North Shore Rapid Transit Programme Business Case

Aurecon NZ Ltd for Auckland Transport

[March 2018]

VERSION 17

Programme Business Case

More information

NZ Transport Agency
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APPROVAL

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11	11 September 2017	Final Draft for Review
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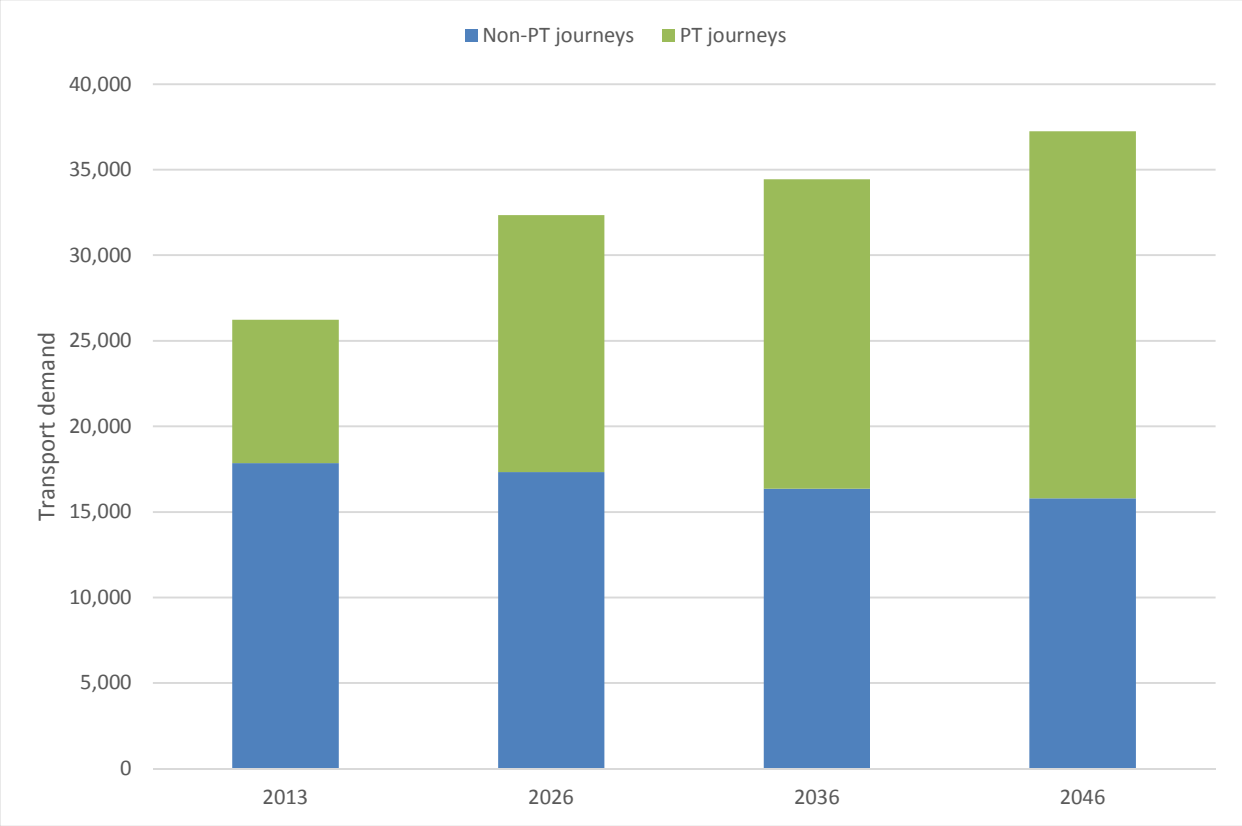
EXECUTIVE SUMMARY

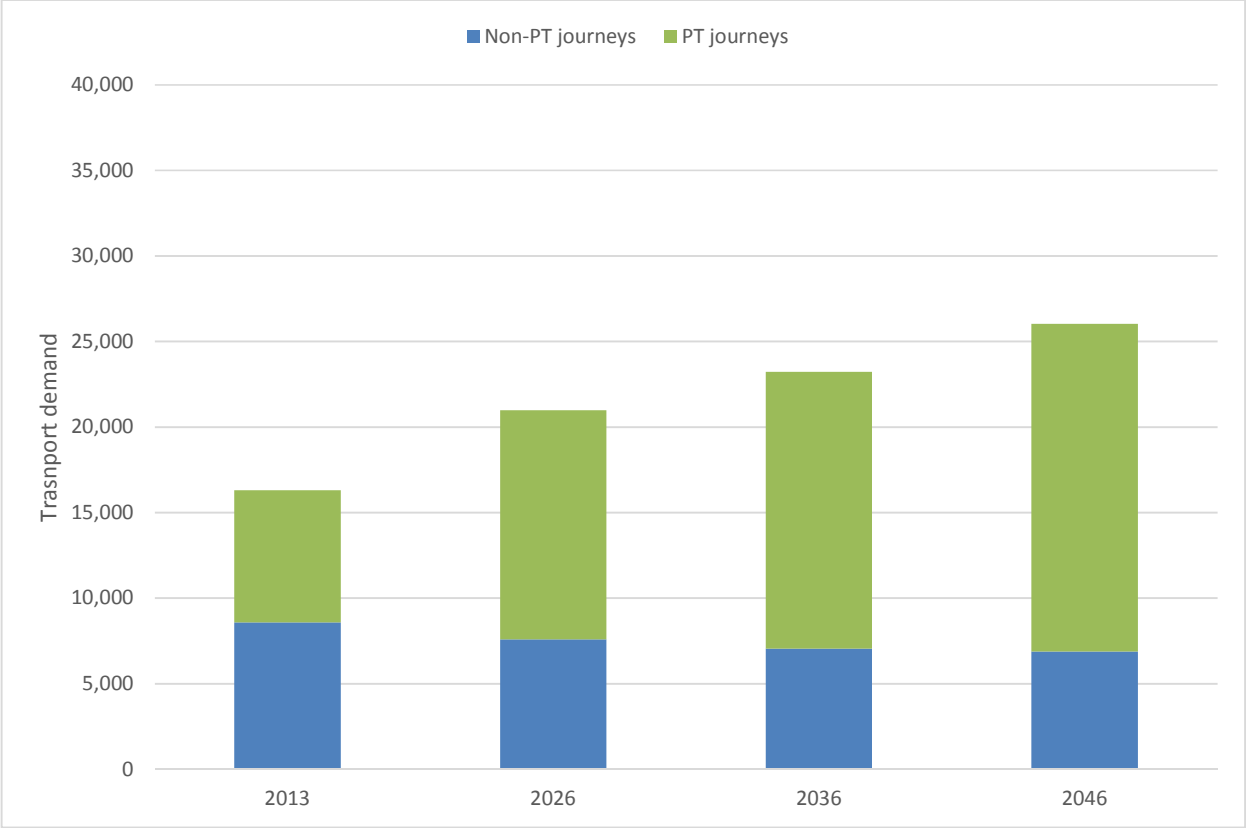
Auckland Transport is responsible for the planning of the region's public transport network and has been assessing current and future changes in the North Shore area, in particular the role of the rapid transit (RTN) network.

Growth in demands from the North Shore and Northern Auckland

The North Shore and northern Auckland is expected to grow significantly in the next 30 years through both greenfield growth and further development within the existing urban areas. This growth in the North Shore and northern Auckland is expected to generate significant growth in demand for travel across the Waitemata Harbour. Due to capacity constraints in the road network and the high proportion of cross-harbour trips that terminate in the City Centre, which lacks parking and is expected to have limited, if any additional road capacity, public transport has, and is expected to continue to take nearly all of the forecast growth in travel demand.



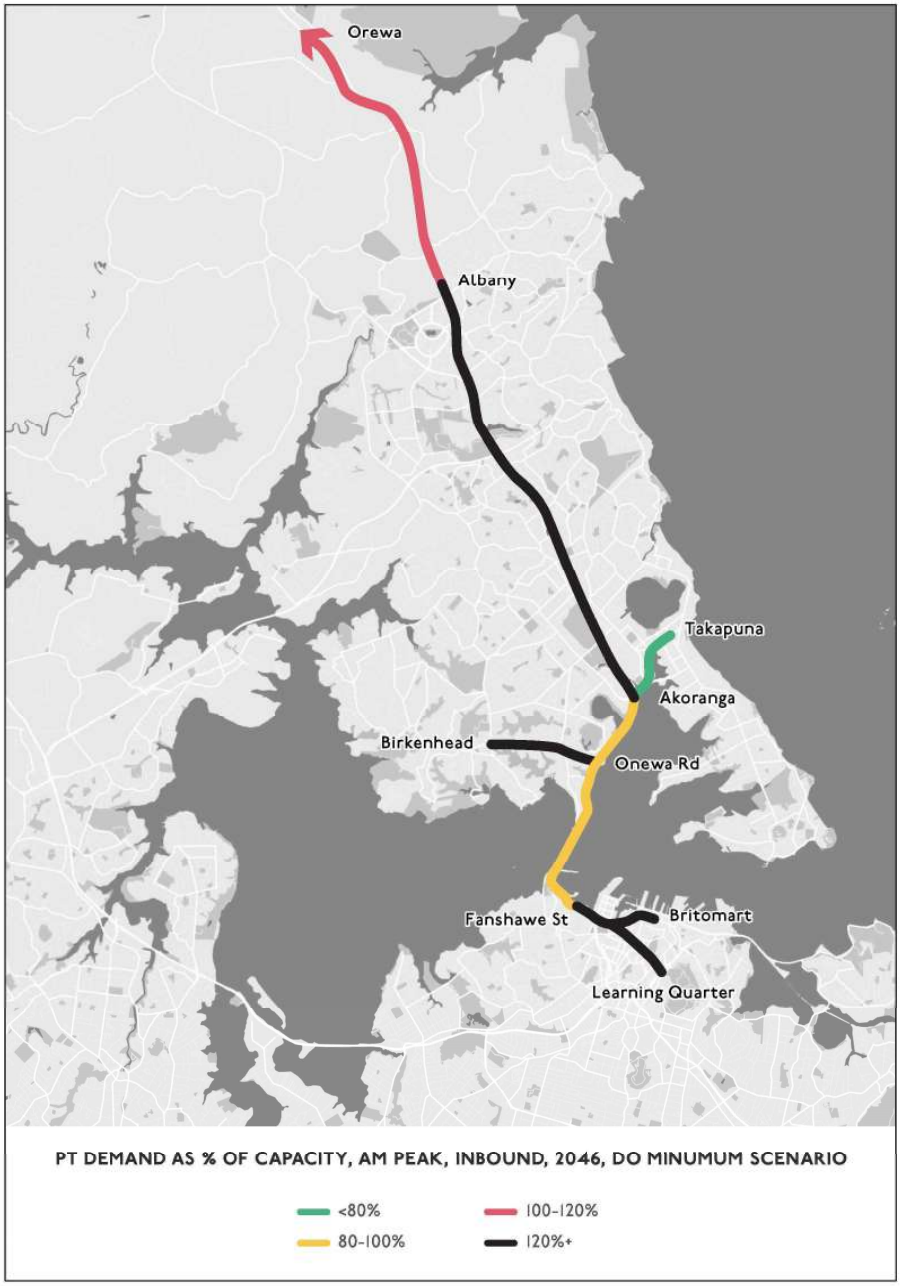
Forecast AM peak travel across the Auckland Harbour Bridge from the North Shore to all areas *(source: ART model, i11, ATAP Common Elements network: excludes Additional Waitemata Harbour Crossing)*



Forecast AM peak travel across the Auckland Harbour Bridge from the North Shore to the City Centre and fringe *(source: ART model, ATAP Common Elements network: excludes Additional Waitemata Harbour Crossing)*

Adding more bus capacity alone to service this growth in demand is expected to exceed the capacity of the Northern Busway over time and lead to a degradation in performance. This is likely to adversely affect the economic performance of the City Centre and the Auckland region, and lead to poor outcomes for customers.

There are a number of different catchments and trip types which collectively makes up the RTN passenger demands, and each can be considered separately and collectively for the planning of the future RTN system. For example, the Onewa Rd catchment appears likely to be best operated as a bus-based system into the future, regardless of other changes to the RTN network.



Auckland Transport Alignment Project (ATAP)

The Auckland Transport Alignment Project (ATAP) is a joint project including Auckland Transport, Auckland Council, the NZ Transport Agency, Ministry of Transport, the Treasury and the State Services Commission. ATAP recognises that Auckland has transport funding shortfalls and investigates delivery mechanisms.

The North Shore RTN business case analysis follows the guidance of the ATAP process, which highlighted that the Auckland Harbour Bridge has limits on its ability to cater for heavy traffic growth, and that the very high opportunity costs of a new harbour crossing require significant consideration before investment.
ATAP recommended that route protection for a new crossing progresses in a way that integrates road and public transport requirements. Auckland Transport is working with NZTA to develop the best governance and projects structure to achieve this.

Problem definition
Based on assessment of this evidence, the project partners defined the problem for consideration in this Programme Business Case in the following way:

Problem:
Inability to effectively meet projected public transport demand to, from and within the North Shore will constrain Auckland's economic performance and inhibit planned urban growth.

Benefits of investing:

The potential benefits of successfully addressing this problem through appropriate investments, were identified as follows, through an ILM process:

Benefit 1: Planned residential and employment growth in Auckland is enabled.

Benefit 2: Auckland's economic performance is improved by increasing labour market accessibility.

Benefit 3: There is a high degree of certainty that road, active mode and public transport outcomes are achieved.

These benefits are used as the basis for developing investment objectives used for assessing options and alternatives.

Investment objectives

1. The RTN network has the capacity to meet forecast demands to, from and within the North Shore.
2. The RTN network operates to a level of service that supports planned growth and encourages mode shift to public transport.
3. The RTN network improves the resilience of the passenger transport system across the Waitemata Crossing to both major and minor disruptive events.
4. Public transport access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.

Recommended Programme
Following a two-stage options assessment that considered demand management, productivity and supply-based approaches, followed by a more detailed assessment of the most effective strategies, the Recommended Programme consists of a staged investment approach that aligns with growth in demand. The first stage is increasing the capacity and performance of the Northern Busway, whilst second is to implement a new, higher capacity RTN mode to meet growing demand.

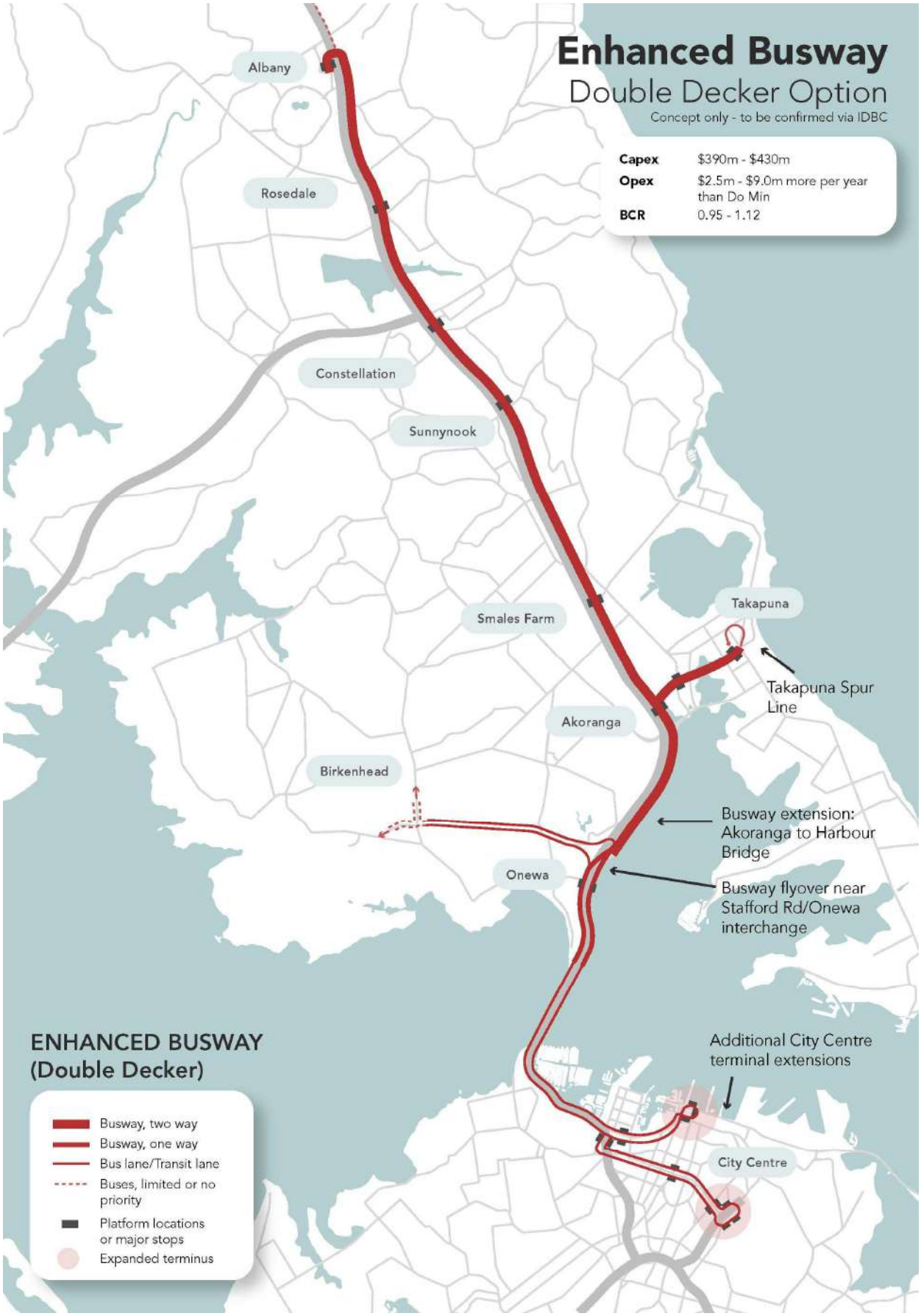
Enhancements to the existing busway
Whilst there is ongoing analysis and numerous scenarios for longer term planning, all options firstly require enhancements to the existing busway. Without this, the problem worsens and expensive interventions are required earlier.

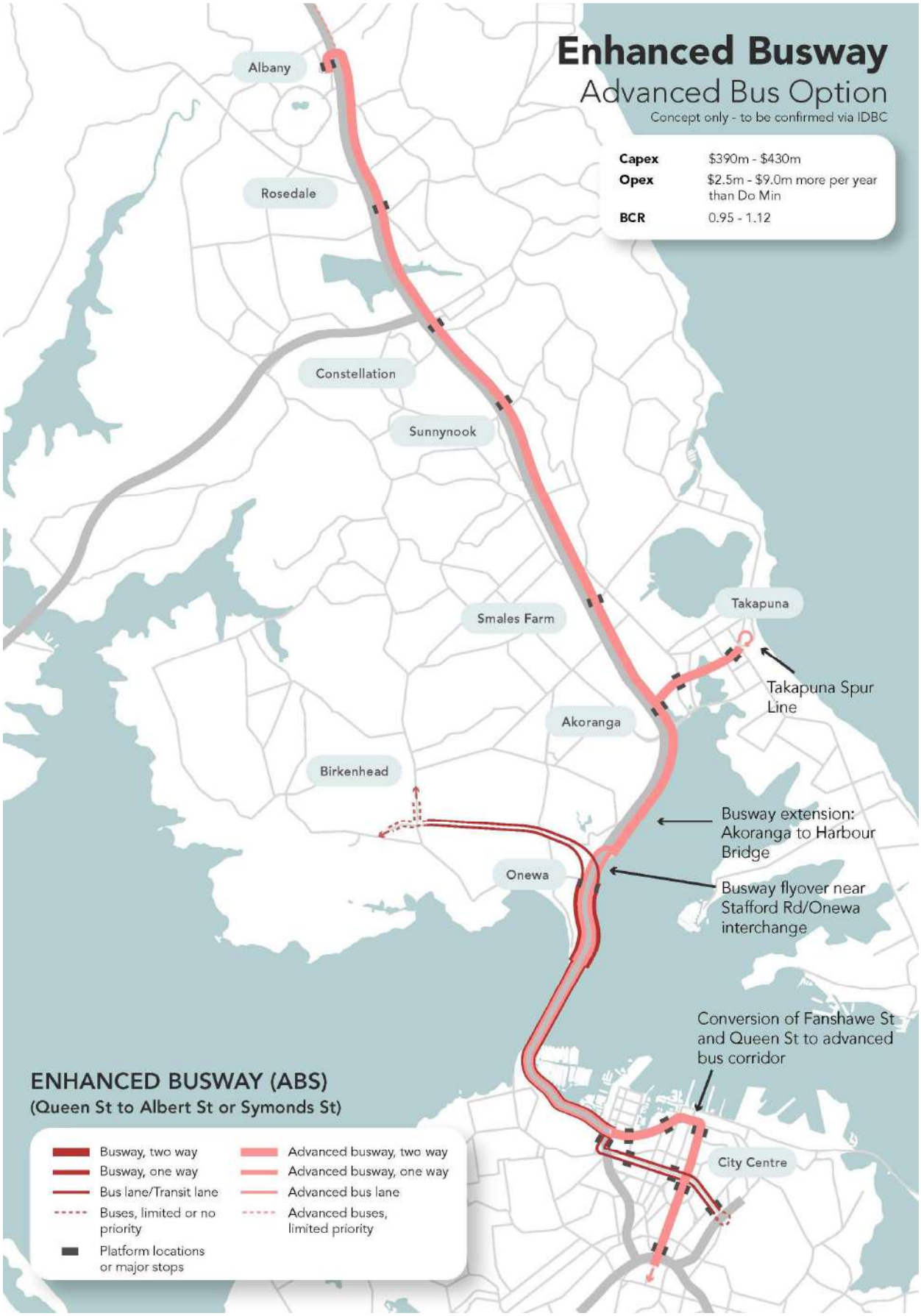
This stage would require increased provision of and priority for double decker buses or alternatively advanced buses (being an alternative, higher capacity bus-based system) operating on the existing busway with physical enhancements. This operation would use the existing Auckland Harbour Bridge. This is expected to provide adequate capacity and performance until the mid 2030s based on current forecasts. Such improvements will also be considered in relation to equivalent RTN investigations elsewhere in the region, to ensure consistency and (if relevant) integration.

Customer-serving outcomes of a capacity and quality of LRT could be achieved by other emerging bus-based technologies (as illustrated in the image below of a prototype in China), beyond those previously envisaged by

the Advanced Bus study, with significantly lower investment. These should be investigated further in future business case phases.

Concepts for this are shown below, however the detailed development of such improvements will be completed through an IDBC process, to fully identify the phasing, costs, benefits and longevity of this enhancement.


Enhanced Busway
Double Decker Option
Concept only - to be confirmed via IDBC
Capex $390m - $430m
Opex $2.5m - $9.0m more per year than Do Min
BCR 0.95 - 1.12
Albany
Rosedale
Constellation
Sunnynook
Smales Farm
Takapuna
Takapuna Spur Line
Akoranga
Birkenhead
Busway extension: Akoranga to Harbour Bridge
Onewa
Busway flyover near Stafford Rd/Onewa interchange
Additional City Centre terminal extensions
City Centre
ENHANCED BUSWAY
(Double Decker)
Busway, two way
Busway, one way
Bus lane/Transit lane
Buses, limited or no priority
Platform locations or major stops
Expanded terminus


Enhanced Busway
Advanced Bus Option
Concept only - to be confirmed via IDBC
Capex $390m - $430m
Opex $2.5m - $9.0m more per year than Do Min
BCR 0.95 - 1.12
Albany
Rosedale
Constellation
Sunnynook
Smales Farm
Takapuna
Takapuna Spur Line
Akoranga
Birkenhead
Busway extension: Akoranga to Harbour Bridge
Onewa
Busway flyover near Stafford Rd/Onewa interchange
Conversion of Fanshawe St and Queen St to advanced bus corridor
City Centre
ENHANCED BUSWAY (ABS)
(Queen St to Albert St or Symonds St)
Busway, two way
Busway, one way
Bus lane/Transit lane
Buses, limited or no priority
Platform locations or major stops
Advanced busway, two way
Advanced busway, one way
Advanced bus lane
Advanced buses, limited priority

Light rail (LRT)

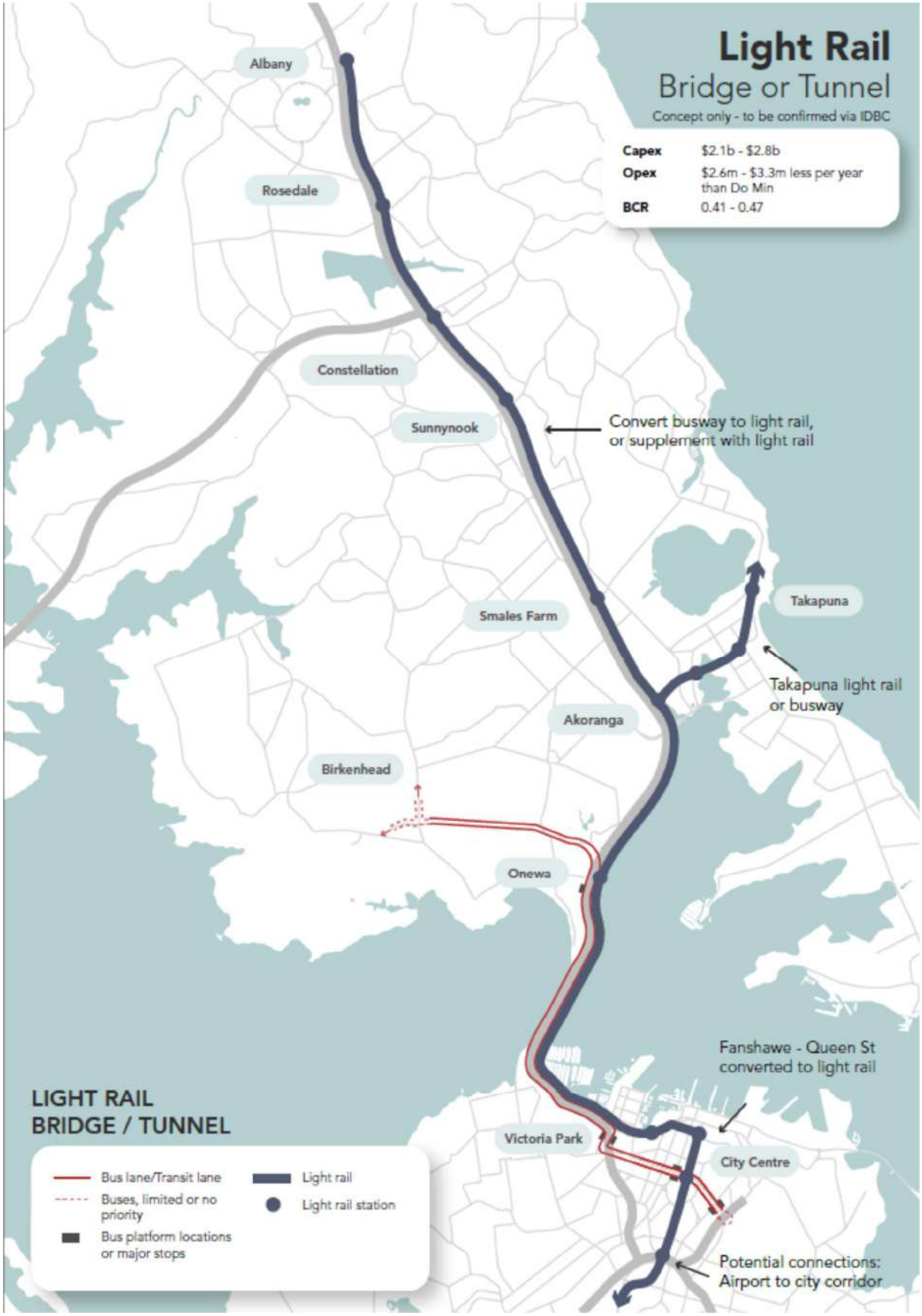
Once the enhanced busway has reached its newly increased capacity and operational performance, a higher capacity RTN mode becomes necessary. This has initially been assumed to be LRT on its own alignment across the Waitemata Harbour.

Introducing light rail on its own crossing of the Waitemata Harbour and conversion of the busway to accommodate light rail is likely to be required by the mid 2030s.

Depending on the network configuration and integration with remaining bus services, this is expected to provide adequate capacity and performance until and beyond the current forecast period in the mid-2040s.

Such a modal transition will also be considered in relation to equivalent LRT investigations elsewhere in the region, to ensure consistency and, if relevant, integration with other regional corridors.

The development of the optimal light rail configuration, including harbour crossing form, timing and integration with other LRT lines should be undertaken via a I/BDC process in parallel with the busway enhancement work.


