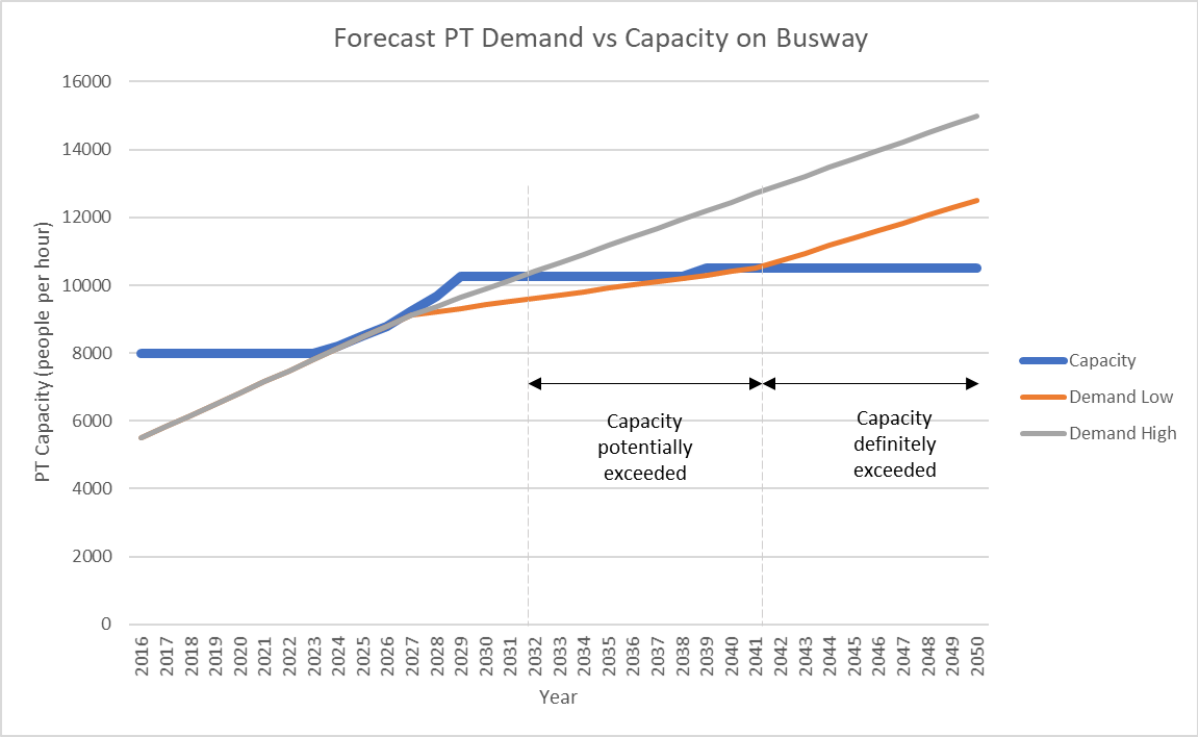
Therefore, whilst road pricing is likely to be an important component of the programme given the positive outcomes it delivers, on its own it does not sufficiently address the challenges facing the corridor.

- **Public transport demand is forecast to grow to a level that means in the long term, a high capacity rail-based system is required.**

The transport modelling (Figure 27) shows that between 2030 and 2040 (depending on the rate of growth and whether/when road pricing is introduced) even an enhanced busway is unable to cope with the forecast public transport patronage. The current busway capacity of around 8,000 people an hour can be increased to approximately 10,500 people an hour through station enhancements, increased services and general productivity improvements. No further enhancements beyond this capacity (140 buses per hour) are considered feasible due to the constraints of the overall network / terminal capacities in the city centre and the continually degrading Level of Service (LOS) along the route and at stations / stops.

Therefore beyond 2040, even an enhanced busway is unable to meet forecast public transport demand in the corridor. Furthermore, work to expand the catchment of services within the downtown area will further increase the attractiveness of the busway as an option. This will help to encourage further mode shift but may also place further pressure on the busway system as it increases demand.

Figure 27 : Forecast Busway Demand



- **The Busway however plays an increasingly critical role in the short to medium term**

As outlined above, forecast demand is expected to push the existing busway system and its supporting infrastructure, beyond its capacity limits. Operating beyond capacity means degrading level of service and reliability for North Shore customers.

Bus congestion results in higher operating costs and/or reduced frequency, in practice a mixture of both is the likely outcome. The customer experience degrades under both outcomes; in practice this looks like overcrowding, delay in boarding and alighting buses, station / platform congestion, higher fares, and delays and extension to total customer travel times. There is a direct correlation between operating speeds, fare price, and patronage – a general rule using demand elasticities says that a 10% decrease in speeds reduces patronage by at least 10%. This would suppress demand and deter uptake in public transport usage, working against Auckland's access goals and mode share growth aspirations.

Using the intervention hierarchy approach outlined earlier, the first focus to find the required additional future public transport capacity was the existing busway. The future demand can initially be satisfied by progressively increasing the number of buses. The ability to increase the number of buses beyond 140 buses per hour is however constrained by the overall network and terminal capacities in the city centre.

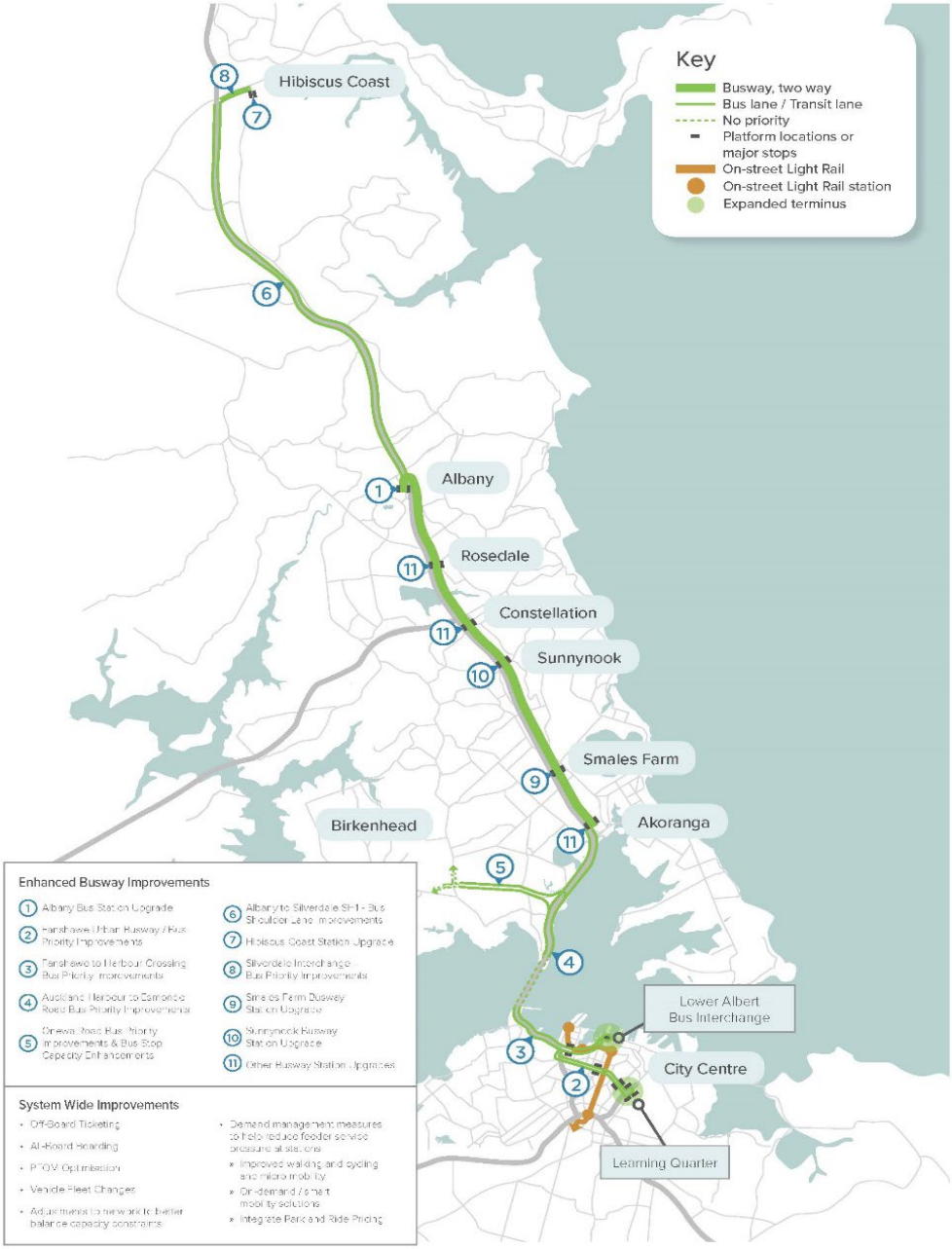
These enhancements are expected to increase the capacity of the existing busway by approximately 30%. This increases the time that the busway can operate effectively by 10-20 years (depending on demand and if pricing is introduced).

Furthermore, an additional rail-based rapid transit connection is estimated to take around 15 years to plan, design and construct (CRL as an example), meaning that even with the best intentions it would not be completed in time to address current and near-term issues. A 15-year lead time means that the busway in its current form would fail adequately meet demand for many years, until a new rapid transit connection could take on the excess passenger demand. It is therefore unlikely that any new rapid transit connections across the harbour would be operational within the next 15 years.

Importantly, the consenting of some elements of the busway enhancement are likely to be challenging where they in involve works in the coastal marine area and in other sensitive locations between Akoranga and the city centre. If consenting or other operational issues mean it is difficult to substantially boost the busway's capacity, then the need for an additional rapid transit connection would come forward.

The Busway Enhancement project is shown in Figure 27, with further details of the busway project featured within Appendix J. The busway enhancement project builds on the North Shore Rapid Transit Programme Business Case undertaken by AT, completed in 2018.

Figure 28: Busway Enhancement Project

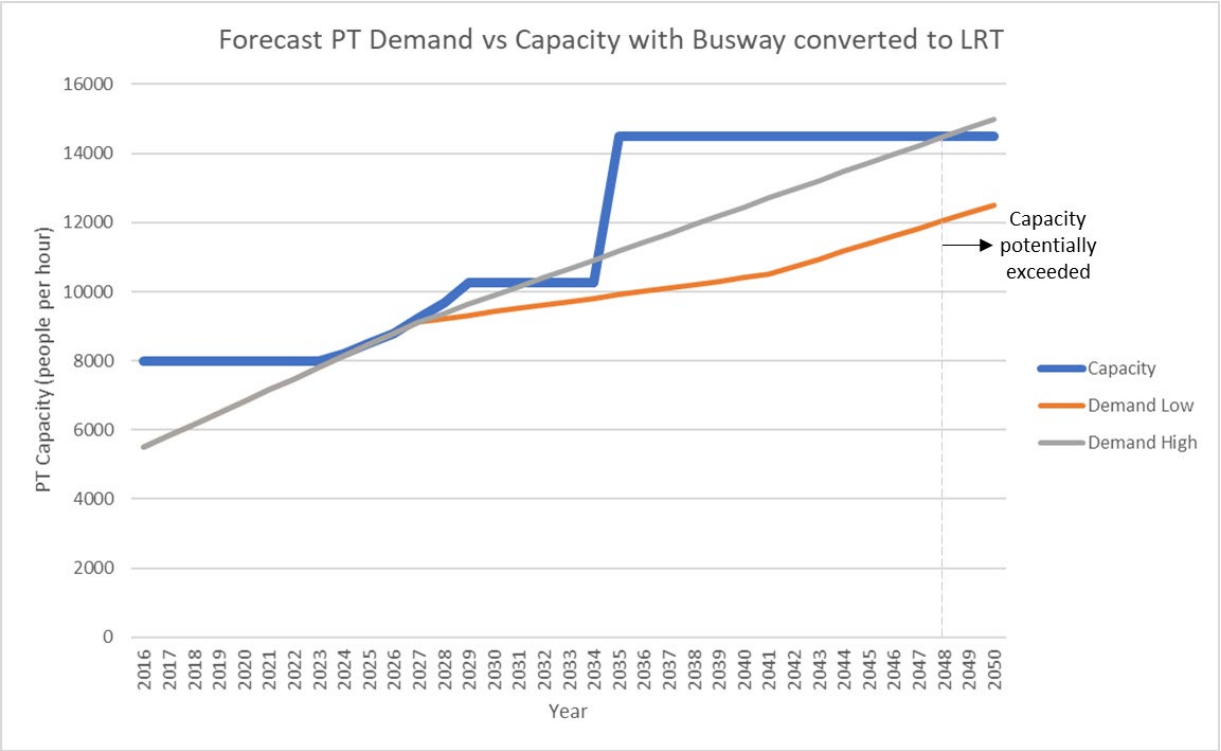


- **Both an enhanced busway and an additional rapid transit connection are required to meet future demand**

Previous studies and regional transport documents (such as ATAP) have identified the busway in its current form is not the long-term rapid transit solution for the North Shore and that it would eventually be converted to an LRT system.

The most recent transport analysis as summarised in Figure 29 has shown that even with an upgrade to LRT, the capacity of this single rapid transit corridor would be insufficient to meet the long-term demand.

Figure 29: Replace buses on Northern Busway with LRT (higher frequency LRT to accommodate CC2M and N.W LRV's)



The analysis above illustrates how simply upgrading the busway to light-rail results in a relatively small 'net' increase in overall corridor capacity (from around 10,000 to just over 14,000 people per hour) because the higher capacity of light-rail is offset through the 'loss' of the busway capacity. In contrast, providing an additional rapid transit corridor as well as retaining the enhanced busway results in a much higher total cross-harbour capacity of more than 24,000 people per hour – sufficient to meet demand for many decades to come. Whilst theoretically the LRT system capacity could be further enhanced by increasing vehicle lengths, this could result in significant operational challenges within the city centre, especially if vehicles were operating on street. There are additional challenges relating to upgrading the busway to another mode while continuing to service existing large volumes of bus passengers and buses during construction.

This issue illustrates how network level rapid transit planning is required to help guide how this corridor integrates with other parts of the rapid transit network, especially in the city centre.

Initial analysis provides some indication about the impacts of the connection:

- An additional rapid transit alignment that only connects to Smales Farm in the north attracts little additional public transport trips across the harbour.
- Connecting further north to Albany significantly increases the number of users (by approximately 25%) and the total number of public transport users in the corridor.

- Public transport demands are forecast to increase by an additional 20% if anticipated land use changes as a result of an additional rapid transit alignment.
- Fast travel times are an important factor in the attractiveness of the public transport system.

Overall, there is a clear need for two rapid transit crossings of the Waitematā Harbour (an enhanced busway over the Auckland Harbour Bridge and an additional rail-based crossing) and a more direct route to Takapuna from both the city centre and the North Shore. More detailed work, appropriate to a detailed business case, is required to find the best balance between bus and rail in serving future public transport demand. This will require holistic public transport network planning.

- **Even with increased public transport capacity there is a need in the long term to provide increased resilience and productivity for private vehicles**

Modelling of the transport network with an enhanced busway and additional rapid transit connection in place provides an indication of the extent to which the problems identified in the strategic case have been addressed. As noted above, these public transport investments make the largest contribution towards addressing the corridor's problems.

However, the modelling outputs indicate that the public transport improvements primarily result in more people being able to cross the harbour, rather than reducing the number of vehicles crossing the harbour (aside from a small southbound AM peak reduction). This means that there are still inefficiencies and unreliability in moving people and goods. Also, network resilience remains a residual issue that is not fully addressed by the public transport upgrades.

The MSM Model forecasts the following two-hour traffic flows across the AHB, compared to 2018 levels.

Table 12: Forecast Traffic Flows on AHB

Southbound	AM Peak (2 hours)	Inter Peak (2 hours)	PM Peak (2 hours)
2018	15041	11133	10002
2048 with public transport	14772	12323	11334
Change	-2%	11%	13%
Northbound	**AM Peak (2 hours)**	**Inter Peak (2 hours)**	**PM Peak (2 hours)**
2018	10045	10131	16309
2048 with public transport	11344	12474	16240
Change	+13%	+23%	0%

Because the public transport improvements do not materially reduce traffic demands on the road network, by 2048 (even with the recommended public transport enhancements and road pricing) the corridor is projected to experience substantial all-day congestion including:

- The road network will be at 90% congestion (or above) for in the order of 10hours of the day between 6am and 7pm.
- This equates to a reduction in 'spare capacity' compared to the present day of approximately 53% in the southbound direction and 74% in the northbound direction.

These inter-peak trips have less ability to transfer to public transport than peak-time trips due to their nature and spatial distribution. For example:

- A higher proportion of inter-peak trips are for business and freight purposes, rather than commuting to employment or education. These trips are more difficult to serve with public transport than commuting.
- Up to 75% of private vehicle trips during the inter-peak have an origin or destination outside the city centre, which would require increased transfer for public transport users, reducing the attractiveness for users (compared to the morning and evening peak).

Furthermore, because the public transport improvements do not reduce demand for vehicle travel across the harbour bridge, the many resilience issues faced by the corridor remain. This includes:

- When there is an incident, the future impacts of closures (planned or unplanned) are forecast to be worse over time, with recovery taking longer due to a reduction in 'spare capacity'.
- Growing traffic volumes on the harbour bridge will increase the difficulty of undertaking required maintenance activities – especially where these require lengthy closures.
- Growing freight volumes will increase the need to manage heavy vehicles to preserve the structural integrity of the harbour bridge.