Light Rail
Bridge or Tunnel
Concept only - to be confirmed via IDBC
Capex $2.1b - $2.8b
Opex $2.6m - $3.3m less per year than Do Min
BCR 0.41 - 0.47
Albany
Rosedale
Constellation
Sunnynook
Convert busway to light rail, or supplement with light rail
Takapuna
Smales Farm
Takapuna light rail or busway
Akoranga
Birkenhead
Onewa
Fanshawe - Queen St converted to light rail
LIGHT RAIL
BRIDGE / TUNNEL
Victoria Park
City Centre
Bus lane/Transit lane
Buses, limited or no priority
Bus platform locations or major stops
Light rail
Light rail station
Potential connections: Airport to city corridor

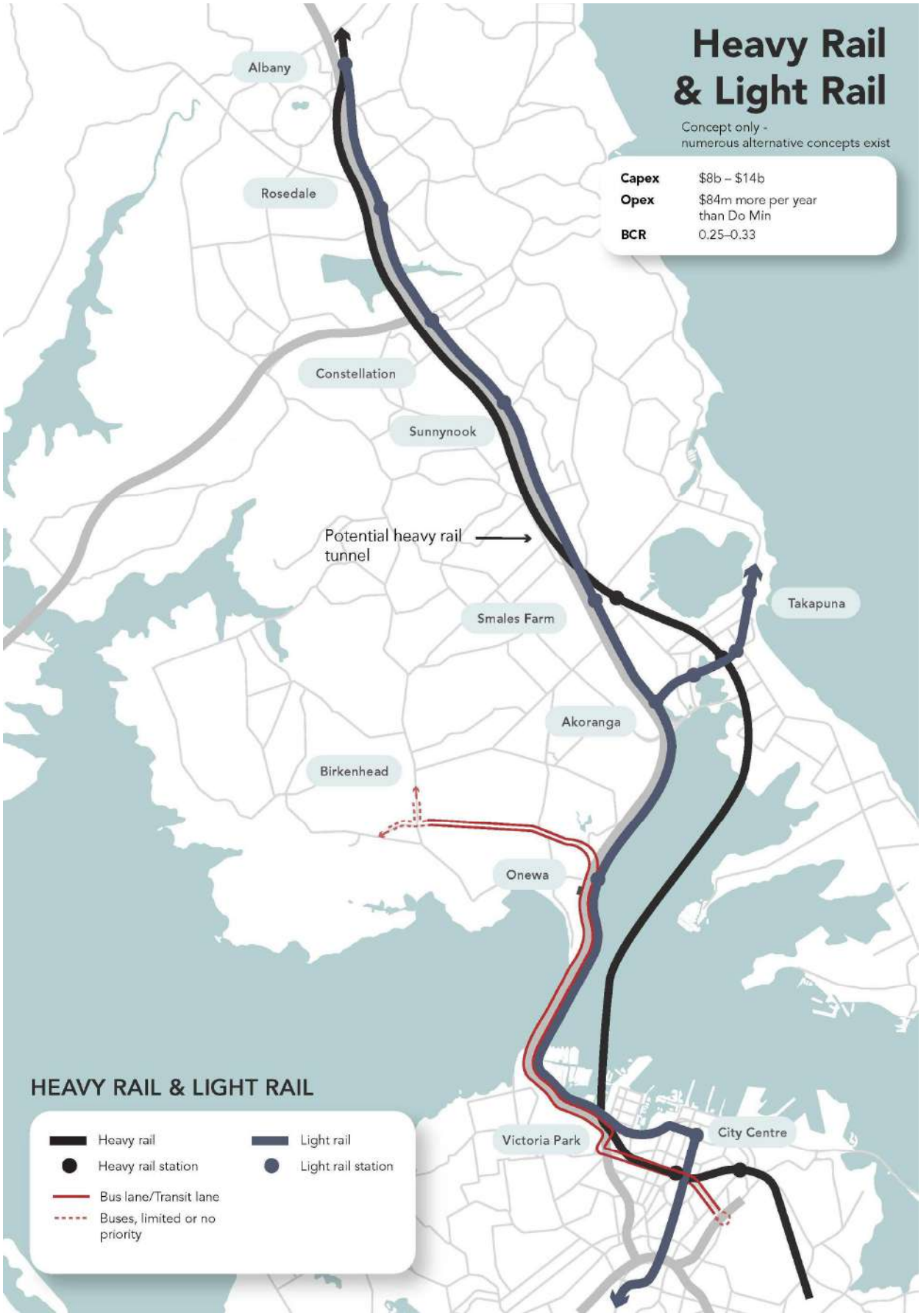
Potential heavy rail

This programme business case takes a ”long-term view” of potential demand and capacity. Despite the combination of enhanced bus operations and LRT provision (depending on the configuration), ongoing growth may still require further RTN capacity in the longer term, especially for long-distance travellers resident in regional growth areas in the north. Current LRT capacity assessments appear to show capacity being reached at the end of the current planning horizon.

Therefore, heavy rail should be considered a viable long-term option and various alignments and configurations should be contemplated when developing preceding RTN solutions.

Given that NZTA is investigating provision of heavy rail in an additional harbour crossing and desirability of integrating planning for all mode outcomes, the Recommended Programme includes preserving the long-term ability to implement heavy rail to the North Shore. While not required during the current forecast horizon (2046), in the long term, land use decisions may require additional capacity and the option should be preserved. This could augment the earlier light rail programme.

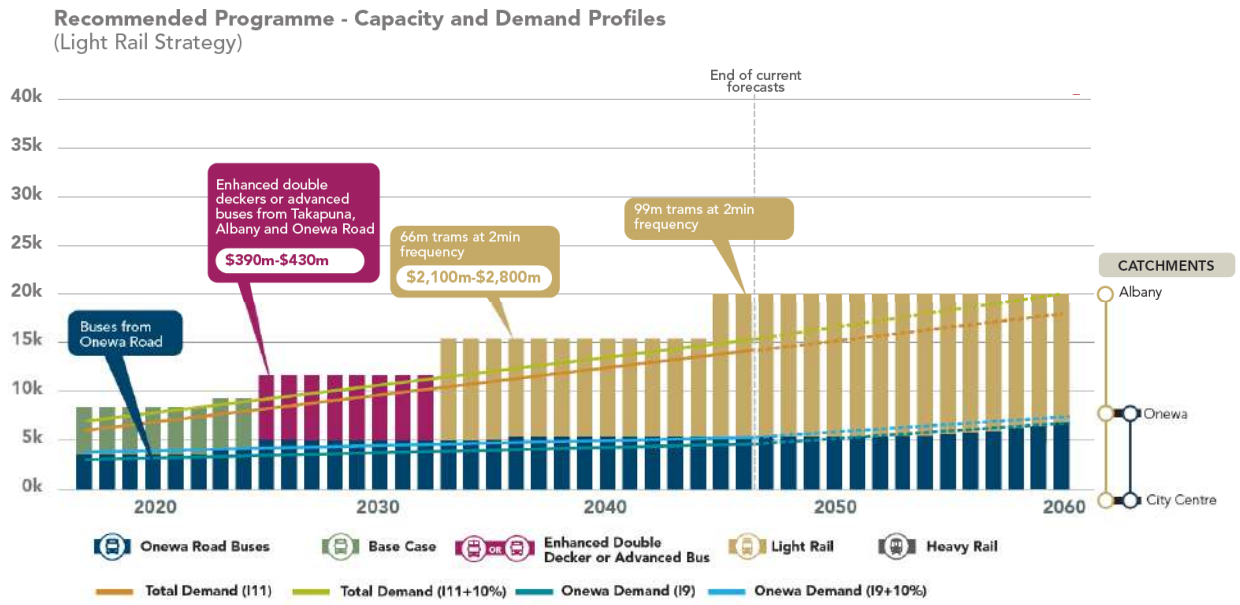
The potential role of heavy rail, including the potential benefits of earlier or later delivery, should be included in the LRT I/DBC process as part of a holistic system optimisation assessment.


Heavy Rail & Light Rail
Concept only - numerous alternative concepts exist
Capex $8b – $14b
Opex $84m more per year than Do Min
BCR 0.25–0.33
Albany
Rosedale
Constellation
Sunnynook
Potential heavy rail tunnel
Smales Farm
Takapuna
Akoranga
Birkenhead
Onewa
Victoria Park
City Centre
HEAVY RAIL & LIGHT RAIL
Heavy rail
Heavy rail station
Bus lane/Transit lane
Buses, limited or no priority
Light rail
Light rail station

Staging and timing

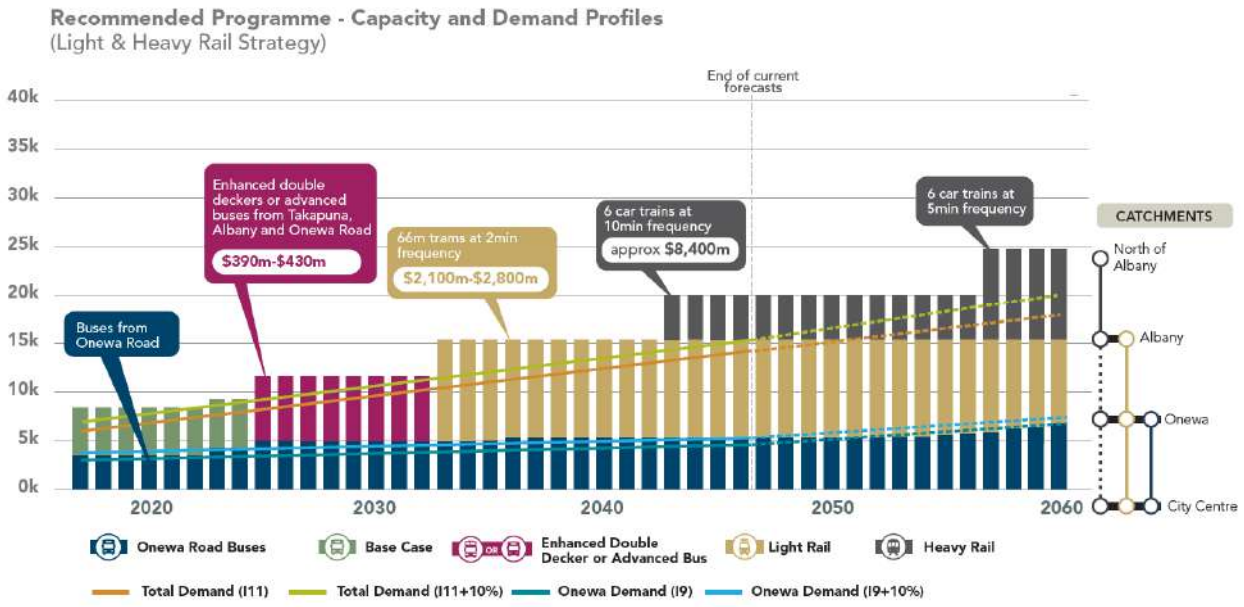
The recommended IBC process will assess a range of intervention issues, one of which is staging. Trigger points for staging are generally driven by increasing passenger volumes and their impacts on the capacity and performance of the rapid transit connection. Provision of LRT to supplement bus services, on its own alignment across the harbour, would likely be required in the mid-2030s based on current forecasts. Onewa Road and the Glenfield-Birkenhead catchment would continue to be served by buses directly to the City Centre, while Takapuna could have a light rail connection via Akoranga. These assumptions will be reviewed through the I/DBC process.

One way of approaching the growth in passenger demands - as a programme of successive busway and LRT improvements - is shown below: (noting no change in customer volumes from additional capacity improvements, when the reality is that the implementation of LRT is expected to result in an increase in patronage).



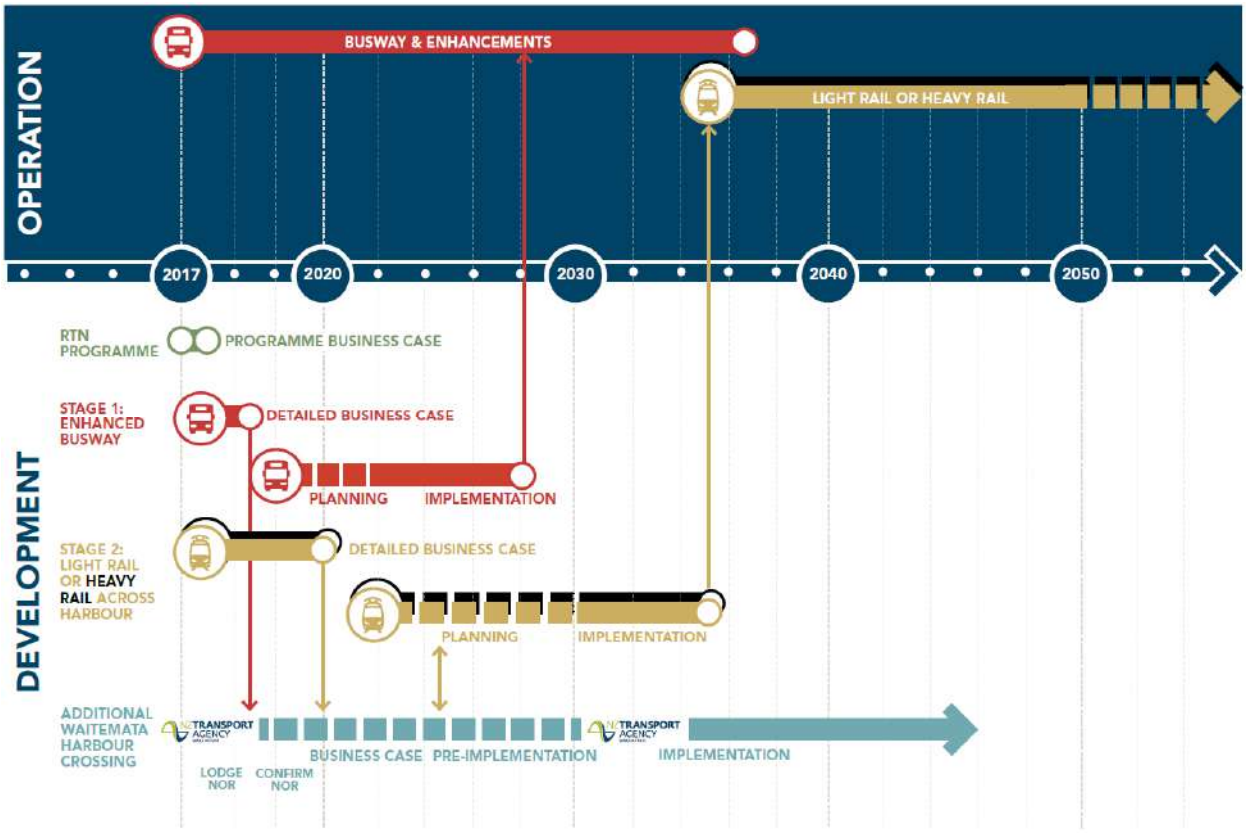
The overall patronage demands appear to indicate the need for higher capacity LRT vehicles, additional heavy rail or some other additional RTN capacity in the longer term (or increasingly early if accelerated growth continues). In terms of catchments and future demands, it is important to recognise the relationship with mass rapid transit in the Isthmus which may influence demands and service patterns

At, or toward the end of the current forecast period, a decision is likely to be required as to whether longer light rail vehicles are implemented (above), or a heavy rail connection is added (below) to service any additional urban growth beyond that currently envisaged. The approach will be affected by the respective growth of each North Shore catchment and the relative merits and combinations of RTN modes and configurations. The connections to the existing heavy rail network is also a consideration. These issues should be examined in more detail in the I/DBC process.



Implementation

Given the potential lead-times to implement major infrastructural elements of the enhanced busway, it is recommended that an indicative/detailed business case is commenced in 2018 following approval of this programme business case. This workstream should investigate, as soon as possible, the improvements and options in the first stage of the Recommended Programme, including comparing an enhanced double decker bus operation with an advanced bus operation or the timing of a migration between the two. This indicative/detailed business case should also include improved productivity measures such as station operations, ticketing and connected journey enhancements as well as physical capacity and reliability improvements.



The I/DBC process should in parallel assess the optimal network configuration and timing of a LRT system, also considering a potential heavy rail system in the longer term. The output of the I/DBC process could be a delivery programme for busway improvements as well as a recommended network and timing for a future North Shore LRT system.

PART A – THE STRATEGIC CASE

1 PROGRAMME CONTEXT

This chapter outlines the geographic, economic, social, environmental and transport context to the PBC.

1.1 GEOGRAPHIC AND ENVIRONMENTAL CONTEXT

The focus for this PBC is the rapid transit connection to the North Shore and in particular the connection between the North Shore and the Isthmus. However, the area of influence for the North Shore RTN programme is large and connects with regional-scale multi-modal transport networks (bus, rail, state highway and local road networks). The regional RTN, of which North Shore RTN is part, will be strategically influential in shaping urban development patterns.

The northern boundary for the project includes consideration of the northern reaches of the Auckland region, focussing on the need to service areas of urban growth, notably around Warkworth, Wainui, Dairy Flat and Silverdale. Further, intensification is expected within the urban limits. The southern reaches of the project are connections with regional RTN networks, including rail and bus in the city centre. State Highway 1 is a key consideration as it is the route of the current North Shore RTN (Busway). Other considerations include access from the west via SH18 and any future SH18 RTN alignment.

The programme business case established a study area, as illustrated in Figure 1. The study area is defined with reference to planned urban growth areas and associated transport implications. The study area includes all of the former North Shore City area and the existing Future Urban Zones to the north including Dairy Flat, Silverdale and Whangaparoa. Figure 2 shows the state highways and existing North Shore RTN. The maps illustrate the resulting influence of the extensive coastline, hilly terrain and harbour inlets on the road transport infrastructure being concentrated on ridgelines and on a limited number of harbour crossings.

The North Shore RTN programme will need to consider environmental impacts, likely to be most significant in coastal areas, particularly on the Waitematā Harbour foreshore where potential new harbour crossings may impact on landscape and ecological values. Elements of the programme are likely to be predominantly within

urbanised areas, ranging from suburban residential areas in the North Shore to the densely built city centre. The programme may also influence a rural area between Albany and Silverdale.

Figure 1: North Shore RTN Programme Study Area (pink) and key links to other urbanised area (green)

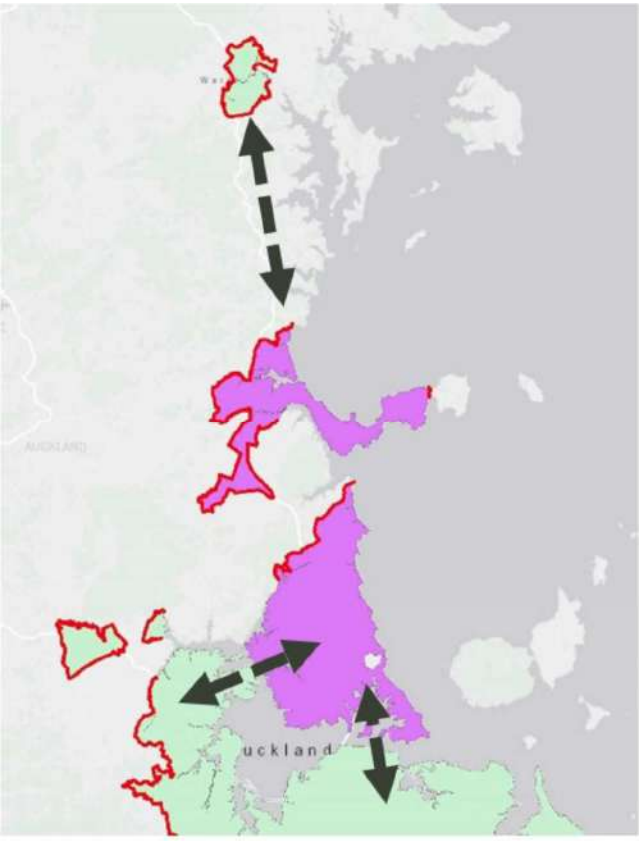


Figure 2: Current North Shore road transport network and Northern Busway

1.2 SOCIAL CONTEXT

The North Shore RTN programme is likely to be of a scale that is regionally and nationally significant, with its scope including regional-scale public transport connections. The predominant areas of influence, however, will be for North Shore and Auckland City Centre residents and businesses.

The North Shore study area is home to approximately 265,000 people, 20% of the Auckland region's total population (Census, 2013). Its resident population scores well on various social indicators, relative to the rest of Auckland and the rest of New Zealand. Figure 3 maps the levels of social deprivation across the Auckland region and illustrates that areas within the North Shore are among the least deprived in New Zealand, particularly in the Northern and coastal areas. There are, however, some areas of higher deprivation in Northcote, and medium deprivation in Beach Haven and parts of the Whangaparaoa Peninsula. The deprivation index combines various statistical indicators on resident's health, income, well-being and access to opportunities.

Figure 3: Deprivation index, Auckland region, 2013 (Source: NZ Herald visualisation of Ministry of Health data)

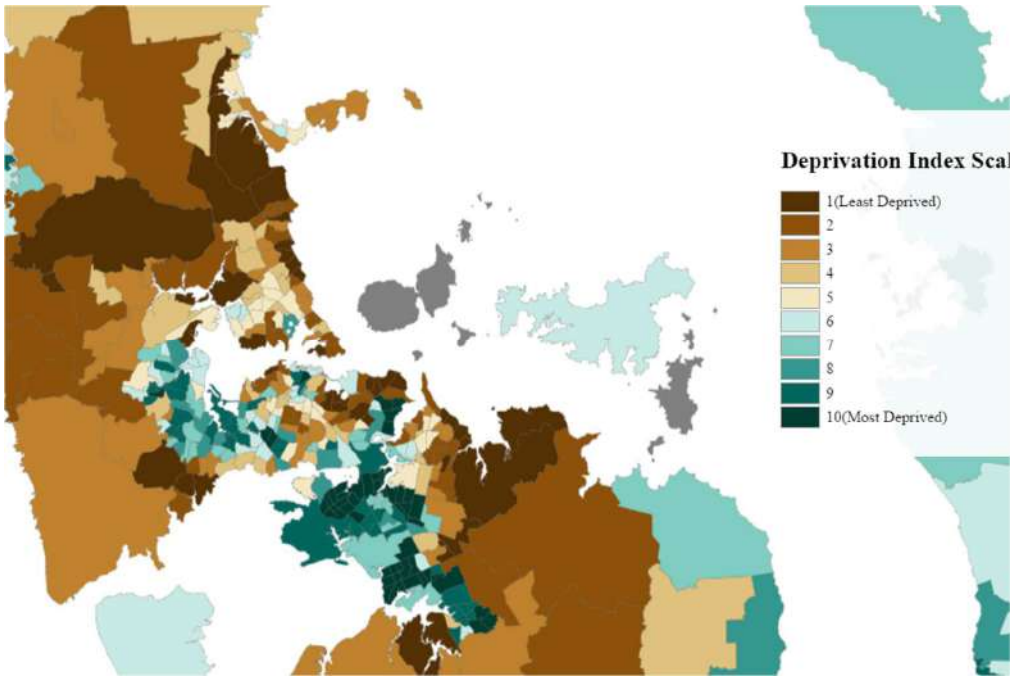


Table 1 summarises selected statistics from Census 2013 that describe key social characteristics of the North Shore population. For the four main local board areas relevant to the study area, the population in general has higher incomes, is slightly older and has a higher than average percentage of university qualifications than the Auckland or New Zealand averages. These social characteristics may have implications for transport demands within the area, with relatively well-paid and well-educated working age populations suggesting high transport demands, while older population groups in some parts of the study area will potentially require lower transport demands.

Median personal income for all local board areas is higher than both the Auckland and New Zealand wide figures. Median personal income varies across the study area, with substantially higher incomes in the Devonport-Takapuna area. The median age is higher in all local board areas than in Auckland in general, but lower than across all New Zealand in all but the Hibiscus and Bays area. The Hibiscus and Bays area has a noticeably older population.

The proportion of the population with university qualifications is highest in the Devonport-Takapuna Local Board area, being 50% higher than the New Zealand average. In all areas, except the Hibiscus and Bays local board

This income and social dynamic has an effect on the problems identified in this PBC in that the North Shore has a high proportion of journey to work trips to the City Centre, which has high numbers of professional, financial, scientific and telecommunications jobs. The majority of peak-period trips originating from the North Shore to destinations outside the North Shore end in the City Centre. This is discussed further in Section 4.4.2 that outlines evidence underpinning the problem statements.

Table 1: Selected social indicators, North Shore Local Board Areas, Census 2013.

Geographic Area	Total usually resident population	% of population with university qualifications	Median personal income	Median age
Hibiscus and Bays Local Board Area	89,829	20%	$ 31,700	42.4
Upper Harbour Local Board Area	53,670	24%	$ 31,100	36.2
Kaipātiki Local Board Area	82,494	25%	$ 31,900	35.2
Devonport-Takapuna Local Board Area	55,470	30%	$ 35,300	39.7
Auckland	**1,415,550**	**22%**	**$ 29,600**	**35.1**
New Zealand	**4,242,048**	**20%**	**$ 28,500**	**38**

1.3 ECONOMIC CONTEXT

The North Shore RTN programme will affect transport provision and levels of accessibility for economic activity across the Auckland region. However, it will have most direct influence on transport provision for City Centre and North-Shore economic activity.

In particular, the programme has the potential to address forecast passenger transport capacity constraints between the North Shore and City Centre, including over the Waitematā Harbour Crossing. Forecast employment growth in the City Centre and residential and employment growth in the North Shore will increase passenger transport demand to a level that exceeds the functional capacity of the existing road and public transport infrastructure. Excessive transport demands on these economically important access routes to the city centre will likely increase congestion and constrain planned growth on the North Shore and employment growth in the City Centre. Constraints to this growth risk diminishing potential agglomeration-related productivity benefits associated with central city employment, while also pushing planned North Shore growth to other locations.

The North Shore is the location for around 100,000 jobs, 16% of Auckland's total. The City Centre is the location for an additional 97,000 jobs, or another 16% of Auckland's total (67,000 of these jobs in the City Centre Core). In total, the North Shore RTN programme will impact a corridor with approximately 200,000 jobs, or a third of Auckland's total jobs.

The predominant industries active in the study area include service-sector, professional, retail, hospitality, education and government services in the City Centre and a mix of service-sector and light industrial activity in

the North Shore. Within the North Shore, employment is clustered around the SH1 Corridor at Rosedale (25,000 jobs in a predominantly light industrial area), Takapuna/ Smales Farm (20,000 jobs in a predominantly service-sector business area), Wairau Valley (8,000 jobs) and Albany (6,000 jobs).

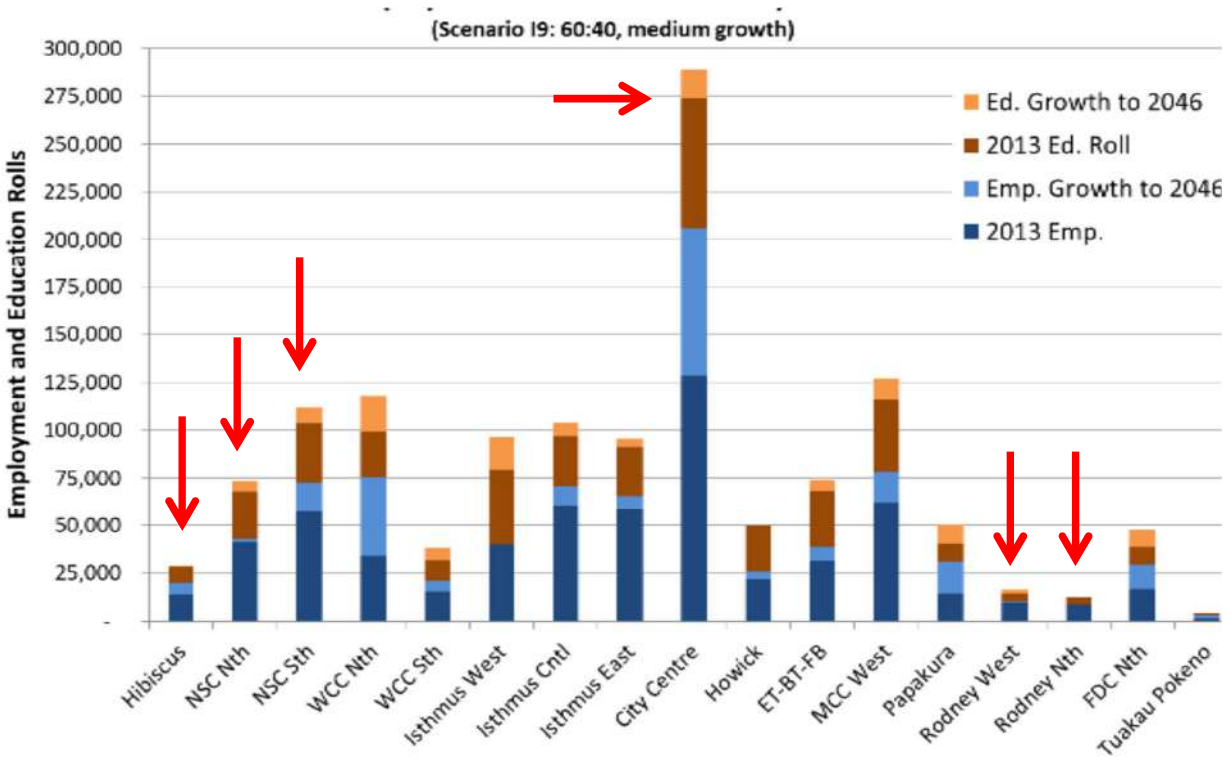
Between 2001 and 2013, the highest growth in number of jobs occurred within the City Centre (+25,000 jobs) and at Rosedale (+13,000 jobs). Growth rates were also high in Albany (+4,000 jobs) and Silverdale (+2,000 jobs). Takapuna and Wairau Valley saw a decline in job numbers during the period.

Table 2: Job numbers in areas relevant to the programme, 2001 and 2013.

Location	2001	2013	% Change 2001-2013	% of Auckland total (2013)
Total North Shore study area	**73,445**	**100,435**	**37%**	**16%**
Takapuna	9,040	7,950	-12%	1%
Smales Farm	7,700	12,040	56%	2%
Albany	1,940	6,320	226%	1%
Rosedale	12,030	24,890	107%	4%
Wairau Valley	9,130	7,720	-15%	1%
Silverdale	1,855	3,890	110%	1%
City Centre Core	49,059	66,933	36%	11%
City Centre Total (incl. Ponsonby, Newmarket)	**71,937**	**96,591**	**34%**	**16%**
Total Auckland Region	**499,940**	**620,010**	**24%**	**100%**

Forecasts indicate a potential growth of +70 000 jobs by 2046, most substantially in the City Centre and to a smaller extend for the Southern part of the North Shore. Figure 4 illustrates forecasts growth for both employment and education rolls. It highlights that the increase of economic and educational activity to be particularly high in the City Centre, which will influence travel demands to and from the centre.

Figure 4: Forecast employment and education roll growth, Auckland sub-regions, 2013-2046



1.4 TRANSPORT CONTEXT: CURRENT CONDITIONS

Private vehicle use currently dominates the passenger transport requirements within the study area. Road-based transport also provides the bulk of freight transport needs. The public passenger transport system consists of an extensive bus system with coverage across the urbanised area and ferry services to the City Centre from terminals at Devonport, Bayswater, Northcote Point, Birkenhead, Beach Haven and Gulf Harbour on the Whangaparoa Peninsula.

Public transport patronage has grown strongly in recent years, notably following the introduction of the Northern Busway. Table 3 summarises patronage data for rapid transit buses operating on the Northern Busway (NEX, and 881 from 2015/16) and other public transport services across Auckland. Patronage on the trunk busway services has grown fivefold from just under 1 million trips in 2007/08, to close to 5 million trips per year in 2016/17. Annual average growth rates on the Northern Busway rapid transit services have been 21% during the period, outpacing the 14% average annual growth rate on the total Auckland Rapid Transit Network (RTN).

Table 3: Annual public transport patronage in Auckland 2007/08 -2014/15 (Source: AT/ARTA monthly patronage reports)

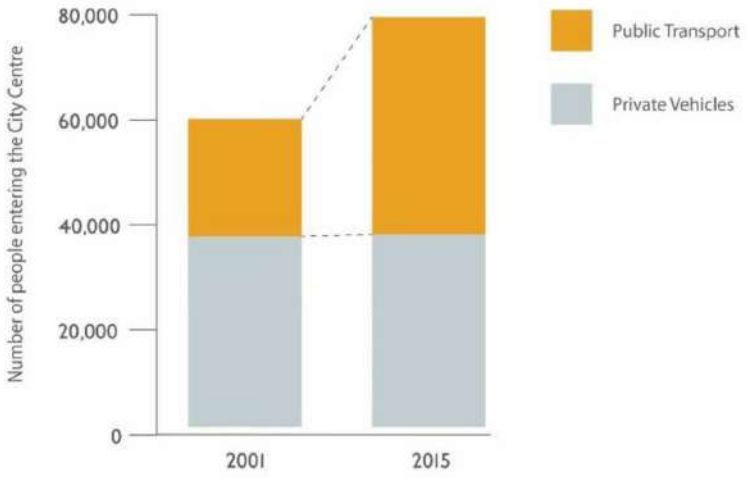
Financial Year	RTN (Rail + NEX)	Rail	NEX (Northern Busway services)	Freq., Conn., Local Bus	Ferry
2007/08	7,757,000	6,794,000	963,000	39,721,000	4,380,000
2008/09	9,150,000	7,650,000	1,500,000	42,482,000	4,374,000
2009/10	10,271,000	8,479,000	1,792,000	43,966,000	4,528,000

2010/11	11,921,494	9,864,604	2,056,890	46,475,891	4,735,717
2011/12	13,184,020	10,904,160	2,279,860	49,833,439	5,447,335
2012/13	12,317,391	10,038,806	2,278,585	48,689,513	5,506,218
2013/14	13,861,830	11,435,085	2,426,745	50,824,641	5,109,947
2014/15	16,760,032	13,916,822	2,843,210	54,224,722	5,536,389
2015/16	20,968,200	16,786,500	4,181,700 *	56,057,700	5,878,100
2016/17	24,514,297	19,595,200	4,919,097 *	57,778,603	6,149,200
Annual average growth rate	14%	13%	21%	4%	4%

**Note: From the 2015/16 financial year, Northern Busway data includes patronage counts from an additional rapid transit service operating on the busway (Route 881, to become the NEX2). This route supplements the NEX and partially replaces some non-rapid transit buses from the North Shore.*

The growth in the utilisation of the North Shore public transport system has contributed to a wider trend of an increasing proportion of trips to/from the City Centre being made using bus, rail and ferry modes. The Northern Express services has rated very highly in Auckland Transport's customer satisfaction research, rating above rail and other bus services. Figure 5 illustrates that the entire growth in peak period passenger transport to the City Centre since 2001 has been served by public transport modes. Due to limitations to cater for increased vehicle volumes, the growth in City Centre employment and education accompanied by growing transport demand will have to be served by increased public transport capacity.

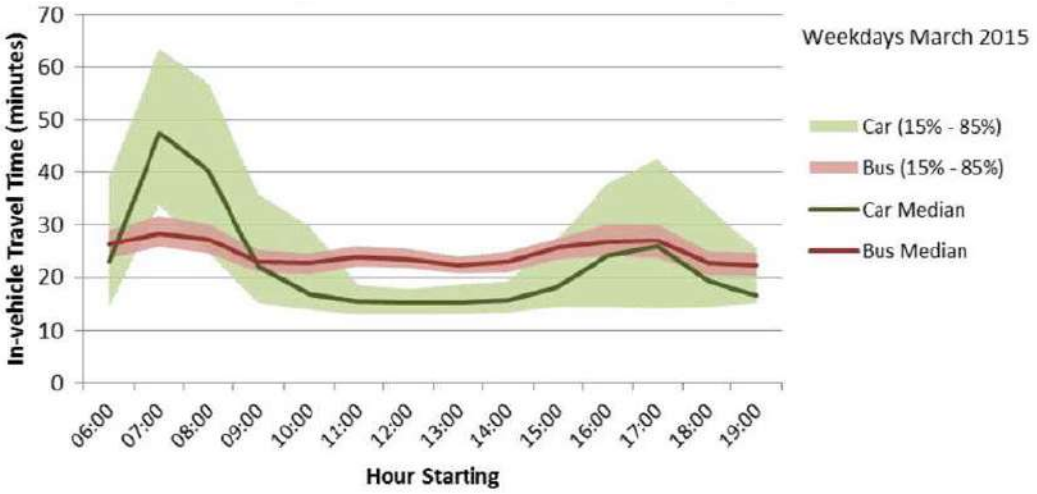
Figure 5: Private and public transport access to the City Centre, AM peak period (Source: Annual City Centre Screenline Survey: Auckland Transport/Auckland City Council)



The current quality of the Rapid Transit Network on the North Shore, with regard to travel speed and reliability, is good. This is reflected in current passenger perceptions. In 2016, the Northern Express marginally exceeded all other RTNs in terms of customer satisfaction rating, with over 90% customer satisfaction. This is compared to 85% for all bus services.

Figure 6 shows that journey times on the Northern Busway are reasonably consistent throughout the day, and more consistent than for private modes during peak travel periods.

Figure 6: Journey times from Albany to City Centre by mode and time of day, 2015 (Source: Auckland Transport)

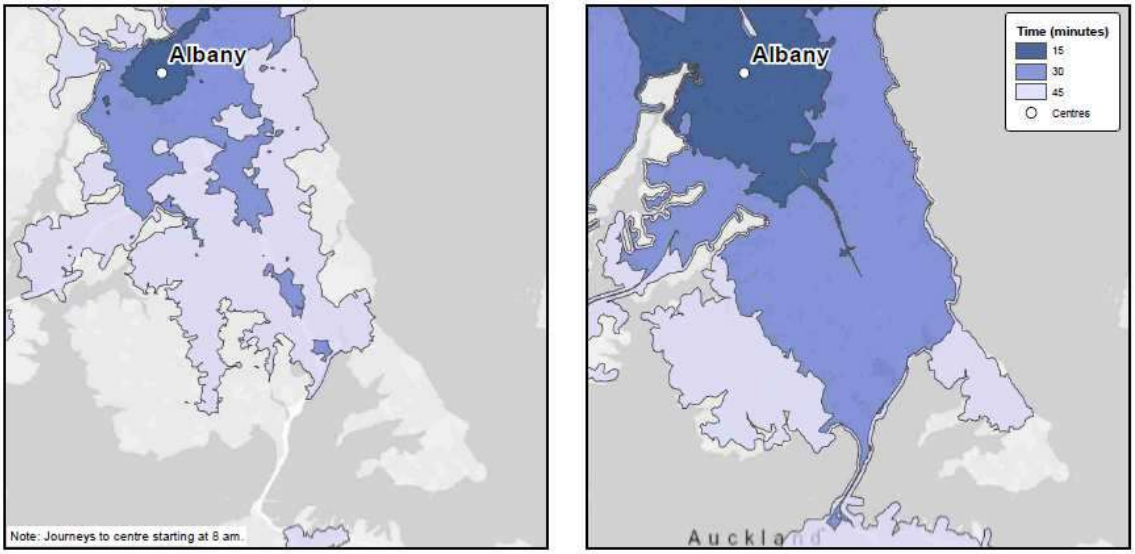


The performance of the current public transport and road network for passenger trips has also been assessed using an analysis of travel time and accessibility to the following major centres; Albany, Takapuna and Britomart (City Centre).[1] While public transport quality has improved in recent years, accessibility levels using private vehicle modes remain higher for most parts of the North Shore.

Accessibility travel time isochrones for travel to Albany (shopping centre) by bus and car are illustrated in Figure 7. This shows a far greater number of origins are within 30 minutes travel time by car to Albany compared to travel by public transport. The analysis shows the benefit of the busway in providing pockets of enhanced accessibility by public transport as far south as Akoranga.

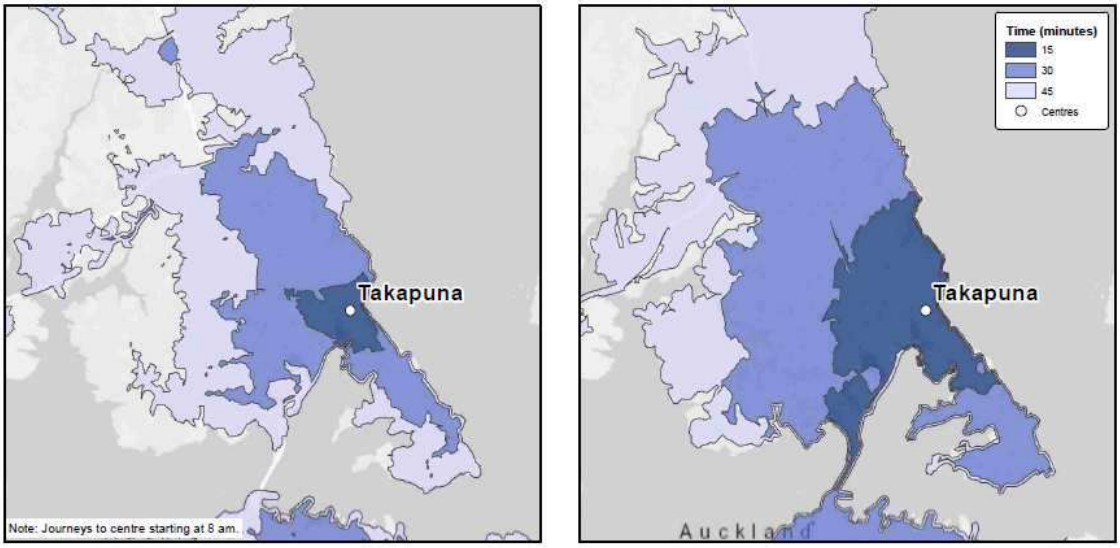
[1] The analysis was undertaken using AT's journey planner engine for public transport accessibility times, with an 8am departure time as well as using google traffic information for 8am road traffic conditions. Car travel times assume door-to-door commutes, i.e., they do not account for factors such as parking, whereas public transport travel times include walking times to and from stops/stations, as well as wait times at stops/stations.

Figure 7: Travel time isochrones to Albany in AM peak (bus left, car right)



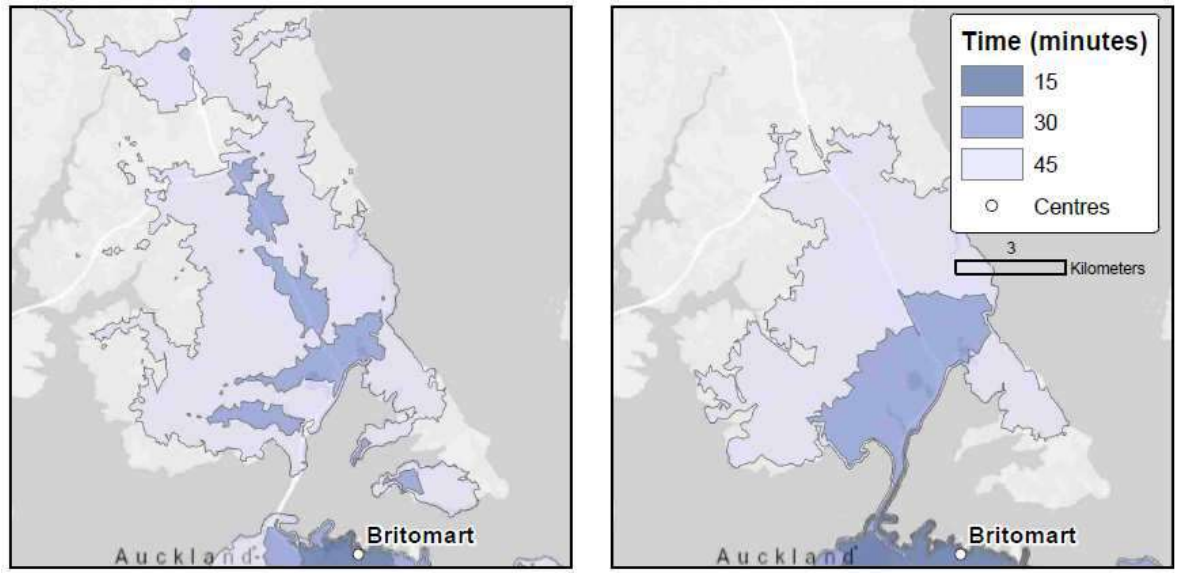
Accessibility travel time isochrones for travel to Takapuna by bus and car are illustrated in Figure 8. Again, this shows a greater number of origins are within 30 minutes car travel time to Takapuna compared to travel by public transport. However, there is a clear corridor of enhanced accessibility by public transport to the north, corresponding with the busway corridor.

Figure 8: Travel time isochrones to Takapuna in AM peak (bus left, car right)



Accessibility travel time isochrones for travel to Britomart by bus (+ ferry) and car are illustrated in Figure 9. In this instance, the isochrones show advantage for public transport accessibility in some areas. The 30-minute travel catchment for public transport extends north to Albany, further than that for cars. Along core public transport corridors (i.e. Busway and Onewa Road) accessibility is higher for public transport than for cars, reflecting peak-period congestion impacting car travel to a greater extent than buses.

Figure 9: Travel time isochrones to Britomart in AM peak (PT left, car right)



1.5 TRANSPORT CONTEXT: FUTURE CONDITIONS

With regard to forecasting future levels of transport demand and transport conditions, the Auckland Regional Transport model outputs have been analysed.[2] AM peak travel demands from the North Shore study area to anywhere within the Auckland region are plotted in Figure 10. This chart shows that:

- Growth in total demand is expected to happen at a reasonably steady rate over the study period
- Demand for travel within the North Shore accounts for nearly three quarters of total AM peak travel demands from the North Shore to anywhere in the Auckland region.
- Half of the total demand from the North Shore to the rest of the region (intra-regional travel) is for journeys to the City Centre + Fringe + Newmarket zone.

While the demand for travel within the North Shore is dominant, these trips are dispersed and not easily served by an RTN concentrated along a few key corridors. Nevertheless, this does not undermine the need for a core RTN, and some of these internal North Shore trips will make use of the RTN.

The need to provide public transport connectivity to destinations other than the North Shore itself is dominated by the need to provide City Centre access. This is particularly the case when the density and scale of the City Centre, and as a result its propensity to generate public transport trips, is considered.

[2] ART model outputs from the ATAP Common Elements base case scenario were used to quantify flows within the Auckland region. It should be noted that the ATAP base case scenario excludes the Additional Waitematā Harbour Crossing (AWHC) and as a result the demands produced by the ART model may be influenced by the constraints on the road network.

Figure 10: Forecast total travel demand from the North Shore, AM peak, 2013 - 2046 (ART ATAP base case scenario).

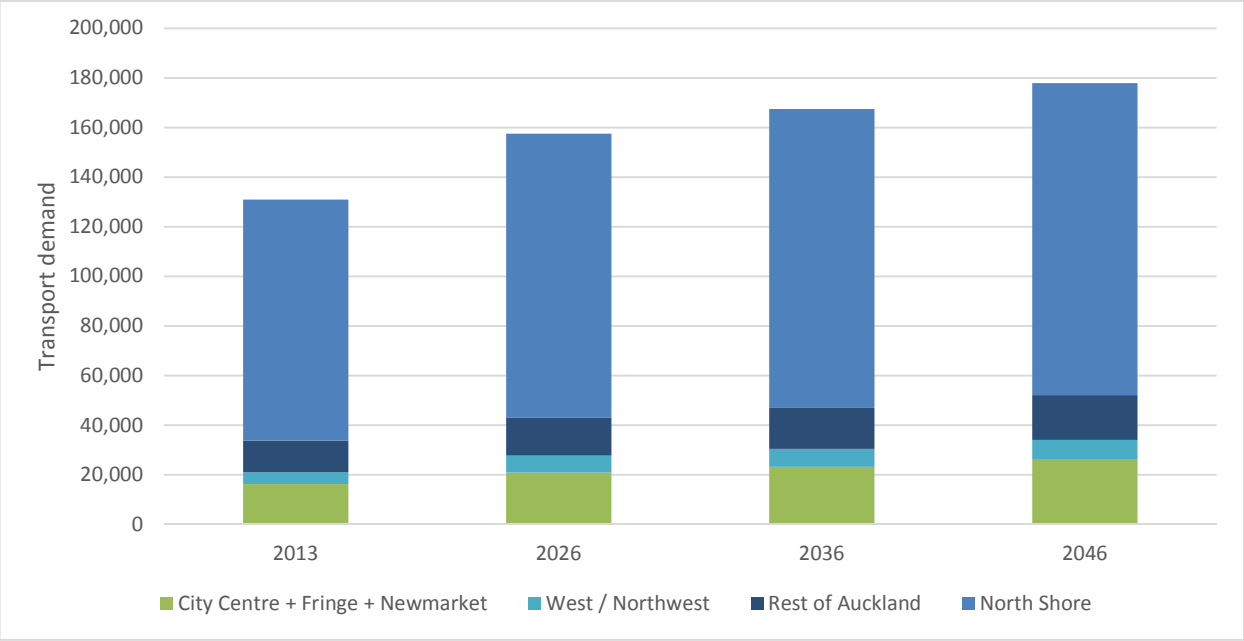
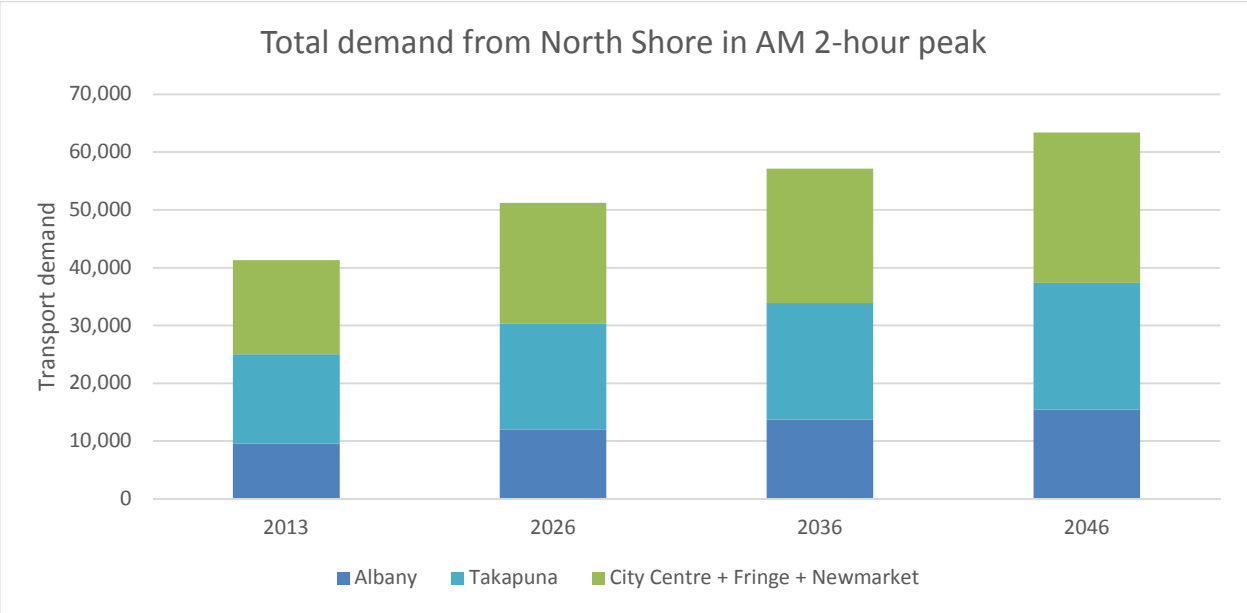


Figure 11 compares AM peak travel demands from the North Shore study area to the City Centre + Fringe + Newmarket and the zones containing the two North Shore metropolitan centres, Albany and Takapuna. Demand for travel to Takapuna is similar to that for the City Centre + Fringe + Newmarket zone, while demand to Albany is about two-thirds of demand to each of the other two zones.

Figure 11: Forecast travel demand from the North Shore to City Centres + City Centre Fringe + Newmarket, AM peak, 2013 - 2046 (ART ATAP base case scenario).



Total travel demands from the North Shore study area to the rest of the Auckland region are shown in the following maps for 2013 and 2046 (Figure 12). Strong growth in travel demand is observed for trips originating in the Silverdale–Orewa area and for all trips to the City Centre + Fringe + Newmarket. These maps show three primary corridors for demand from the North Shore:

- A “spine” from Albany and the north, currently using the SH1 corridor (including the busway);
- Onewa Road providing a link to the Birkenhead–Glenfield catchment; and
- Esmonde Road from Takapuna.

In addition, a smaller corridor for demand exists along SH18 from the North Shore towards Northwest and West Auckland.

Figure 12: Total transport demand (AM peak), North Shore to other parts of the Auckland region, 2013 and 2046

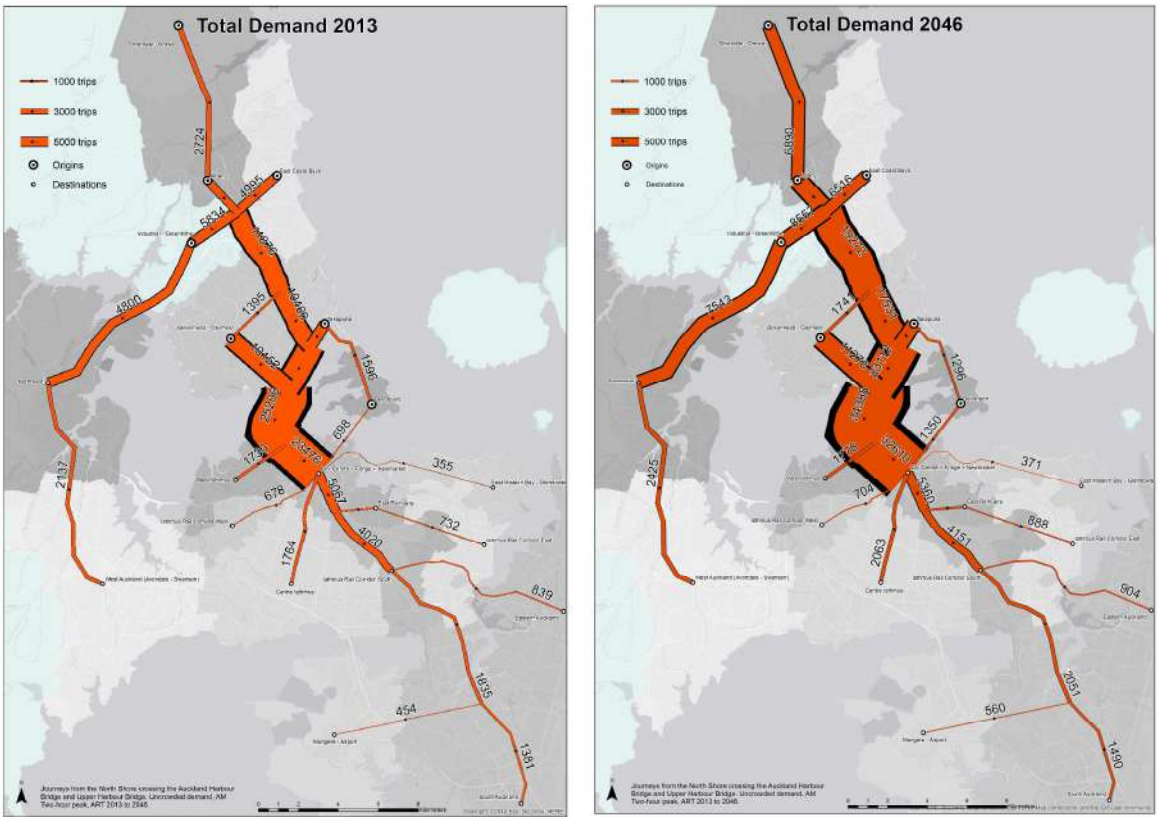


Figure 13 and Figure 14 summarise the change in demand for public transport and private vehicle travel to all areas south of the Waitemata Harbour crossing and to the City Centre + Fringe + Newmarket zone, respectively. By 2046, public transport mode share for AM peak journeys from the North Shore is forecast to increase to over half of all journeys across the AHB and three quarters of journeys to the City Centre + Fringe + Newmarket zone.

Of note is the extent to which public transport is anticipated to cater for the growth in demand. Even accounting for the non-inclusion of the AWHC project and the additional capacity it will provide across the Waitematā Harbour (model runs with its inclusion were not available), the following observations suggest that public transport is likely to be required to provide for the vast majority of future cross-harbour demand:

- Currently, the majority of peak trips from the North Shore across the harbour terminate in the City Centre. The model does not predict an increase in peak vehicle trips in the future, as the ability of the road network and parking supply in the City Centre is not expected to increase to accommodate growth in vehicle trips. Furthermore, direction such as that provided in AT's Parking Strategy support RTN use and development to the City Centre and metropolitan centres by actively managing parking supply and demand.[3]
- The AWHC project is expected to improve capacity for strategic trips past the City Centre and currently is not anticipated to provide for significant improvements to City Centre access. This is particularly the case for the expected destinations within the City Centre for the majority of North Shore originating trips at Wynyard, the City Centre core and the Learning Quarter.
- The testing of modelled 2016 ART public transport demand against observed patronage indicates that ART may underestimate the level of public transport demand on the North Shore (refer Section 2.6).

On this basis, and with the information available, it is considered prudent to assume for the purposes of defining the strategic "task" for public transport, that the ART forescasts are accurate and relevant for defining the public transport task.

Figure 13 below provides mode share forecasts for AM peak North Shore trips across the Waitemata Harbour over time. This provides an indication of the scale of the public transport task, which, as indicated earlier, is in the vicinity of 20,000 in the peak 2 hours, but also the expected change in mode share.

At the present time around one third of all trips on the Waitemata Harbour crossing are public transport trips. By the mid-2030s public transport demand exceeds general traffic and by the mid-2040s public transport is forecast to be the dominant mode across the harbour. This forecast is based on the ATAP programme without an Additional WaitematāHarbour Crossing.

This provides an indication not only as to the scale of the public transport task, but also the importance of ensuring that the public transport capacity is provided.

[3]Additionally, increasing parking supply to meet additional demand for driving to the city centre would result in an increase in parking prices, as new parking buildings would tend to be priced to cover construction and operating costs. Increases in parking prices would tend to dissuade people from driving to the city centre.

Figure 13: Forecast AM peak PT and private vehicle travel demand across the Auckland Harbour Bridge.

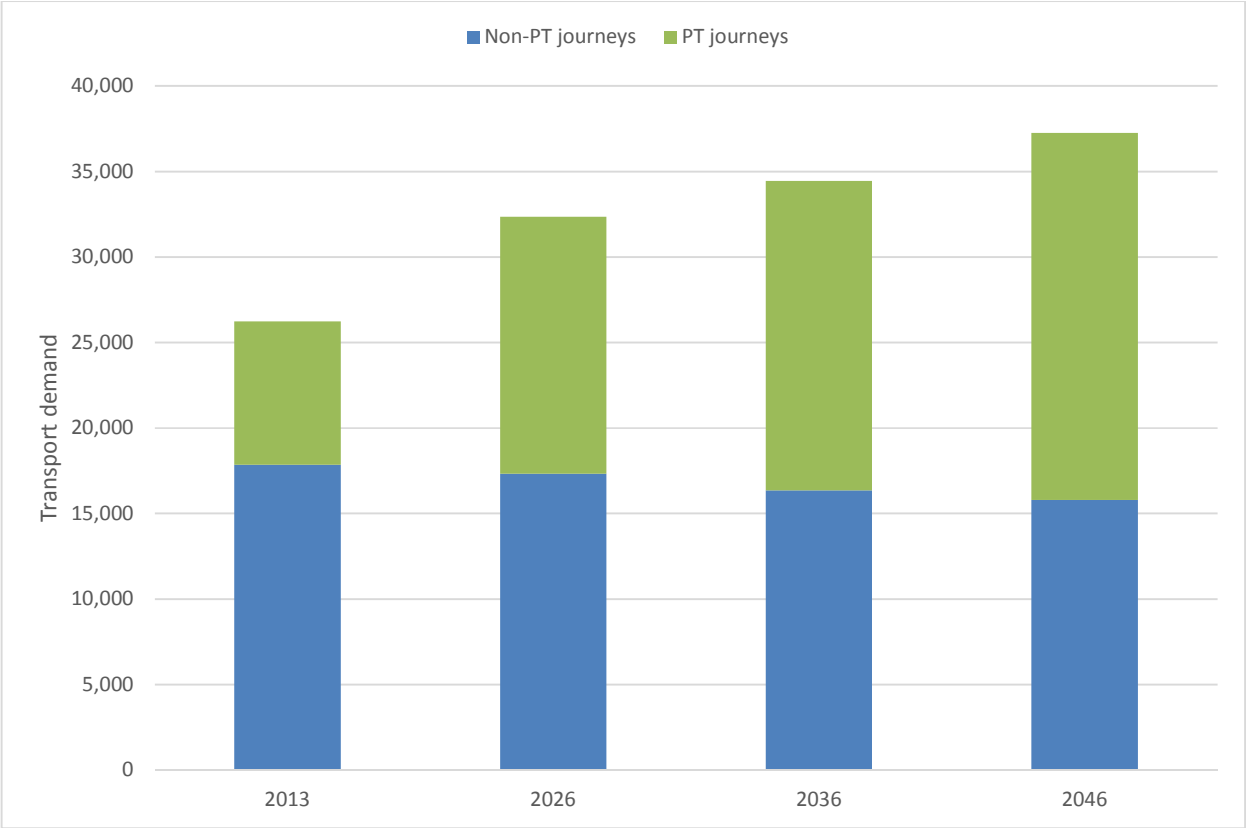
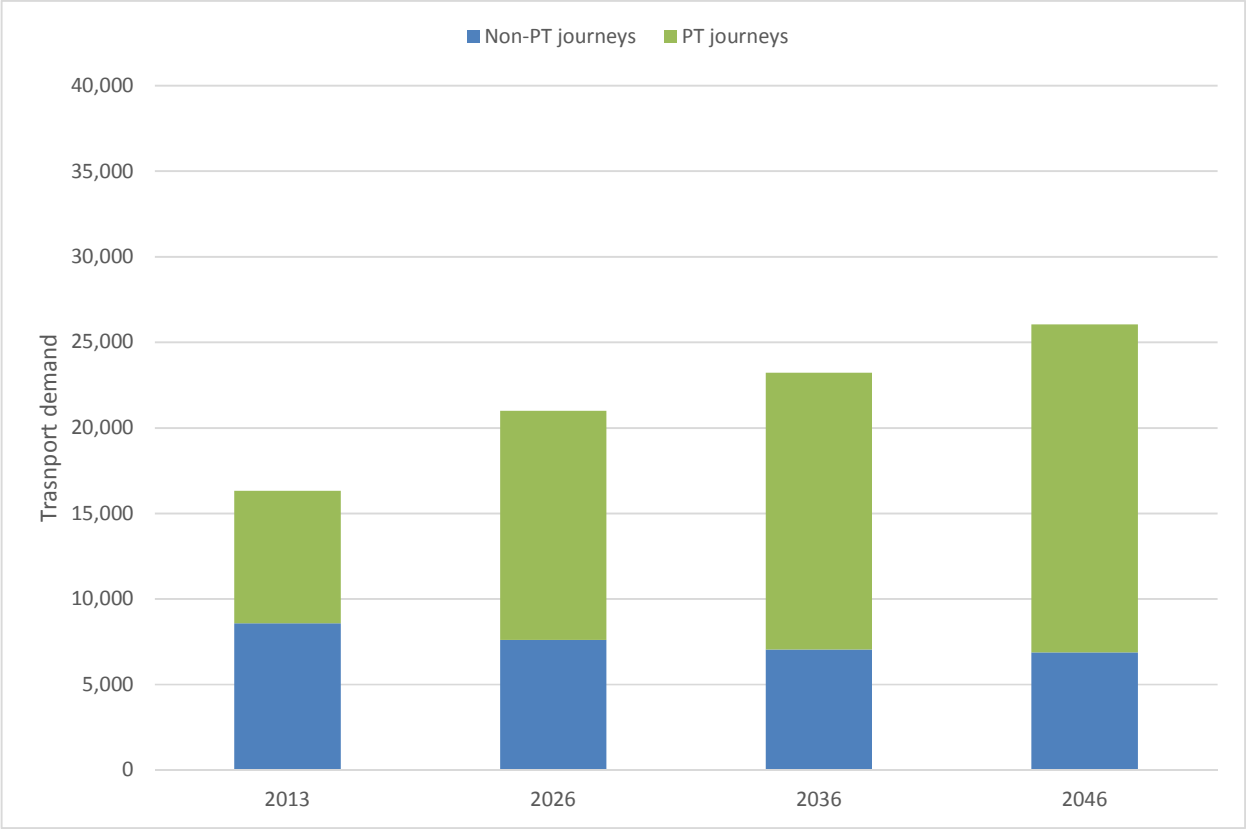


Figure 14 below examines the forecast AM peak mode share specifically to the City Centre + Fringe + Newmarket zone. At present, mode share to the City Centre + Fringe + Newmarket zone is evenly split between general traffic and public transport from the North Shore. General traffic trips are expected to decline gradually over time in actual numbers and decline dramatically as a share of total trips. By the mid-2040s it is forecast that three quarters of trips from the North Shore to the City Centre + Fringe + Newmarket zone are expected to be on public transport.