The extremely high dependence on the corridor means leaving these issues unaddressed is not a viable long-term strategy. Therefore, some form of road improvement appears to be a necessary part of the long-term programme. More detailed work, appropriate to a detailed business case, is required to find the best cross-harbour traffic solution to address these remaining problems. This will require holistic network planning as well as confirmation of timing and integration with other modes.

The provision of further traffic lanes needs to be considered carefully to ensure that they do not erode the benefits of the rapid transit investment or undermine the performance of other parts of the motorway network. It is also necessary to understand the costs and implications of associated widening of the upstream motorway and local network which makes the additional cross-harbour traffic capacity viable.

9.5. Recommended programme level response

Based on the option analysis and the conclusions drawn from the associated MCA and technical analysis as outlined in the previous sections, we have summarised the programme of identified interventions as per the 'Intervention Hierarchy'. This summary is shown in Figure 30:

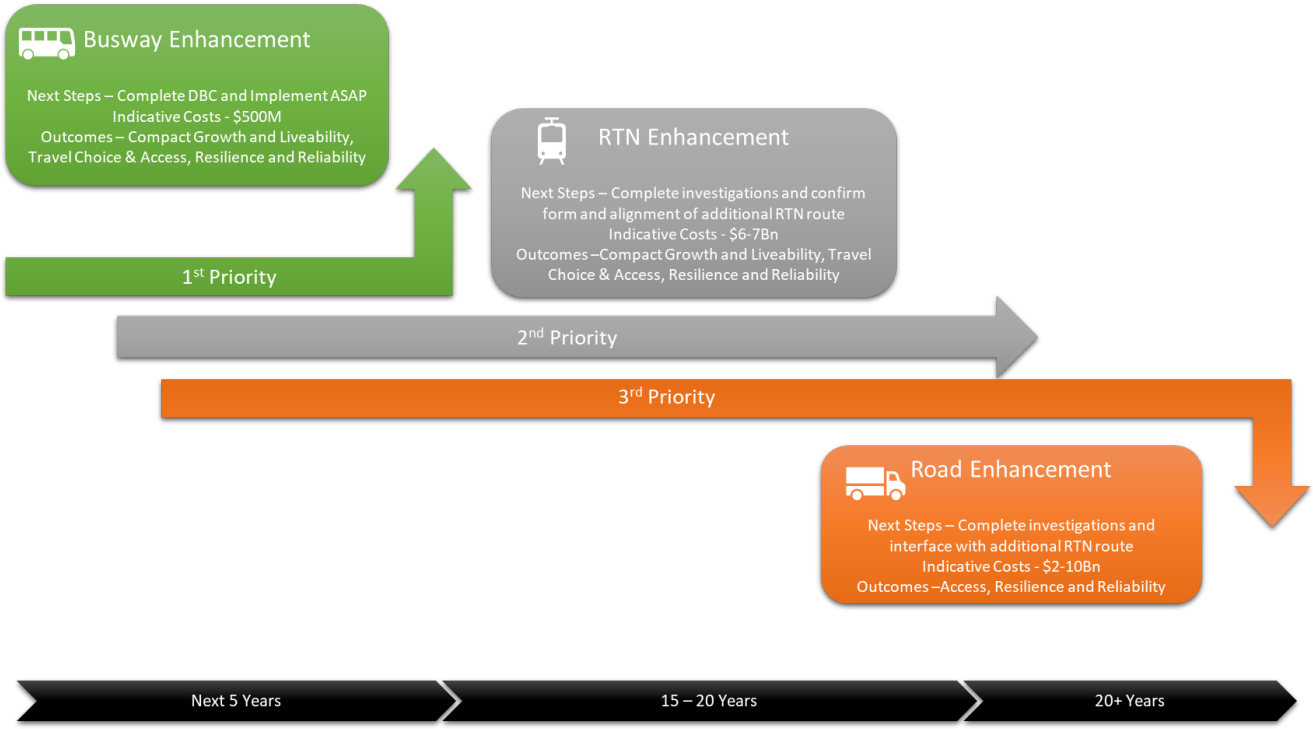
Figure 30 : Programme level intervention response

Intervention Stage	Key findings
Integrated planning	• The timing, location and scale of growth on the North Shore is a key driver of the timing of investment. There is an important link between the timing of greenfield urbanisation around Dairy Flat and the need for high-cost rapid transit and road investment. • Focusing growth in and around major centres (especially Takapuna and Albany) will help reduce travel demand and support mode shift to public transport. • Employment growth on the North Shore will ease pressure on the harbour crossing part of the corridor and potentially delay the need for major investments.
Demand management	• Road pricing can help reduce congestion on the corridor, potentially delaying the need for road investment. However, it will increase public transport demand and potentially bring forward the need for rapid transit upgrades. • City centre plans will reduce road capacity, discourage people from driving there, and increase public transport demand.

Best use of existing network	• Filling gaps in the Northern Busway (i.e. sections without a dedicated corridor), expanding busway stations and resolving city centre constraints can unlock spare capacity in other part of the busway, realising the full potential of existing infrastructure. • Increasing non-peak direction road capacity (rather than peak direction capacity) across the harbour will help unlock spare capacity on the existing motorway network. • Protecting the ongoing functionality of the Auckland Harbour Bridge will mean this critical asset continues to provide value to Auckland and New Zealand.
New infrastructure	• An upgraded busway will not have sufficient capacity to meet medium-long term public transport demand. An additional rapid transit connection is therefore required to ensure public transport remains an attractive travel option and to retain resilient cross-harbour access. • The additional rapid transit connection should directly serve Takapuna and Smales Farm from the north and south, as well as integrate with the busway and the wider public transport network. Two rapid transit crossings of the harbour (i.e. the busway over the Harbour Bridge and an additional rapid transit crossing on a separate alignment) are required to meet forecast demand. • In the longer-term improved road connectivity is required in the Albany to city centre corridor to address projected all-day congestion, to protect the motorway from increasingly frequent flooding and to preserve the long-term structural integrity of the Harbour Bridge.

These outcomes indicate a programme of significant investment in the strategic spine of the North Shore transport system over the next 20+ years, broadly outlined in Figure 31.

Figure 31: Programme level outcomes



The Busway Enhancement element of the programme is already being assessed in more detail through a Detailed Business Case. To help inform the appropriate next stage of investigation into the other two key investment components of the programme (the Additional Rapid Transit Connection and Improved Road Connectivity), this business case undertook further work to examine options for these components of the programme in more detail.

10. FURTHER RAPID TRANSIT ASSESSMENT

The programme level assessment outlined in previous sections concluded that both an Enhanced Busway and an Additional Rapid Transit Connection are required in the corridor to meet future public transport demand. As the busway enhancements were being investigated further through a separate Detailed Business Case, this work has focused on further developing the Additional Rapid Transit Connection understanding.

Initially, this further assessment work was intended to identify the preferred form, function and timing of the Additional Rapid Transit Connection. However, as discussed in this document, as the work progressed the complexities and interdependencies identified mean that much more work is required before these details can be confirmed with confidence. Nevertheless, the options explored have helped to refine key issues and inform that future more detailed assessment.

Key questions this work sought to answer are:

Alignment	Mode	Network Integration
- **How should Takapuna and Albany be served by the rapid transit network?** - **Should the new connection extend north of Smales Farm?** - **What alignments between Smales Farm and Albany are preferable?** - **Is a bridge or tunnel crossing of the harbour preferred?**	- Is light rail or heavy rail the most appropriate mode for the new connection? - What's the most appropriate mode between Smales Farm and Albany? - What's the most appropriate mode north of Albany?	- How does the new connection integrate with other key rapid transit corridors in the city centre? - How does the new connection integrate with the enhanced busway? - How does the new connection integrate with the wider North Shore public transport network?

10.1. Option Development

The programme assessment reached some key conclusions that inform the development and assessment of options for the Additional Rapid Transit Connection. These are:

- Directly connecting the city centre and Takapuna with rapid transit is important to fully unlock Takapuna's potential as a successful metropolitan centre with significant growth potential.
- Better connecting Takapuna, Smales Farm and residential areas of the North Shore is important for increasing public transport ridership and mode share for trips within the North Shore and increasing access to employment opportunities in Takapuna and Smales Farm.
- Rapid transit alignments away from the Northern Motorway are likely to have much higher cost (due to the need to secure a new corridor) but provide greater opportunity for unlocking growth potential.
- The success of any rapid transit system is a trade-off between the number of stations and speeds reached between them. In this corridor the speed of a journey from North Shore to the city is a major determinant of mode share.

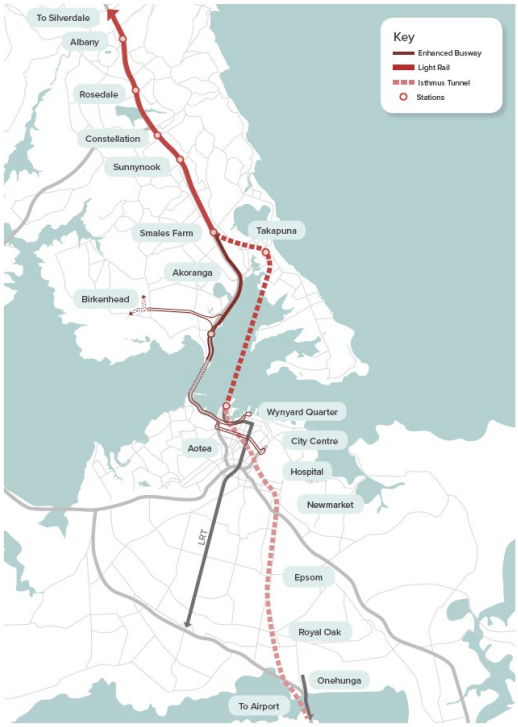
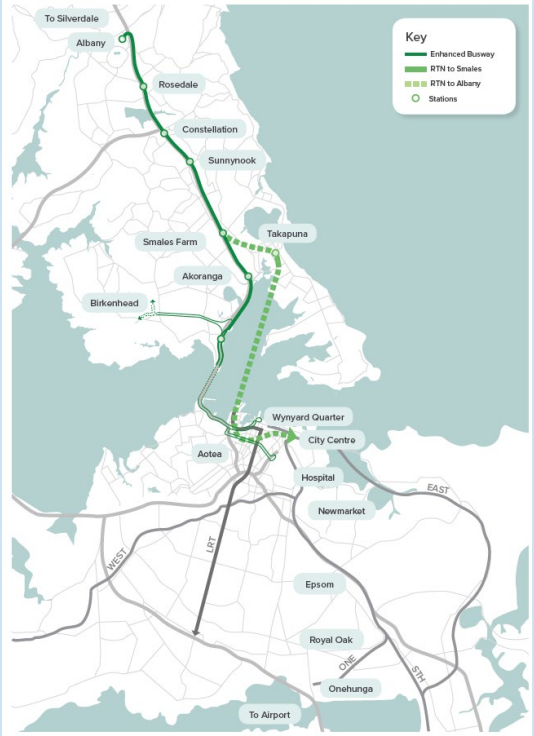
The programme level assessment had considered a wide range of illustrative rapid transit options. Some of these were taken forward for further refinement in this phase of the work and to be able to better understand comparisons between indicative solutions:

Development of the options then fed into modelling of the options for comparative performance testing, as in the first stage of assessment. Three additional options were analysed further, for comparison purposes, being:

- New light rail to Takapuna and Smales Farm with conversion of the busway to light rail north of Smales (to Silverdale post 2038).
- Additional heavy rail alignment to Takapuna, terminating at Smales Farm.

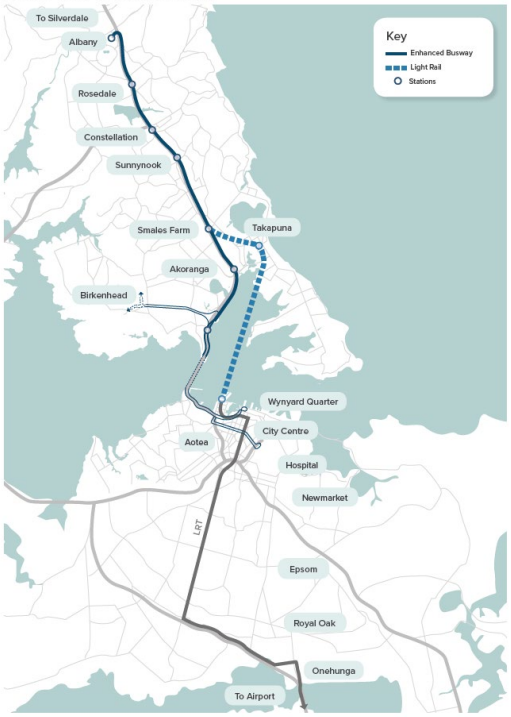
- Additional light rail alignment to Takapuna, terminating at Smales Farm.

These options are set out below. More detail on the option analysis (and further sensitivity tests undertaken for each option) can be found in Appendix E. The options were not put through the full MCA process as the programme level analysis had already assessed a wide variety of rapid transit options, with the results of that assessment informing this more detailed work. Furthermore, this option analysis was more focussed on understanding the comparative option performance to inform the definition of further work, rather than to confirm an exact preferred option.

Option Map	Description
	**Option Busway Converted Light Rail - RED** *Intent:* To provide an option that converts the majority of the busway to light rail, as considered in the design of the Northern Busway. The refinement of this option diverts through Takapuna and provides a light rail scheme that is grade and gauge compatible with CC2M. *Description:* • Conversion of the current Northern Busway to a light rail corridor with one physical line southbound and one northbound, theoretically allowing up to two-minute headways • Modelled as street-running light rail within the city centre (connecting to the CC2M line) but grade separated on the North Shore • The Light Rail alignment necessitates a new piece of infrastructure crossing the harbour, which would be a dedicated Rapid Transit crossing • Do minimum road provision with assumed road pricing scheme (City Centre Cordon)
	**Option New Alignment Heavy Rail - GREEN** *Intent:* To test a very high capacity and high-speed option that retains the busway. New alignment provides more transit-oriented development opportunities and should be more responsive when sensitivity testing land use, with an expectation that mass transit infrastructure in the lower portion of the North Shore would encourage densification of the North Shore. The first refinement of this option was modelled with the line terminating at a busway interchange at Smales Farm, with a mind to extend northwards to Albany once this portion of work was completed (or at least largely underway). *Description:* • Necessitates a new tunnel crossing the harbour, which would be a dedicated Rapid Transit crossing • Network compatible trains which connect into the wider rail network • Modelled as an interchange at Aotea (as per CRL future proofing), with options to continue to the Eastern or Southern line. Either provides network

wide benefits of >6 9-car trains per hour accessing the city centre

- New Stations at: Aotea, Wynyard, Takapuna and Smales Farm. Assumed post 2048 (beyond the traffic modelling horizon) an extension can be staged up to Albany if still desirable/required
- The busway would remain in service on its current alignment
- Do minimum road provision with assumed road pricing scheme (City Centre Cordon)



Option New Alignment Light Rail - BLUE

Intent:

This option is a hybrid of the two options above, using light-rail in a new connection to Takapuna, Smales Farm and then (potentially) onto Albany.

Similar to the green option, the initial refinement considered a stageable rail system extending to Smales Farm initially with a mind to extend northwards to Albany once this portion of work was completed (or at least largely underway).

Description:

- Necessitates a new piece of infrastructure crossing the harbour, which would be a dedicated Rapid Transit crossing
- Would connect into the CC2M (City Centre to Mangere) light rail network
- New Stations at: Aotea, Wynyard, Takapuna and Smales Farm. Assumed post 2048 (beyond the traffic modelling horizon) an extension can be staged up to Albany if still desirable/required
- This extension was assumed by the project team to be an elevated structure above the busway, but with lower certainty in form akin to the isthmus extensions required for the red option
- The busway would remain in service on its current alignment
- Do minimum road provision with assumed road pricing scheme (City Centre Cordon)

Table 13 summarises how these tests differ from the earlier programme level analysis and what outcomes they allow to be understood further.

Table 13 : Summary of further Rapid Transit tests after programme analysis

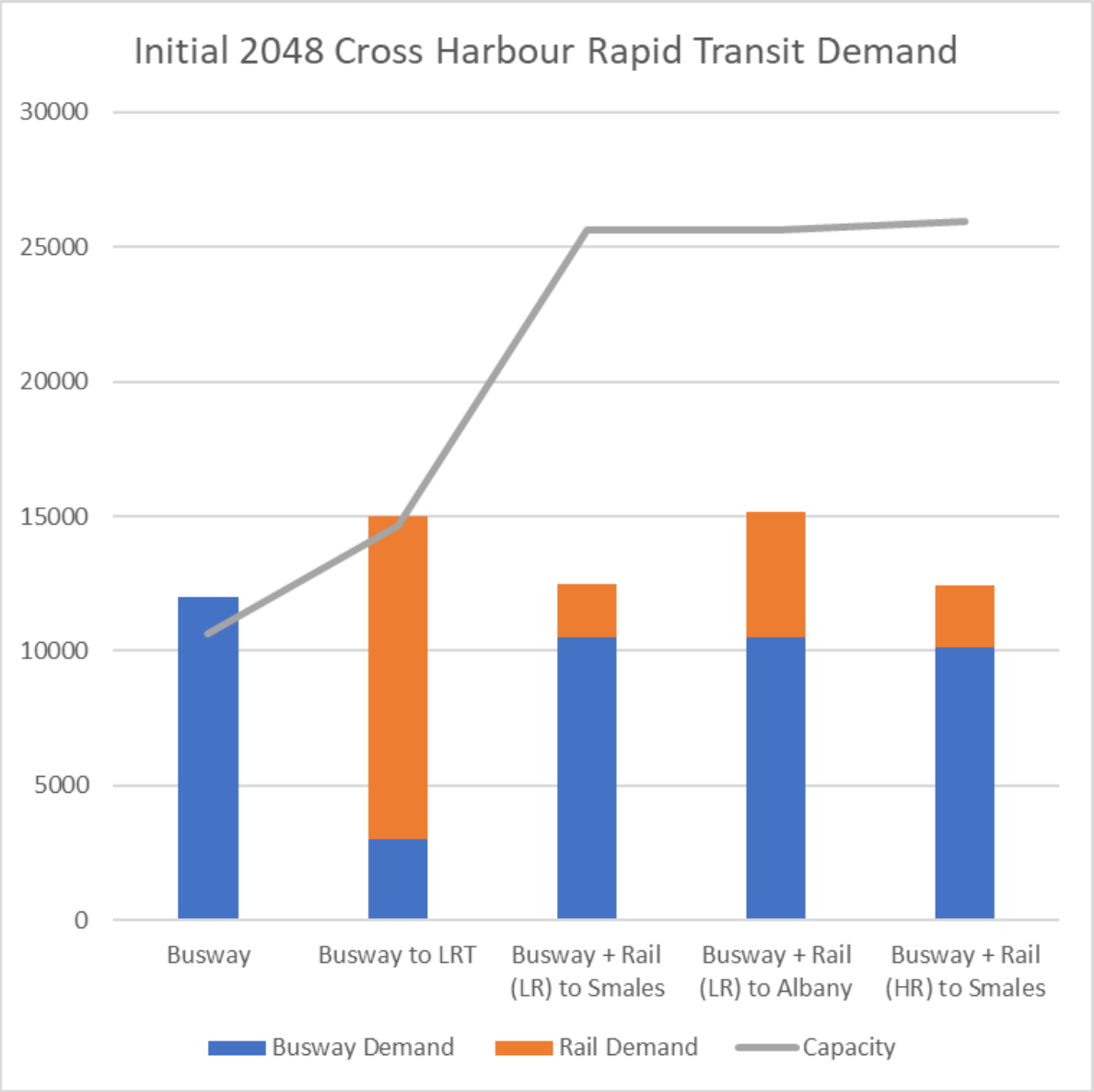
	LRT (incl Busway conversion)	New Heavy Rail alignment	New LRT alignment
Differences to Programme level analysis	- This included a new LRT alignment that links Takapuna and Smales Road before joining and converting the Busway to LRT north of that point. Earlier test converted entire Busway to LRT and had a spur off to Takapuna - Existing Busway in place south of Smales Road - This allowed more detailed assessment of the benefit of LRT to Takapuna and Smales Road and how best to interface with the existing busway	- This provided a Heavy Rail alignment linking Takapuna and Smales Farm where it terminated. This is different to the programme test as it terminated at Smales Farm - This allowed an understanding of how heavy rail versus LRT attracted passenger (or not) and provided the opportunity to understand the transfer penalty for rail	- This provided a LRT alignment linking Takapuna and Smales Farm where it terminated. This is different to the programme test as it terminated at Smales Farm - This allowed an understanding of how heavy rail versus LRT attracted passenger (or not) and provided the opportunity to understand the transfer penalty for LRT and what difference the mode made to patronage further north, given the comparison with the other LRT test in this stage of analysis

10.2. Rapid Transit Alignment

10.2.1. Route Alignment

Modelling of forecast 2048 demand shows the option where the busway has been converted to light rail as having the highest forecast southbound AM peak demand of the options tested, seen in Figure 32. This is attributable to the travel time savings for journeys from Albany northwards and indicates the sensitivity of users to having to transfers services within their journey.

Figure 32: Southbound public transport demand 1-hour morning peak demand 2048



However, this option is expected to already be operating close to peak capacity by 2048, offering limited opportunities to accommodate additional demand beyond this time period. This finding was consistent with earlier work (as discussed in the previous section) that recommended two cross-harbour rapid transit connections will be needed to serve long-term demand.

The options (Heavy Rail or Light Rail) which terminate at a Smales Farm rail/bus interchange are not able to achieve the same patronage of a busway conversion in the peak period southbound. This is because rail is only serving a very small part of the North Shore (Takapuna and Smales Farm), with the rest of the area continuing to be served by the busway. Most importantly, this analysis shows the importance of extending rail further north of Smales Farm to serve longer-distance journeys and the parts of the North Shore projected to see the greatest amount of growth.

There are key challenges with extending the rapid transit connection to Albany and more detailed investigations are needed to understand these incremental costs and benefits. This work will need to be well integrated with any planned improvements to the current busway, as well as with the work the Supporting Growth Alliance are currently undertaking on options north of Albany.

The analysis also indicates that the patronage across the harbour is similar during interpeak for all options. Interpeak demand is forecast to have no more than a two per cent difference in patronage

across all options, which indicates additional capacity at peak times provides the greatest benefit for users.

A land use sensitivity test was undertaken to test the extent to which a more aggressive assumption around the growth potential of Takapuna and Smales Farm would affect projected ridership levels. This work found a 20% increase in public transport ridership from higher levels of growth. Further work should be done in the next phase of analysis to test this relationship further, especially in terms of fully realising the benefits of the additional rapid transit connection in shaping a quality compact urban form.

Key findings:

- The only substantial difference in 2048 performance is in southbound AM peak public transport demand, where a rail-based system to Albany has 25% higher forecast demand than the busway only 'do minimum' and rail options which terminate at Smales Farm.
- Interpeak and contra-peak forecast patronage are relatively similar under all options.
- Where the additional rapid transit route terminates in the north is an important component of the scheme and has considerable impacts of the rest of the North Shore transport system.
- There is little difference in patronage between Heavy Rail and Light Rail indicating the additional cost and complexity of Heavy Rail is not justified based on North Shore demands.

The implications on the cost, Benefit Cost Ratio (BCR) and on consenting and environmental impacts for these options are discussed in the relevant Appendix. Furthermore, detailed analysis is required to a Detailed Business Case level before a final decision on the alignment can be made.

This analysis also shows that the additional rapid transit connection, in whatever form, provides capacity for growth beyond the 2048 analysis period.

10.2.2. Form technical specification – Tunnels and Bridges

The new rapid transit connection could be delivered as a bridge or a tunnel. Both have their advantages and disadvantages. Key considerations in choosing between these options are cost (both capex and opex), environmental impact and associated ability to consent the design, public input, and the directness of connection.

Table 14: Bridge and tunnel high-level comparison

Form	Benefits	Drawbacks	Risks and Opportunity
Bridge	+ Could be delivered at significantly lower cost than a tunnel (in the order of $2-3Bn) + Significantly lower operational expenditure	- Significantly riskier consenting pathway based on current environmental and planning framework - Previous public feedback in Auckland Plan submissions did not support bridge (visual & environmental impact) - Indirect route, >30% longer in-vehicle journey time for a bridge adjacent to the Auckland Harbour Bridge for a Wynyard to Takapuna journey - Bridge infrastructure creates severance, reducing walk up catchments. Total journey time from Takapuna to Wynyard could almost triple* when including walking time	+ Opportunity for an Onewa rapid transit station - High consenting risk - Public opposition (based on previous feedback noting it was 10 years ago) - Limitation on mode, heavy rail gradients usually unable to achieve greater than +/- 4%
Tunnel	+ Lower but still substantial consenting risk + Direct route affords greater in-vehicle travel time savings + Direct route traverses underneath key employment	- Significantly higher cost than a bridge - Significantly higher operational expenditure	+ Greater potential for transport-oriented development with excavated stations, particularly for Takapuna

	and residential hubs reducing walk up times + Mana whenua preferred option + More likely to be supported by public		

based on an average walk for a Takapuna station being an 800m walk, and Wynyard being 500m. A light rail vehicle could be surface running through Takapuna to minimise walk-up time, however the in-vehicle travel time would increase further (compared to a tunnel) impacting all customers further north from Takapuna.

One of the differences between the two options is what the cross-harbour structure means for the potential station location in Takapuna. A tunnel is able to more easily deliver the rapid transit line much closer to the centre of Takapuna, where as a bridge located alongside the current Harbour Bridge would deliver the alignment alongside the motorway, making it more challenging to directly access the centre of Takapuna.

While further work will confirm the exact alignment, the analysis to date prefers a tunnel option connecting the city centre directly to Takapuna and Smales Farm. This is predominantly because of the lower consenting risk (as outlined in Appendix I) and the ability to deliver a much higher quality service - this outcome has greater alignment with agreed project outcomes and objectives. Accordingly, all evaluation of the progressed options has assumed a tunnel as the form for the rapid transit crossing.

This preference for a tunnel does not fully discount the possibility of a rapid transit bridge. The next phase of analysis will assess rapid transit alignments in more detail and should include a robust comparison of bridge and tunnel options, especially considering the potential capital and operational expenditure savings.

10.3. Mode

The programme level assessment confirmed the need for a substantial boost in cross-harbour public transport capacity beyond that expected from the enhanced busway. This is because of the very high level of projected future public transport demand in the corridor. Through the assessment of different options, the programme level assessment concluded that the Additional Rapid Transit Connection should be rail-based, as bus-based connections would not provide a sufficient increase in overall network capacity and would simply add to existing city centre bus congestion issues.

Several rail-based rapid transit modes could potentially be suitable for the corridor:

- Modern light-rail vehicles that can be joined together to carry 450-700 people and are able to run on-street or off-street. An example of this mode is the light-rail system recently opened in Sydney, Australia.
- Light-metro vehicles that generally operate without drivers, carry 300-700 people per train (depending on train length) and must be off-street. An example of this mode is the Skytrain system in Vancouver.
- Heavy rail vehicles like on Auckland's existing rail network that can carry up to 750 people (for a six-car unit) and must run off-street on dedicated tracks.

All these modes would provide a high-quality public transport option and operate on dedicated corridors to provide fast, frequent and reliable travel choices. Therefore, the key factors affecting the choice of mode are:

- The extent to which the mode has sufficient capacity to meet future demand.
- The extent to which the mode will support wider urban form outcomes.
- The extent to which the mode integrates with the rest of the rapid transit network.
- Cost, environmental effects, delivery risk and overall value for money.

In general, heavy rail has the highest people-moving capacity and light-rail the lowest, with light-metro falling in the middle. Similarly, heavy rail has the most demanding technical requirements and therefore the highest cost. Light-rail's unique ability among these rail-based modes to operate on-street (in dedicated lanes) means it generally has the lowest cost.

To understand the 'outer bounds' of these mode options, key findings from that comparison are outlined in the table below:

Table 15: Mode discussion of recommended rapid transit specification

Mode	Existing Network	Opportunity	Drawbacks
Heavy Rail	3 commuter lines (West, South, East) and a spur line to Onehunga Current investment into CRL of $4.4B	• Would leverage investment in the current ATAP rail network and delivers further benefits from existing investment. • Heavy rail is the higher capacity mode, accommodating for greater population growth potential (however similar level of patronage forecast at this time)	• More expensive than a comparable light rail alignment ($1-2Bn). • More limited in expansion options north of Smales Farm as heavy rail is usually gradient restricted to +-4% • Greater footprint and impact to implement
Light Rail	None at time of writing but plans to deliver 1-2 light rail lines and facilities over the next decade	• More flexibility in expansion options beyond Smales Farm (e.g. elevation above the busway, further tunnelling, street running) • Cheaper than a comparable heavy rail alignment.	• Cost and operational assumptions in this report are reliant on leveraging a future network. If this future network does not exist, or dramatically changes form, this option may not be as feasible and the costs associated could be much higher. At the time of writing this is a large risk.

This means that the final choice of mode depends on wider network planning issues such as:

- The selection of mode for other rapid transit corridors, especially the city centre to Mangere and Northwest corridors.
- How the Additional Rapid Transit Connection and the Enhanced Busway interact north of Smales Farm. The existing busway requires very significant reworking to accommodate heavy rail (i.e. major tunnels and viaducts) that are unlikely to be feasible, meaning that light rail would be preferred for routes that continue northwards.

10.4. Network Integration

Currently there is significant uncertainty about the modes, routes and timing of future rapid transit interventions in Auckland, which has significant implications for the mode choice of this corridor. Therefore, it is pragmatic for indicative light-rail, light-metro and heavy rail options to be carried forward to the next phase of analysis. This will enable detailed information about these options to inform and be informed by wider rapid transit network planning – which is a better way of making a final mode decision for this corridor as it may be that wider network decisions dictate the mode of this project.

Key integration issues relevant to the additional rapid transit connection that will need to be considered in future work are:

- Connections with other rapid transit corridors in the city centre, particularly in relation to the City Centre to Mangere and Northwest corridors that are shown as 'through-routed' to the North Shore in ATAP rapid transit diagrams.
- The way in which the enhanced busway and the additional rapid transit connection work together to efficiently serve travel demand within the North Shore and between the North Shore and the isthmus. While work to date has shown both cross-harbour connections are needed, it will be important to balance their capacity with demand and ensure the corridors do not unnecessarily duplicate each other.
- Integration between the busway, the additional rapid transit connection and the wider North Shore public transport network will also be critical. This means ensuring different parts of the

network (i.e. rapid transit, frequent bus routes, local feeder bus routes etc.) all play to their strengths and come together to form an efficient and effective overall network.

- Connections with the Upper Harbour (State highway 18) planned rapid transit corridor will be important around Constellation station and Albany. This corridor is intended to connect the North Shore with West Auckland and ensuring seamless integration with the main 'north-south' corridor discussed in this work will be important in ensuring the corridors operate as a network.
- Extensions further north beyond Albany. As discussed earlier, different alignments for rapid transit north of Albany are being worked through as part of wider transport planning of the Dairy Flat and Silverdale growth areas. Any mode and alignment choices made south of Albany will impact on planning further north.

The issues above highlight the importance of seeing this corridor as part of a wider rapid transit and public transport network. This means the next phases of work will need to be informed by, and integrate with, wider network planning.

.

10.5. Summary of Findings

Following on from the programme level assessment, the more focused rapid transit assessment has further developed our understanding of the benefits of the intervention and importantly what areas still require further investigation to address this complex but incredibly important component of the North Shore transport system. The findings of this additional assessment can be summarised as follows:

Alignment

- Stations at Takapuna and Smales Farm are important for the function and performance of the additional Rapid Transit connection (and the wider transport system) and present opportunities for further intensification of land use.
- There is benefit in extending the Additional Rapid Transit Connection north of Smales Farm to Albany (either via the busway or on a new alignment). More detailed assessment is required to understand the best alignment north of Smales Farm, including integration with the busway and the catchment north of Albany. How this Additional Rapid Transit Connection interfaces with the Enhanced Busway is critical as the analysis shows that users do not want to transfer between different modes if they do not need to.
- The additional rapid transit route should cross the harbour, segregated from other transport modes on a new crossing. This initially recommended approach is a tunnel due to the environmental, grade and alignment challenges, however a bridge option should be considered in the next phase for completeness, given its much lower cost.

Mode

- There is little difference in attractiveness between light and heavy rail, with the final decision likely to be based on the wider Auckland rapid transit network and ensuring compatibility with this system.

Network Integration

- The rapid transit network on the North Shore is heavily dependent on several other factors such as the form of the wider Auckland Rapid Transit network and land use provisions. It is critical that the Rapid Transit scheme is investigated in more detail alongside the development of these interdependencies, to ensure the appropriate decisions are made for the form of the North Shore Rapid Transit network, whilst also ensuring the appropriate outcomes for the wider Auckland Rapid Transit network.
- The combination of an enhanced busway and the additional rapid transit route delivers most, but not all of the investment objectives sought. The public transport focussed interventions deliver well against the growth and high-quality city outcomes as well as the access and choice outcomes. There are enhancements to the resilience, productivity and reliability of the transport system, predominantly relating to public transport users by providing a cross-harbour travel choice that is fully independent of the existing motorway network.

11. FURTHER ROAD BASED OPTIONS ASSESSMENT

The programme level analysis discussed earlier in this document highlighted the need to improve road connectivity and resilience, alongside the busway enhancements and additional rapid transit connection. To develop the nature of these improvements further, analysis was undertaken that looked at:

- The **alignment and form** of this additional capacity (and should the transit and road be in a combined tunnel).
- The **timing** for the additional road capacity.
- How this capacity could be provided to address the **productivity and resilience** challenges whilst not eroding the rapid transit benefits.

11.1. Road Option Identification

As noted earlier, a key outcome of the programme level work was that even with increased public transport capacity, there is a long-term need to provide increased resilience and capacity.