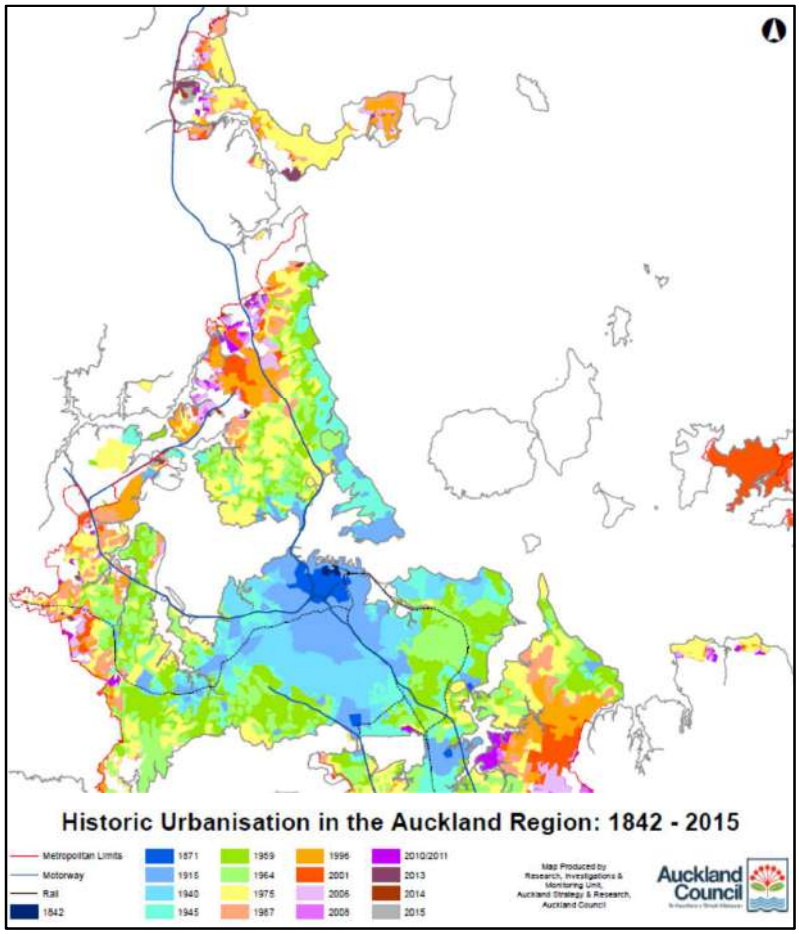
Figure 14: Forecast AM peak PT and private vehicle demand from North Shore to City Centre + Fringe + Newmarket.



1.6 LAND-USE PLANNING CONTEXT

Figure 15 illustrates the historic expansion of the North Shore's urbanised area since the late nineteenth century, revealing how land-use change and development has been closely linked to the provision of transport services and infrastructure. Early settlement was limited due to coastal areas served by ferry transport across the Waitemata Harbour to Auckland's centre. In 1959, the Auckland Harbour Bridge opened. It improved access and spurred development in the North Shore suburbs of Northcote, Wairau Valley, Glenfield, Sunnynook and Forrest Hill. Extensions of State Highway 1 led to a proliferation of inland growth with expansion of suburbs such as Northcote, Glenfield, Wairau Valley, Forrest Hill and further north around the East Coast Bays. Further development of the SH1 during the 1990s stimulated development around Albany, supported around a decade later by improved access from SH18 from the west.

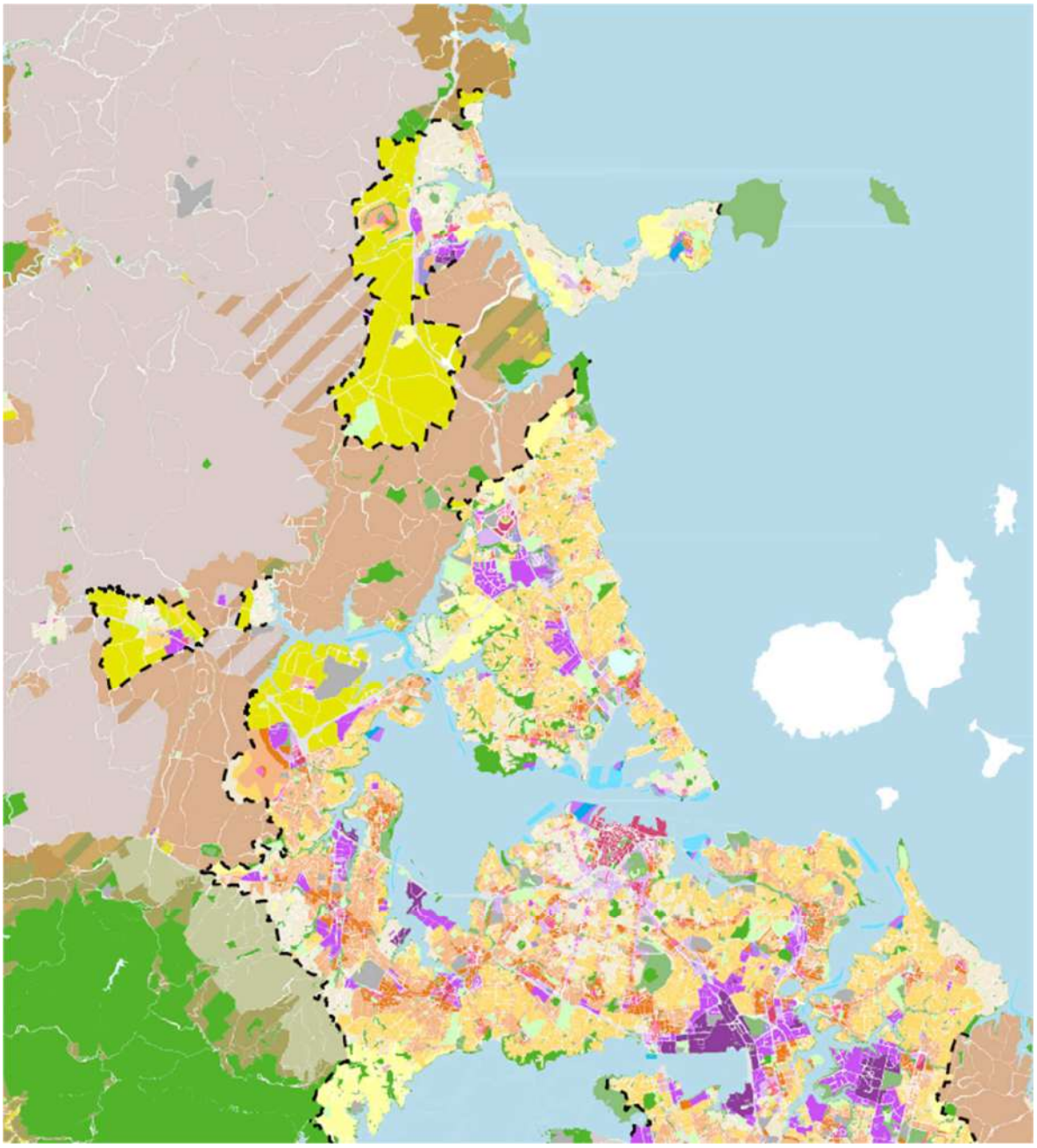
Figure 15: Historic urbanisation in the Auckland Region



Planning for future growth (the Auckland Unitary Plan) aims to enable intensification of dwellings and employment in and around metropolitan and town centres. Figure 16 illustrates the spatial distribution of various planning zones for the Study Area. Albany and Takapuna are zoned as Metropolitan Centres, enabling building heights up to eighteen storeys. Rosebank and Wairau Valley are zoned for light industry business uses (purple areas).

In addition to encouraging intensification of existing centres, the Unitary Plan also enables new urban growth areas within the programme study area around Dairy Flat, Silverdale, Orewa and Warkworth (yellow areas in Figure 16). These new urban growth areas are substantial and will have implications for transport demand once developed. New urban growth zones in the North-West will also mean increased transport demands on the State Highway 18 Corridor between the North Shore and Westgate.

Figure 16: Auckland unitary plan zoning (Source: Auckland Council).



2 PARTNERS AND KEY STAKEHOLDERS

This section outlines the key partners to the business case who will have a responsibility for delivering on the investment and identifies key stakeholders who have an interest in the expected outcomes or can influence the investment proposal.

2.1 INVESTMENT PARTNERS AND STRATEGIC ALIGNMENT

NZ Transport Agency

As a partner to this business case, the NZ Transport Agency has two relevant roles:

1. Co-investor in the programme
2. Manager of the State Highway infrastructure, with which the North Shore RTN programme is likely to be integrated.

The current North Shore RTN (Northern Busway) is part of the State Highway 1 corridor, while a future State Highway harbour crossing is currently in the planning phase and may present opportunities to integrate rapid transit infrastructure.

With respect to (1), The NZ Transport Agency is the Crown Entity responsible for fulfilling the expectations of government as expressed in the Government Policy Statement on Transport (GPS). In its role as investor and planner, NZ Transport Agency Planning & Investment (P&I) provide funding to co-invest in transport projects and programmes undertaken by Auckland Transport, Auckland Council and Highways and Network Operations (HNO). The NZ Transport Agency allocates the National Land Transport Fund to activities which give effect to the GPS, including for public transport infrastructure and services (relevant for the North Shore RTN programme).

With respect to (2), NZ Transport Agency manage the state highway network and motorway corridors. Relevant to this programme, it is custodian of the existing Auckland Harbour Bridge and currently leads planning for route protection for an AWHC, which could enable future access for the North Shore RTN. The NZ Transport Agency is a requiring authority for state highways and cycle ways, it does not have requiring authority status or financial responsibility for rail and therefore cannot designate for rail.

Auckland Transport

Auckland Transport is the strategic transport planning authority for Auckland and has responsibility for all non-state highway transport infrastructure. AT is responsible for giving effect to the Auckland Plan. Planning and providing for public transport is a core responsibility. In respect of the North Shore RTN, this includes the Northern Busway, any potential rail services and facilities, as well as arterial and local roads, other bus services and facilities, walking and cycling. Departments within AT will provide specific advice/feedback on the RTN development.

AT's responsibility in relation to rapid transit planning and implementation is contained in two key statutory documents:

1) Regional Land Transport Plan (RLTP) - this identifies AT's approach to investment and lists all future transport investments in the Auckland region over a ten year period, including local roads, public transport services and infrastructure, maintenance and renewals, walking and cycling and investment, management activities as well as (NZTA) state highway activities.

2) Regional Passenger Transport Plan (RPTP) - which outlines AT's approach to public transport over a three year period. This includes policies that relate to fare box recovery and concessions.

KiwiRail

KiwiRail is responsible for network planning of the national heavy rail network. KiwiRail will lodge the Notice of Requirement for a rail corridor across the harbour as part of the AWHC project. They are also responsible for integration with rail freight and any intercity passenger rail services.

Strategic Alignment

Auckland Plan (2012)
The Auckland Plan (2012) supports rapid transit and recognises the role of the Northern Busway in providing access to and from the North Shore. It also supports the need for an additional Waitematā Harbour Crossing, including rail, to improve transport resilience, capacity and connectivity. While strategic thinking has evolved since the Auckland Plan was published, the intent for continuous improvements to the Rapid Transit Network (RTN) remain. The Auckland Plan refresh is underway and is expected to be confirmed mid 2018.

Integrated Transport Plan, Regional Land Transport Plan, Regional Public Transport Plan
These are currently under development by Auckland Transport and are expected to provide strategic context and guidance for the development of rapid transit to the North Shore. Further stages of business case development should be include the direction provided by these strategies.

Statement of Intent (2016/17-2018/19)
The Auckland Transport Statement of Intent outlines the three-year work plan to continue delivering to the strategic direction for transport in Auckland, the key actions required for achievement and the consequential key performance measures.

This SOI is presented using the five strategic themes endorsed by Auckland Transport's Board:

- Prioritise rapid, high frequency public transport
- Transform and elevate customer experience
- Build network optimisation and resilience
- Ensure a sustainable funding model
- Develop creative, adaptive, innovative implementation

Planning for and developing the rapid transit network strongly aligns with Auckland Transport's strategic themes.

The SOI notes that prioritising rapid (and frequent) public transport will contribute to realising the Auckland Plan's vision by significantly enhancing transport choices, thereby improving transport accessibility in Auckland. The development of a rapid and frequent network will make public transport a more compelling choice for those that currently favour car travel. As more people use trains, buses and ferries, the transport system will be better able to cope with Auckland's significant growth, leading to better environmental and economic outcomes.

Supporting Growth
The Supporting Growth work recognises that significant transport infrastructure will we needed to support the considerable growth that is planned for the north of Auckland.

At the heart of the future transport network in the Silverdale area is extension of the RTN linking Albany to Dairy Flat, Silverdale, Wainui and Grand Drive via an extension of the Northern Busway. As well as the spine of the RTN, the Supporting Growth work recognises the need for high-frequency bus connecting Orewa and Silverdale with Wainui and the RTN will also be developed and could include bus lanes, bus priority at intersections and interchanges.

Additional stations along the RTN will become hubs for extended public transport services into the growth areas and Orewa, providing opportunities for this growth as well as improved access to employment, town centres and residential areas.

The Supporting Growth work recognises the need for new and upgraded arterial roads, as well as dedicated walking and cycling networks linked to public transport hubs will provide a range of options for getting around. Refer online for further details:
https://at.govt.nz/projects-roadworks/supporting-growth-delivering-transport-networks/supporting-growth-in-the-north/ (note that this does not include up-to-date growth to 2026, the ATAP August 2017 report does.)

Auckland Transport Alignment Project (ATAP)
ATAP is a joint project including Auckland Transport, Auckland Council, the NZ Transport Agency, Ministry of Transport, the Treasury and the State Services Commission. ATAP recognises that Auckland has transport funding shortfalls and investigates delivery mechanisms.

The ATAP strategic approach looks to make better use of existing networks, target investment to the most significant challenges, and maximise new opportunities to influence travel demand. The North Shore RTN business case analysis follows the guidance of the ATAP process, which highlighted that the Auckland Harbour Bridge has limits on its ability to cater for heavy traffic growth, and that the very high opportunity costs of a new harbour crossing require significant consideration before investment.

The ATAP August 2017 update recognises recent planning decisions for more progressive greenfield development in north Auckland around Wainui/Silverdale. It notes that transport improvements will need to be completed faster than originally anticipated and that projects such as Penlink, arterial roads in the growth area and state highway 1 improvements, including bus priority, need to be accelerated over the next decade.

ATAP's indicative programme shows anticipated investment delivery, over the next three decades. In the case of the AWHC (and potentially related transit improvements) this is indicated for the third decade (2038-2048). However, the scale and complexity of this investment, as well as the long lead-in time for procurement and construction requires significant advance lead-in planning.

The recommended programme approach is aligned with the ATAP recommended strategic approach for progressive delivery through infrastructure investment (in this case enhancing the busway), policies and services over the next 30 years.

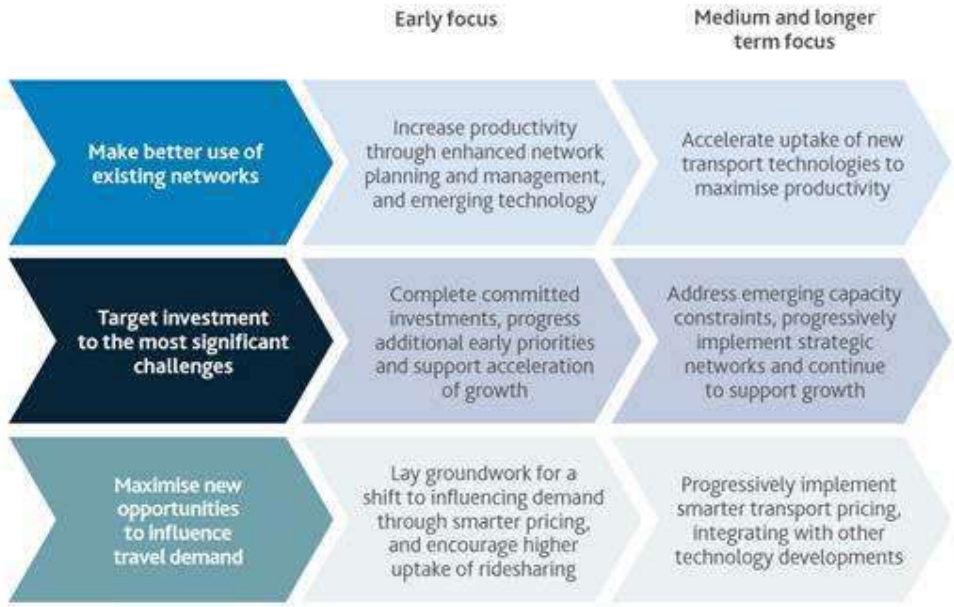


Figure 17: ATAP recommended strategic approach for progressive delivery through infrastructure investment, policies and services (ATAP Recommended Strategic Approach, September 2016)

2.2 KEY STAKEHOLDERS

The area of influence for the North Shore RTN strategic case is large and is highly connected to a wide range of parallel or related workstreams. RTN investment can also be strategically influential in city-shaping. These factors generate a wide range of stakeholders that may have an interest in or may be able to inform and shape the project outcomes.

Auckland Council is the most significant of the key stakeholders, and provides direction for integration between land use and transport development and investment. It is the statutory planning authority for the Auckland region.

The Council is responsible for the Auckland Plan, which provides strategic direction for developing and managing the Auckland Region. The Auckland Plan outlines overall objectives and funding to which Auckland Transport is to give effect. Council is also responsible for preparing the Unitary Plan, which is a key mechanism for delivering the Auckland Plan.

Auckland Council has interests in both the significance of this project, in terms of the strategic and regional role of an AWHC and the North Shore RTN, and from a statutory and consenting point of view.

Table 4 below includes identified stakeholders. Note that stakeholder involvement is also contingent on the level of detailed feedback sought. For instance, Local Boards would be interested in the whole of life of the project, whereas individuals may be interested in more immediate land impacts.

Table 4: Programme stakeholders

Stakeholders	Focus Areas
Auckland Council	Regional strategies, land use, unitary planning
Local Boards	Local issues, strategies and community aspirations and views. Likely to be most relevant to immediately adjacent Local Boards, with other Local Boards interested in respect of regional benefits.
Iwi	Cultural issues and aspirations of Tangata Whenua
Members of Parliament	Community and political views and risks
Councillors	Community and political views and risks
Resident groups	Local issues and community aspirations
Business groups	Requirements, dynamics and risks to business
Transport interest groups	Needs and aspirations of users of all transport modes
Environmental groups	Risks and issues associated with specific environmental issues and wider sustainability
Specific businesses and residents close to option routes	Issues, risks and needs of specific areas

3 STRATEGIC ASSESSMENTS – OUTLINING THE NEED FOR INVESTMENT

3.1 DEFINING THE PROBLEM

An investment logic map (see Appendix A) identified the following key problems, to which the investment proposal seeks to respond:

Problem: *Inability to effectively meet projected public transport demand to, from and within the North Shore will constrain Auckland's economic performance and inhibit planned urban growth.*

The problems being addressed by this PBC include forecast passenger-carrying capacity constraints on an Auckland transport corridor of nationally-strategic importance that provides access to Auckland's City Centre (New Zealand's key centre for high-productivity business service industries) as well as to the Albany and Takapuna Metropolitan Centres. The PBC also addresses anticipated accessibility and public transport problems and benefits.

3.2 THE BENEFITS OF ASSESSMENT

The potential benefits of successfully addressing this problem through appropriate investments, were identified as follows, through an ILM process:

Benefit 1: Planned residential and employment growth in Auckland is enabled.

Benefit 2: Auckland's economic performance is improved by increasing labour market accessibility.

Benefit 3: There is a high degree of certainty that road, active mode and public transport outcomes are achieved.

These benefits are used as the basis for developing investment objectives and performance measures used for assessing options and alternatives.

3.3 INVESTMENT OBJECTIVES

Responding effectively to the problem is expected to contribute to achievement of the following objectives:

1. The RTN network has the capacity to meet forecast demands to, from and within the North Shore.
2. The RTN network operates to a level of service that supports planned growth and encourages mode shift to public transport.
3. The RTN network improves the resilience of the passenger transport system across the Waitemata Crossing to both major and minor disruptive events.
4. Public transport access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.

These SMART investment objectives, in combination with more detailed performance measures, have been used as the basis for assessment of alternatives and options in Part B of this PBC.

4 ALIGNMENT TO EXISTING STRATEGIES/ORGANISATIONAL GOALS

The Auckland Transport Alignment Project's (ATAP) Recommended Strategic Approach to future transport network management and investment in Auckland has been published[4]. It provides clarity about the timing and need for key transport infrastructure projects, and identifies the context in which they will take place.

[4] Auckland Transport Alignment Project Recommended Strategic Approach September 2016, Ministry of Transport, The Treasury, Auckland Council, Auckland Transport, State Services Commission, NZ Transport Agency.

ATAP sets out common objectives for Auckland's transport network:

- Improve access to employment/labour
- Improve travel time and reliability
- Improve public transport mode share
- Deliver net benefits from new investments.

Based on these common objectives, and analysis of alternative investment programmes, ATAP recommended a strategic approach to managing and investing in Auckland's transport network. There are three elements to this approach:

- Make better use of existing networks, via better network management and use of new technology
- Target investment to the most significant challenges, e.g. enabling growth and addressing emerging capacity constraints
- Maximise opportunities to influence travel demand, including through smarter pricing.

As part of the Recommended Strategic Approach, ATAP sets out indicative priorities for major new investments over a three-decade period. ATAP recommends in the third decade a "Waitemata Harbour crossing improvements, including mass transit upgrade of the Northern Busway".

4.1 NZ TRANSPORT AGENCY

Effectively addressing the problems identified in the strategic case will contribute to achieving the goals and objectives of the NZ Transport Agency. The NZ Transport Agency is responsible for delivering on the government's strategic direction for land transport investment, as outlined in the Government Policy Statement on Land Transport (GPS). The 2015-2018 GPS seeks to drive improved performance from the land transport system by focusing on economic growth and productivity, road safety and value for money. Relevant objectives from the GPS for this programme are:

- *"A land transport system that addresses current and future demand for access to economic and social opportunities"*
- *"A land transport system that provides appropriate transport choices."*

The North Shore RTN programme is addressing growing demand on a critical transport corridor that provides access to significant economic and social opportunities. Approximately 200,000 employment opportunities, or a third of Auckland's total employment are within the area of influence of the programme. This provides a sense of the scale of economic and social opportunity influenced by the programme. The North Shore RTN programme is likely to contribute to a land transport system that provides improved choices for people by ensuring the continued availability of a high quality public transport connection on a key Auckland corridor.

The programme will assist in achieving the long-term goals and medium term objectives identified in the NZ Transport Agency's *Statement of Intent 2015-18.* Relevant long-term goals include:

- *"Integrate one effective and resilient network for customers"*
- *"Deliver efficient, safe and responsible, and resilient highway solutions for customers"*
- *"Maximise effective, efficient and strategic returns for New Zealand".*

The North Shore RTN programme addresses transport problems on a strategic-level connection of national significance. The programme has the potential to shape land-use, improve integration of land-use change and transport infrastructure. The programme has the potential to significantly improve the resilience of this critical connection.

The programme seeks to improve value for money from transport investment by planning for road and public transport modes in an integrated way that achieves cost savings.

4.2 AUCKLAND TRANSPORT

The programme contributes to achieving strategic goals set by the Auckland Transport Board. It has adopted the following set of strategic themes in its 2015-2018 Statement of Intent relating to the Auckland Plan directions:

- *Prioritise rapid, high frequency public transport*
- *Transform and elevate customer focus and experience*
- *Build network optimisation and resilience*
- *Ensure a sustainable funding model*
- *Implement accelerated, adaptive, innovative solutions*

Although these can be more easily applied to an operational situation than planning for a RTN, these strategic themes, directly relate to the transport benefits that a RTN delivers. For example, the programme has the potential to significantly improve the customer experience for public transport customers, increase network resilience and improve value for money.

The Auckland Transport Alignment Project (ATAP) is a joint project including Auckland Transport, Auckland Council, the NZ Transport Agency, Ministry of Transport, the Treasury and the State Services Commission. ATAP recognises that Auckland has transport funding shortfalls and investigates delivery mechanisms. Upcoming business case analysis of the current and future improvements to North Shore RTN will follow the guidance of the ATAP process, which highlighted that the AHB has limits on its ability to cater for heavy traffic growth, but that the very high opportunity costs of a new harbour crossing require significant consideration before investment.

ATAP recommended that route protection for a new crossing need to progress in a way that integrates further road and public transport requirements. Auckland Transport is working with NZTA to develop the best governance and projects structure to achieve this.

4.3 ISSUES AND CONSTRAINTS

Table 5 lists issues that introduce uncertainties for the programme. There are multiple factors that may influence the long-term travel demand forecasts, some of these factors may significantly change transport supply within the study area and factors that may influence the costs of the programme.

Table 5: Issues and uncertainties log

Factor	Time	Uncertainty	Impact on programme	Comments
Factors affecting demand				
Land-use change: greenfield growth in future North Shore urban growth areas (e.g. Silverdale) – scale, location, timing of development	2016+	Reasonably foreseeable	High	Significant land areas zoned for future urban growth that will impact-on demand. Considerable uncertainties about the extent and timing of development uptake.
Land-use change: scale of residential growth within existing North Shore	2016+	Reasonably foreseeable	High	Recent changes to land-use planning provisions (Unitary Plan) may have increased re-development and infill capacity. Uncertainties about

				the timing and uptake of this capacity.
Land-use change: scale and distribution of employment change in the City Centre and North Shore employment centres	2016+	Reasonably foreseeable	High	Uncertainties about the future geographic distribution of jobs growth between the City Centre and other North Shore employment centres.
Emerging technology: impact of future transport technologies on RTN demand	2020+	Hypothetical	Medium	Uncertainties about how future transport technologies may change demand for public transport services.
AWHC – road crossing	2036+	Reasonably foreseeable	Medium	Uncertainties about the scale and timing of new road capacity across the Waitemata Harbour crossing and its impact on public transport demand.
Factors affecting supply				
AWHC – road crossing	2036+	Reasonably foreseeable	High	Uncertainties about the scope, location, potential for integration with transit and timing of an additional road crossing of the Waitemata Harbour.
Emerging technology – vehicles and infrastructure	2016+	Hypothetical	Medium	Uncertainties about the potential for future passenger transport technologies to impact on passenger-carrying capacity of infrastructure.
Factors affecting cost				
Emerging technology - vehicles	2020+	Hypothetical	Medium	Uncertainties about the potential for future RTN vehicle technologies to impact on capital and operating costs.
Emerging technology – construction methods	2020+	Hypothetical	Medium	Uncertainties about the potential for future changes to infrastructure construction methods (e.g. tunnelling) impacting-on costs.

Local environmental impacts	2016+	Reasonably foreseeable	Medium	Uncertainties about how mitigating local environmental impacts may impact-on costs.

Potential constraints that will impact the programme options include:

- Ecological and landscape values constraining harbour crossing options
- Spatial constraints (e.g. street width) within the densely built-out City Centre that will affect transport mode and technology options
- Planning, feasibility, operational and implementation constraints.
- Spatial constraints on other parts of the corridor (e.g. hills, conservation areas) that may limit new alignments for infrastructure.

4.4 PROBLEM STATEMENT

Problem: Inability to effectively meet projected public transport demand to, from and within the North Shore will constrain Auckland's economic performance and inhibit planned urban growth.

The following sections outline evidence for the problems identified by the Strategic Case.

Forecast growth in demand for public transport on core North Shore corridors will mean demands exceed the capacity of currently planned services and infrastructure, at least by the 2030s. This will inhibit planned growth, both on the North Shore (predominantly planned residential growth) and in the City Centre (predominantly employment growth). Inhibited growth will constrain Auckland's economic performance.

4.5 THE EVIDENCE

Evidence for the problem is organised by the following sub-sections:

- Evidence of forecast public transport demand growth and land use change.
- Evidence that forecast public transport demand exceeds the functional capacity of planned public transport infrastructure and services.
- Evidence that poor performance of the North Shore public transport system will have negative economic impacts.

Evidence on growth in public transport demand

The recent study, *North Shore RTN: Transport and land use deficiency and opportunity analysis* (Aurecon and MRCagney for Auckland Transport, 2016) provides forecasts of passenger transport demand accompanying planned growth on the North Shore and in the City Centre. A summary of the transport demand forecasting analysis is included in Section 9 of this PBC. Key findings are reiterated in this section.