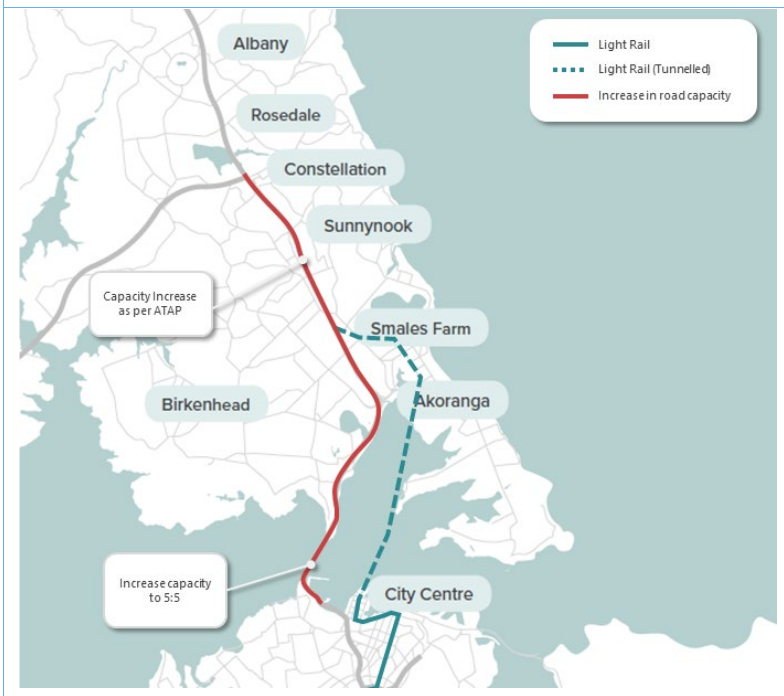
At the programme level assessment, the only consideration of road capacity enhancement option was the six-lane tunnel option between Esmonde Road and the Central Motorway Junction as considered by Waka Kotahi in its earlier Additional Waitematā Harbour Crossing Route Protection work. Following the Programme Level assessment, a more detailed assessment of road interventions was then tested against the identified traffic problems (assuming an additional rapid transit connection was in place) to understand if the same scale of road investment was still required given the increased public transport response.

Three options were considered in this more detailed analysis:

- Ten Lane Auckland Harbour Bridge (i.e. 2 additional lanes near the existing AHB)
- Ten Lane Auckland Harbour Bridge and wider corridor improvements
- Additional 6 lane road tunnel and wider corridor improvements (akin to the programme level option)

In carrying out these tests, a single rapid transit reference case was used as a base in all options, namely a light rail route from Smales Farm via Takapuna, connecting with a city centre system via a tunnel, supplementing an enhanced Northern Busway (as described in Section 9). While not directly consistent with the options in the initial MCA, this option was a product of a parallel process refining the recommended way forward. Consistent approaches to road pricing were also used across the different tests.

The three options are described below in more detail.

Option Map	Description
	**Option 1 – Ten lane Auckland Harbour Bridge (two extra lanes)** *Intent:* The intention is to test the scale of an alternative road solution to the scale of the residual traffic problems. *Description:* • Widening of AHB to provide ten lanes of vehicle capacity in addition to walking and cycling facilities • Modelled as five lanes per direction all day with no tidal flow • Improvement to counter-peak capacity, which increases from three lanes to five • Widening of SH1 between Esmonde and Onewa to provide four southbound lanes with likely reclamation needed • Parallel, independent structure to existing AHB
	**Option 2 – Ten lane AHB (Two extra lanes) and corridor improvements** *Intent:* To test the merits of widening of the SH1 corridor between Akoranga and Constellation in addition to the Harbour Bridge being widened in accordance with Option 1. *Description:* • South of Esmonde – as per Option 1. • Esmonde-Northcote: One extra lane per direction (Four lanes each way) • Northcote-Tristram: One additional southbound lane (Four lanes Southbound and Northbound) • Tristram – Constellation: One extra lane per direction (Three Southbound and four Northbound) • Parallel, independent structure to existing AHB

Option 3 – Additional road tunnel crossing

Intent:

To test an addition of a new road tunnel crossing of the harbour, separate and in addition to the existing bridge.

Description:

- New road connections in tunnels, three lanes in each direction. SH1 function by-pass city centre to south of city
- The Harbour Bridge is reduced to six lanes (three per direction) which directly serve the city centre and fringe only
- Total traffic capacity would be six lanes in each direction (three on the existing bridge and three in a new tunnel)
- Opportunity to utilise excess Harbour Bridge capacity converted to active modes/public transport
- SH1 widening as described in option 2 included
- The road tunnels are assumed to be in a separate crossing to the rail tunnels which require different alignments

The MCA process was adopted for testing of these options given the level of previous work undertaken on a road crossing and also due to the focus on comparing the options with a view to identifying a recommended option if possible.

11.2. Assessment Summary

11.2.1. General

The summary of the MCA assessment is shown in Figure 33. A more detailed summary of the Assessments can be found in Appendix E.

Figure 33: Multi-Criteria Analysis Scoring Summary (Road options)

ILM Benefits	Investment Objectives	KPI (MCA)	Reference - Pink	Option 1 (10 Lane AWHC)	Option 2 (10 Lane AWHC + SH1 Widening)	Option 3 (Tunnel + SH1 Widening)
			LRT on new alignment	Removal of Clip-Ons, addition of 3 lane additional structures in each direction	Removal of Clip-Ons. Addition of 3 lane structures in each direction. Widening of SH1 between AHB and Constellation	Additional 6-lane motorway tunnel under harbour
High quality growth & improved amenity	Enable Auckland to achieve quality, compact growth and improved amenity	Greater density close to high frequency PT routes (and key locations)	0	0	0	-1
		Improved amenity for City Centre & Metropolitan Centres	0	-1	-1	-2
		Reduced impact of transport on Auckland's environment	0	-1	-1	-1
Improved travel choice	Provide improved travel choices and access to employment, education and social opportunities	Increased use of public transport (during AM, IP and PM peak periods)	0	1	1	0
		Improved access to rapid transit.	0	0	0	0
		Improved capacity in the transport system to better serve travel demand	0	1	2	1
		Improved accessibility of key destinations & centres for people by PT	0	0	0	0
		Increased access to employment for North Shore residents. By PT	0	0	0	0
		Improved accessibility of key destinations & centres for people by private vehicle	0	1	1	2
		Increased access to employment for North Shore residents by private vehicle	0	1	1	2
More productive and reliable transport and utilities	Improve the productivity, resilience and reliability of Auckland's transport networks	Improved recovery from incidents	0	1	1	2
		Reduced vulnerability to natural and human induced events	0	0	0	1
		Improved reliability of key journeys by user type & time of day	0	1	1	1
		Reduced risk to key utilities	0	1	1	2

Feasibility		Reference - Pink	Option 1 (10 Lane AWHC)	Option 2 (10 Lane AWHC + SH1 Widening)	Option 3 (Tunnel + SH1 Widening)
Feasibility	Affordability	0	-1	-1	-3
	Engineering	0	-2	-2	-3
	Consentability	0	-3	-3	-2

Environmental		Reference - Pink	Option 1 (10 Lane AWHC)	Option 2 (10 Lane AWHC + SH1 Widening)	Option 3 (Tunnel + SH1 Widening)
Environmental	Landscape visual (e.g. ONF's, ONL's, Volcanic viewshaft, Section 6A and B)	0	-2	-2	-1
	Coastal Environment (e.g. CMAs / Maritime SEAs)	0	-3	-3	-1
	Built heritage (Section 6F), Natural heritage & Archaeology (Section 6F))	0	-3	-3	-1
	Ecology (e.g. SEA's, terrestrial, threatened- Section 6C)	0	-2	-2	-1
	Social (e.g. recreational, severance, property, noise (Localised effects / Contsruction / road traffic) , Section 6D)	0	-2	-2	-1

To assess the impacts of the forecast growth on traffic demands across the day, growth rates have been applied to the existing 24 hour northbound and southbound traffic flow profiles to produce forecast 2048 daily profiles assuming the recommended public transport option (Pink) is in place. The resulting demand and capacity profiles are shown on Figure 34 and Figure 35

Figure 34: Forecast 2048 AHB Southbound demand and capacity profile

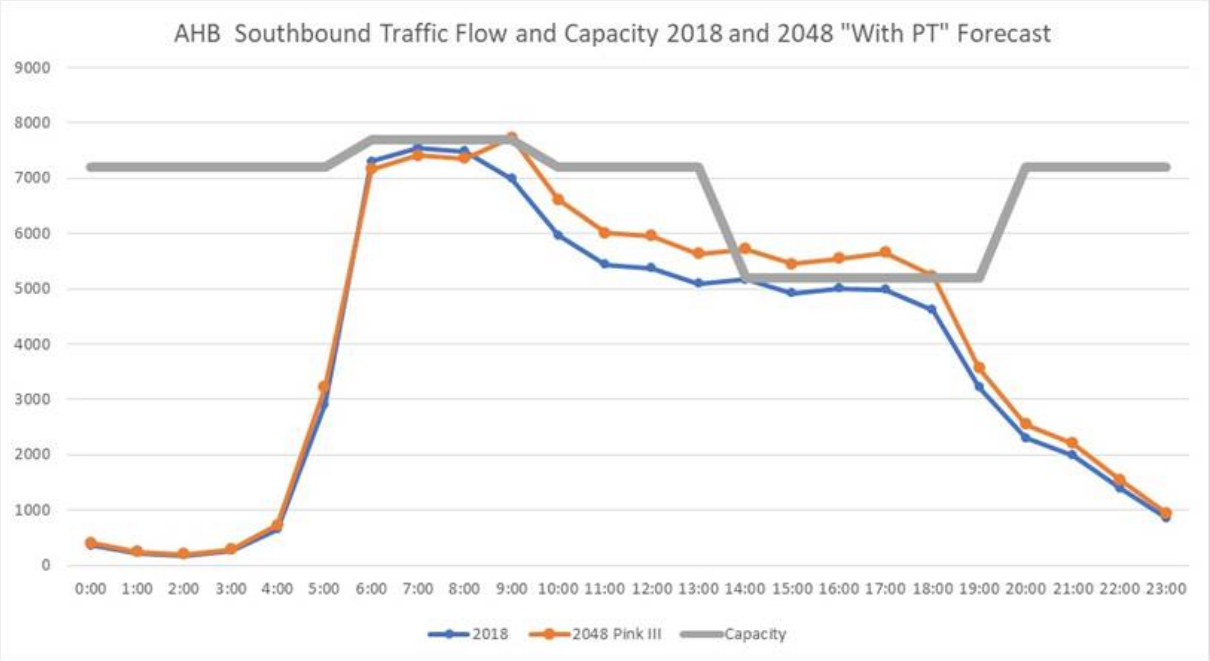
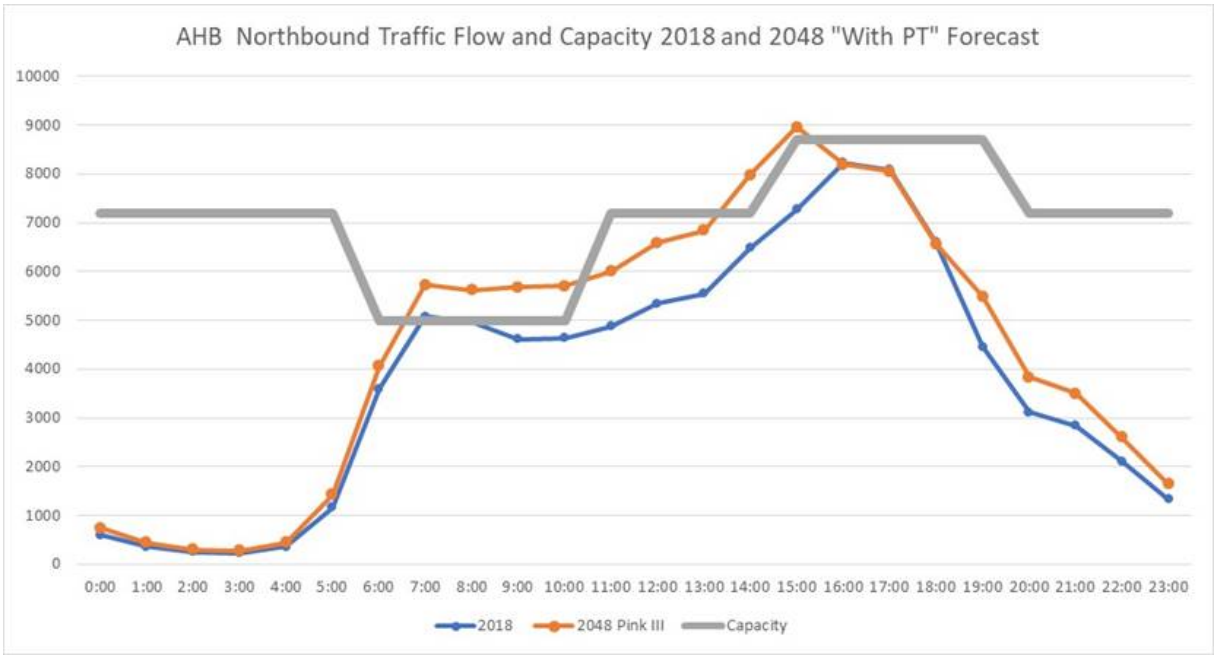


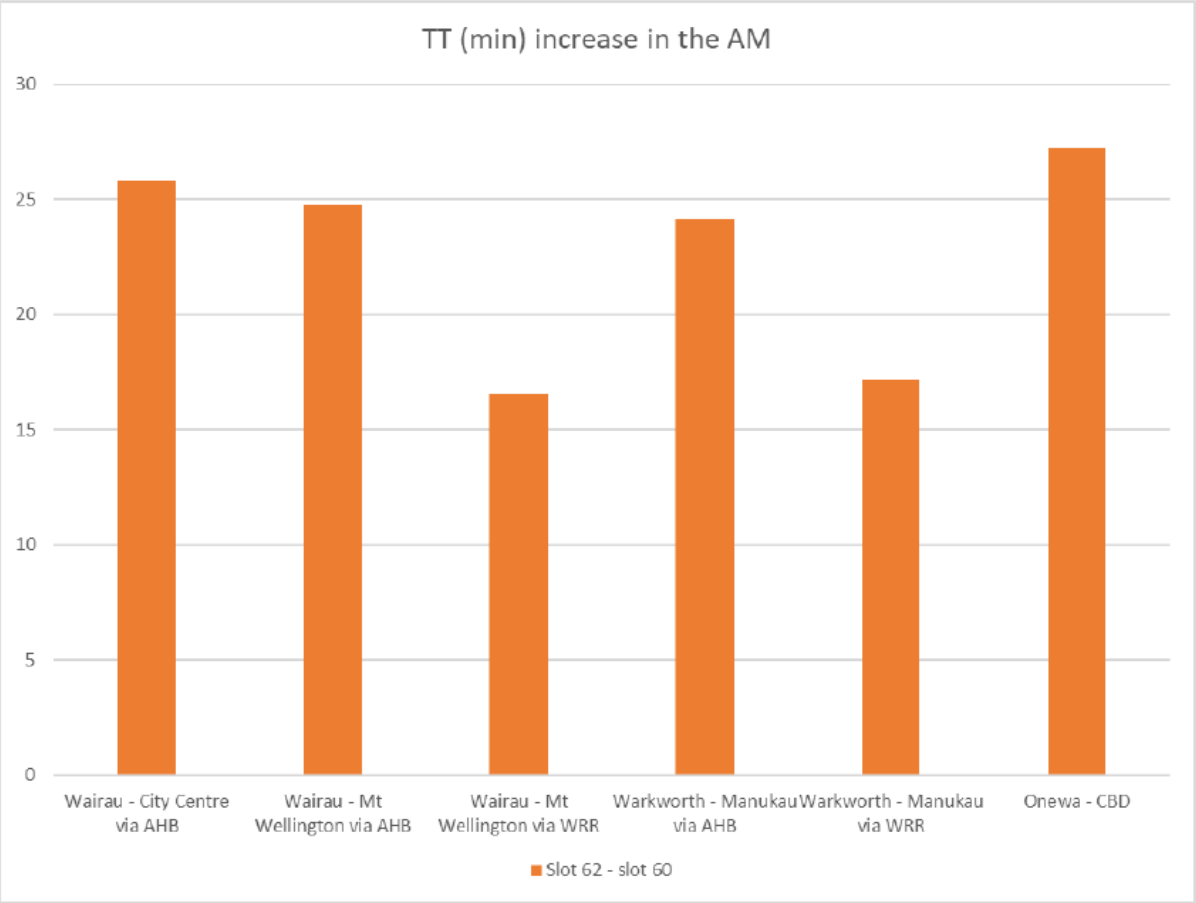
Figure 35: Forecast 2048 AHB Northbound demand and capacity profile



It is acknowledged that the approaches are also operating at high levels of congestion in the future, however the analysis indicates that the congestion on the Harbour Bridge will increase travel times and reduce reliability for inter peak trips including high value freight, business and commercial trips. Ultimately this will affect the productivity of the corridor and Auckland.

Analysis was also undertaken to understand the resilience challenge facing the corridor in the future. Assuming a two-lane closure on the existing harbour bridge (with an Additional Rapid Transit Connection in place) Figure 36 shows the increase in travel times that would result. This indicates a significant increase in travel time and congestion, which would take many hours to clear.

Figure 36: Resilience test outputs



The options seek to address these challenges.

11.2.2. Option 1: Widen AHB

Widening the AHB to provide a total of ten lanes would provide substantial benefits for corridor resilience and productivity, particularly addressing recent and forecast contra-peak and inter-peak traffic flow increases.

Operating the ten lane AHB as five lanes in each direction would retain existing peak hour peak direction (i.e. southbound in the AM peak and northbound in the PM peak) capacity – albeit widening southbound between Esmonde and Onewa to four lanes would increase the ability to utilise five lanes). Retaining the same level of peak direction capacity would ensure that additional road capacity would not severely alter the peak direction commuter mode share and traffic flows between North Shore and the central city and fringe.

Key findings from the assessment of this option (in comparison to public transport improvements alone) are:

- A 3.6% increase to the number of jobs accessible within 30 minutes in a private vehicle.
- Travel times for freight from the region's northern boundary to the city will improve by 4% in the morning peak with no noticeable improvements during the inter-peak or on time spend in severe congestion along this corridor.
- A 1% improvement in average speed on the region's freight network.
- A small reduction in public transport mode share to the city centre (from 77% to 76.5%).