Figure 17 illustrates modelled public transport demand from the North Shore to other parts of the region in 2013 and 2046. It shows substantial growth in demand over the 30-year period, with demands converging across the Auckland Harbour Bridge, and the bulk of demand being to City Centre destinations.

Figure 18: Forecast public transport demands North Shore to external zones 2013 and 2046, AM peak

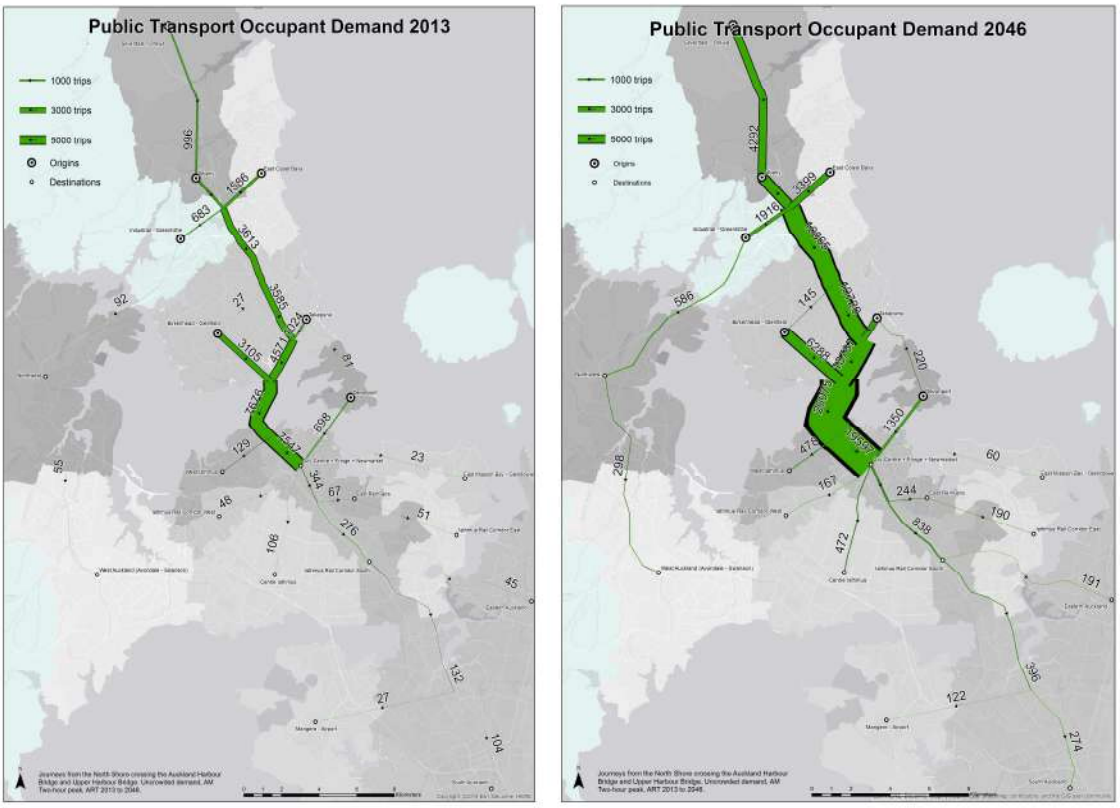
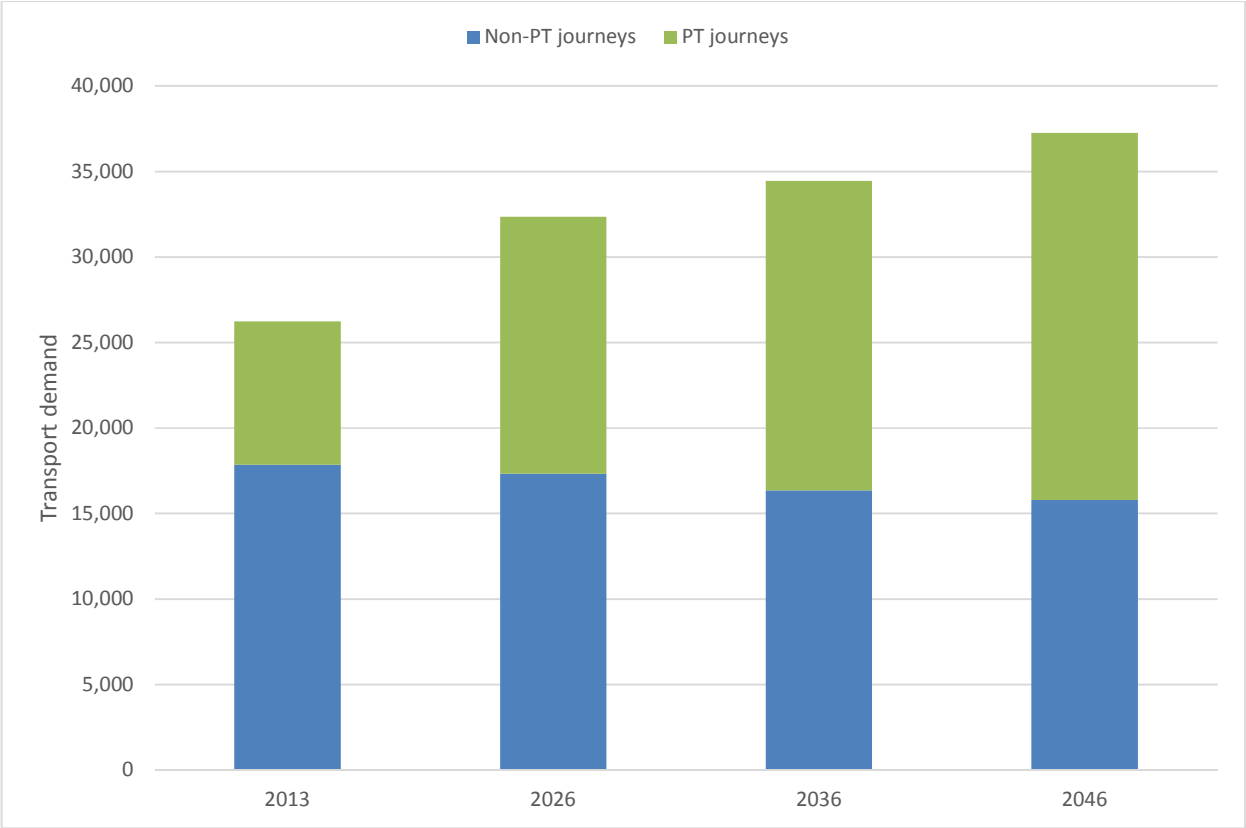


Figure 18 below provides mode share forecasts for peak-period North Shore trips across the Waitematā Harbour. This provides an indication of the scale of the public transport task across the Harbour which increases to around 20,000 passenger trips during the peak 2 hours by 2046. At present, around one third of all trips on the Waitematā Harbour crossing are public transport trips. By the mid-2030s public transport demand exceeds general traffic and by the mid-2040s public transport is forecast to be the dominant mode on the Waitematā Harbour crossing.

The ATAP work also observes this travel demand noting that projected growth in public transport demand appears likely to trigger the need for a new crossing within the next 30 years.

Figure 19: Forecast AM peak PT and private vehicle travel demand across the Auckland Harbour Bridge.



As with any demand forecasts, there are uncertainties about the modelling inputs and changes to these inputs may significantly change the demand forecast. For example, key uncertainties include:

- **The land use scenario underpinning transport demand forecasts**. Recent increases in plan-enabled development capacity introduced with the Auckland Unitary Plan may mean the land use forecast is under-predicting the scale and/or location of land use change and consequently the level of PT demand. Conversely, the land use forecast may be predicting more change than is likely given inherent uncertainties in translating information about plan-enabled development capacity to precise forecasts for the scale, location and timing of development uptake and accompanying population and employment growth.

- **Use of a fixed land use forecast.** A core assumption underpinning the demand forecast is that land use is 'fixed', or held constant regardless of which transport investments are made. This assumption is not necessarily realistic, as there is a two-way interaction between transport infrastructure investment and land use change. For example, North Shore RTN investment may increase the relative accessibility of North Shore locations and hence its attractiveness, accelerating land use change and development. Future stages of the business case process will need to consider how North Shore RTN can shape and enable land use and development, rather than simply responding to a fixed land use forecasts and associated level of demand.

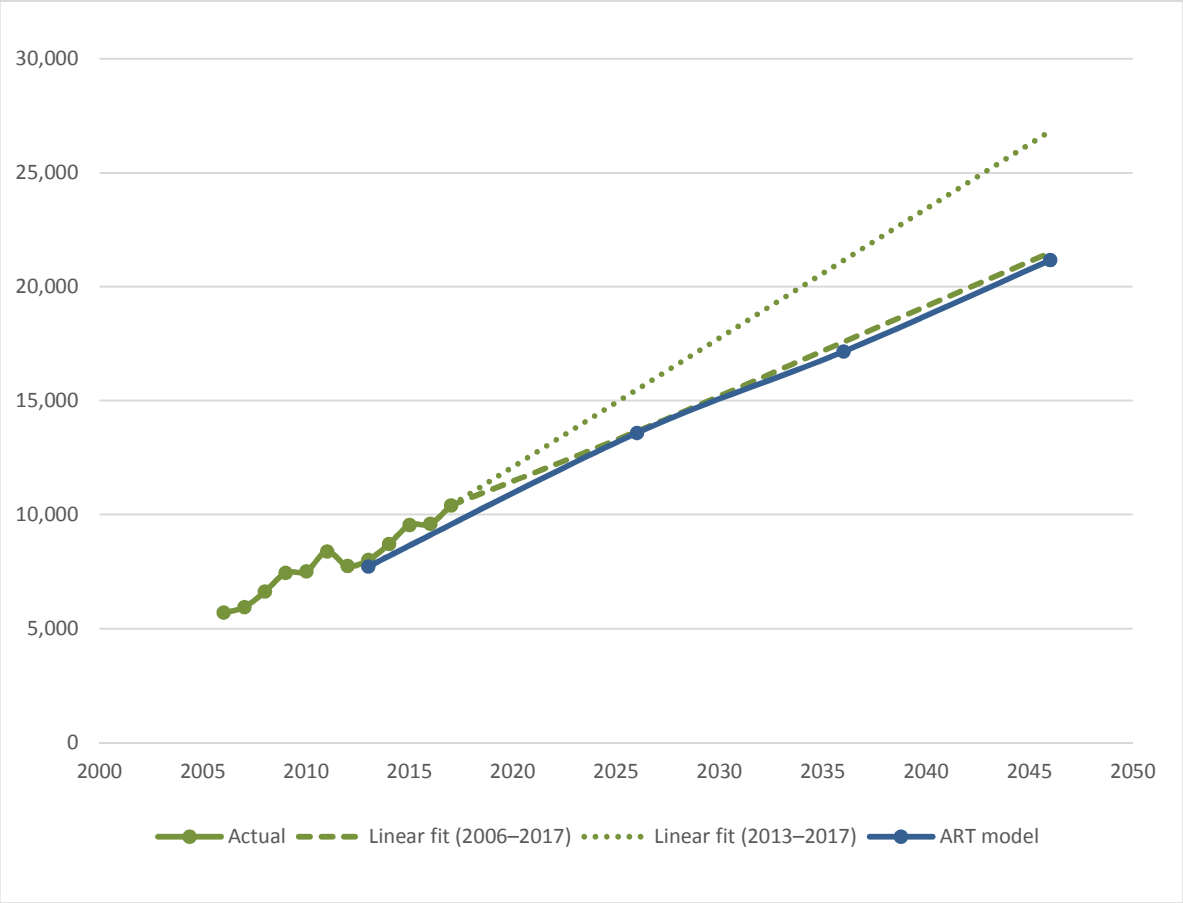
- **Attractiveness of PT modes relative to other modes**. There are uncertainties about ART modelling processes and the modelled attractiveness of PT relative to other modes. For example, recent PT patronage growth rates exceed modelled growth rates. This may mean that ART modelling is under-estimating future PT demand growth.

- **Impact of the AWHC road crossing on PT demand.** The future transport infrastructure scenario used for modelling demand excludes the Additional Waitematā Harbour Crossing (AWHC) and as a result the PT demands produced by the ART model may be influenced by the constraints on the road network.

The North Shore RTN Study also considered alternative scenarios for growth in PT demand from the North Shore across the Waitematā Harbour. Figure 19 compares the modelled travel demands with historical patronage data for am peak travel on this corridor. The average annual increase in patronage in the last five years was significantly higher than the average annual public transport demand increase forecast from 2013 to 2026. The chart shows linear extrapolation of actual patronage using the average growth rate from the last five years (2013–2017) and from the last twelve years (2006–2017). The twelve-year trend is closely consistent with model projections, while the five year trend is considerably higher than the model forecasts.

While the five-year extrapolation is considered too short to inform a view on a 30-year forecast, and is shown for context of sustained strong growth, the twelve-year extrapolation is a more valid picture of underlying trends. By 2046, the twelve-year trend linear extrapolation remains closely aligned with the ART model outputs, while the five-year trend extrapolation is some 26% higher. Thus, while it is not expected that travel demands will grow linearly for the next three decades and may be influenced by a range of factors, the ART model forecast appears to fall at the middle to lower end of possible demand growth rates.

Figure 20: Comparison of trends and projections for public transport patronage across the Auckland Harbour Bridge, from ART model outputs (i11 scenario) and actual screenline counts.



Evidence that forecast public transport demand exceeds the functional capacity of planned public transport infrastructure and services.

The recent study, *North Shore RTN: Transport and land use deficiency and opportunity analysis* (Aurecon and MRCagney for Auckland Transport, 2016) provides evidence that forecast passenger transport demand is likely to exceed the functional capacity of core North Shore–City Centre public transport corridors by the 2030s.

Despite substantial upgrades to North Shore public transport infrastructure and services assumed to occur in the period to 2046 (i.e. the 'Do Minimum scenario')[5], demand growth is expected to exceed the rate of increase to the functional capacity of the public transport system, with demand exceeding capacity by at least the 2030s. Insufficient capacity is a problem in itself, and can contribute to other problems of poor operational performance (slow and unreliable trips).

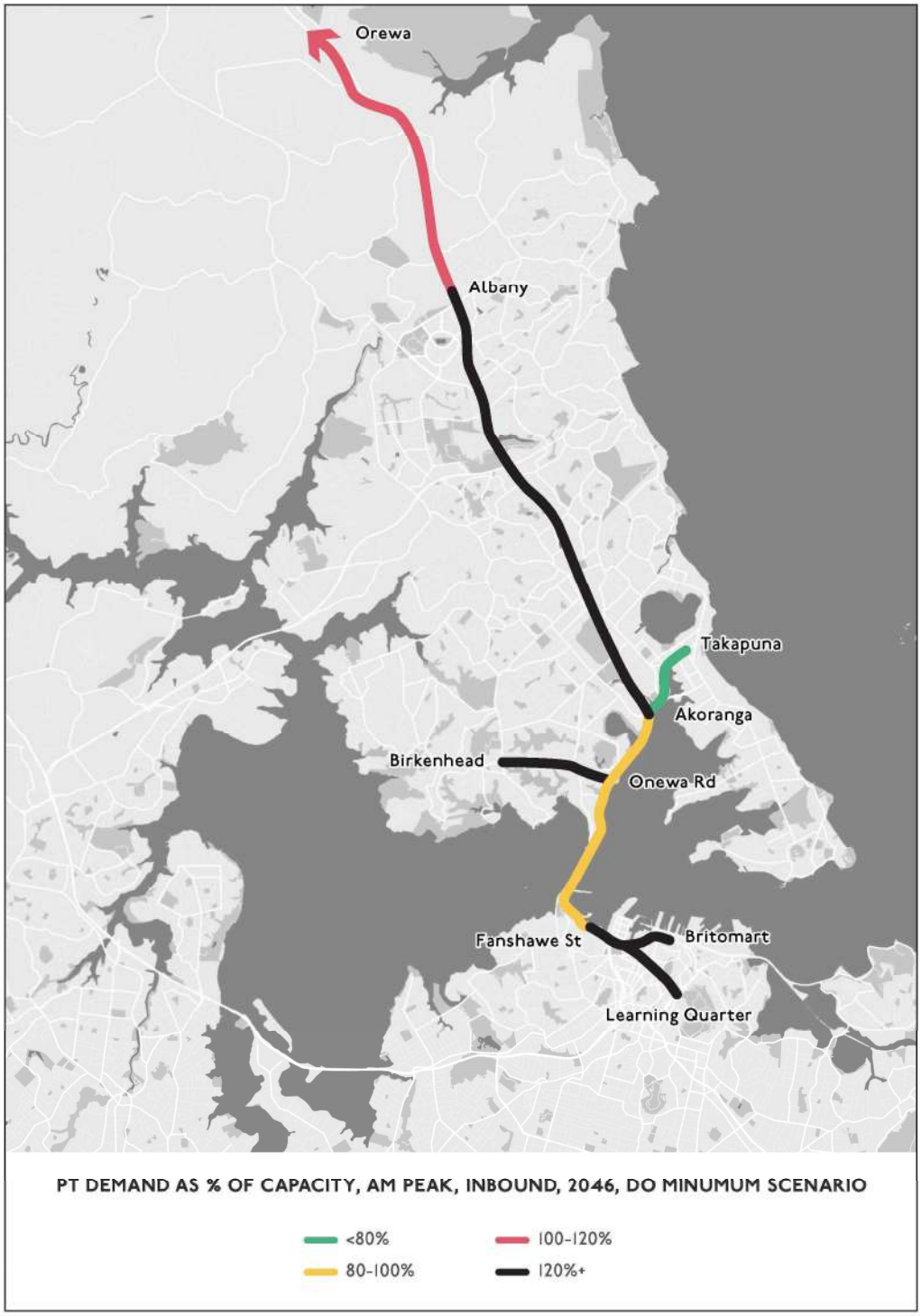
Figure 20 illustrates that passenger demand on most parts of the core North Shore public transport corridors is expected to exceed capacity in 2046. This figure summarises analysis that compares public transport demand forecasts (ART modelled forecasts, as reported previously in Section 1.5 with the infrastructure capacity of the

[5] The Do-Minimum scenario is specified in Section 9 and includes upgrades to public transport including Northern Busway extension to Albany, New City Centre bus terminals, upgraded City Centre bus corridors and introduction of the New Network.

corridors (a function of bus stop space, bus volumes, intersection signal timing, corridor space and terminal capacity).

Demand is more than 200% of capacity on the length of the existing Northern Busway (largely due to bus stop lengths being insufficient to provide for required bus volumes) and on the Onewa Road corridor. On both City Centre corridors, demand is more than 130% of capacity. Capacity on the Auckland Harbour Bridge section of the RTN is a lesser issue because the potential bus volume and passenger throughput on a motorway corridor without bus stops or intersections is very high. However, operational performance (travel time and reliability) is likely to be poor due to lack of priority lanes for buses (particularly in the Northbound direction).

Figure 21: Public transport demand as percent of capacity, core North Shore corridors, 2046 AM peak inbound



Detailed evidence for PT demand exceeding the functional capacity of the existing Northern Busway and City Centre corridors provided by the *North Shore RTN* study, considers four evaluation years: 2016, 2026, 2036 and 2046 and finds that:

- Current peak-period bus volumes exceed functional capacity already in 2016 in the City Centre and at Constellation Station.
- Capacity problems are somewhat reduced by 2026 due to implementation of bus infrastructure improvements in the City Centre and the upgrade of Constellation Station as part of the Northern Corridor Improvements (NCI) project. However, Albany Station experiences capacity problems.
- By 2036, operating bus volumes that are sufficient to cater to forecast demand mean significant over-capacity operations in the City Centre and at Albany, Constellation, Sunnynook and Akoranga Stations.
- By 2046, capacity problems exist at all North Shore stations and in the City Centre.

We note that patronage growth on the Northern Busway system has been somewhat higher than projected in the year since the previous study was completed. This indicates that the identified capacity problems may be experienced even earlier than the timeframes identified above.

The analysis also assesses the performance of the Northern Busway against a broader range of criteria beyond capacity, including: alignment with land use, operational performance, urban amenity, quality, service frequency and span and cost-effectiveness. In addition to the capacity problems summarised above, the assessment also predicts poor performance with regard to integration with land use and operational performance by 2036.

Key findings from the *North Shore RTN* (2016) assessment discussed below, in terms of the following main components of the existing North Shore RTN:

- Busway
- Harbour Crossing
- City Centre

Busway: Performance issues identified in 2016 include:

- limited capacity, slow travel speeds and variable travel times for the missing segment of busway between Constellation and Albany;
- inadequate size and capacity of Constellation Station to accommodate a large volume of bus services and passenger demand

However, by 2026, the joint AT/NZTA Northern Corridor Improvements (NCI) project anticipated to have completed the missing section of the busway, constructed a new Rosedale Busway station and provided an additional platform to Constellation Station, therefore improving these deficiencies.

Nevertheless, by 2026, increased patronage on the busway and busway stations is likely to manifest in over capacity conditions and poor operational performance at Albany Station due to large volumes of commencing services in the AM peak, which use up a lot of station capacity. Sunnynook Station, which has the shortest platforms of all the busway stations, will also be experiencing over capacity conditions affecting dwell times. Akoranga Station is also starting to experience congestion by this time.

By 2036, performance has degraded further at the above stations, with Constellation and Smales Farm now also expected to experience over capacity conditions affecting operational performance (i.e. dwell times).

By 2046 all of the busway stations are expected to be at or near capacity suffering from increased dwell times and greater dwell time variability affecting operational performance.

Harbour Crossing: The assessment of 2016 conditions finds quality, capacity and performance issues associated with the northbound link from Victoria Park (Fanshawe Street) to Akoranga Station via SH1 Northern Motorway including the Auckland Harbour Bridge. This is due to a range of factors including limited bus priority on the motorway itself and on the Esmonde Road off ramp. In the southbound direction significantly greater bus priority is already in place with a one-way busway from Akoranga Station for over 2km (to south of Onewa Road on ramp) and another bus lane on the City side of the AHB approaching Fanshawe Street. These bus lanes, along with the fact that there is more upstream capacity south of the bridge than provided on its approaches

from the north, means that inbound traffic over the bridge itself (where there is no bus priority) is relatively free flow with minimal bus journey time variability experienced here.

The Additional Waitematā Harbour Crossing (AWHC) project is currently undergoing further design development ahead of route protection and the proposed level of bus priority as part of this project is not yet known. However, previous plans proposed dedicated bus lanes on the AHB itself as well as a bus only bridge linking the northbound 'kerbside' bus lane to the two-way busway on the eastern side of the motorway south of Esmonde Road. These are expected to improve travel time and reliability performance on this section of the North Shore RTN once the AWHC is operational, currently proposed to be some time from the mid-2030s.

City Centre: The city centre extension of the busway from Victoria Park to Britomart and Learning Quarter has been shown to be the weakest link in the North Shore RTN for every assessment period.

In the 2016 assessment year, significant issues are evident with the operational performance of all City Centre sections of this RTN extension. However, by 2026, significant improvements in city centre bus infrastructure has been assumed. These interventions, while still conceptual in nature and subject to funding commitments, could improve operational performance. However, these upgraded bus priority corridors and new termini are still constrained by signals at intersections. As such, even in 2026, soon after implementation the city centre infrastructure is likely to only just provide sufficient capacity to meet demands.

By 2036, all City Centre corridors and termini are likely to be over capacity during peak times. This is likely to lead to degraded performance, with dwell times becoming more variable, increased bunching of buses and accumulation of passengers at stops congesting footways. In this time period the performance of the busway is likely to no longer be to an acceptable RTN standard.

By 2046, virtually all parts of the City Centre used by buses would be operating at over 120 per cent of theoretical capacity, and with highly degraded and unacceptable levels of performance (slow and highly variable travel times).

We note that all of these City Centre bus operational considerations are based on the exclusive use of high capacity double-decker buses running with conventional operations and standard bus stop designs. Alternatively, the use of an advanced bus system with specialised vehicle and stop design may provide some additional capacity and longevity to the busway system.

Evidence on wider economic impacts of poor transport performance on the North Shore RTN

There is some evidence that future poor passenger transport outcomes on the North Shore RTN will have negative economic impacts. Evidence for the 'wider economic benefits' of improved North Shore RTN will need to be developed further as part of later stages of the business case process, potentially including some degree of quantification in the Economic Case.

Economic theory and evidence suggests that improved transport accessibility, including PT accessibility, can lead to economic benefits over and above the benefits to transport users. This includes higher economic productivity resulting from increased agglomeration economies. This suggests that North Shore RTN investment that can overcome accessibility or transport capacity constraints to the Auckland City Centre may have regionally and nationally significant benefits for economic growth and productivity.

Kernohan and Rognlien (2011) review several ways in which transport improvements can lead to wider economic benefits.[6] They find evidence for four key mechanisms through which wider economic impacts may arise, including:

[6] Kernohan, D. and Rognlien, L. 2011. Wider economic impacts of transport investments in New Zealand. *NZTA Research Report 448*.

- Agglomeration economies, i.e. the economic benefits associated with increased scale and density of economic activity;
- Imperfect competition benefits, i.e. the additional savings from reductions in the cost of business travel in imperfectly competitive markets;
- Labour supply benefits, i.e. the impact of reduced commuting costs on labour market participation and hence income tax collections; and
- Job relocation impacts, i.e. the wage and productivity increases arising when major transport improvements allow people to move to higher-productivity locations.

Kernohan and Rognlien's findings were subsequently incorporated into recent updates to the NZTA's Economic Evaluation Manual, and their proposed methodologies for quantifying these benefits have been applied in a number of projects.

Agglomeration economies tend to account for the majority of wider economic impacts of major transport projects. These arise from fixed costs in production or increasing returns to scale at the firm level (Fujita, Krugman and Venables, 2001) or knowledge spillovers or improved potential for specialisation between firms and workers (Glaeser, 2008). This enables businesses located in larger or denser areas to be more productive. Following Alfred Marshall, there are three main "micro-foundations" for agglomeration:

- Geographically concentrated industries can support a wider and more specialised range of local providers of inputs and better supply-chain linkages

- Increased accessibility between firms and workers can support labour market pooling, which increases productivity by better matching workers to jobs and enabling firms to better adjust their labour input in response to demand shocks

- Geographic proximity facilitates knowledge spill-overs between firms and between workers.

A number of empirical studies have confirmed a relationship between locations' 'effective density', or their accessibility to a larger number of other firms or workers, and higher productivity levels. There is evidence of bidirectional causality at work – i.e. higher density/accessibility leads to higher productivity, and vice versa (Graham et al, 2010). In New Zealand, Maré and Graham (2009) have studied agglomeration economies in different industries, finding a positive (causal) relationship between the effective density of employment and productivity. This relationship tends to be strongest in service sectors that tend to locate in major centres, including financial services, professional services, and retail trade.

Maré (2008) provides further evidence on the "Auckland productivity premium". As shown Table 6, the Auckland urban area is 29 per cent more productive than the rest of New Zealand even after adjusting for industry composition. He finds an even higher productivity premium of 72 per cent in the Auckland City Centre, which is the city's most accessible and dense employment centre. The North Shore as a whole also enjoys a productivity premium relative to the rest of the country, albeit not as large a premium.

Table 6: Auckland's productivity premium, 2006 (Source: Maré, 2008)

Area	Value added per worker (VAPW)	Industry-adjusted VAPW	Productivity premium (industry-adjusted)
New Zealand	$52,037	-	-
New Zealand excluding Auckland	$45,440	$48,126	-
Auckland Urban Area	$68,435	$61,943	+29%

Former Auckland City Council area	$76,930	$66,836	+39%
Auckland city centre	$106,873	$81,638	+72%

If observed relationships between transport accessibility, effective density, and productivity continue to hold true, then it is reasonable to expect reductions in the performance of North Shore public transport will reduce agglomeration economies in Auckland. Longer or less reliable commuting for some North Shore residents and constraints to peak-period capacity of the overall passenger transport system (both road and public transport) will constrain the growth of employment and limit labour market pooling.

However, further analysis, potentially including modelling of the agglomeration benefits of alternative transport and land use arrangements using procedures set out in the NZTA's Economic Evaluation Manual, is likely to be useful in establishing the degree to which constraints on PT capacity and reliability will affect economic outcomes. This is likely to be a focus for economic cases, particularly at the Indicative Business Case level.

4.6 IMPLICATIONS OF THE EVIDENCE

Currently committed PT infrastructure and services to, from, and within the North Shore will be unable to provide sufficient capacity and service quality to support planned residential and employment growth. If left unaddressed, a lack of adequate PT capacity connecting planned North Shore growth areas with key employment centres and with the regional public transport network will inhibit planned urban growth. It will also negatively impact on economic performance by constraining regional labour market accessibility.

Presently, during the morning peak period, the North Shore RTN (on the Auckland Harbour Bridge) carries around 10,000 people, comparable to Britomart train alightings during the same morning peak period. The harbour bridge is the only viable cross-harbour road connection and a critical link for journeys to/from the City Centre and the North Shore. Planning for the North Shore RTN will consider the options, benefits and implications of improving PT network resilience with and without an additional harbour crossing. Furthermore, planning should consider the implications of this occurring before, with or after NZTA's planned motorway crossing.

Forecast growth in population and employment on the North Shore (and Auckland more generally) will drive future transport demands, including demand for PT. The Auckland Plan land use forecasts developed in 2011/2012, and subsequently used as a basis for transport planning, recognise the high expected level of growth. However, since then, three policy changes have affected expectations for future PT demand growth and the distribution of demands within the network:

- The Auckland Unitary Plan will enable greater levels of urban intensification and greenfield growth on the North Shore than previous district and regional plans. This will contribute to accommodating expected population and employment growth, but it may also change the spatial distribution of that growth.
- Auckland Transport is currently implementing the New Network, which is intended to deliver greater region-wide PT accessibility by enabling transfers between frequent PT services and better integration of the bus network and existing rapid transit network. In effect, while services may still travel to the city centre, enabling connections allows passengers to access a wider range of destinations by public transport.
- Since its development in 2008, demand on the Northern Busway has grown more rapidly than forecast, in the context of overall growth in demand on the PT network. The Northern Busway's success in attracting patronage means that the expected date that it reaches capacity is sooner than expected in the 2008 study of future PT requirements on the North Shore underpinning the Indicative Business Case for the AWHC (Parsons Brinkerhoff, 2008).

As a consequence of these policy developments, the forecast scale of PT demand on the Northern Busway, the North Shore's PT trunk route, is expected to exceed the capacity of currently planned infrastructure and service

by the mid-2030s at latest. There is already evidence of service quality and capacity problems on portions of the Busway, particularly when it reaches the City Centre, and evidence that these problems are arising faster than previously projected.

Attempting to meet future demand growth within the constraints of the existing infrastructure will result in inefficient and costly public transport operations and poor customer experience, including extended and unreliable travel times. Furthermore, capacity constraints and poor service quality on North Shore PT will reduce the attractiveness of PT relative to private vehicle modes, increasing private vehicle demand on congested corridors such as the Harbour Bridge and reducing the efficiency of the region's road network.

Unaddressed transport problems also create risks that economic and urban growth will be constrained, or pushed to less optimal locations (e.g. other parts of the North Shore, other parts of the Auckland region or beyond the region) that are less productive or less attractive for households and businesses. Limited capacity or long/unreliable travel times on PT services to, from, and within the North Shore will, over time, reduce households' accessibility to the City Centre and Metropolitan centres, which are expected to accommodate significant employment growth for office-based and retail activities.[7]

Reduced PT accessibility will have negative impacts on the region's economic performance, as it will reduce the potential for agglomeration economies arising from labour market pooling (i.e. businesses being able to access a large pool of workers, including workers with specialised skills), supply-chain efficiencies (i.e. better accessibility between businesses and their customers), and knowledge spillovers (i.e. exchange of information between firms and workers). Given the scale of Auckland's economy, these negative economic impacts are of national significance.

[7] Office-based and retail activities are expected to account for a large share of Auckland's future employment growth. These activities primarily, although not exclusively, locate in centres, in contrast with industrial and warehousing activities which are typically more dispersed.

PART B – DEVELOPING THE PROGRAMME

Part B of the programme business case maps the path from identifying a broad range of fields of action to a recommended programme. The fields of options are assessed for their suitability and effectiveness regarding the investment objectives. Sequentially the fields scoring most satisfactory will be further developed into specified alternatives and options. After assessment a recommended programme will be discussed.

5 ALTERNATIVES AND OPTIONS

The development and testing of options in this PBC was carried out in two stages.

Stage 1: a long list of programme alternatives that considered a broad range of potential intervention approaches.

Stage 2: further developed the potentially effective options from stage 1 and a further assessment was carried out to identify a recommended programme.

5.1 ALTERNATIVE AND OPTION GENERATION: STAGE 1

A range of alternatives and options have been identified for responding to the problems and achieving the benefits identified in the strategic case. The process for generating options included using a workshop of stakeholders (held on 20th September 2016) to identify the broadest possible range of plausible options. Options also draw on work completed to identify rapid transit options undertaken for the *North Shore Rapid Transit Study* (Aurecon and MRCagney 2016).

Table 7 provides an overview of the identified programme alternatives and options. Programme alternatives fall into three broad categories that use different approaches to address the demand/capacity mismatch identified in Problem 1:

i. demand management measures that seek to reduce demand to a level that matches planned supply – alternative B;

ii. productivity measures that seek to increase the efficiency of the existing public transport network – alternative C; and

iii. supply measures that seek to increase transport capacity in line with projected demand – alternatives D and E.

Options are more specific activities that fit within one of the three alternatives. A total of 16 options are identified. Table 7 describes each option with reference to common/existing components (e.g. components of the Do-Minimum) and new or upgraded components. The options identified are indicative examples of the types of specific interventions that may be possible. The options listed have been selected as representative of the likely range of potential responses that may be plausible within each thematic alternative. There are, however, likely to be a number of other plausible detailed configurations of technologies, policies, and infrastructure components for each option.

Table 7: Summary of alternatives and options

Alternatives	Options	Existing/common components	New/upgraded components
A: Do-minimum	**A1: Do-minimum**	Busway on North Shore; on-street running/mixed priority elsewhere. Ferries as per existing routes.	• Northern Busway extension to Albany including an offline two-way busway between Constellation and Albany, new northbound mainline platform at Constellation, new footbridge connecting Constellation to Unsworth across the motorway, and new Rosedale station. • Expanded park-and-ride at Constellation and Albany stations (400 space extension). • New Network introduced with Northern Busway service routed to Britomart (NEX1) and Aotea–University (NEX2). Services exclusively use double decker buses, upgraded frequencies. • New City Centre bus terminals and interchanges at Britomart, Wynyard Quarter, Aotea and Learning Quarter. • Upgraded City Centre bus corridors as per Wynyard–Fanshawe and Wellesley St–Learning Quarter projects, including integrated corridor/stop/routing patterns and extra stop capacity. • Bus frequency improvements and service changes to meet growth, particularly in growth areas north of Albany (e.g., more frequent NEX services to Hibiscus Coast). • Minor capacity and frequency upgrades to ferries to match growth.
B: Demand management	**B1: Land use**	As per Option A1.	• Significant additional business/ employment zoning and density on the North Shore, e.g., in Takapuna and Albany, to increase North Shore job levels and enable greater 'self-containment' of jobs (i.e. North Shore residents being employed within the North Shore). • Transit-oriented, mixed-use developments to reduce needs for longer-distance travel between residential areas and employment or other activities. • Reduced residential zoned capacity, through reduction in intensification potential within the existing urbanised area and reduction in land zoned for future urban growth.

Alternatives	Options	Existing/common components	New/upgraded components
	B2: Pricing	As per Option A1.	• Alternate fares policy to significantly increase PT fares at peak periods to force peak spreading – i.e., encourage more shoulder and off-peak commuting. • Introduce charging for park-and-ride at busway stations. • Combine PT pricing with road pricing to mitigate crossover impact on private vehicle demands across the harbour.
	B3: Carpooling	As per Option A1.	Incentivise use of carpooling through measures such as: • More T2/T3 lanes, including on the Harbour Crossing; • Autonomous vehicle carpooling schemes.
C: Enhance existing network	**C1: PT network design**	As per Option A1 for infrastructure (but different bus network).	Alternative to the New Network to spread passenger loads across multiple routes, corridors and stops. For example: • Reconfigure North Shore network to provide more direct bus services to the City Centre (less interchanging) with multiple additional routes between the North Shore and City Centre. • Reconfigure City Centre network to use new road corridor(s) within the City Centre and fringe, e.g., some North Shore buses travel via Cook Street and Mayoral Drive. • Route bus services from north of Constellation to the City Centre via the Western Ring Route.
	C2: Emerging technology	As per Option A1.	Optimising public transport system capacity with use of emerging technologies including: • Platooning technologies for buses enabling buses to travel together more closely and increasing capacity; • Autonomous public transport vehicles allowing platooning; • Autonomous large vehicle lane(s) across the harbour, i.e., bus + truck; • ITS allowing more dynamic signalling priority and lane management to benefit buses; • Ticketing systems allowing faster boarding.

Alternatives	Options	Existing/common components	New/upgraded components
D: Upgrade existing modes	**D1: Enhanced ferry**	Busway on North Shore only as per Option A1. On-street bus running/mixed priority elsewhere.	New passenger ferry terminals and routes: • Akoranga "SeaBus"; • East Coast Bays route (stopping at Takapuna Beach, Milford, Mairangi Bay, and Browns Bay); • Island Bay and Greenhithe terminals (combined with Beach Haven/Hobsonville Point route). • Increased frequency on existing North Shore ferry routes: Devonport, Stanley Bay, Bayswater, Northcote Point/Birkenhead, and Gulf Harbour.
	D2: Active modes	PT network as per Option A1.	• Incentivise use of active modes to relieve demand on PT and road networks, e.g., building more "SkyPaths" across the harbour and promoting greater uptake of electric bikes.
	D3: Upgrade road capacity	PT network as per Option A1.	Additional capacity for private vehicles across the harbour and into the City Centre to relieve demand on the PT network. • Additional vehicle lanes on the existing AHB or a new harbour crossing, and/or new ferry services for vehicles using roll-on, roll-off vessels. • Reallocate more road space in the City Centre for private vehicles. Likely to require greater uptake of carpooling and autonomous vehicles to manage demand for parking and road space in the City Centre.
E: New North Shore modes	**E1: LRT full**	Buses on local roads feeding RTN. Ferries as per Option A1.	LRT on 3 main corridors of demand: Onewa Road, Busway, Takapuna: • Convert busway to LRT; • New grade-separated LRT right-of-way to Takapuna; and • New on-street LRT on Onewa Road. Requires 4-track harbour crossing (e.g., 2 tracks under the harbour in a tunnel and 2 over a new or existing bridge, or 4 tracks in a tunnel).

Alternatives	Options	Existing/common components	New/upgraded components
	E2: LRT part	Buses on local roads feeding RTN spine; buses on Onewa Road + AHB. Ferries as per Option A1.	• LRT on one corridor of demand, e.g., Busway. • Initially LRT from Albany to City Centre via Fanshawe Street interlined with Queen Street/Dominion Road/Airport LRT. • Options for LRT in AWHC tunnel or on a new bridge or separate tunnel (TBC). • Enhanced bus priority on Onewa Road and Takapuna corridors as per Options D1/D2.
	E3: Metro	Buses on local roads feeding RTN spine; buses on Onewa Road + AHB. Ferries as per Option A1.	• Metro on two corridors of demand, e.g., Busway + Takapuna. • Metro continues through City Centre in a tunnel with three stations (Wynyard Quarter, Aotea, Learning Quarter) • Options for metro in AWHC tunnel or on a new bridge or separate tunnel (TBC). • Enhanced bus priority on Onewa Road corridor as per Options D1/D2.
	E4: Heavy rail	Buses on local roads feeding RTN spine; buses on Onewa Road + AHB. Ferries as per Option A1.	• Heavy rail on two corridors of demand, e.g., Busway + Takapuna. • Rail continues through City Centre in a tunnel with up to three stations (Wynyard Quarter, Aotea, Learning Quarter) and connects with southern line at Parnell. • Options for rail in AWHC tunnel or on a new bridge or separate tunnel (TBC). • Enhanced bus priority on Onewa Road corridor as per Options D1/D2.
	E5: Light + heavy rail	Buses on local roads feeding RTN spine; buses on Onewa Road + AHB. Ferries as per Option A1.	• Light rail serves “inner” Busway and Takapuna corridors then crosses harbour via a new bridge or tunnel and interlines with on-street Queen Street/Dominion Road/Airport LRT. • Heavy rail serves longer distance commuters from Orewa/Silverdale to City with limited stops. Mostly tunnelled on North Shore. • Heavy rail continues under the harbour and through the City Centre as per Option E4.

Alternatives	Options	Existing/common components	New/upgraded components
	E6: Elevated transit	Buses on local roads feeding RTN spine; buses on Onewa Road + AHB. Ferries as per Option A1.	• Elevated rail or cable system (e.g., cable car, gondola, or monorail) above the busway corridor and on a new ROW to Takapuna. • New cable car, gondola or monorail ROW across the harbour. • Buses continue to operate on the busway from north of Albany to the City Centre. • Enhanced bus priority on Onewa Road and across the AHB as per Options D1/D2.

5.1.1 DO-MINIMUM OPTION

The do-minimum option incorporates the existing Northern Busway and the programme of currently planned public transport network improvements included in the Auckland Transport Alignment Project (ATAP) Common Elements Enhanced project list. The ATAP project list has been used for specifying the do-minimum, being the most current and widely-agreed list of committed projects and policy interventions. The following service and infrastructure upgrades relevant to the study area are expected by 2046:

- Northern Busway extension to Albany as part of the Northern Corridor Improvements (NCI) project, including an offline two-way busway between Constellation and Albany, new northbound mainline platform at Constellation, new footbridge Constellation to Unsworth across motorway, and new Rosedale station.
- Expanded park-and-ride at Constellation and Albany stations (400 space extension).
- Introduction of the New Network, with Northern Busway service routed to Britomart (NEX1) and the Learning Quarter (NEX2), frequent service from Birkenhead and Glenfield to Britomart via Onewa Road, and frequent service from Milford to the Learning Quarter via Takapuna.
- Exclusively double-decker buses on the core North Shore to City services—NEX, Takapuna, Birkenhead and Glenfield—and upgraded frequencies as per the Bus Reference Case.
- New City Centre bus terminals and interchanges at Britomart, Wynyard Quarter, Aotea and Learning Quarter.
- Upgraded City Centre bus corridors as per Wynyard–Fanshawe and Wellesley St–Learning Quarter projects, including integrated corridor/stop/routing patterns and extra stop capacity.
- Bus frequency improvements and service changes to meet growth, particularly in growth areas north of Albany (including more frequent NEX service to Hibiscus Coast).
- Minor capacity and frequency upgrades to existing ferry routes to match limited growth.

6 ALTERNATIVES AND OPTIONS

6.1 DEMAND MANAGEMENT

The following options were identified within the demand management programme alternative:

- **B1. Land use:** high employment growth and/or reduced population growth on the North Shore.
- **B2. Pricing:** alternate PT pricing policy to manage peak demand.
- **B3. Carpooling:** increasing private vehicle occupancy rates during the peak by promoting and incentivising carpooling.

These options aim to reduce demand for public transport travel between the North Shore and the City Centre in order to bring demand closer in line with infrastructure capacity.

For option **B1. Land Use**, two potential components were identified:

- increasing potential for employment growth
- decreasing potential residential growth in North Shore areas.

Increased job growth in North Shore areas may allow for greater ‘self-containment’ of employment on the North Shore (i.e. more North Shore residents also working in North Shore locations). This in turn, may reduce peak-period public transport demand on some parts of the network (e.g. the Harbour Crossing). Reduced residential growth on the North Shore may also reduce forecast growth in public transport demand.

Increased job growth and self-containment of employment on the North Shore (and accompanying reductions in job growth in the City Centre) could potentially be achieved through additional business zoning or other land-use planning measures that incentivise employers to locate on the North Shore. In aiming to reduce public transport commute demands between the North Shore and City Centre, the most likely North Shore centres that may be

able to substitute for City Centre employment locations are the Metropolitan Centres of Albany and Takapuna with existing clusters of professional and retail service businesses.

Reduced residential population growth could be achieved by decreasing the North Shore areas zoned for future urban growth or reducing the developable capacity of the existing urban area through revised zoning codes (e.g. reducing potential for intensification in centres such as Takapuna).

Option **B2. Pricing** allows peak PT demand to be managed through the use of higher peak fares (or off-peak fare discounts) to encourage peak spreading, and/or introducing a charge for park-and-ride at busway stations. Higher prices for PT journeys should be implemented in combination with road pricing measures to mitigate any crossover impacts on private vehicle demands across the harbour.

For Option **B3. Carpooling**, PT demand is managed by introducing new peak-only or full-time T2/T3 lanes on the North Shore, in the City Centre, and/or across the AHB. Further measures to incentivise carpooling could include banning single-occupant vehicles across the AHB, providing carpool-only parking in the City Centre, or developing autonomous vehicle carpooling schemes.

6.2 ENHANCE EXISTING NETWORK (PRODUCTIVITY)

The following options were identified within the Enhance Existing Network programme alternative:

- **C1. PT network Design:** additional city centre bus corridor(s) and North Shore routes to spread demand and add stop capacity.
- **C2. Technology:** optimising bus capacity with autonomous vehicle (AV) buses allowing platooning, ITS for signal priority and lane management, ticket systems to allow faster boarding.

These options aim to increase the efficiency of the existing PT network by enabling higher volumes of buses to run within the do-minimum infrastructure capacity.

Option **C1. PT Network Design** proposes a redesign of the North Shore New Network to spread passenger loads across multiple corridors and stops instead of relying on a trunk-and-feeder network design. This would involve:

- reconfiguring the North Shore network to provide more direct bus services to the City Centre, thus reducing demand on the busway trunk corridor
- spreading City Centre bus services across additional road corridors (e.g., some North Shore buses travelling via Cook Street and Mayoral Drive) to reduce demand on Fanshawe and Wellesley Streets and at the Britomart and Learning Quarter terminals.
- Reducing bus volumes across the harbour by routing bus service to the City Centre from north of Constellation via the Western Ring Route.

Option C1 is dependent on sufficient capacity being available on the SH16 corridor and is unlikely to be plausible. This would also significantly increase operating expenditure with a longer route.

Option **C2. Technology** would optimise the use of existing infrastructure through use of emerging technologies such as:

- Platooning technologies that enable closer running of conventional buses;
- Autonomous buses, enabling buses to form platoons, thus using corridor and stop space more efficiently;
- ITS signal priority and lane management to improve bus travel time and reliability; and
- Ticketing systems that enable faster boarding and alighting, resulting in more efficient use of existing stop space.

The introduction of autonomous vehicles could also be used in combination with priority lanes across the harbour to further optimise the transport network, e.g., autonomous large vehicles lanes for buses and trucks.

6.3 UPGRADE EXISTING MODES

The following options were identified within the Upgrade Existing Modes programme alternative:

- **D1. Enhanced Bus On-street:** increased bus priority on core corridors.
- **D2. Enhanced Bus Off-street:** new City Centre bus tunnel (Wynyard to Learning Quarter, with three underground stations), and upgrades to core North Shore bus corridors (incl. lengthening all Northern busway station platforms).
- **D3. Enhanced Ferry:** new ferry terminals and routes, increased frequency and capacity on existing ferry routes.
- **D4. Active Modes:** higher use of active modes, including electric bikes.
- **D5. Upgrade Road Capacity:** additional capacity for private vehicles across the harbour to reduce PT demand.

These options involve upgrades to bus, ferry or road infrastructure to increase passenger-carrying capacity on core North Shore routes. Options D1–D3 involve increasing public transport capacity while Options D4 and D5 involve increasing total passenger-carrying capacity on key routes through upgrades to private transport modes (bicycles or cars).

Option D1 Bus On-street focuses on using relatively minimal infrastructure interventions to increase bus capacity. Interventions could include:

- A new busway or grade-separated right of way from Akoranga to Takapuna
- Upgraded (continuous, full-time) bus lanes along Onewa Rd
- Enhanced bus priority over Auckland Harbour Bridge
- Maximised on-street bus priority, including through the City Centre (e.g., continuous bus lanes and signal priority on Wellesley and Fanshawe Street)
- Opportunity to interline North Shore buses with Isthmus buses

Option D2 Bus Off-street involves more substantial infrastructure interventions that aim to address key capacity constraints on the bus network. Components likely to be required in order to address capacity constraints include:

- Lengthened platforms at all existing Northern Busway stations
- New busway or grade-separated right of way from Akoranga to Takapuna; upgraded (continuous, full-time) bus lanes and lengthened stops along Onewa Rd
- Enhanced bus priority over Auckland Harbour Bridge and/or a bus-only tunnel under the harbour
- New City Centre tunnel from Wynyard Quarter to the Learning Quarter with 3 underground bus stations at Wynyard, Aotea, and Learning Quarter.

Option D3 Ferry focuses on enhancing the North Shore to City Centre ferry network to increase public transport capacity on these routes. In addition to increased frequency on existing North Shore ferry routes (Devonport, Stanley Bay, Bayswater, Northcote Point/Birkenhead, and Gulf Harbour), new passenger ferry terminals and routes could include:

- Akoranga “SeaBus”;
- East Coast Bays route (stopping at Takapuna Beach, Milford, Mairangi Bay, and Browns Bay);
- Island Bay and Greenhithe terminals (combined with Beach Haven/Hobsonville Point route).

Option D4 Active Modes uses enhancements to bicycle infrastructure to increase passenger-carrying capacity on North Shore to City Centre routes. This could include:

- Construction of more cross-harbour walking and cycling paths to complement the planned SkyPath
- Additional ferry service could also provide the cross-harbour section of walking and cycling journeys
- Measures to incentivise the use of electric bikes would aid in greater uptake of active modes for travel between the North Shore and the City Centre due to the long distances involved for many journeys.

Option D5 Upgrade Road Capacity involves new road infrastructure to provide additional passenger-capacity between the North Shore and the City Centre. This could consist of:

- Additional vehicle lanes on the existing AHB or a new harbour crossing; and/or
- New ferry services for vehicles using roll-on, roll-off vessels; and
- Reallocating more road space in the City Centre for private vehicles.

Option D5 is likely to also require greater uptake of carpooling and autonomous vehicles to manage demand for parking and road space in the City Centre.

6.4 NEW NORTH SHORE MODES

The following options were identified within the New North Shore Modes programme alternative:

- **E1. LRT Full:** LRT across the harbour and on 3 North Shore corridors – Onewa, Takapuna, Busway.
- **E2. LRT Part:** Upgrade the Northern Busway (Albany to City Centre) to LRT.
- **E3. Metro:** 2 corridors – Busway and Takapuna
- **E4. Heavy Rail:** 2 corridors – Busway and Takapuna
- **E5. LRT + Heavy Rail:** LRT on 2 corridors – Takapuna, Busway. Heavy Rail 'express' – Newmarket to Orewa/Hibiscus Coast.
- **E6. Elevated Transit:** An elevated rail-based (e.g., monorail) or cable-based (e.g., cable car or gondola) right-of-way on 2 corridors – Busway and Takapuna.

These options aim to increase public transport infrastructure capacity across the harbour in order to cater for projected demands. They also aim to increase the customer service quality and operational performance of the public transport system.

It is acknowledged that a range of sub-options exist with variations in the extent, timing and combination of these 'headline' options.

Option E1 LRT Full would provide LRT on three core North Shore public transport corridors. In addition to the City Centre–Albany line (Option E2), additional LRT lines would be provided to Takapuna and Birkenhead (via Onewa Road). This LRT configuration would require a 4-track LRT harbour crossing, which would require a new harbour crossing (tunnel or bridge; may be integrated with AWHC) as four tracks could not be provided for using the existing Harbour Bridge. This option would result in minimal North Shore buses travelling into the City Centre.

Option E2 LRT Part involves a single LRT line that replaces the current Northern Busway and provides a North Shore extension to the planned LRT line between the Airport and the City Centre (Queen Street). This LRT configuration would require a 2-track LRT harbour crossing (rather than a 4-track configuration under Option E1). The LRT line could cross the Harbour using either the existing Harbour Bridge, considered impractical, or a new crossing (tunnel or bridge; may be integrated with AWHC). It would terminate at Albany. This option would provide a high capacity public transport line on the major corridor of North Shore–City Centre demand. Other core parts of the network (Takapuna–City Centre, Onewa Road–City Centre and Hibiscus Coast–Albany) would continue to be served by buses.

Option E3 Metro involves using Metro rail technology (e.g. driverless rail on a dedicated corridor) to provide high capacity public transport service on two major corridors of demand. This would likely involve replacing the Northern Busway on the Albany–City Centre corridor with Metro and a branch line to Takapuna. This option would require a new harbour crossing (tunnel or bridge; may be integrated with AWHC). The line is likely to

include a Wynyard Quarter station, an Aotea station (allowing for transfers with the existing heavy rail network), and terminate at a Learning Quarter station. Buses would continue to serve the other major corridor of demand on the Onewa Road–City Centre corridor.

Option E4 Heavy Rail uses heavy rail technology (similar to that in use for Auckland's existing heavy rail network) to provide a high capacity public transport service on up to two major corridors of demand. As with Option E3 this is likely to involve the Albany–City Centre and Takapuna–City Centre corridors, with heavy rail replacing the busway. Heavy rail could integrate with the existing network with a transfer station at Aotea in the City Centre and a connection to the Southern Line at Parnell or Newmarket. This would enable continuous North–South services, potentially running between Albany and Papakura. This configuration would enable higher-capacities on the remainder of the existing heavy rail network by removing existing junctions and allowing for higher train frequencies. A new East–West crosstown rail tunnel could include up to three stations at Wynyard, Aotea and the Learning Quarter. The Onewa Road–City Centre corridor would continue to be served by buses.

Option E5 Light + Heavy Rail would serve the existing urbanised area of the North Shore with light rail on the Albany–City Centre and Takapuna–City Centre corridors, as per Option E2, while serving growth areas further north with a limited-stops heavy rail line from Orewa to the City Centre. The heavy rail line could serve the outer areas with stops at Orewa, Silverdale and Dairy Flat, while heavy rail stations at Albany and Akoranga would enable transfers to the light rail and bus networks. The heavy rail line would be predominantly tunnelled between Albany and Akoranga, and would continue in a tunnel under the harbour to the City Centre, connecting to the Southern Line as per Option E4. Buses would continue to serve demands on the Onewa Road–City Centre corridor.

Option E6 Elevated Transit involves using elevated rail technology (e.g., elevated monorail) or cable transport technology (e.g., a gondola or cable car) to provide public transport service on the major corridors of demand. As with Option E3, this is likely to include the Albany–City Centre and Takapuna–City Centre corridors, although the reduced spatial requirements compared to traditional rail-based modes may also allow for an RTN line on the Onewa Road–City Centre corridor. Under this option, some buses could continue to operate on the Northern Busway below the elevated line, thus enabling passengers from north of Albany to travel to the City Centre without transferring to a new mode at Albany; the same applies to buses on the other corridors from Takapuna and Onewa Road.

7 ALTERNATIVE AND OPTION ASSESSMENT

This section reports on the relative performance of programme alternatives in addressing the problems identified in the strategic case and achieving the investment objectives identified in this PBC. It provides a summary of the approach to assessment and results. More detailed information on methods and results is provided in Appendix C.

7.1 APPROACH TO ASSESSMENT

Completing the assessment involved four steps:

1. **Establishing performance measures for each investment objective:** identifying indicators that closely reflect the investment objective and for which the performance of options can be viably estimated and quantified over the course of the 30-year study period to 2046.

2. **Specifying indicative options for each programme alternative:** creating indicative improvements to the transport network or new land-use scenarios to a level of detail that allows for measurement of performance against the indicators established in step 1 (e.g. specifying new transport mode technologies and route alignments that allow for measurement of passenger carrying capacity and travel speed). A range of options within each alternative was specified to provide an understanding of

the potential range of performance within a single alternative. The options have been detailed previously in Section 6.

3. **Evaluating the performance of options:** estimating the performance of each option against each measure using various methods, depending on the performance measure (details available in Appendix C). For measures where a target level of performance was readily available, performance was measured against a target or benchmark level. For other measures, performance was assessed relative to the Do-Minimum option.

4. **Reporting the results of evaluation for each programme alternative:** summarising and presenting the performance of each alternative using a seven-point scoring scale. The overall score for an alternative was derived by using the results of the highest scoring option within each alternative. Programme alternatives were scored positively if they exceeded the target performance level or performed better than the Do-Minimum. Alternatives were scored negatively if they did not meet the target level or performed worse than the Do-Minimum

When assessing options, new and emerging technologies that have not been proven operationally within an existing PT network were excluded from being carried forward into a recommended programme because of the risks surrounding operation and security of procurement.

Table 8 lists the performance measures established for the seven investment objectives (the output of Step 1 from above). The methods used to assess each option against these measures are detailed in Appendix C.

Table 8: Investment objectives and performance measures

Investment Objective	Performance measure for assessing options
IO 1. The PT network has the capacity to meet forecast demands to, from and within the North Shore.	1.1 Forecast PT passenger demand (peak hour) as proportion of PT capacity on the following major corridors: – Onewa Road–City Centre (AHB) – Takapuna Centre–Akoranga – Birkenhead–SH 1 (Onewa Road) – Albany–Akoranga (Northern Busway) – Orewa–Albany (SH 1)
IO 2. The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.	2.1 Average peak period PT travel time between the following centres: – Takapuna–City Centre – Highbury Shops–City Centre – Albany–City Centre – Orewa–Albany
	2.2 PT travel time variability between the following centres: – Takapuna–City Centre – Highbury Shops–City Centre – Albany–City Centre – Orewa–Albany
IO 3. The PT network improves the resilience of the passenger transport system across the Waitematā Crossing to both major and minor disruptive events.	3.1 Impact on passenger carrying capacity of an incident or major event blocking general traffic lane/s on the Harbour Crossing
IO 4. PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.	4.1 Job accessibility: Number of jobs accessible to the average Auckland resident within a 45-minute PT travel time (AM peak period).

Investment Objective	Performance measure for assessing options
	4.2 Number of residents within 45-minute PT travel time (AM peak) to selected centres: – City Centre – Albany – Takapuna – Newmarket – New Lynn – Sylvia Park – Manukau
	7.2 Level of long-term impacts from infrastructure and operations (environmental and social)

7.2 RESULTS OF ASSESSMENT

The results of assessing programme alternatives against the investment objectives and performance objectives relevant to the problem statement is summarised in

Table 9 . The following paragraphs highlight key findings for assessment against each investment objective.

Performance against investment objective 1: ***The PT network has the capacity to meet forecast demands to, from and within the North Shore.***

- Only alternatives D and E ('Upgrade Existing Modes' and 'Add New Modes') scored positively. These alternatives both provide sufficient public transport capacity to meet forecast levels of demand in 2046. Upgrading existing mode (bus) provides sufficient capacity in 2046, but provides little headroom to accommodate faster than forecast growth during the evaluation period or further growth after 2046. Installing new modes provides sufficient capacity on all corridors in 2046. The higher capacity options within this alternative (e.g. heavy rail) provides considerable headroom for further growth.
- Alternatives B and C ('Demand Management' and 'Enhance Existing Modes') do not produce enough change to Do-Minimum conditions to score positively. 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. Options for enhancing the existing network (for example, technology improvements allowing bus platooning or introducing additional bus corridors in the City Centre) do not increase public transport capacity sufficiently to cater to forecast demand.
- The Do-Minimum scenario scores very poorly. The capacity of planned levels of bus service and accompanying infrastructure is insufficient to provide for forecast public transport demands on most core corridors in the study area. Bus stop space and terminal space are key constraints on capacity, particularly on the Northern Busway and in the City Centre.

Performance against investment objective 2: ***The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.***

- Scores for this investment objective only included assessment relative to the Do-Minimum rather than against any target levels of travel speed or reliability.
- Performance of the Do-Minimum is expected to be poor, with bus congestion at over-loaded stops and in the City Centre and buses mixing with traffic congestion on parts of the network.
- All alternatives provide improvements to PT network speed and reliability, relative to the Do-Minimum scenario.

- Alternative E ('Add new modes') scores best, with new rail-based modes expected to provide a higher level of customer service, including faster and more reliable travel times on core corridors.

Performance against investment objective 3: ***The PT network improves the resilience of the passenger transport system across the Waitematā Crossing to both major and minor disruptive events.***

- Scores for this investment objective only included assessment relative to the Do-Minimum rather than against any target levels of resilience to major and minor disruptive events.
- Performance of the Do-Minimum is expected to be poor, with a single bridge crossing meaning that in the event of major disruption, the next shortest alternative route will add considerable travel time for users. With no dedicated road space for public transport, even minor disruptive events on the Harbour Crossing are expected to mean low levels of resilience to disruption.
- Alternatives B and C do not change the level of resilience as they do not involve construction of any additional Harbour Crossing route.
- Alternative D provides minor benefits by providing bus priority measures on the Bridge, reducing the impacts of minor disruptive events on public transport.
- Alternative E provides a significant improvement, by establishing an additional public transport crossing and introducing some redundancy and spare capacity into the network.