- A 0.4% increase in the region's private vehicle travel per capita and small increases in traffic levels on lower North Shore arterials.
- More significant improvements to access and resilience for counter-peak and inter-peak trips, with additional capacity largely addressing forecast interpeak congestion in much of the corridor.

This option scored minor negative against the investment objective "*Enable Auckland to achieve quality, compact growth and improved amenity*", while scoring minor positive against most of the criteria for the other two objectives, "*Provide improved travel choices and access to employment, education and social opportunities"* and "*Improve the productivity, resilience and reliability of Auckland's transport networks".* Overall the option scored +6 against all Investment Objective KPIs.

It is noted that several scores required assumptions about the location and form of the widening, which is currently unknown. Further engineering and design (including assessment of environmental and consenting effects based on this additional design understanding) would improve the accuracy of the assessment and may be able to improve the feasibility and reduce the environmental, social and cultural impact of this option. This design would look at the scale and location of any additional piers, its cultural visual and environmental impact across the Waitematā harbour including the impact of the interface at the 'landing' and widening locations.

The recent Northern Pathway (walking and cycleway crossing) is currently being designed and although of smaller scale, is a similar concept and could inform the next phase.

11.2.3. Option 2: Widen AHB and SH1 corridor

This builds upon option 1 with the additional widening of SH1 between Esmonde Rd and Upper Harbour Highway.

There was very little difference in the MCA evaluation of Options 1 and 2, the only different score was against *"Improved capacity in the transport system to better serve travel demand*" where option 2 scored +2 against +1 for option 1.

The transport modelling analysis did however indicate that this enhancement to the northern approach made important improvement to the corridor's performance.

This additional performance does however come at a significant additional cost.

11.2.4. Option 3: New Road Tunnels and widen SH1 corridor

This option was the best performing option from an unweighted MCA perspective. Upgrading the SH1 corridor between Constellation and Akoranga with a new road tunnel crossing the Waitematā Harbour will improve inter-and counter peak travel times. It also provides a physical alternative to the AHB that significantly reduces the disruption risk due to natural events (sea level rise), operational incidents as well as impact of prolonged maintenance closures to ensure AHB remains structurally sound.

Key findings from the assessment of this option (in comparison to public transport improvements alone) are:

- A 7.5% increase in the number of jobs accessible within 30 minutes of travel by a private vehicle in the morning peak.
- An 11% reduction in travel times for freight from the region's northern boundary to the city centre in the morning peak and 8% in the inter-peak.
- A reduction from 45% to 41% of time spent in severe congestion along the corridor.
- A 2% increase in average speed on the region's freight network.
- A reduction in public transport mode share from the North Shore to the city centre from 77% to 75%.
- A 1% increase to the region's private vehicle travel per capita.
- Increased traffic volumes on lower North Shore arterials.
- 3000 additional people in vehicles driving into the city centre and fringe in the morning peak.
- Forecast congestion in the new harbour tunnels across much of the day, with the Auckland Harbour Bridge busy at peak times.

This option scored moderately negative against the investment objective "*Enable Auckland to achieve quality, compact growth and improved amenity*", while scoring moderate positive against most of the criteria for the other two objectives, "*Provide improved travel choices and access to employment, education and social opportunities"* and "*Improve the productivity, resilience and reliability of Auckland's transport networks".* Overall the option scored +8 against all Investment Objective KPIs.

Compared to the bridge widening options this option has an extremely high cost of around $9.5 billion, with funding a significant challenge.

11.3. Summary of findings

Following on from the programme level assessment, the more focused road option assessment has further developed our understanding of the benefits of the intervention and importantly what areas still require further investigation to address important component of the North Shore transport system. The findings of this additional assessment can be summarised as follows:

Productivity and resilience

- Neither road option would eliminate congestion in the corridor at peak or interpeak times. Most interpeak trips in the corridor would be one-three minutes faster in 2048 due to the road investments (compared to only investing in public transport improvements) However, trips are predicted to be much more reliable and resilient to incidents.
- Any road option would likely need to be accompanied by widening on upstream and downstream elements of the motorway and local network in order to achieve tangible benefits, and the costs and implications of these network changes need to be understood as part of any decision on additional cross-harbour roading capacity (along with downstream effects from increased traffic capacity across the harbour).
- The Northern Motorway needs to be raised between the Onewa Road and Esmonde Road interchanges to reduce flooding risk.
- A new crossing would ease pressure on the Auckland Harbour Bridge to a greater extent than an upgrade to the existing crossing, assisting with enabling maintenance of the existing structure and providing a level of improved resilience (noting the corridors merge back together north of the crossing).
- Further work is required in the next phase of work to ensure longer term roading improvements effectively target the key problems in a way that supports wider transport and urban outcomes, in particular:
    - The improvements need to sufficiently ease pressure on the existing Auckland Harbour Bridge so that major maintenance activities can be undertaken to preserve its long-term structural integrity.
    - Detailed design and operational needs to ensure peak direction traffic volumes:
        - between the North Shore and the city centre decrease in line with City Centre Masterplan aspirations
        - travelling past the city centre does not unreasonably exacerbate congestion in other parts of the network
    - The size and timing of investment needs to be carefully considered, to ensure value for money

Alignment and form

- There is a significant difference in cost (around $8 billion) between upgrading the Auckland Harbour Bridge (most likely via a parallel structure on the western side) and constructing new road tunnels under the harbour between the city centre and Akoranga.

- However, upgrading the Auckland Harbour Bridge is likely to have significant environmental, cultural and social impacts. While its consentability would not be truly known until tested through normal processes, advice informing the business case has suggested it would be unlikely under current legislation.

Timing

- The productivity and resilience challenges facing the corridor in the future require resolving within the next 20-30 years. Importantly the analysis has shown that a careful balance needs to be struck in resolving these issues to ensure the other outcomes sought (such as not increasing vehicles into the city centre) are not compromised. Timing of the road component of this programme has a potential role to play in balancing these outcomes, with the priority investment being in the Additional Rapid Transit Connection with the road investment following this public transport investment.

Given the uncertainty around the exact form and function of the Additional Rapid Transit Connection and the interdependency of this element of the programme on the roading solution, it is important that these two elements are considered together to a Detailed Business Case level before a final decision on the form, function and alignment of each is made.

11.4. Combined or Separate tunnels

Given the findings of previous studies, a key question to be answered in this business case was to recommend whether a combined public transport and road tunnel remains a recommended option or whether separate crossings for public transport and road are preferred.

Given the uncertainties surrounding the preferred form of a road crossing discussed above, it is not yet confirmed at this time that a road tunnel is the preferred road option. Therefore, confirming a combined tunnel or not is not possible at this time.

There are a number of considerations when assessing these two options, including the impacts of:

- Technical differences
- Investment outcomes
- Impacts

Table 16 provides a summary of the relative benefits and challenges of each option.

Table 16 : Combined or Separate tunnel assessment summary

Option	Benefits	Challenges
Separate tunnels	• Allows for separate timing and funding of the two crossings • The alignment of each mode can be optimised for that particular mode rather than being combined. For example, rail-based gradients are more onerous than road design gradients, meaning the road alignment would be of a higher standard than otherwise required if combined. • Separate tunnels provide greater resilience to the transport system overall. • Allows the critical public transport components to be progressed separately from the road tunnel which is likely to result in a quicker delivery date.	• The cost of two tunnels is marginally more than a combined tunnel approach. • There is increased risk of two consenting and funding processes, in particular for the second tunnel. • There is the potential for a larger footprint, resulting in greater effects. • Cumulative construction impacts.
Combined tunnel	• There are minor efficiencies in overall cost to be gained potentially by a single tunnel. • A single tunnel provides the benefit of providing for all modes at once and removes the risk of the second tunnel (if	• Requires timing and funding of elements to be aligned. • Affordability, the combined cost of both tunnels would need to be funded at once and the cost is very significant.

	delivered separately) being relitigated closer to the time of implementation. • There could be less construction disruption at the southern (critical) city centre end as there would be a single period of disruption rather than two (which combined would be for longer).	• There is greater technical risk with a combined tunnel due to the complexities of bifurcation and the tunnel diameter is at the top of the range of current capability. • Requires both alignments to be in the same corridor which will result in compromises for one or both modes. • There could be complexities in the operation with shared use of different modes (such as deeper stations).

Based on the analysis undertaken as part of this investigation and the current uncertainty of the Additional Rapid Transit Connection alignment, separate tunnels are preferred at this time.

However, given the complexities and associated uncertainties surrounding the preferred form for a road crossing discussed above, it is recommended that the final consideration of a combined tunnel be undertaken as part of the further analysis of roading options (in combination with investigating the rapid transit requirements).

A major factor for consideration is timing and location, as the need for a new road crossing appears to be later than a new rapid transit crossing and the 'landing point' in the city centre and the North Shore is different for public transport and road, which more naturally leads to these being considered for separate delivery.

12. OVERALL ASSESSMENT FINDINGS

The business case investigations have led to the following key findings:

- A programme of interventions is required to address the transport challenges forecast for the strategic corridor of the North Shore transport system.
- Demand management plays an important role, with the timing, location and scale of growth on the North Shore a key driver of the timing of investment. There is an important link between the timing of greenfield urbanisation around Dairy Flat and the need for high-cost rapid transit and road investment. Focusing growth in and around major centres (especially Takapuna and Albany) will help reduce travel demand and support mode shift to public transport. Employment growth on the North Shore will ease pressure on the corridor and potentially delay the need for major investments.
- A demand management on its own is insufficient to address the challenges facing the corridor.
- Road pricing could have substantial impacts on private vehicle demand (depending on pricing) in the corridor, potentially delaying the need for road investment. However, it will increase public transport demand and potentially bring forward the need for rapid transit upgrades.
- There is an urgent need to progressively add capacity to enhance performance of the Northern Busway in order to meet ongoing growth in cross-harbour public transport demand, support mode shift to public transport and support the ongoing success of Auckland's city centre.
- While an Enhanced Busway will deliver important benefits, by the mid to late-2030s it is expected to struggle to meet growing demand. After considering a wide range of options, the preferred approach is to provide an additional rail-based rapid transit connection across the harbour that will supplement the Enhanced Busway. Stations at Takapuna and Smales Farm are required with further analysis to confirm if extending the system north to Albany (and potentially beyond) is justified, with initial analysis indicating this has substantial transport benefits.
- An additional Rapid Transit route is a significant addition to the North Shore transport system and will require careful integration with the current transport system and will be heavily influenced by the wider Auckland Rapid Transit network (such as the form of CC2M). More detailed investigation to determine the exact alignment and form of this additional Rapid Transit route is required and will need to address these interdependencies.
- An initial assessment is that tunnels are preferred to a bridge for this rapid transit connection, but additional understanding of external factors (such as a decision on the form and timing of the CC2M project) is required to confirm this and whether it is light-rail or heavy rail and how it integrates with the Enhanced Busway and the North Shore public transport network more broadly.
- Even with the enhanced busway and additional Rapid Transit crossing initiatives in place, in the longer-term, interpeak congestion and increasingly significant management interventions to preserve the structural integrity of the Harbour Bridge are expected to create significant productivity and resilience problems for the road-based users of the corridor.
- Any road option would need to be accompanied by widening on upstream and downstream elements of the motorway and local network in order to achieve tangible benefits, and the costs and implications of these network changes need to be understood as part of any decision on additional cross-harbour roading capacity (along with downstream effects from increased traffic capacity across the harbour).
- To address these issues, two options were investigated, a bridge and a tunnel across the harbour.
    - A road tunnel involves a new (six lane) road crossing tunnel with entry/exit portals likely at Akoranga and Wynyard Quarter and widening of the motorway corridor to Constellation.

This option has a very significant cost associated with it and would need operational management to ensure that it does not deliver additional traffic into the city centre.

  - An 'upgrade' of the existing Harbour Bridge corridor to a total of ten lanes (five in each direction) is proposed as a way of addressing the transport capacity problems at a much lower cost than additional road tunnels. However, this option has significantly greater social, cultural and environmental impacts and associated consenting risks than the tunnel-and does not address the resilience issues.

- Further work is required in the next phase of work to ensure longer term roading improvements effectively target the key problems in a way that supports wider transport and urban outcomes, in particular:
  - The improvements need to sufficiently ease pressure on the existing Auckland Harbour Bridge so that major maintenance activities can be undertaken to preserve its long-term structural integrity.
  - Detailed design and operational needs to ensure peak direction traffic volumes:
    - between the North Shore and the city centre decrease in line with City Centre Masterplan aspirations
    - travelling past the city centre does not unreasonably exacerbate congestion in other parts of the network
  - The merits and complications of combined or separate road and rapid transit connections needs to be considered in more detail, including when they are needed and whether the optimal design is consistent with a combined crossing, as well as cost and environmental impact considerations.
- The size and timing of investment needs to be carefully considered, to ensure value for money and delivery of the outcomes. The hierarchy of intervention for this programme being demand management first, followed by the Enhanced Busway, with the additional rapid transit connection to follow. The final piece of the programme being the road-based intervention. This hierarchy is important to ensure the outcomes sought are achieved.
- It is important that the further investigations into the Rapid Transit route are integrated with the road enhancement works to ensure that a total transport system approach is taken to determining the final form, function and timing of each mode.

13. RECOMMENDED LONG TERM PROGRAMME

The North Shore transport system is an important component of the Auckland region's transport environment. Considerable growth is forecast in land use in this area and this is forecast to result in significant growth in transport demands. The North Shore transport systems strategic corridor is one of the busiest and most congested in the country and therefore a comprehensive and substantial investment package in the transport system is required to ensure the outcomes sought are achieved.

The hierarchy of interventions approach has been used to ensure that demand management and existing infrastructure are maximised before new infrastructure is considered. Given the scale of the problems and the growth forecast even with demand management and the maximisation of existing infrastructure, new infrastructure is also required.

The recommended programme of investment is summarised in Table 17 and involves progressive development of the transport connections between the Isthmus and North Shore over time:

1. Upgrading / enhancing the Northern Busway
2. Developing an additional rail base rapid transit between the city centre and the North Shore
3. SH1 capacity and resilience improvements (dependent on demand and network conditions)

It should be noted that there may be resilience benefits that can be achieved through delivery of this or other programmes over the short, medium and long term.

Table 17: Recommended way forward summary and timing

Priority	Intervention	Timing (Years)	Problems addressed			Cost Range ($ billion)
			Problem 1 - connectivity	Problem 2 - productivity	Problem 3 - resilience	
1	Busway enhancement from city centre to Albany	1 – 5	□□	□	□	0.5
2	Rail connection (tunnel) from city centre to Takapuna, Smales Farm and potentially to Albany	10 – 20	□□	□	□□	LRT - 7.6 HRT - 8.4
3	SH1 capacity and resilience improvements	20 +	□	□□	□□	Bridge – 1 to 2 Tunnel – 9.6

13.1. Upgrading / Enhancing the Northern Busway

Enhancing the busway provides a progressive and programmed improvement in the capacity and quality of service along the entire public transport corridor. These enhancements are outlined in Figure 27 with more details also provided in Appendix J.

The improvements can be implemented relatively quickly and undertaken with the busway remaining operational. The immediate prioritisation of these enhancements allows the continued growth in patronage over time (as North Shore growth modal shift continues). The enhancements of the busway require close coordination with city centre public transport improvements and the ongoing review of North Shore services to complement the NX services.

There is also a strong need to integrate with the work Supporting Growth is doing along the northern growth area Rapid Transit (also anticipated to be bus based) to ensure the connections north of Albany, to Silverdale, whether along SH1 or through the growth area are considered and planned together. The development of the busway programme would also need to consider the outputs of the new city centre to North Shore connection, so as to plan the level of investment required at locations north of Smales Farm.

The busway enhancement allows investment to be scaled to the short to medium term growth and demand forecasts. Depending on interventions in the city centre, this has the ability to delay the need for the mass transit connection. The busway can also be adapted over time as new technologies develop which could extend the performance further than currently predicted. There is also opportunity to coordinate busway enhancements and environmental resilience (sea level inundation) interventions along the SH1 corridor, in particular, between Onewa Road and Esmonde Road.

13.2. Developing a rail-based additional rapid transit connection

Connecting the city centre to the North Shore though a rail-based mass transit connection develops a long-term public transport corridor. The project focusses on increasing connectivity which also looks to deliver wider economic benefits though intensification of the Takapuna metropolitan centre and the growth around Smales Farm and potentially Albany.

This new connection will supplement the existing Northern Busway. The recommended option for this connection is a CC2M compatible light rail through a tunnel between Wynyard Quarter and Takapuna with a longer-term view to connect up to Albany.

There is also an option that this could be delivered via bridge connection, but at this stage this is not the preferred option. This would need to be re-tested in a subsequent DBC which will assess these options in more detail. It is also important to note that this new rail connection could connect to the heavy rail network, developing a region wide service. This would require a decision to be made at or before the DBC, based on the outputs of the CC2M project and the regional public transport network planning that is currently being undertaken.

This DBC would be heavily influenced by the progression of CC2M and intentions for region wide heavy commuter rail. The project or programmes would influence the nature of the city centre connection and the potential form of the cross-harbour connection (tunnel / bridge).