Performance against investment objective 4: ***PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.***

- Scores for this investment objective only included assessment relative to the Do-Minimum rather than against any target levels of accessibility.
- Alternatives B and C make little change to levels of accessibility. Land-use options tested within Alternative B may reduce accessibility by decentralising employment. Shifting employment from the City Centre to Albany and Takapuna will reduce accessibility to jobs for Auckland residents outside the North Shore.
- Alternatives D and E have minor positive impacts on accessibility, with faster and more reliable public transport on North Shore corridors meaning increased jobs and other opportunities are available within the same level of travel time.

Table 9: Results of assessment against investment objectives relevant to the problem statement.

Investment objective/ Alternative	A. Do-minimum	B. Demand management	C. Enhance existing network	D. Upgrade existing modes	E. Add new modes
IO 1. The PT network has the capacity to meet forecast demands to, from and within the North Shore.	✗✗✗ – over capacity on all core corridors except Takapuna–Akoranga and AHB	✗✗ – over capacity on all core corridors except Orewa–Albany, Takapuna–Akoranga and AHB	✗ – over capacity on busway corridor (Albany–Akoranga) and Onewa Road	✓ – sufficient capacity on all core corridors but minimal headroom to meet growth	✓✓✓ – sufficient capacity on all core corridors with good headroom for growth
IO 2. The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.	0 – network comprises a mix of grade-separated busway, urban and suburban bus lanes, and mixed running	✓ – minor improvements in congestion and delay possible due to reduced demand	✓ – minor improvements in operational performance due to improved signal priority, platooning, etc.	✓✓ – improved service to Takapuna, Onewa Road, and across harbour	✓✓✓ – improved service on all corridors
IO 3. The PT network improves the resilience of the passenger transport system across the Waitematā Crossing to both major and minor disruptive events.	0 – no protection for PT against major or minor incidents on AHB	0 – no change	0 – no change	✓ – bus lanes on the AHB protect against disruption from incidents in general traffic lanes	✓✓✓ – additional harbour crossing provides resilience against major and minor disruptive events
IO 4. PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.	0 – no change	0 – minor decrease in job accessibility for the average Auckland resident due to decentralisation of jobs	0 – no change	✓ – small improvement in overall accessibility due to faster, more reliable PT service on existing corridors	✓ – small improvement in overall accessibility due to faster, more reliable PT service on existing corridors

7.3 SUMMARY OF FINDINGS

As the assessment of the alternatives shows, of all alternatives only **D. Upgrading existing modes** and **E. Add new modes** scored positively throughout all investment objectives. According to the evaluation, adding new modes is expected to have the most favourable and sustainable effects. In the following section options to upgrade the existing and introduce new modes will be discussed.

Other options are likely to provide benefits as part of a wider programme and should be included in the recommended programme, but on their own are insufficient to meet the objectives or address the problems.

8 DEVELOPED OPTIONS – STAGE 2

8.1 OUTLINE OF STAGE 2 ASSESSMENT

The assessment of the alternatives in the previous sections indicates that alternatives **D. Upgrading existing modes** and **E. adding new modes** scored positively throughout all investment objectives. The evaluation, suggests that adding new modes is expected to add the most value to the future public transport network and service and has the most sustainable long-term effects. In the following section of the report, discuss in more detail the requirements and influence of introducing either of these two alternatives.

The following section further investigates the viability of the two alternatives, in terms of existing modes will investigate the upgrading and enhancement of the current busway, and the adding of new modes will include the introduction of an advanced bus system, LRT of heavy rail. It is noted that these were developed as nominal networks and multiple alternative configurations and combinations are possible.

Upgrading Existing Modes

- Enhanced Busway – Double Decker

Adding new modes

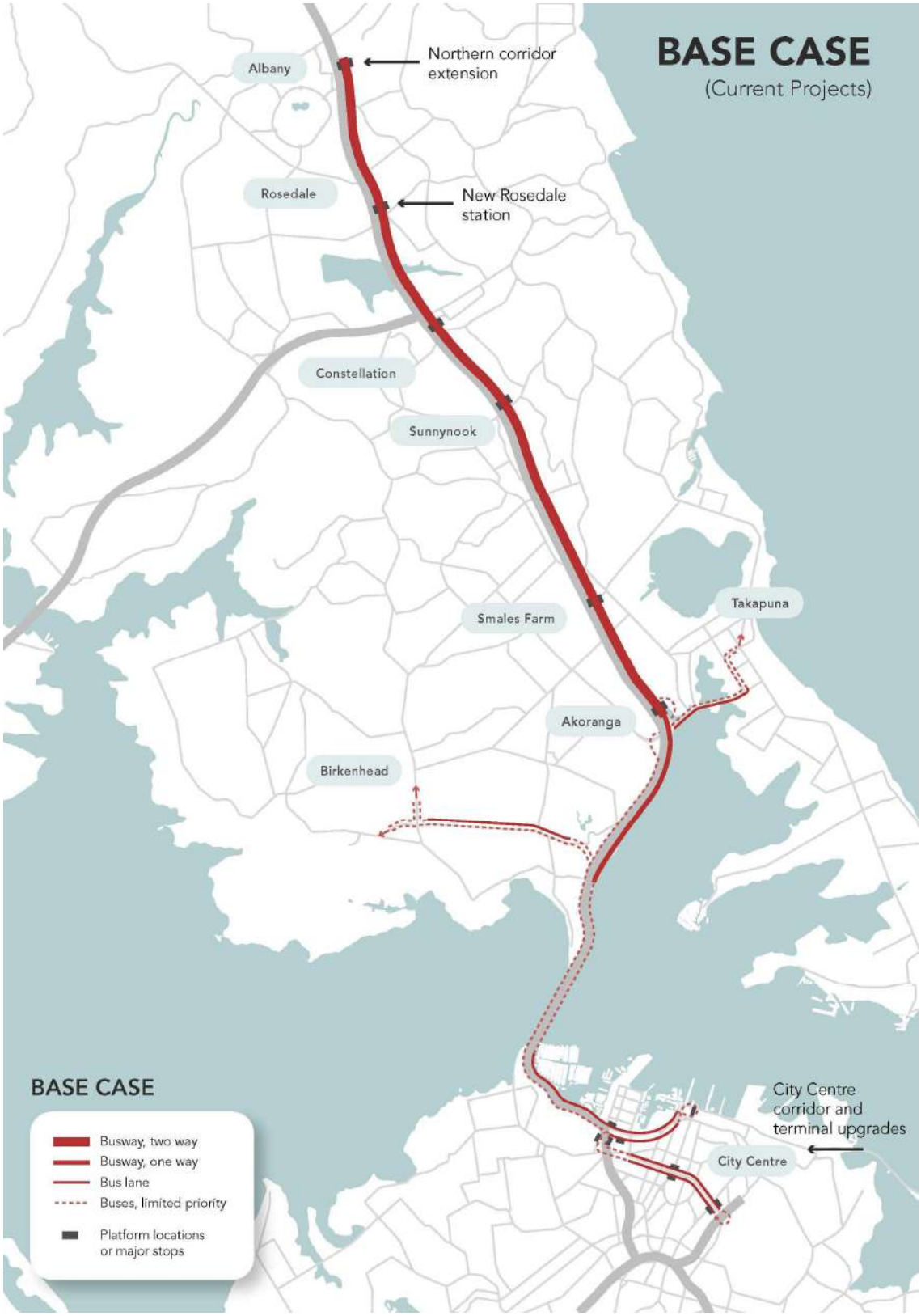
- Advanced Bus System
- LRT (requires additional harbour crossing)
- Heavy Rail (requires additional harbour crossing)

8.2 BASE CASE (DO MINIMUM)

The base case or do minimum is the same as was included in the Stage 1 assessment. This includes

- Northern Busway extension to Albany as part of the Northern Corridor Improvements (NCI) project, including an offline two-way busway between Constellation and Albany, new northbound mainline platform at Constellation, new footbridge Constellation to Unsworth across motorway, and new Rosedale station.
- Expanded park-and-ride at Constellation and Albany stations (400 space extension).
- Introduction of the New Network, with Northern Busway service routed to Britomart (NEX1) and the Learning Quarter (NEX2), frequent service from Birkenhead and Glenfield to Britomart via Onewa Road, and frequent service from Milford to the Learning Quarter via Takapuna.
- Exclusively double-decker buses on the core North Shore to City services—NEX, Takapuna, Birkenhead and Glenfield—and upgraded frequencies as per the Bus Reference Case.
- New City Centre bus terminals and interchanges at Britomart, Wynyard Quarter, Aotea and Learning Quarter.
- Upgraded City Centre bus corridors as per Wynyard–Fanshawe and Wellesley St–Learning Quarter projects, including integrated corridor/stop/routing patterns and extra stop capacity.
- Bus frequency improvements and service changes to meet growth, particularly in growth areas north of Albany (including more frequent NEX service to Hibiscus Coast).
- Minor capacity and frequency upgrades to existing ferry routes to match limited growth.

Figure 22: Base Case (do minimum)



8.3 ENHANCED BUSWAY – DOUBLE DECKER

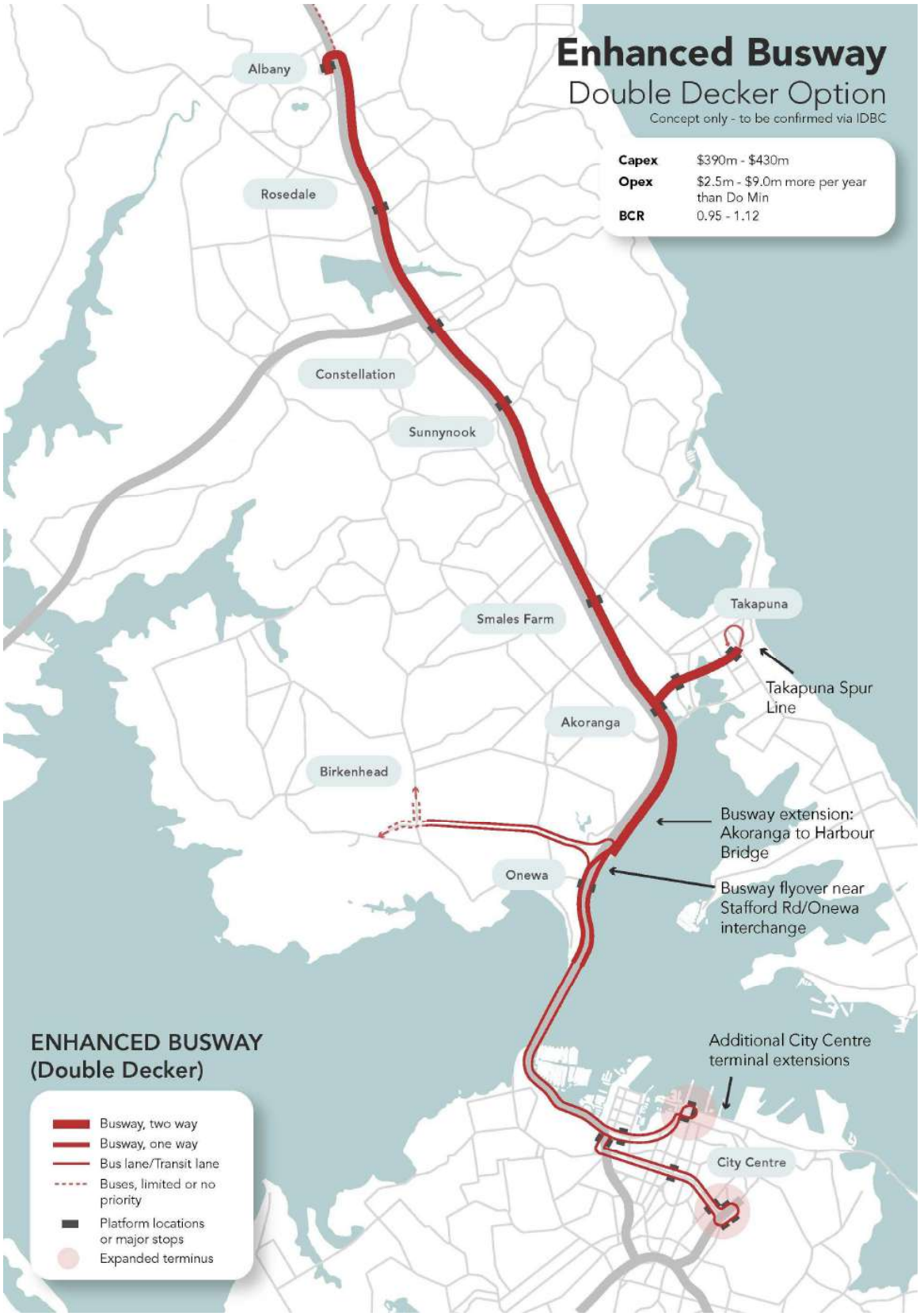
This option aims to increase capacity and improve performance by enhancing the existing infrastructure including servicing the route with double decker's. The alignment is along the motorway from Albany to the city centre with a number of infrastructural updates.

In order to appreciate the requirements of an enhanced busway, serviced with double-decker buses. Key metrics are outlined in Table 10 and plan in Figure 22.

Table 10: Enhanced busway - double decker metrics

Capex	$390m
Opex	$22m pa
BCR	0.95-1.12
Capacity utilization by 2046	75%
Running Distance (Albany-Aotea)	17.9km
System Life-Time	8 -14 years
Peak Capacity/hour	2,500 – 6,000

Figure 23: Enhanced busway - double decker option



The enhanced busway infrastructural updates will include the items in the following table

Table 11 Enhanced Busway (Double Decker) infrastructure developments

Infrastructure component	Reasons for inclusion
Extending the fully separated busway from Akoranga Station bus lanes to the northern edge of the Auckland Harbour Bridge. **Introducing a series of ramps that will allow direct access to the harbour bridge ramps.**	– Removes the need for buses to run in motorway traffic through Onewa Road motorway Interchange, and removes the need to operate on street through traffic light intersections in the Akoranga motorway interchange and along Esmonde Road. – Provides a faster, more direct route for busway operations without traffic lights. – Insulates rapid transit busway operations from traffic congestion on the motorway and approach roads. – Improve passenger benefits with faster journeys and reduced travel time reliability. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre. – Removes buses from the Northern Motorway, Akoranga offramp and Esmonde Road, slightly increasing capacity and performance for remaining general traffic.
A new station at Onewa to provide for interchange between Onewa corridor buses and the busway, and to provide direct local access to rapid transit.	– Provides connectivity between the Onewa Road bus corridor and the busway/rapid transit corridor to access destinations within the North Shore and across the City Centre. – Improves operating performance, and optimizing service delivery to demand, to maximise vehicle occupancy. – Reduces service delivery costs by allowing routes to terminate at Onewa. – Allow a network where only high-occupancy double decker buses and/or specialist transit vehicles cross the harbour. – Avoids the need to run low utilization local services into the City Centre to maximise the number of passengers carried and best utilise fixed terminal capacity. – Provides direct local access to rapid transit for the Northcote Point area.
Significant operational improvements such as off board ticketing and active management of the busway, along with enhanced stations.	– Improves passenger benefits with faster journeys and reduced delays. – Improves fleet utilisation and reduces operating costs with faster turnaround. – Reduces dwell time per passenger and per bus, allowing a greater throughput of buses at existing stations and bus stops. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre.
Introducing on-bridge bus lanes, on the outermost lanes that allow limited priority to buses with private vehicles allowed to take exit to Shelly St/Curran St.	– Insulates rapid transit busway and/or Onewa Road bus operations from traffic congestion on the bridge and motorway, especially in the outbound direction. – Simplifies interaction of buses and traffic on the harbour bridge, reducing weaving and merging conflicts. – Improve passenger benefits with faster journeys and reduced travel time reliability.

	– Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre.
Introducing allocated bus lanes in both directions to Fanshawe St; where required such as at traffic signals private lanes can converted into bus lanes, to allowing for turning.	– Insulates rapid transit busway and bus operations from traffic congestion Fanshawe Street, especially allowing buses to avoid left-turn queues. – Simplifies interaction of buses and traffic through intersections. – Improve passenger benefits with faster journeys and reduced travel time reliability. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre.
The route will split at Fanshawe: Britomart / Uni servicing these two destinations.	– Provides direct rapid transit access to all major sectors of the City Centre, and to all central bus, ferry and rail interchange nodes. – Divides terminal bus stop, layover and repositioning requirements across two terminals to minimise the land requirements and impacts at any one point.
The proposed service will require 12 bus bays in downtown / City Centre, resulting in the expansion of bus stops and current terminal facilities for double decker vehicles with the resulting increase of passenger volumes.	– Provides increased vehicle termination capacity to deliver sufficient passenger capacity to meet projected patronage demand at peak times (in conjunction with other capacity and efficiency optimisations).
Takapuna spur including terminus and bus, walking/cycling bridge at Barry's Point Road.	– Provides true rapid transit service to the Takapuna Metropolitan Centre as per Auckland Plan strategy. – Provides a faster, more direct, and more reliable route for rapid transit between Takapuna, Akoranga, and the busway/rapid transit corridor. – Insulates Takapuna corridor transit operations from traffic congestion in the Takapuna area, and vice versa. – Improves fleet utilisation, reduces travel time and operating costs. – Removes buses from Esmonde Road entirely, improving capacity and performance for general traffic and allowing existing bus lanes to be repurposed.

These proposals are expected to facilitate the creation of a reliable, high performance corridor, which is fed by local bus routes to maximise occupancy as well as efficiency between the City Centre and Akoranga. North of Akoranga the same solution exists as described in the Do-Min option.

These hold opportunities for Onewa as well as Takapuna due to the improved connectivity and increasing significance in the network.

The number of buses needed per hour (120/h with 106 pax/bus) and the space needed for the terminus will have significant effects on the urban environment, which should be improved through public transport provision and not be worsened.

8.4 ADVANCED BUS SYSTEM (ABS)

The Advanced Bus System is part of the suite of options provided in alternative E. Add new modes. The Advanced Bus System vehicles are 24m long double-articulated buses, with a 40% higher capacity than a regular double decker bus.

This option will have the same alignment as the Double Decker, Enhanced Busway option. It will operate along state highway 1 until Fanshawe St. The main differing attributes from the Enhanced Busway being the bus type servicing the Advanced Bus system. The existing infrastructure will require upgrading in order to accommodate the longer vehicles, in order to maximise the efficiency impact providing a high performing corridor.

It is noted that the advanced bus concept is an emerging technology with ongoing advancements in configuration and outcomes. This assessment is a nominal one for the purposes of evaluation, based on current ABS vehicles available on the market. It is not meant to be exhaustive of all possible future outcomes.

Customer-serving outcomes of a capacity and quality of LRT could be achieved by other emerging bus-based technologies (as illustrated in the image below of a prototype in China), beyond those previously envisaged by the Advanced Bus study, with significantly lower investment. These should be investigated further in future business case phases.

Key metrics of the advanced bus system and the outcomes of the required service delivery are outlined in Table 12 and in Figure 23.

Table 12: Enhanced busway - ABS metrics

Capex	$430m
Opex	$17m pa
BCR	0.95-1.12
Capacity utilization by 2046	94%
Running Distance (Albany-Aotea)	18.2km
System Life-Time	8 -14 years
Peak Capacity/hour	4,000 – 6,000

This option entails the following infrastructural updates:

- Introducing a dedicated Advanced Bus System (24 m articulated buses) corridor from Fanshawe St through to Queen St
- Allocated bus lanes to Fanshawe St in both direction; where necessary lanes converted into bus lanes
- The route will split at Fanshawe between Britomart and the university precinct, to serve the two destinations
- Takapuna spur including terminus and bus walking/cycling bridge at Barry's Point Road

Table 13 Enhanced Busway (Advanced Bus System) infrastructure developments

Infrastructure component	Reasons for inclusion
Extending the fully separated busway from Akoranga Station bus lanes to the northern edge of the Auckland Harbour Bridge. **Introducing a series of ramps that will allow direct access to the harbour bridge ramps.**	– Removes the need for buses to run in motorway traffic through Onewa Road motorway Interchange, and removes the need to operate on street through traffic light intersections in the Akoranga motorway interchange and along Esmonde Road. – Provides a faster, more direct route for busway operations without traffic lights. – Insulates rapid transit busway operations from traffic congestion on the motorway and approach roads. – Improve passenger benefits with faster journeys and reduced travel time reliability. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre. – Removes buses from the Northern Motorway, Akoranga offramp and Esmonde Road, slightly increasing capacity and performance for remaining general traffic.
A new station at Onewa to provide for interchange between Onewa corridor buses and the busway, and to provide direct local access to rapid transit.	– Provides connectivity between the Onewa Road bus corridor and the busway/rapid transit corridor to access destinations within the North Shore and across the City Centre. – Improves operating performance, and optimizing service delivery to demand, to maximise vehicle occupancy. – Reduces service delivery costs by allowing routes to terminate at Onewa. – Allow a network where only high-occupancy double decker buses and/or specialist transit vehicles cross the harbour. – Avoids the need to run low utilization local services into the City Centre to maximise the number of passengers carried and best utilise fixed terminal capacity. – Provides direct local access to rapid transit for the Northcote Point area.
Significant operational improvements such as off board ticketing and active management of the busway, along with enhanced stations.	– Improves passenger benefits with faster journeys and reduced delays. – Improves fleet utilisation and reduces operating costs with faster turnaround. – Reduces dwell time per passenger and per bus, allowing a greater throughput of buses at existing stations and bus stops. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre.
Introducing on-bridge bus lanes, on the outermost lanes that allow limited priority to buses with private vehicles allowed to take exit to Shelly St/Curran St.	– Insulates rapid transit busway and/or Onewa Road bus operations from traffic congestion on the bridge and motorway, especially in the outbound direction. – Simplifies interaction of buses and traffic on the harbour bridge, reducing weaving and merging conflicts. – Improve passenger benefits with faster journeys and reduced travel time reliability. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs

	per passenger, and easing the requirement for layover/recovery spaces in the City Centre.
Introducing a dedicated Advanced Bus System (24 m articulated buses) corridor from Fanshawe St through to Queen St **Allocated bus lanes to Fanshawe St in both direction; where necessary lanes converted into bus lanes**	– Provides reliable, high frequency rapid transit service through the City Centre, operating Advanced Buses in a manner analogous to Light Rail. – Insulates rapid transit ABS operations from traffic congestion Fanshawe Street, especially allowing buses to avoid left-turn queues. – Simplifies interaction of buses and traffic through intersections. – Improve passenger benefits with faster journeys and reduced travel time reliability. – Minimises the requirement to timetable recovery time into schedules, improving fleet utilisation, minimizing operating costs per passenger, and easing the requirement for layover/recovery spaces in the City Centre
24m long double-articulated buses **The dedicated ABS corridor would operate on Customs and Queen Street in an in-line manner.** **This would require termination in the southern end of the City Centre and/or through-running to Dominion Road, or the North Western corridor.**	– Provides faster boarding speeds with multiple double doors and level floors boarding. – The ABS concept is an integral system with running lane geometry and stop platforms designed to suit extra-long ABS buses. – This requires a transit corridor dedicated to ABS, without sharing with conventional buses. – With only single ABS corridor in the City Centre dedicated to North Shore rapid transit, extending that corridor across the City Centre is required to provide good coverage and to connect to major regional interchange points. – Through running to Dominion Road or elsewhere allows for direct cross-regional trips and improved utilisation and stop efficiency.
Takapuna spur including terminus and bus, walking/cycling bridge at Barry's Point Road.	– Provides true rapid transit service to the Takapuna Metropolitan Centre as per Auckland Plan strategy. – Provides a faster, more direct, and more reliable route for rapid transit between Takapuna, Akoranga, and the busway corridor. – Insulates Takapuna corridor transit operations from traffic congestion in the Takapuna area, and vice versa. – Improves fleet utilisation, reduces travel time and operating costs. – Removes buses from Esmonde Road entirely, improving capacity and performance for general traffic and allowing existing bus lanes to be repurposed.

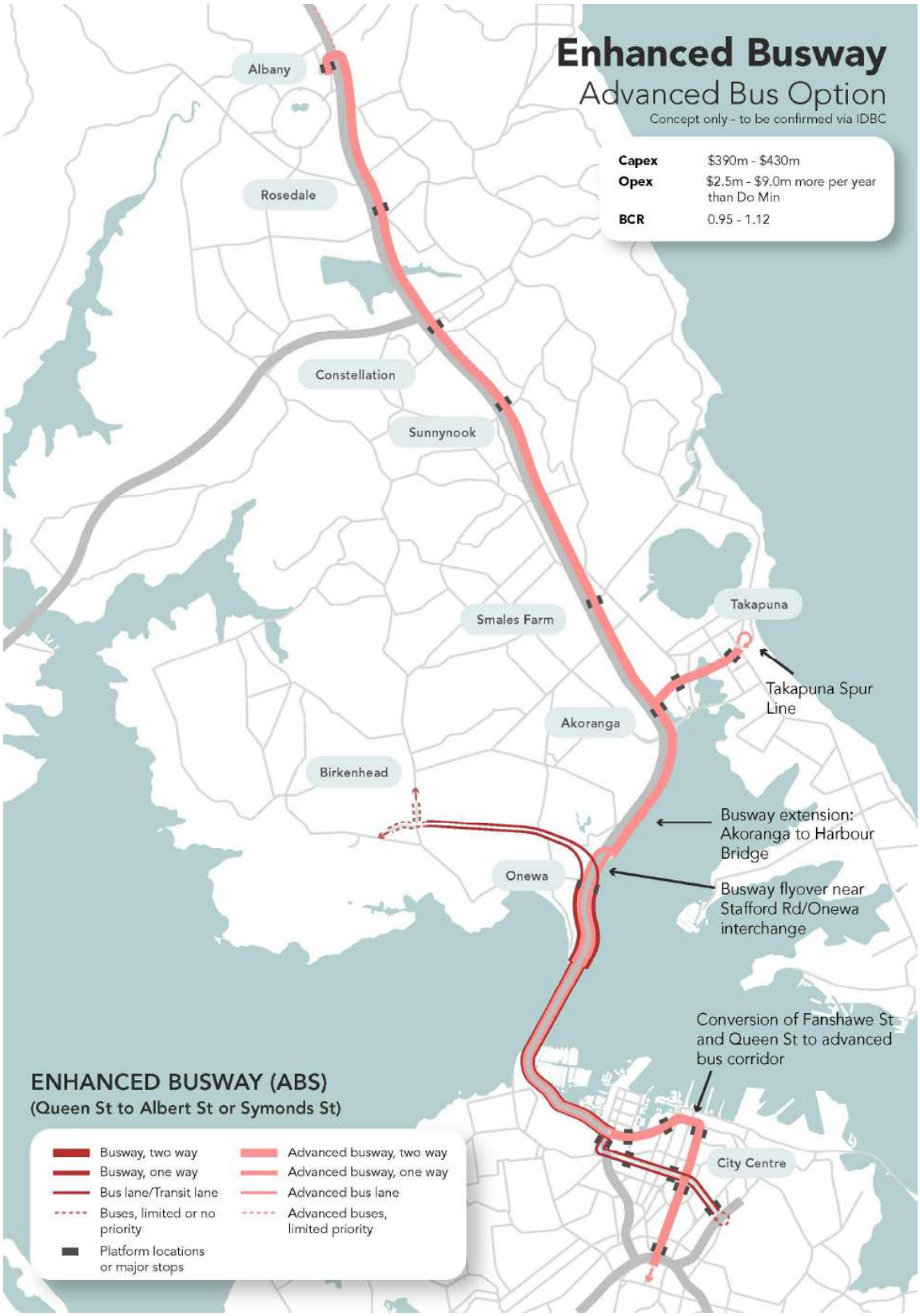
This Enhanced busway option would involve a different City Centre operating pattern. In this option a dedicated bus corridor would operate on Customs and Queen Street in an in-line manner, much like a light rail system would operate. This would require termination in the southern end of the City Centre and/or through-running to Dominion Road, or the North Western corridor. In this respect the Advanced Bus option would logically be considered as part of a wider operating strategy.

In addition, conventional buses on the Onewa Rd corridor would continue to operate across the harbour bridge, onto the Wellesley St corridor. The corridor will remain for conventional buses since a number of other corridors from across the region connects into Wellesley St. Conventional buses (either single or double decker) will not share any regular stops with the Advance Bus System, except for the proposed specially designed Onewa interchange station.

Although the capacity of a single Advanced Bus System vehicle is higher than the one double decker bus, the headroom capacity is similar to the Double Decker option due to the faster saturation of the traffic with advanced bus vehicles.

Due to the in-line nature of the operating corridor and use of “light rail style” stops, the effects on urban amenity and the on-street functioning of the City Centre for pedestrians in particular are considered significantly better than the Double Decker option.

Figure 24: Enhanced busway – Advanced Bus System option



8.5 LIGHT RAIL TRANSIT (LRT)

A Light Rail system would run on an alignment along the existing busway in the section between Albany and Akoranga. It is understood that the existing harbour crossing is not able to accommodate the proposed light rail infrastructure due to structural loading and network constraints, this option is likely to require an additional harbour crossing in the form of either a tunnel or bridge. This crossing will extend from Akoranga to the Wynyard Quarter.

Key metrics are outlined in Table 14 and a plan in Figure 24

Table 14: Light rail metrics

Capex	$2,100m - $2,800m (bridge / tunnel)
Opex Bridge	$5m pa
Opex Tunnel	$14–17m pa
BCR	0.41-0.47
Capacity utilization by 2046	69%
Running Distance (Albany-Aotea)	18.2km (bridge) 17.6km (tunnel)
System Life-Time	25-50 years
Peak Capacity/hour	15,000

The infrastructure development and upgrades will consist of the following:

Table 15 Light Rail Transit infrastructure developments

Infrastructure component	Reasons for inclusion
Converting the existing busway to light rail from Albany to Akoranga.	– Extends the passenger-carrying capacity of the existing corridor, improves speed and reliability, reduce dwell times and improve passenger experience.
Provision of a dedicated harbour crossing introducing either an additional bridge or tunnel.	– Provides a dedicated rapid transit crossing entirely independent of traffic, without reducing or impacting on traffic capacity. – As an additional crossing, this approximately doubles cross-harbour transport capacity over existing conditions, while maintaining all existing traffic capacity on the harbour bridge. – Operating LRT on the existing harbour bridge is technically difficult and would greatly impact on traffic capacity.
Onewa Road (Birkenhead catchment) would continue to be served by high frequency buses.	– If light rail is implemented after either of the Enhanced Busway options are implemented, the Onewa Road services could continue to make use of the additional busway and bus priority measures implemented as part of that option. This includes additional bus

	ramps and busway on the northern side of the Harbour Bridge and the priority measures through St Mary's Bay.
The introduction of a Takapuna spur with potential extension further north, as an LRT spur line, or the option of a bus-based rapid transit connection.	– Provides true rapid transit service to the Takapuna Metropolitan Centre as per Auckland Plan strategy. – Provides a faster, more direct, and more reliable route for rapid transit between Takapuna, Akoranga, and the main North Shore corridor. – Insulates Takapuna corridor transit operations from traffic congestion in the Takapuna area, and vice versa. – Improves fleet utilisation, reduces travel time and operating costs. – Removes buses from Esmonde Road entirely, improving capacity and performance for general traffic and allowing existing bus lanes to be repurposed. – Costs included in Appendix, but not in economics.
Introducing a segregated LRT corridor from Fanshawe St through to Queen St (and potentially beyond as service to Airport).	– LRT is an integral system that requires dedicated lanes and stops, without sharing space with traffic or buses. – With a single LRT corridor for North Shore rapid transit, extending the corridor through the City Centre provides extensive coverage of the CBD and to connect to major regional interchange nodes. – Through running to the Airport or elsewhere allows for direct cross-regional trips and improved utilisation and corridor efficiency.
99m long train sets	– Provides very high passenger capacities from a single street-level corridor, with faster boarding speeds, multiple double doors and level floors boarding. – Allows very high passenger volumes to be carried while maintaining moderate headways, and allowing full LRT priority through signalised intersections without undue impacts on traffic and pedestrian phase timings or intersection capacity.