13.3. SH1 Capacity, Operations and Resilience Improvements

The State Highway network improvements are anticipated to respond to increasing congestion over time and the impacts that has on productivity, reliability and resilience of the network. This congestion is forecast to result in peak spreading to ultimately create all day peak conditions north bound and southbound. At this stage there are two potential options that can be taken forward for further investigation, these are:

1. The widening of the existing Auckland Harbour Bridge corridor (to a ten-lane configuration (five+five) with the option to widen up to Constellation)
2. Development of a road tunnel connection (two three lane tunnels plus widening to Constellation)

Each of these options have merits and challenges and further work is required to understand these better. The bridge widening costs are significantly less but has significant consenting risk and does not address the resilience problem as much. The tunnel has a very high construction operating cost but provides resilience and has fewer consenting issues. The SH1 Corridor improvements are heavily influenced by demand and the structural performance of the AHB. The Corridor is also at risk of sea level rise inundation which impacts on the resilience and reliability of the corridor which will likely need to be addressed irrespective of any capacity improvements.

It is important that the final decision on this option is made in conjunction with the recommended form, function and alignment of the additional Rapid Transit route.

13.4. Programme Wide Influencing Factors

The scale, pace and location of North Shore growth also influences the timing of the elements of the programme. Accelerated growth without any demand intervention would put significant pressure on the existing busway and the roading network. The growth forecasts are a critical input to this

programme and should be periodically reviewed and updated to understand the scale and timing of travel demand. This should include the existing urban growth forecast in areas such as Takapuna as well as the more greenfield growth anticipated in the Supporting Growth Programme further north in Dairy Flat as an example.

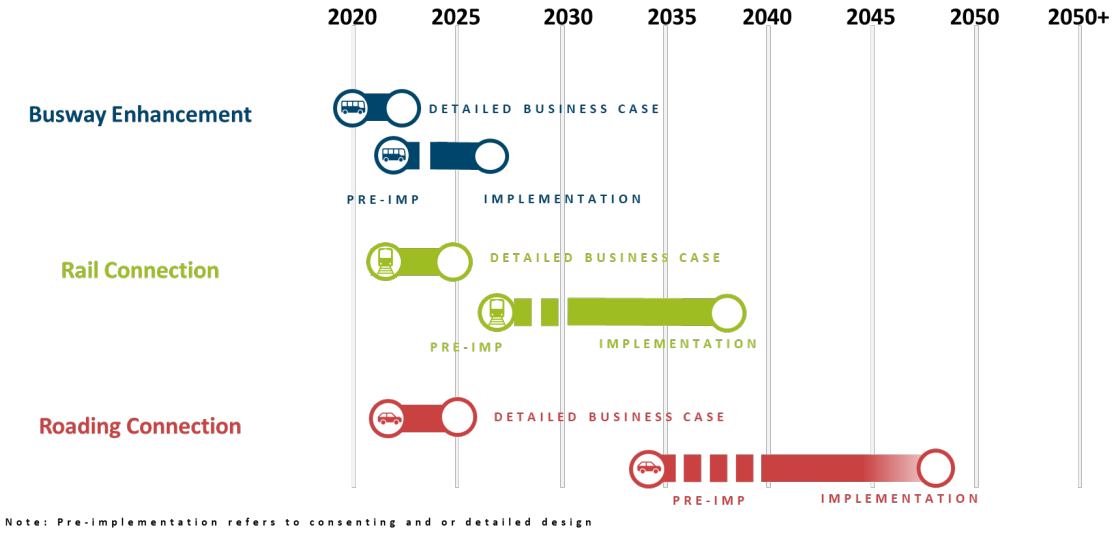
The impact of any road pricing regime will also impact on the demand for passenger transport and car trips with the level and form of any charge impacting the overall demand for travel for point to point but also the time of day selected for the trip. The general efficiency of the operation of the network with the introduction of new technologies could also impact the timing and need of the programme components. These trends and factors should be monitored as part of the wider programme delivery.

The impact of decisions made in relation to the wider Auckland transport network are also a key interdependency for the programme. Decisions made on the form and alignments of projects such as CC2M will have a direct impact on the form and alignment of the additional Rapid Transit component of this programme. It is important that this programme is progressed alongside these other projects.

13.5. Timing and Staging

The indicative timing of the phases of each of the programme elements is shown in Figure 37, this indicates the need for short terms investigations to allow for an integrated planning approach of the next stages, in particular the passenger transport DBCs. It is important to note that it is likely there is a 10 to 15-year lead time for major infrastructure projects (in this case the rail connection and the road connection) which impacts on the urgency to progress the next stages.

Figure 37 Indicative Programme Timing



14. VALUE-FOR-MONEY OUTCOMES

14.1. Cost Estimates

The programme costs have been developed though pricing up indicative options which at this stage most closely represent the programme components. These have been based on concept alignments and an assessment of the land required, the ground and environmental conditions and any other factors that would influence the scale of construction required. The capital costs include allocations for all phases of the project.

In tandem with the measurement and determination of the various programme options, the costings workstream has looked at the engineering feasibility of routes. This takes into account whether the options are possible to build within reasonable costs and (for new routes) whether a diversion is necessary (around reserve land or other constraints). This analysis was undertaken using GIS and Infraworks and informed the costings calculations.

Cost estimates were peer reviewed by Bond CM and variances reconciled through a collaborative process. The full cost report can be found in Appendix G.

14.1.1. Capital costs

The cost range of the recommended programme is approximately $6-18 billion anticipated to be incurred between 2024 to 2047. Options for connectivity with the rail network (light or heavy) remains unconfirmed, potentially increasing this range.

Full cost sheets of the programme capital costs in Table 18 can be found in Appendix G.

Table 18: Estimated CAPEX of Programme options ($ billion)

	Option	Cost	Year
Busway Enhancement	City Centre to Albany	0.5	2027
	Onewa Road Bus Lanes	0.1	2027
Rapid Transit - LRT	Wynyard to Smales Farm	5	2037
	Smales Farm to Albany	3	2037
Rapid Transit – HRT*	Wynyard to Smales Farm	5	2037
	Smales Farm to Albany	3	2037
Road	In-line Bridge	1	2047
	In-line Bridge + Widening	2	2047
	Tunnel + Widening	10	2047
Additional projects	Demand Management**	0.2	2024

*HRT assumed at 10% higher cost than LRT

** Allowance for general demand management investment consistent with intervention hierarchy

14.1.2. Operational & maintenance costs

Once completed, the cost range of the above programme's operations and maintenance is approximately $100-130million annually.

These programme operational and maintenance costs (and assumptions) in Table 19 are documented and full cost sheets can be found in Appendix G. The cost assessment included consideration of:

- Rolling stock purchase and liquidation (Bus and Rail)
- Pavement renewal (Motorway, Tunnel and Busway)
- Operational costs (Bus, Rail, existing dynamic lane)
- Station maintenance and operations (Bus and Rail)
- Track maintenance
- Operational efficiencies from integration with CC2M
- 5% reduction as a result for value capture at Wynyard, Takapuna and Smales Farm

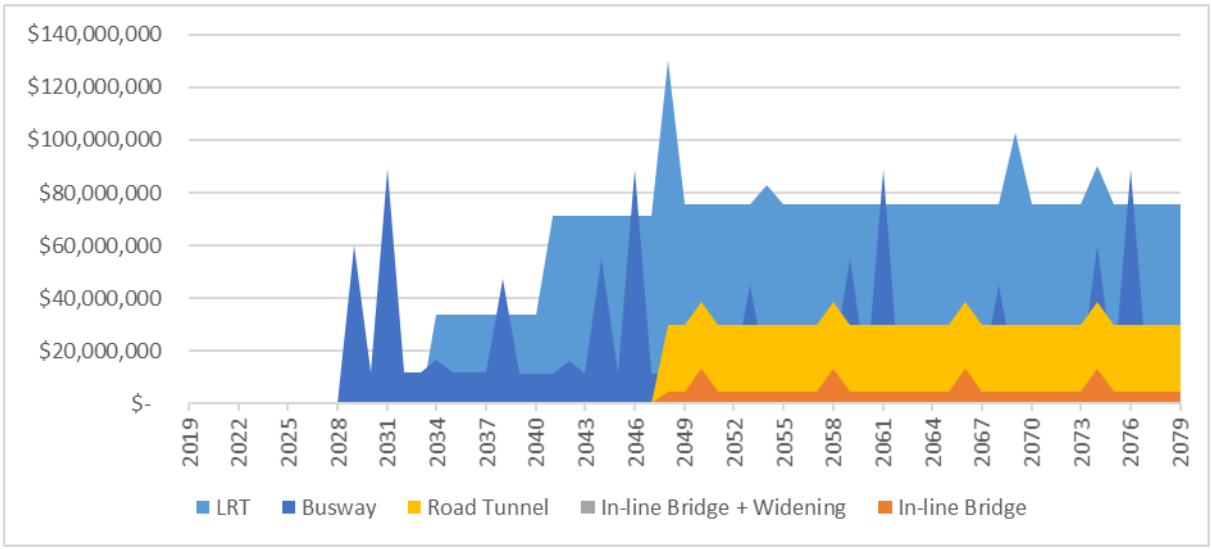
Table 19: Estimated cashflow by decade ($ million)

Option	2020-29	2030-39	2040-49	2050-59	2060-69	2070-79
Busway*	60	236	239	200	229	239
AHC Corridor	0	0	9	60	52	52
AHC Corridor + Widening	0	0	9	59	50	50
Tunnel	0	0	60	317	308	308
LRT (incl. Albany)**	0	202	738	762	782	769

*including Onewa Rd Bus Lanes, excluding Silverdale extension | **HRT approx 10% higher cost

NB: Refer to Table 19 for differences between bridge options

Figure 38: Estimated OPEX of potential Programme options



14.2. Economic Analysis

The economic appraisal of value for money has been undertaken in accordance with the Economic Evaluation Manual (**EEM**). The Cost-Benefit Appraisal of the scheme is also categorised against Waka Kotahi Investment Assessment Framework (**IAF**) criteria for the 2018/21 National Land Transport Programme (**NLTP**). Full details of the evaluation are in Appendix H.

14.2.1. Approach

Economic benefits of the options have been calculated in accordance with the EEM, December 2018 update. In alignment with the optioneering of the AWHC project, the economic evaluation was split into two stages with the Public Transport (**public transport**) options considered first, and then how additional road options complement that investment. This section summarises the economic evaluation for the combined public transport and road options.

14.2.2. Do Minimum Scenario

The Do Minimum is the existing transport network with I11.4 land use, and congestion charging for forecast years of 2028, 2038 and 2048.

14.2.3. Option Scenarios

As detailed in Appendix H, the best value for money public transport option included enhancing Northern Busway by 2028 and extending it to Silverdale by 2038. LRT is to be constructed in a tunnel on a new alignment between the city centre and Takapuna / Smales Farm opening in 2034. The scale of the road options and the wide range in costs meant we have looked at the entire programme BCR considering both the bridge and tunnel road options investigated in addition the Enhanced Busway and Additional Rapid Transit Connection as LRT, being:

- Option A: Upgrading the Auckland Harbour Bridge to ten lanes, plus SH1 improvements
- Option B: Road tunnel to Takapuna, plus SH1 improvements

14.2.4. Costs

Capital 'expected' cost estimates have been prepared by the project team, as detailed in Appendix G. The Net Present Value (N**PV**) capital costs for the three options are shown in Table 20.

Table 20: Whole-of-life NPV Costs ($ billion)

Description	Option A	Option B
	AHB Widening and SH1 Improvements	Tunnel and SH1 Improvements
NPV Capital Costs	4.0	5.9
NPV Maintenance and Operating Costs	0.4	0.5
Total NPV Costs	**4.4**	**6.3**

Maintenance and operating costs have been estimated for the Do Minimum and the options including: annual and periodic maintenance costs, public transport operating costs, and operating costs for the bridge and tunnel as detailed in Appendix G. The NPV maintenance and operating costs for the three options are also shown in Table 20.

The overall NPV costs for the *two options are shown in* Table 20.

Table 20 shows that NPV cost is $4.4b for including SH1 improvements in addition, and $6.3b for a road tunnel and SH1 improvements.

14.2.5. Source of Benefits

The total NPV benefits of the options are summarised in Table 21.

Table 21: Benefits breakdown by option

Benefits	Option A Benefits (NPV $M)	Option B Benefits (NPV $M)
Travel time savings	459	545
VOC savings	63	133
Crash cost savings	53	61
Vehicle emissions	3	7
Congestion relief	69	82
public transport travel time	489	483
public transport reliability	24	24
Travel time reliability	23	27
TOTAL	1183	1360

This shows that public transport provides the bulk of benefits with travel time benefits the other significant contributor.

14.2.6. Benefit Cost Ratio

The BCR for the options are presented in Table 22.

Table 22: Benefit Cost Ratio Summary (NPV $ billion)

Description	Option B	Option C
	AHB Widening and SH1 Improvements	Tunnel and SH1 Improvements
NPV Benefits	1.19	1.36
NPV Costs	4.42	6.32
Benefit Cost Ratio	**0.3**	**0.2**

The BCR is based on strategic modelling outputs. The best value for money option is the programme with the road bridge option with an initial BCR of 0.3. However, these are valuable for comparison between the tunnel option, but care should be taken to assign this as absolute BCR of the proposal. As indicated in Table 24, the absolute BCR could be in the range of 0.3 – 1.0 and these should be explored further in the next phase of the project. There are several opportunities to increase the absolute value of the BCR that could be explored in the next phase of the project as detailed in Appendix H.

14.2.7. Incremental Assessment

Option A has the lowest NPV costs and incremental analysis against this option confirms that Option B is the preferred option with an incremental BCR of 1.2.

14.2.8. *Sensitivity* Testing

The sensitivity of the evaluation has been assessed against three key assumptions:

- 4% and 8% discount rate;
- +/-20% on total benefits; and
- Base and 95th percentile cost estimates.

The results of the sensitivity testing are shown in Table 23, with the highest BCR highlighted in green and the lowest in orange.

Table 23: Sensitivity Testing Summary

Description	BCR	
Sensitivity	Option A	Option B
Base evaluation	0.3	0.2
8% discount rate	0.20	0.2
4% discount rate	0.4	0.3
80% of benefits	0.2	0.2
120% of benefits	0.3	0.3
Base cost estimate	0.5	0.4
95th %tile cost estimate	0.3	0.2

Table 23 shows that the BCR is relatively insensitive to the changing sensitivity assumptions. Using the base cost estimate without the contingency allowances included in the expected estimate, has the most upside effect on the BCR. Using an 8% discount rate generally produces the lowest BCRs.

14.2.9. WEBs and Scenario Testing

The recent investigation of the wider economic benefits (**WEBs**) for AMETI Stage 2A (Eastern Busway Stage 1) supports the view that the agglomeration benefits for major public transport projects in Auckland can be significant. The initial estimate of the agglomeration benefits estimated using Waka Kotahi's standard EEM procedures found that the agglomeration benefits equated to approximately 129% per cent of 'traditional' EEM transport benefits, which is significantly higher than usual. A revised assessment (which excluded some model zones and included a benefit decay function) estimated agglomeration benefits to be approximately 78% per cent of transport benefits. An Independent Peer Review confirmed the robustness of this assessment.

Based on this assessment, it is reasonable to assume (prior to detailed investigation) that a significant public transport scheme which provides better access to the city centre than in the case of AMETI Stage 2A could generate wider economic benefits which are of similar magnitude to the traditional transport benefits. The results from adding 100% of traditional benefits to estimate the magnitude of WEBs is shown in Table 24.

Two 'upside' tests which combines a 4% discount rate or base cost estimates with 100% uplift for WEBs is also shown in Table 24.

Table 24: WEBs and Upside Testing Summary

Description	BCR	
Sensitivity	***Option A***	***Option B***
Base evaluation	0.3	0.2
100% WEBs	0.5	0.4
4% DR + 100% WEBs	0.7	0.6
Base $ + 100% WEBs	1.0	0.7

Table 24 shows that including an estimate for WEBs along with the base cost estimate gets the BCR for Option A close to 1. Combining this with another upside sensitivity could push the Option A BCR over 1.

14.2.10. Opportunities to Improve the BCR

The economic evaluation has not produced an absolute BCR where the NPV benefits are greater than the NPV costs. However, the results have confirmed the best value for money option based on a relative multi-modal comparison of the options using the MSM. The opportunities to improve the BCR are to:

- Reduce the capital and maintenance costs of the scheme by doing more engineering work around the preferred solution and its operating costs. Lower costs will greatly help to improve the BCR, for example, limiting the extent of or use of tunnels;
- Use a more detailed traffic model to assess the benefits to vehicular modes, which is likely to better represent the effects on congestion and improve benefits from this source. The AWHC SATURN model would be an appropriate starting point for this evaluation;
- Similarly, use a more detailed public transport model to better reflect public transport benefits. The public transport model run by AFC is likely to be the best candidate for this assessment;
- Perform a detailed WEBs assessment of the preferred option. This would be expected to produce a good quantum of benefits given the improved public transport accessibility from the North Shore residential areas to the city centre from the project; and
- Investigate the potential to claim other economic benefits from likely land use changes in Takapuna as a result of the improved public transport accessibility to the city centre and other areas on the North Shore.

14.2.11. Findings of the Economic Analysis

The economic analysis indicates that while the programme delivers larger benefits it is also weighed down with very large costs. The analysis indicates that a light rail scheme (compatible with the ATAP version of CC2M) to the North Shore via a tunnel has the best transport economics outcome.

The roading options indicate that the bridge options are most effective, due to their lesser cost than a tunnel. However, the main transport benefits of the roading options come from network relief though addition capacity up to Constellation. It is understood that any widening to Constellation needs an additional cross harbour capacity to relieve the bottle neck that the existing AHB creates.

The benefits cost ratio of a programme such as this requires wider economic benefits to develop a positive BCR, due to the very large costs of the programme. It would be expected that these wider economic benefits would be sizable due to the city shaping and transformation scale of the programme elements.

15. ASSESSMENT OF THE RECOMMENDED PROGRAMME

The recommended programme has been assessed against the following frameworks which are detailed in sections 15.1 through to 15.3:

- Waka Kotahi Investment Alignment Framework (IAF)
- Government Policy Statement on Transport (GPS)
- Project Investment Objectives, Benefits and KPIs

The assessments provide an overview to the strategic alignment of the programme with key outcomes and objectives.

15.1. Investment Assessment Framework (IAF) Results Alignment

The AWHC Programme falls within the following three activity classes:

- Existing public transport programmes
- Public transport improvement activities, including rapid transit and transitional rail
- Road improvement activities

The programme has been assessed as having a **very high** results alignment for public transport improvement activities. It is considered that for existing public transport programmes, the road improvement activity results alignment is **high.** These assessments are documented Table 25. The overall rating for the programme has been assessed as very high, as the biggest contributor to the programme outcomes is the public transport component and the new rail from the city centre to the North Shore.

The cost benefit appraisal has been classified as **Low***, this is documented in Section 14. The low start rating assumes that the programme has significant wider economic benefits and agglomeration that have not been identified through the economic modelling undertaken to date. The current cost benefit ratio is based on strategic transport model outputs which are useful for assessing the relative merits of large long-term infrastructure projects, but do not adequately identify the benefits of land use changes over time, responding to the investment in infrastructure and the wider benefits. There are significant opportunities to develop a more robust economic assessment as the programme develops into the next stages.

Table 25: IAF Alignment

Activity Class and Criteria Met	Alignment
Existing public transport programmes **Access – thriving regions; liveable cities** Addresses a gap in an appropriate customer level of service that can be addressed through moderate increase in investment	**High** The continual enhancement of the busway provides an immediate lift in the level of service and allows the forecast degradation of service to be addressed. This has a significant impact on existing customers and will attract new patronage as growth occurs and modal shift continues. The busway enhancement shows greater connectivity between the city centre and the northern growth areas and can be enhanced for a relatively moderate cost with respect to the wider programme.
Public transport improvement activities **Access – liveable cities** Enables a substantial increase in access to social and economic opportunities for large numbers of people along dedicated key corridors and enables transit-oriented development	**Very High** The development of a rail-based connection between the city centre, Takapuna, Smales Farm and ultimately Albany provides a high capacity service that will complement and supplement the busway enhancements. The new rail connection is anticipated to generate significant intensification around the North Shore metro centres and growth nodes and generate wider economic benefits and uplift. The opportunity for transit orientated developments is facilitated by the direct connection to Takapuna and Smales Farm and the proximity of these areas to the city centre.
Road improvement activities **Access – thriving regions** Addresses significant resilience gap or impediment to access on nationally important social and economic connections Makes best use of key corridors that prioritise national freight and tourism **Access – liveable cities** Addresses a significant resilience risk to continued operation of the network Makes best use of key corridors that prioritise multi-modal use and freight	**High** The roading improvements focus on increasing resilience along the vulnerable AHB SH1 Corridor and connect the wider North Shore to the Auckland economic markets. The SH1 corridor and the AHB is a nationally important corridor and improving the resilience is a key outcome for this business case. This corridor is a key national freight corridor connecting Auckland to the North and ultimately the Far North. The AHB has significant freight volumes and is nationally important freight route. The SH1 corridor is a multi-modal connection for cars, commercial and heavy vehicles. It also acts as a key route for the Northern Busway and the services that operate on it. The corridor will also soon have upgraded walking and cycling facilities between Esmonde Road, across the AHB to Westhaven. The roading enhancement is expected to provide benefits to all users once implemented. It is worth noting that the bridge widening and tunnel options have different impacts on these criteria, but both would classify as high. There will be impacts on the environment of increased CO_2 emissions.

15.2. Government Policy Statement on Transport Alignment

Table 26 displays an assessment of the AWHC programme against the GPS strategic direction. This highlights the programme is strongly aligned with the GPS priorities. Safety is considered neutral as the programme does not specifically target this strategic priority. The programme contributes strongly across the other priority areas of access and environment and it is too early in the programme to fully understand the value for money of a programme of this scale.

Table 26: GPS Strategic Direction Alignment

GPS 2018: Strategic Direction				AWH Connections Programme		
Strategic Priority	**Objective**	**Impact**	**Result**	Busway Enhancements	Rail to North Shore	SH1 Capacity and Optimisation Improvements
Safety	A land transport system that is a safe system, free of death and serious injury	The recommended programme does not actively target safety as a priority. However, the programme will embed safety as a key driver as it develops the component projects and progresses individual workstreams	Significant reductions in deaths and serious injuries - Renewing our strategic focus - State highways and local roads are safer for everyone - Cycling and walking is safer - Effective enforcement activity to promote safe behaviour by road users - Safer road use through appropriate education and promotion activities and regulatory changes	–	–	–
Access	A land transport system that provides increased access for economic and social opportunities	The programme will result in an improved public transport system which will reduce public transport journey times and increase access to economic and social activities, especially for those without access to private vehicles The programme will invest heavily in public transport and develop strong connections between jobs, housing, education and social activities. The road improvements will ensure that productivity and resilience are maintained, and journeys not catered for by public transport will be provided for The new public transport connection and road improvements will add to resilience and reliability of the cross-harbour connection	Metropolitan and high growth urban areas are better connected and accessible	✓	✓	✓
			Better access to markets, business areas, and supporting tourism	✓	✓	✓
			Sustainable economic development of regional New Zealand is supported by safer and better transport connections	✓	✓	✓
	A land transport system that enables transport choice and access		Increased mode shift from private vehicle trips to walking, cycling and public transport in our towns and cities	✓	✓	X
			More transport choice (including for people with less or limited access to transport)	✓	✓	✓
	A land transport system that is resilient		Improved network resilience for the most critical connections	✓	✓	✓
Environment	A land transport system that reduces the adverse effects on the climate, local environment and public health	The mode shift from single occupancy vehicles to public transport achieved by this programme will enable the movement of more people in fewer vehicles which will accommodate population and employment growth while mitigating the adverse impacts of the transport system. The roading options may have a negative environmental effect	Reduce transport's negative effects on the global climate	✓	✓	–
			Reduce transport's negative effects on the local environment and public health	✓	✓	
Value for money	A land transport system that delivers the right infrastructure and services to the right level at the best cost	The programme focuses on harnessing new and emerging technologies to improve efficiencies in the delivery of services and use of infrastructure. The programme will result in a shift to higher vehicle occupancy levels which will make more efficient use of the transport network and will reduce future capacity expansion requirements However, the scale of the programme is very expensive and there is significant work to do to understand the full costs and benefits	Better informed investment decision-making - Delivery of the right infrastructure and services to the right level - Investments are at the best cost	✓	–	–
			Improved returns - Improved returns from maintenance - Innovation and technology are used to increase the net benefits from land transport investment and use	✓	–	–

15.3. Investment Objectives

Table 27 displays an assessment of the AWHC programme against the benefits and KPIs. This shows that the programme contributes positively to the KPIs, benefits and Investment Objectives

Table 27: Programme Assessment Against Investment Objectives

Benefit	KPI	Contribution	Assessment of Recommended Programme
High quality growth & improved amenity	Greater density close to high frequency public transport routes (and key locations)	✓✓✓	Busway upgrade has a positive effect on promoting density around existing busway stations, the rail connection delivers new rail stations at Takapuna, Smales Farm and Albany, the road upgrade could be neutral or slightly negative depending on the option.
	Improved amenity for City Centre & Metropolitan Centres	✓✓	Public transport upgrades showed moderate to substantial decreases (1,000-1,600 car trips) in traffic entering the Auckland city centre, Takapuna and Albany in the AM peak. Modelling predicts road upgrades (particularly tunnel option) could increase AM peak car trips into city centre substantially, however this can be prevented by limiting AHB / city street capacity. Overall, by increasing public transport capacity, attractiveness, reliability and relative performance, and with ensuring private vehicle capacity into the CBD is not increased, it is likely the programme would have a positive effect on city centre and metropolitan centre amenity
	Reduced impact of transport on Auckland's environment	✓✓	The programme is forecast to reduce total VKT by between 0 and 0.5% (80,000 km), while reducing CO_2 emissions by between 0.4% and 0.5% (about 70,000 kg/day).
Improved travel choice	Increased use of public transport (during AM, IP and PM peak periods)	✓✓✓	Overall forecast is a 15-16% increase in cross harbour public transport patronage.
	Improved access to rapid transit.	✓✓✓	The programme opens new Rapid Transit rail stations at Takapuna, Smales Farm, Albany and potentially Glenfield.
	Improved capacity in the transport system to better serve travel demand	✓✓✓	The programme delivers substantial increased capacity across the harbour for all modes, approx. doubling public transport capacity in peak direction in peak hours, and increasing road capacity particularly in contra-peak direction and inter-peak period.
	Improved accessibility of key destinations & centres for people by public transport	✓✓✓	Population living within 45 min public transport journey of key destinations (City Centre, Newmarket, Takapuna, and Albany) in Interpeak is forecast to increase by about 20% with the programme
	Increased access to employment for North Shore residents. By public transport	✓✓✓	Employment accessible within 45 min public transport journey of key residential areas (Takapuna, Albany, Birkenhead, Browns Bay and Silverdale) in AM Peak is forecast to increase by about 80% with the programme
	Improved accessibility of key destinations & centres for people by private vehicle	✓	Population living within 30 min car journey of key destinations (Takapuna, Albany, Wairau and Newmarket) in Interpeak is forecast to increase by 5-7% with the programme
	Increased access to employment for North Shore residents by private vehicle	✓✓	Employment (excluding within city centre) accessible within 30 min car journey of key residential areas (Takapuna, Albany, Birkenhead, Browns Bay and Silverdale) is forecast to increase by about 10% with the programme
More productive and reliable transport and utilities	Improved recovery from incidents	✓✓	The combination of a new rail service on a separate alignment, with increased road capacity (especially contra-peak) would alleviating traffic pressure during incidents. In the event of major incidents, people could choose to transfer journeys from car (or bus) to rail, reducing recovery times.
	Reduced vulnerability to natural and human induced events	✓✓	The rail system is less exposed to coastal and inland flooding, and while they do not represent significantly reduced sensitivity to the hazards assessed compared to the do min, their adaptive capacity scored greater due to the provision of an alternative route to cross Waitematā Harbour. A new road tunnel would maximise the reduction in vulnerability
	Improved reliability of key journeys by user type & time of day	✓✓	The busway enhancement would improve reliability for public transport. The supplementary rail system would provide very high public transport reliabilities. The additional road capacity would improve travel time reliability for cars and freight especially contra-peak and inter-peak.
	Reduced risk to key utilities	✓✓✓	A new rail system (tunnel) supplementing the existing bridge could carry key utilities across the harbour. A new road tunnel or supplementary bridge structure could also be used for utilities equipment

16. FINANCIAL AND COMMERCIAL CONSIDERATIONS

The financial case looks at the preferred programme and assesses the costs, affordability and funding options.

16.1. Long-term Programme

The recommended programme involves a significant cost over the 30-year time frame horizon, much of which is not budgeted for at this stage.

As the preferred programme relies on construction of new infrastructure and the operation of public transport, it is appropriate to qualify the cash flow for the programme over its life. These costs have been developed from existing data sources for road and rail maintenance and operations, and the operation of relevant public transport modes (bus and rail). A summary of these costs is found in Table 19 which displays the whole of life costs. An operation and maintenance period of 40 years has been applied to each of the activities, but it should be noted that due to the duration of the programme the overall timeframe is actually 60 years in duration.

Table 18 and Figure 38 display the estimated capex and opex cashflows for the programme depending upon which options are taken forward. The scale of the options result in very high implementation costs followed by increased opex. The nature of the public transport based options (busway and rail) result in high vehicle and system operational costs, which will be offset partially by fare revenues. The tunnelling options (road and rail) both have significant operation costs due to the operational requirements of tunnels.

16.2. Affordability

The recommended programme is equivalent to 30-50% of the RLTP programme (ATAP Programme). Within the current NLTP and RLTP there is approximately $500million budgeted for projects related to the recommended programmes. This results in a funding gap for the entire programme of between $6.4-17.9 billion.

Table 28: Current NLTP and RLTP projects

NB: Numbers are from current RLTP and NLTP, using totals from 2019/20 onwards

Plan	Project	Funding ($ million)
RLTP	Northern Busway Enhancements	119.9
NLTP	SH1 North of Albany Improvements – incl. shoulder lane provision	292.4
	Sea Level Rise North of Harbour Bridge	33.0
	SH1 Waitematā Harbour Crossing	54.1
Total		**500**

The implementation of the long-term programme could be undertaken though a variety of models, depending on the urgency and the risks associated with the delivery, and the long-term funding and financing arrangements. This should be revisited once the future business cases are completed and there is more certainty around the scale, timing and risk of the implementation programme.

16.3. Alignment with other projects

Over the next two to three years, greater clarity on how the recommended programme aligns with other projects will be gained. This in turn will provide greater opportunity to understand the costs of future transport requirements. The current CC2M project, SGA and implementation of road pricing, are not expected to conflict with this business case's recommended programme. Synergies between the projects already exist, allowing for the amalgamation of potential funding requirements, e.g. Rapid Transit scheme north of Albany within the SGA programme. In turn, reducing the scale of potential future investment and providing possible opportunity for new regional funding mechanisms to be implemented.

16.4. Funding Arrangements

There are a number of potential funding sources for the programme depending on the scope of the component projects. The project partners are limited in their mandates as to the types of interventions and improvements they are able to fund.

- Waka Kotahi is solely responsible for the funding of state highway improvements, andcontributes funding assistance (approximately 50 per cent) to local roading projects and passenger transport through the RLTP.
- AT is responsible for the funding of strategic transport policy and planning, and implementation and operation. In partnership with Waka Kotahi, AT also provide funding for local roading projects, passenger transport services and infrastructure.
- AC is responsible for the costs associated with planning and policy, such as the development of structure plans for future urban areas and the administration of the regional growth fund.

Waka Kotahi funding is sourced from the National Land Transport Fund (NLTF) and subject to Transport Agency approval process. It is also able to access third party contributions that are directly attributable to the development and improvement of state highway assets. AT is allocated funding from AC. AC funding is primarily sourced through rates, user pays services, investments and holdings and development contributions (including the regional growth fund).

Developer contributions (DCs) are based on the level of infrastructure use attributable to growth and development areas. This is generally assessed on the forecast of proportional use by development traffic and existing users, as agreed with developers. As part of further business case processes a high-level of analysis may be required to determine what the programme of work will deliver and whether it is for growth or level of service improvements/renewals. To determine if DCs may be an appropriate funding source, the current capacity in the network needs to be identified. Then, when the programme has been delivered, the new capacity in the network is split by new development growth and changes in modal usage. Once this high-level programme has been approved for funding and a determination of individual projects for implementation are identified, each individual project that has a development growth calculation needs to go through a cost allocation methodology. To collect DCs initiatives must first be identified in the AC Long-term Plan.

Funding mechanisms such as smarter transport pricing, which ATAP have explored for demand management purposes, can be progressed through the next stages of the business case.

16.5. Alternative financing options

The Financial Case has considered these options at a high level, as potential funding options. As many of these measures require regional alignment and policy but also are very project specific in their application, as outlined in the Programme Wide Management Case, the DBC phase will consider these alternative funding sources in more detail, firstly at the programme wide level and then at the project specific level. This will provide greater clarity on the potential scale and use of alternative funding mechanisms.

The transformational nature of the programme provides a realistic opportunity to apply different and innovative sources of infrastructure funding. There are a variety of different sources to consider for the future funding of infrastructure. These include:

- Value capture
- Over-Station Development (OSD)
- Targeted rates
- Pricing
- Public private partnerships (PPPs)

This Financial Case has not considered these options in detail as they are significant interventions that require a region-based approach and alignment across a number of projects.

Value capture and OSD are potential options that have stronger merit for these growth focused projects; however, until a mechanism is developed across the region it remains a concept rather than a tangible funding option.

16.6. Delivery Approaches

The programme components can be delivered through a variety of different models. The selection of these delivery models will be selected once the risks and opportunities of each workstream are better known. Table 29 documents a variety of deliver approaches that could be used for this programme.

Table 29: Delivery Models

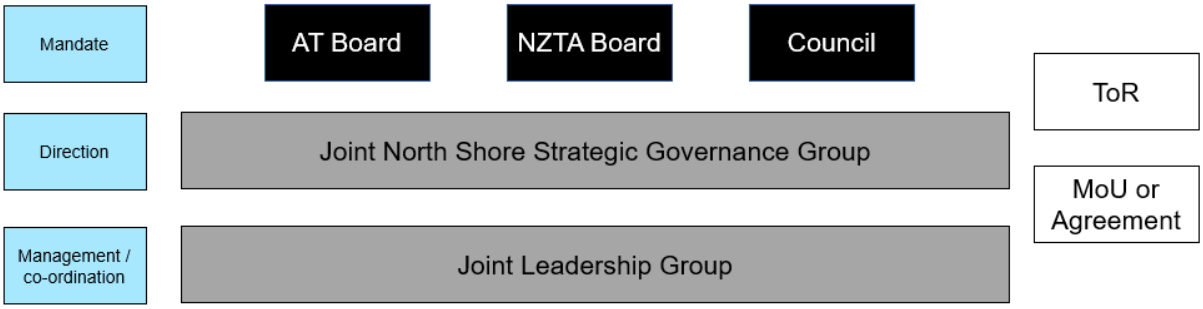
Model	Advantages	Disadvantages
Traditional	Simple contractual terms and conditions Superior client control Widely used, well understood	Adversarial relations possible Limited incentive for optimization and innovation Limited opportunity for collaboration throughout project phases
Design - Construct	Fixed sum for budgets Fosters innovation and collaboration Reduced adversarial relations Single responsibility for client Transfers risk to constructor	Challenging to administer outcome qualities Harder for client to influence scope and design post-award Higher tendering costs for market Post-award variation can be costly Relies on suppliers to manage risk effectively
PPP	'Lifetime' considered, minimising trade-offs Increases chance to advance other projects (less cost and risk for client) Superior contractual incentives for early completion Superior opportunity for innovation across all phases	Direct cost to consumers (assuming tolling) Reduced public ownership Reduces competitiveness in market long-term Risk not wholly managed by client
Alliance	Broad spectrum skills on hand Collaboration throughout project Commercial flexibility for client Greater understanding for contractor/consultant More tasks in parallel, sooner completion Team culture/innovation created	Higher project establishment costs Higher uncertainty of costs Can place large demand on senior client resources (leadership) Pressure on client staff skillsets (contribution needed) Value for money harder to quantify, subjective KPI/KPA Loss of knowledge gained throughout duration can be lost

PART C MANAGEMENT CASE

17. PROGRAMME GOVERNANCE

The recommended programme is large and complex, with many interactions and interdependencies. The successful delivery of the programme will require the continuation and evolution of the collaborative pan-agency partnership and working arrangement between AT, AC and Waka Kotahi that has been developed through this business case. This will be one of the largest and most complex programmes delivered in NZ and will require strong governance and robust capability embedded. It is proposed to continue the existing governance arrangements (with inclusion of Mana Whenua leadership), as identified in Figure 39. A vertically integrated approach is proposed to drive effective project outcomes, delivery and monitor the programme.

Figure 39: Potential governance structure for AWHC



17.1. Managing the Programme

The delivery of this programme and its component parts will need strong leadership, and collaboration though all the partners. This will be required to effectively govern the programme as a whole, but also to manage the various workstreams and interfaces with other projects and programmes. It is suggested that a dedicated partner team be established to progress the programme, procure professional services and drive the delivery.

To achieve this, consideration could be given to the establishment of a collaborative model such as an alliance to share risk, integrate decision making and develop a long-term agreement to progress the programme workstreams. A Procurement Strategy will be developed to confirm the most appropriate option once funding for the next phase is secured.

17.2. Capability

It is likely that the programme will need a wide range of skills and resources both from the client partners and provided by external suppliers. The skills to deliver programmes of this nature are limited in the NZ market and it would be expected that international support may be required. The scale of the project would likely require specialist skills in engineering, economics and finance and well as programme management and leadership. The opportunity to develop capability through the delivery of a programme such as this is significant. An initial assessment of the capability required for the next phase (programme development) indicates the following specialist needs:

- Business Case leadership
- PT Planning (network level)
- Land-use integration
- RMA Planning
- Environmental Specialists
- Geometric design (rail, heavy and light)
- Tunnelling Expertise (rail and road)
- Large project cost estimation
- Financial analysis

17.3. Recommended Next Steps

Through this work, a number of areas have been highlighted where more detailed investigations are required to confirm the exact form of the future transport system.

The mass transit DBC requires a greater level of understanding of the options for connections to either the CC2M light rail network or the heavy rail system. This information is expected to be available in 2021 and will allow option development and testing to be undertaken with more confidence. It is suggested that this DBC interfaces strongly with any rail developments in the city centre.

The SH1 investigations will be required to progress investigations of the AHB widening and cross harbour tunnel options to better understand the feasibility, risk and effectiveness of each. Work will also investigate resilience and network optimisation management and operation.

In the immediate term four key steps are proposed:

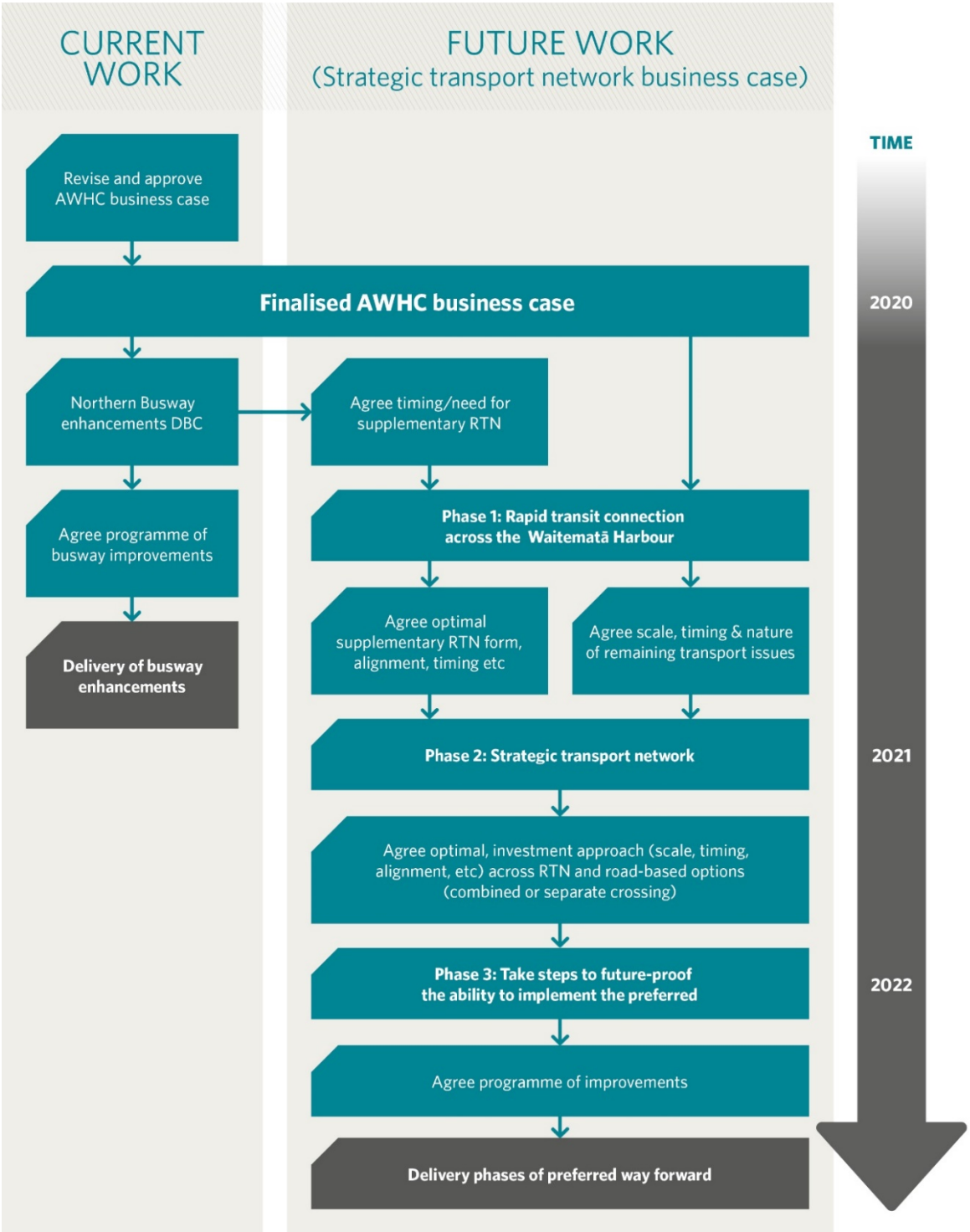
1. **DBC for Busway improvements**: This will develop the exact form of the busway enhancements for early implementation. This is urgent and has been commenced by AT.
2. **Strategic Transport Networks single-stage business case** for:
    - An additional rapid transit connection across the Waitematā Harbour (Phase 1): This phase will confirm the exact form (including mode) and alignment of the new cross harbour rapid transit connection
    - Strategic transport networks (road and rapid transit) (Phase 2): This phase confirm the wider rapid transit network on the North Shore and what additional roading network across the harbour should look like and how any new road crossing would interact with Phase 1
3. **Future proofing and route protection** (Phase 3):
    - This phase will seek to route protect the land required from Phases 1 & 2

These next steps are shown in Figure 40.

The Strategic Transport Networks single-stage business case will be procured through an as yet to be defined procurement approach (a Procurement Strategy will be developed once funding is secured). It is envisaged that this tendering will occur late 2020, however this will be dependent on a number of the interdependencies (such as CC2M rapid transit) being able to provide the required clarity for the scope.

It is intended that whilst the Strategic Transport Networks single-stage business case will be jointly managed and governed as outlined above, that Waka Kotahi will be the procuring entity for this commission.

Figure 40 : Next Steps for Programme



This is a complex programme of substantial scale. There are many interdependencies and stakeholders. It is therefore recommended that a communication and engagement strategy for the programme is developed and implemented to inform the DBC's and decision making. A full engagement campaign will be rolled out and integrated as part of the next phase of work to ensure we work with stakeholders and the community to achieve the best outcomes for Aucklanders and New Zealand as a whole.

A suggested short-term programme for these works based on key decision timeframes and construction lead in is:

Table 30: Short-term programme indicative costings

Workstream	2019/20	2020/21	2021/22	2022/23	2023/24
Busway	$2.5M	$2.5M	$4M	TBA	TBA
Rapid Transit	$2M	$5M	$5M	$2M	$2M
Roading	$1M	$1M	$4M	$2M $2M	$2M

Investigations	DBC	Consenting	Pre-implementation

The above costs are totals and the partners have agreed in principle to a cost sharing arrangement between Waka Kotahi and Auckland Transport. This agreement is for a 50/50 share for the Rapid Transit component. The Busway component is being led by AT and those costs attract Waka Kotahi FAR component. This in principle agreement is yet to be formally confirmed (AT needs to confirm funding availability). However, based on this agreement, the following costs by organisation are forecast (for the business case phase):

- Auckland Transport $8.5M
- Waka Kotahi $16.5M (including 50% FAR share)

The above costs include the Enhanced Busway. The DBC for the Enhanced Busway has been procured and is underway.

The future proofing/route protection is not included in the above estimates as the scale and complexity is very much dependent on the final form and alignment of the recommended option(s). It is therefore considered prudent from an investment decision perspective to make this decision once more information is available upon which to base this very significant decision.

17.4. Risk and Opportunity Management

High level risks and opportunities associated with the AWHC are shown in Table 31. A number of these are directly and indirectly related.

Table 31: Risks and Opportunities

No.	Risk	Opportunity
1	There has been limited engagement so far with the public - this is a significant project for the region and this could influence the project in another direction moving forward.	Engagement presents an opportunity to get public opinion into the option development and to get behind the project. Engagement with stakeholders and the community will be undertaken as part of the next planning phase to give people an opportunity to help shape the project and its future outcomes.
2	The project will impact the harbour, either on or under the harbour. The Treaty of Waitangi implications could restrict options or delay the project.	Continue engagement with Mana Whenua partners on this critical issue - this could identify areas where there is alignment and opportunities for enhancement.

3	The potential for failure of the AHB has been documented in the AHB long term management plan as a low risk. The implication of such a failure would be widely spread and hugely disruptive.	The structural risk on the AHB can be mitigated by reduced loadings and modifications to improve the structural performance of the bridge. This may include replacing the clip-ons with structures designed to accommodate the increasing load of heavy vehicles.
4	The frequency and impact of incidents on the corridor is likely to increase in the future along with growing traffic volumes. The forecast interpeak flows would reduce capacity headroom impacting the recovery time and increasing the risk of effects due to an incident lasting until the end of the PM peak period (which would likely further extend due to the incident).	The ability of the corridor to recover to normal operating conditions post incident requires capacity headroom, which would be increased through additional lanes and improved public transport options.
5	The corridor south of Akoranga currently remains vulnerable to natural events (sea level rise). With growing traffic volumes, the level of disruption caused by these events will increase.	Upgrading the SH1 corridor between Constellation and Akoranga with a new connection crossing the Waitematā Harbour will improve inter-and counter peak travel times. It also provides an alternative to the AHB that significantly reduces the disruption risk due to natural events (sea level rise) as well as impact of prolonged maintenance closures to ensure AHB remains structurally sound.
6	A bridge would introduce a significantly riskier consenting pathway (based on the current planning and legislative framework) including impact on the Coastal Marine Area (CMA), cultural, visual and environmental aspects.	While further work will confirm the exact alignment, our recommendation is a tunnel, connecting the city centre directly to Takapuna and Smales Farm due to significantly lower consenting risk and delivering a much higher quality service and its contribution to the agreed project outcomes and objectives.
7	Compatibility of a rapid transit connection with existing planned transport infrastructure (such as CC2M and CRL).	The funding shortfall for the recommendations allow for the introduction and trial of new funding mechanisms would result in greater revenues (annual and periodic) and improved levels of service.
8	The affordability of the programme of works is subject to a funding shortfall, especially for the higher end of the estimated range. Current financial models and funding sources will need to supplement through additional investment and/or alternative mechanisms in order to afford the required amounts. This risk is also subject to the selected procurement model/s and their associated risks.	Help foster desired travel behaviours that enable net improvements in the performance of transport infrastructure. This could include increased capacity of competitive modal choices and travel demand management.
9	The timing of the programme is subject to multiple factors that have yet to be determined or realised. These include patronage uptake, funding, further work completion (for AWHC and other related projects) and the impact of road pricing.	The recommendations enable authorities to implement desired development outcomes, such as Transit-Orientated Developments. Allowing broader objectives of the project to be achieve, there is the potential to create greater density and amenity within the existing urban realm.
10	Understanding of future factors, and their related assumptions, remains subject to future works and decision-making. Relied upon by the project, these dependencies are subject to change, which could influence the scope and objectives of the project. Notable assumptions include land use scenarios, impact of road pricing and future technologies/capabilities. This risk is closely related to the funding and timing risks also.	Part of the recommended works can be included as co-benefits for climate change resilience work. This providing efficiencies for Waka Kotahi to achieve desired outcomes and minimise disruption to the network in the future. Land use policy could delay the need for this significant infrastructure.
11	There is a risk of 'build out' in key locations for rail and roading options, notably Wynyard Quarter and Takapuna. Delayed protection of these sections of corridors makes the	To take steps to protect the route options to preserve the ability to deliver the rail and road corridors.

	programme vulnerable to the impact if 'build out', affecting the practicality and feasibility of future transport options.	
12	The consenting risk associated with works in the CMA for the Enhanced Busway and future long-term road and/or RTN upgrades is significant and the risk is potentially cumulative as additional stages are consented.	The Enhanced Busway DBC needs to consider the potential cumulative CMA consenting risk.
13	That outcomes do not align with previous work and understandings. The consequences of this threat could be project delays and rework.	The recommended programme has been developed with the GPS, Auckland Plan and ATAP and tested against aligned KPIs and outcomes.

17.5. Issues to be addressed in the next stages

A number of issues, risk and opportunities have been identified through the Business Case, some of which cannot be resolved at this stage. Table 32 documents some of the key items and remaining questions that will be answered through the next stages of the programme delivery.

Table 32: Items to be resolved in the next stage

Workstream	Item
Programme Wide Activities	Land use forecasts and changes Demand Management (especially road pricing) Impact of technology on travel demand and network operation Interface with other projects / programmes Implication of consultation and engagement (Engagement on the programme)
Busway Programme	Interface with City Centre Improvements Refinement of options for the improvements (station layouts, busway enhancements etc) Interface with Supporting Growth Northern Growth Area Rapid Transit Consenting challenges in the CMA and ensuring consideration of cumulative impacts on future elements of the programme (including future consenting risk)
Rapid Transit	Confirm tunnel or bridge connection Light or heavy rail confirmation Confirmation of additional route alignment, including the extent of connection (Smales Farm / Albany) Confirm land use opportunities as a result on alignment and recent National Policy Statement – Urban Development Interface with Busway and local bus services Operational impacts of connection rail-based system (limitations on frequency vehicle length etc). Interface with the required road enhancements Interface with other Auckland rapid transit corridors (like CC2M)
Roading Investigations	Impact of demand management Operational strategy to maximise benefits and minimise impacts including managed lane strategy

	Tunnel / Bridge confirmation
	Management of the AHB for heavy vehicles
	Interventions to address climate change resilience
	Interface with additional Rapid Transit route

17.6. Business Case Approval

This business case has built upon the earlier work undertaken. Through these investigations the work has confirmed the urgent need to upgrade the current busway. Critically, this work has also identified for the first time the need for an additional rapid transit route on the North Shore in the long-term. This provides important clarity for the long-term form of the North Shore transport system. The resultant opportunities and challenges of this finding requires more detailed investigations to confirm the exact form and alignment of this additional rapid transit route and its crossing of the harbour and how it best interacts with Auckland wider rapid transit network. How this new rapid transit network interfaces with the additional road intervention also needs to be carefully considered, as does the exact form and function of the additional roading provision.

This business case seeks approval of the next steps identified, specifically being:

1. Continued priority of DBC for Busway Enhancement project.
2. Commencement of Strategic Transport Networks single-stage business case for:
    - An additional rapid transit connection across the Waitematā Harbour (Phase 1): This phase will confirm the exact form (including mode) and alignment of the new cross harbour rapid transit connection.
    - Strategic transport networks (road and rapid transit) (Phase 2): This phase confirm the wider rapid transit network on the North Shore and what additional roading network across the harbour should look like and how any new road crossing would interact with Phase 1.
3. Development and implementation of programme specific Communications and Engagement Strategy.