The implementation of this option results in higher rapid transit capacity with greater headroom for future growth, while maintaining the current harbour bridge for general traffic and a reduced volume of buses operating to the City Centre from the Onewa corridor.

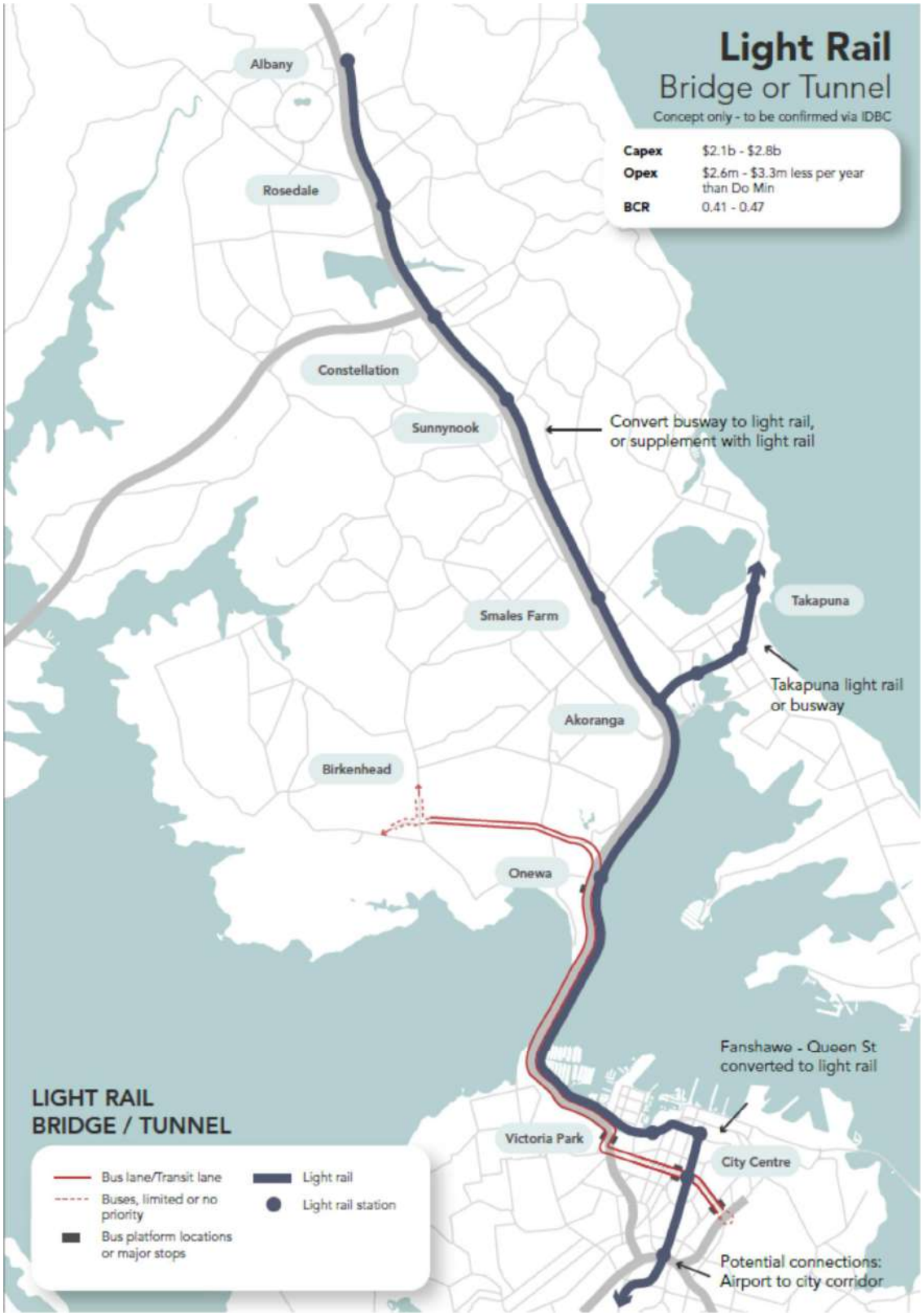
The capacity of the light rail system can be extended in the future to provide sufficient capacity to accommodate projected demands beyond the 2040s.

The evaluation of maximum capacity was based on 99m long train sets operating at 2.5-minute headways. It is noted that current light rail planning in Auckland for Dominion Road has assumed 33m long units, extending to 66m double units over time. Extending the length of train sets further to 99m is the most affordable and operationally-simple way to increase system capacity, however this will require infrastructure such as stations and platforms to be designed to accommodate rolling stock of this length.

Similar to the Advanced Busway option, the introduction of light rail should be considered as part of the wider Auckland rapid transit network development. Both the LRT and ABS options require the Fanshawe Street-Queen Street corridor to be dedicated to the respective mode in order to function effectively. Therefore alignment of mode and operations with other lines that may also operate on this corridor (i.e. The Airport to City corridor) is critical to the function of these conceptual North Shore rapid transit options.

LRT has the potential to interline favorably with the airport and/or the North Western corridors, as the combined demands from these two corridors potentially operating on Queen Street from the south, are closely equivalent to the opposing cross-harbour demands arriving on Queen Street from the north.

Figure 25: Light Rail option



8.6 HEAVY RAIL

The Heavy Rail option provides a level of capacity in excess of the passenger demand projected within the modelled 30-year period. This option is considered here as, either through the AWHC project or separately, heavy rail may provide the opportunity to for a higher capacity transport mode should land use planning and transport planning change and extend growth forecasts beyond current projections. This option has greater significance than the North Shore alone. To be implemented, it would require an additional rail tunnel and new stations in the City Centre and connection into the region's rail network. This would have a high cost and complexity (not captured here) but would generate significant network capacity and opportunities for rapid cross-regional travel that do not currently exist and are not currently planned.

Key metrics are outlined in Table 16 and Figure 25:

Table 16: Heavy rail metrics

Capex	$8.4bn*
Opex	$84m
Opex Tunnel	$14-17m
BCR	0.25-0.33
System Life-Time	25-50 years
Peak Capacity/hour	20,000

* The costs for heavy rail as included in Appendix B include costs for a rail line from Albany to the Learning Quarter in the Auckland City Centre. This cost does not include consequential network improvements that may be required to accommodate the additional trains that would be generated by the line to the North Shore.

Elements of this option are as follows:

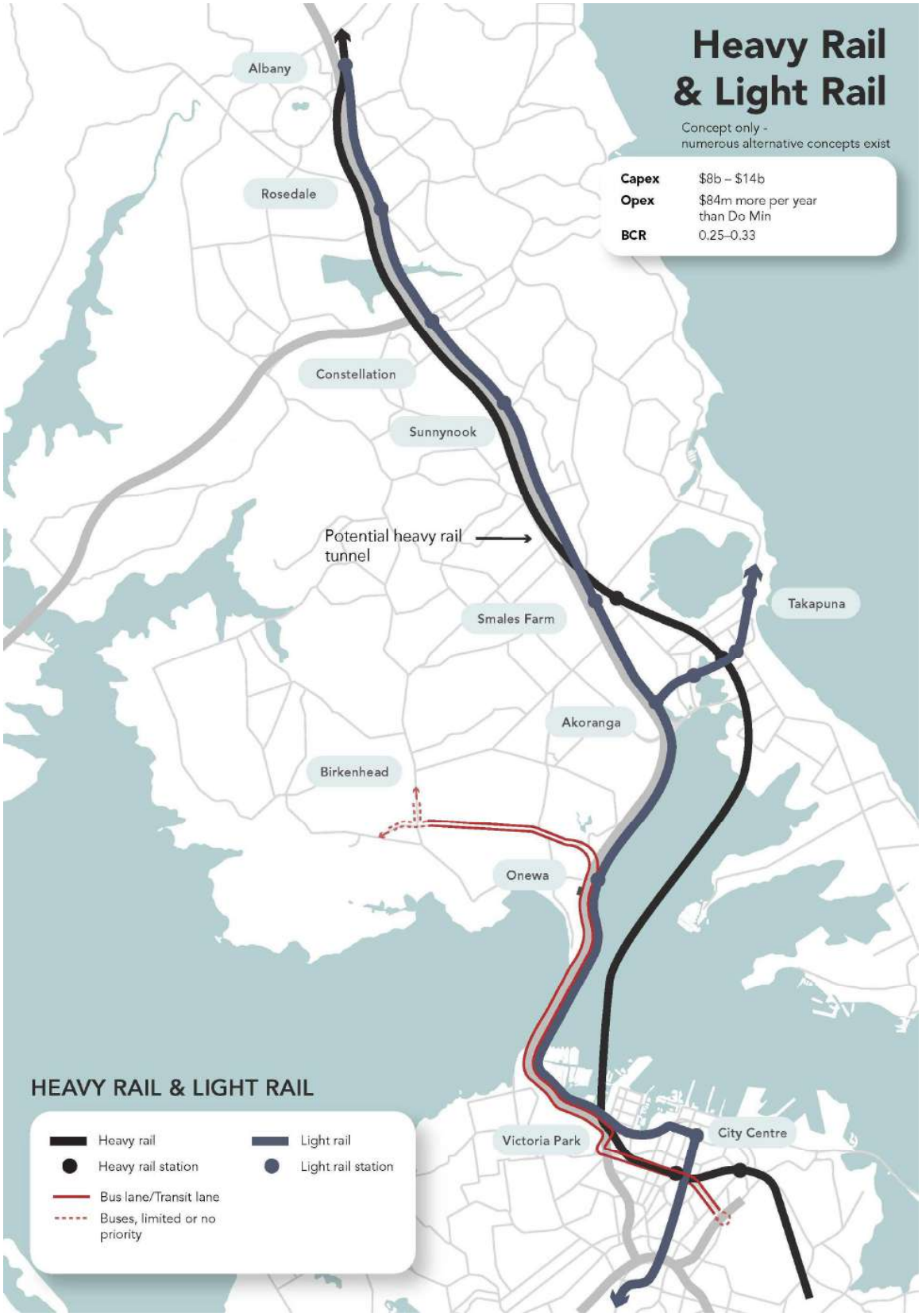
Infrastructure component	Reasons for inclusion
Alignment broadly along State Highway 1 corridor, however mostly/completely underground from City Centre	– As an additional crossing this introduces further cross-harbour transport capacity, equivalent to adding approximately double the current transport capacity of the harbour bridge. – Greatly improves speed and reliability, reduce dwell times and improve passenger experience. – Provides an extremely high performance, high speed, long distance corridor, operating express between outer regional areas and the City Centre, stopping only at the Metropolitan Centres of the North Shore (Albany and Takapuna). – Provides highly reliable, high speed regional travel independent of traffic congestion.
Running on own corridor, independent of the busway or motorway	– Conversion of the busway to heavy rail is largely impractical due to geometric and engineering constraints, a fully tunnelled alignment is most practical and allows local surface-level transit to continue serving the local stations of the busway corridor.

Combined with AWHC across the Waitemata Harbour, in a shared tunnel or parallel tunnels	– Allow for programme alignment and timing and potential cost efficiencies
Onewa Road (Birkenhead catchment) would continue to be served by high frequency buses.	– If heavy rail is implemented after either of the Enhanced Busway options are implemented, the Onewa Road services could continue to make use of the additional busway and bus priority measures implemented as part of that option. This includes additional bus ramps and busway on the northern side of the Harbour Bridge and the priority measures through St Mary's Bay.
Takapuna spur included in assessment but not included in cost	– Provides true rapid transit service to the Takapuna Metropolitan Centre as per Auckland Plan strategy. – Provides a faster, more direct, and more reliable route for rapid transit between Takapuna, Akoranga, and the main North Shore corridor. – Insulates Takapuna corridor transit operations from traffic congestion in the Takapuna area, and vice versa. – Removes buses from Esmonde Road entirely, improving capacity and performance for general traffic and allowing existing bus lanes to be repurposed.

Heavy rail requires a large capital investment due to the extent of tunnelling required, both to cross the harbour and traverse the North Shore. This is due to heavy rail track geometry and gradient limits, which limit the possible incline of the tracks and complicate curves and junctions. This leads to an almost continuously underground track as the heavy rail alignment is unable to follow the undulations of the terrain surface north of the harbour.

In order to save building cost and improve operating speed, this corridor could be built as a linear alignment independent of the busway corridor. Operating this heavy rail tunnel with a reduced number of stations would significantly reduce capital costs while improving travel times for longer distance journeys.

Figure 26: Heavy Rail option



9 OPTION ASSESSMENT

The following sections will assess the specified options against the same investment objectives as in Stage 1 assessment. In order to consider aspects of implementation the options will also be assessed against feasibility, affordability and stakeholders/customer perception. The results will then support the development of the recommended programme. As noted earlier, these are developed solely for assessment purposes and do not represent fully optimised networks.

9.1 RESULTS OF ASSESSMENT

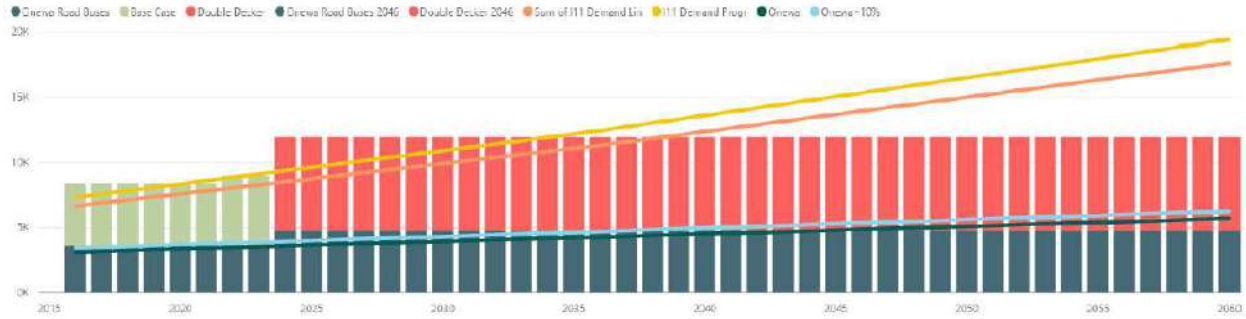
Performance against investment objective 1: ***The PT network has the capacity to meet forecast demands to, from and within the North Shore.***

KPI: Demand Capacity (80% of theoretical Maximum)

The Enhanced Busway, using double deckers or advanced buses has a similar capacity outcome. For context, the two options provide different outcomes from a customer experience, reliability and urban environment perspective due to the different City Centre terminal operation and arrangement.

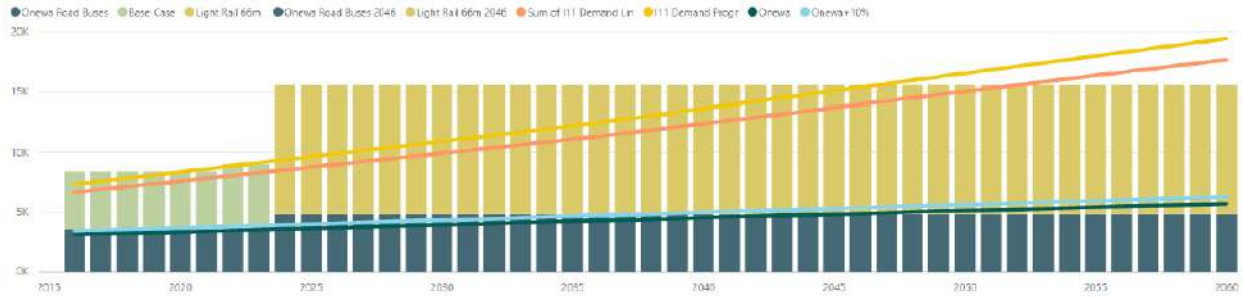
In terms of capacity, an enhanced busway is expected to provide enough capacity until the early to mid 2030s.

Figure 27: Enhanced busway (double decker or advanced bus) demand v capacity



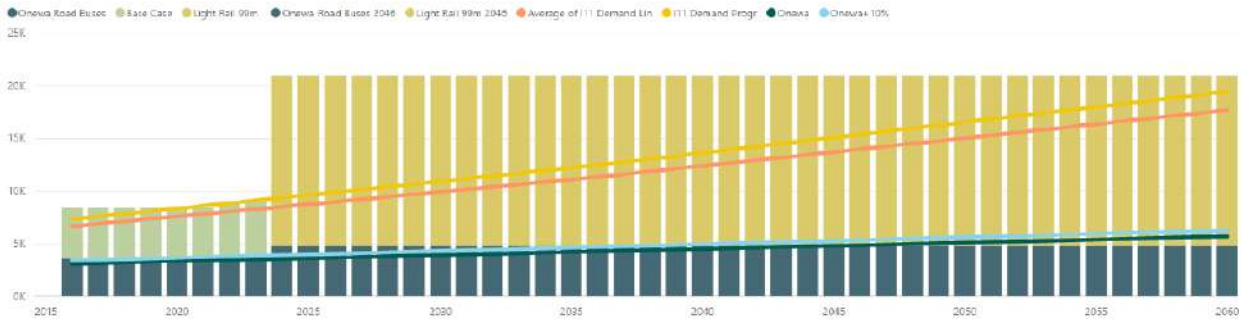
Light rail, on its own harbour crossing, using 66m trams at a 2 minute headway is likely to provide enough capacity for the current demand forecasts which end at 2046, with a small amount of headroom should the modelled demand forecasts not be exceeded. However, if demand growth is stronger or occurs earlier than predicted, additional network capacity would be required before 2046.

Figure 28: Light rail 66m trams @ 2 min headway demand v capacity



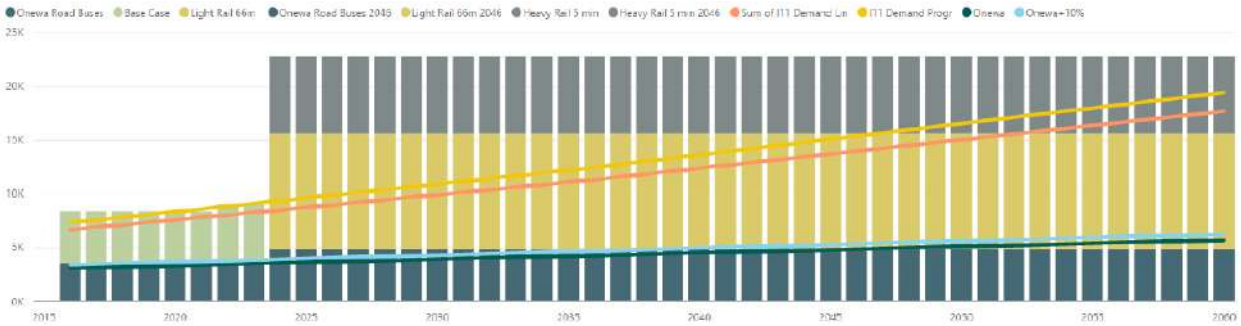
Light rail has also been assessed using a 99m vehicle operating at a 2 minute headway. While this has some risks in terms of its acceptability in a dense urban on-street context, and is not consistent with current planning on Dominion Road, such operations exist. It has capacity for growth well beyond the current forecasts.

Figure 29: Light rail 99m trams @ 2 min headway demand v capacity



Heavy rail has been assessed as an augmentation to the light rail option, assuming 6 car trains at 5-minute headways. Heavy rail can operate at greater lengths and high frequencies enabling significantly greater capacity than the capacity shown, which is aligned with extrapolated forecast growth. This provides significant additional capacity beyond the demand forecast period to 2046, indicating that early delivery of heavy rail together with light rail would provide considerably excess capacity relative to currently projected demands and land use patterns. This assessment does not consider the likely significant additional capacity and regionwide benefits that connecting a North Shore rail line into the regional network could provide. However, it also does not consider the costs of connecting into the regional rail network.

Figure 30: Heavy rail from north of Albany and light rail demand v capacity



In summary:

- Based on current projections, the Enhanced Busway options both provide sufficient public transport capacity to meet forecast levels of demand in the mid to late 2030s.
- Light rail running with 66m trams delivers enough capacity to satisfy the demand projected for 2046.
- Light Rail provides headroom for a further growth beyond 2046 if longer 99m trams are implemented.
- The Heavy Rail option creates significant room for further growth beyond that currently forecast. Heavy rail also opens up opportunities for inter-regional operations and travel patterns that do not exist in the current or planned network.

Performance against investment objective 2: ***The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.***

KPI: Reliability / Separation of corridor

- All alternatives provide improvements to PT network speed and reliability, relative to the Do-Minimum scenario.
- The Double Decker option provides a potentially poor customer and urban outcome in the City Centre. Numerous bus stops will be required, on a number of street frontages providing poor legibility, waiting

spaces and likely reliability. This will also be likely to result in reduced permeability for pedestrians, noise and visual impacts.

- Due to a higher standard of infrastructural improvements, prioritisation and separation in the City Centre sections of the corridor, increased reliability is anticipated for the Advanced Bus system over the Double Decker option..
- The dedicated harbour crossing assumed in the Light Rail option provides a further-improved reliability and corridor separation over the Advanced Bus option (which only has assumed partial priority on the existing Auckland Harbour Bridge at the expense of some general traffic capacity)
- Options with new rail-based modes (Light Rail/ Heavy Rail) are expected to provide a higher level of customer service, including faster and more reliable travel times on core corridors. This positive effect might be most pronounced with the Heavy Rail option, as it operates in a fully dedicated and continuously grade-separated corridor.

Performance against investment objective 3: ***The PT network improves the resilience of the passenger transport system across the Waitematā Crossing to both major and minor disruptive events.***

KPI: New Capacity

- The double decker and advanced bus options provide minor benefits by providing bus priority measures on the bridge, reducing the impacts of minor disruptive events on public transport however due to converting a lane into a bus lane the overall resilience is expected to slightly worsen.
- Rail-based options provide significant improvement, by establishing an additional public transport crossing and introducing some redundancy and spare capacity into the network. This effect is expected to be more significant for the heavy rail option at it runs on an entirely separated corridor with prioritised interaction with other modes.

Performance against investment objective 4: ***PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.***

KPI: Travel Time

- The Double Decker option decreases the travel time from the North Shore to the City Centre compared to Do-Minimum, yet operating in the constrained city centre space on transit lanes is expected to limit the level of time saving.
- Infrastructural improvements and partially separated corridors increase the accessibility and open up counter flow opportunities for both the ABS as well as the Light Rail option.
- Heavy Rail would reduce travel time to a level that increases accessibility significantly, which brings interregional operation into consideration.

Table 17 shows how each of the options scores against the investment objectives.

Table 17: Results of assessment against investment objectives relevant to the problem statement.

Investment objective/ Alternative	KPI	Double Decker (DD)	Advanced Bus System (ABS)	Light Rail Transit (LRT Tunnel/Bridge)	Heavy Rail (HR)
IO 1. The PT network has the capacity to meet forecast demands (2046) to, from and within the North Shore.	**Demand / Capacity (80% theoretical max)**	✓ – 100% Leaves limited room for patronage growth	✓ – 100% Capacity close to full utilisation by 2046	✓✓✓ – 69% Capacity leaves sufficient head room for further patronage growth (assuming 99m trams)	✓✓✓ – 39% Leaves enough head room for local growth and allows for interregional operation
IO 2. The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.	**Reliability / Separation**	✓ - Reliability increased by prioritisation and network improvements; operates partially in shared network/bus lanes/ transit lanes. Offset by likely poor performance in the city centre terminals	✓✓ - Reliability increased by installing dedicated infrastructure (ABS-lanes) with partially limited prioritisation	✓✓- Partially operates on existing road/ /not grade separated yet prioritised	✓✓✓ -Operates on a separate corridor
IO 3. The PT network improves the resilience of the passenger transport system across the Waitematā Crossing to both major and minor disruptive events.	**New Capacity**	✗- Running on existing AHB with priority needed – removing general traffic capacity 0- Running through combined tunnel	✗- Running on existing AHB with priority needed – removing general traffic capacity 0- Running through combined tunnel	✓✓- Partially operates on existing road/ /not grade separated yet prioritised	✓✓✓- Operates on a separate corridor

IO 4. PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels	**Travel Time**	✓ – 35min	✓✓ – 27min	✓✓ - 26/27min	✓✓✓ – 22min
		Double Decker (DD)	**Advanced Bus System (ABS)**	**Light Rail Transit (LRT Tunnel/Bridge)**	**Heavy Rail (HR)**
Feasibility		X X- Terminal & City Centre Operation Extensive special requirements in constraint city centre; negative impact on urban environment	X City Centre Operation (Queen St) Demand for additional space for ABS-stops; no terminus in city centre	X X - Onewa Route/ Busway conversion/ New bridge or tunnel Requires additional harbour crossing (bridge or tunnel) and new infrastructure	X X X- Extensive Project with numerous risks and unknowns Requires additional harbour crossing (bridge or tunnel) and new infrastructure
Affordability		X Capex:$390m Opex:$70m	X Capex:$430m Opex:$65m	X X Capex:$2,100m-2,800m Opex:$53m Opex (Tunnel):$14-17m Costs dependent on type of harbour crossing	X X X Capex:$8,400m+ Opex:$58m (no Takapuna spur) Opex (Tunnel):$14-17m
Stakeholders/ Customers		X X X - Urban amenity and sense of place risks due to high number of bus	X X Urban amenity and sense of place risks on Queen St due to high numbers of vehicles	X X X - Public perception of new bridge/tunnel, particularly the bridge	X X- Public perception of over investment and cost

movement and termination

9.2 SUMMARY OF ASSESSMENT

- Both Enhanced Busway options provide enough capacity for expected growth until the early to mid 2030s. This includes both advanced bus and an enhanced double decker operation.
- Beyond the mid 2030s, a higher capacity mode will be required with its own crossing of the Waitemata Harbour and a dedicated corridor beyond the harbour.
- The key differentiator between the double decker and advanced bus options is likely to be in the City Centre operation. The double decker option requires a large number of bus stops in the City Centre, while the advanced bus operation is likely to operate in a more reliable “in-line” manner similar to a light rail operation. This is likely to generate better urban amenity outcomes.
- The Advanced Bus option is likely to require consideration of integration with another RTN corridor elsewhere in the region
- Light Rail, and to a greater extent, Heavy Rail options offer significantly greater levels of reliability and speed over double decker and Advanced Bus options, primarily due to the assumption that they will operate on their own crossing of the Waitemata harbour.
- Light rail has the capacity to handle expected demands until the mid-late 2040s using 66m vehicles at 2-minute headways, which is consistent with the vehicle assumptions for the proposed light rail line on Dominion Road.
- Light Rail and Heavy Rail options add significant additional whole-of-network capacity and resilience due to the assumption of an additional Waitemata Harbour Crossing for rapid transit. Double Decker and Advanced Bus options require re-allocation of road space across the harbour.
- The Heavy Rail option is a very large project with very high costs and levels of technical difficulty, but potentially large long-term regional benefits that have not been directly assessed in this study.

- There are numerous options for delivering a rail crossing of the harbour. It is not necessarily assumed that a Light Rail or Heavy Rail crossing has to be within the proposed AWHC road tunnel, however any rail crossing must be co-ordinated with that project.
  An additional crossing of the Waitemata Harbour will result in improved resilience of the crossing.

10 RECOMMENDED PROGRAMME

10.1 RECOMMENDED PROGRAMME OVERVIEW

Key Messages:

The busway (through its current service pattern and infrastructure provision) has been extremely successful in attracting patronage. This is demonstrated via a patronage growth of 250% between 2008 when the Northern Busway opened and 2015. Auckland Transport has responded by increasing the service patterns and size of buses over time with double decker vehicles now operating at 3-minute frequencies in the peak.

Limited upgrades to the infrastructure have occurred since the busway went operational and further operational and infrastructure improvements are now required to prevent deterioration in the busway's level of service given the projected increase in passenger volumes over the next 15 years. The most significant infrastructure gap in the Northern Busway is the lack of dedicated bus lanes between the City Centre and Akoranga Station. Therefore, AT needs to consider future RTN options, which provide for a dedicated rapid transit crossing of the Waitemata harbour.

Land use changes over the next 30 years, on the North Shore are expected to generate demands well beyond what even an enhanced busway can accommodate. The forecasted future passenger volumes are expected to be in the range provided for by a light rail system. Beyond the planning horizon these demands may continue to grow to levels more adequately served by heavy rail.

Given the significant cost to implement a heavy rail line for the entire length of the North Shore a programme that responds to demand through incremental improvements (although sizeable in their own right) are now envisaged.

This programme therefore recommends AT:

1 – caters for demands up to mid-2030s, or as long as practicable, by enhancing the lifespan and performance of the existing bus offering through efficiency improvements along congested arterials (Fanshawe Street and Onewa Road) as well as capacity / efficiency improvements at the stations, and:

2 – caters for demands up to around 2050 by supplementing the enhanced bus system through extending the Isthmus light rail or advanced bus system to Albany, and investigates the potential for heavy rail.

The recommended programme for the North Shore RTN PBC takes a longer-term view than many programme business cases on the basis that the strategy:

a) Is tied to regionally strategic land use decisions
b) Has a strong interaction with the Additional Waitematā Harbour Crossing (AWHC) project and the regional transport network– a major strategic investment currently programmed for completion between 2038-48 (third decade of the Auckland Transport Alignment Project)
c) Involves significant investment in assets with long lead times

The recommended programme has emerged from a comparative analysis of a range of alternatives. Following this assessment, the recommended programme is a staged, multi-faceted strategy that responds to the forecast and potential growth in demand for travel to and from the North Shore and northern Auckland.

The recommended programme comprises operational, demand management and increasing levels of supply-based interventions in the form of services and infrastructure.

Region-wide network planning

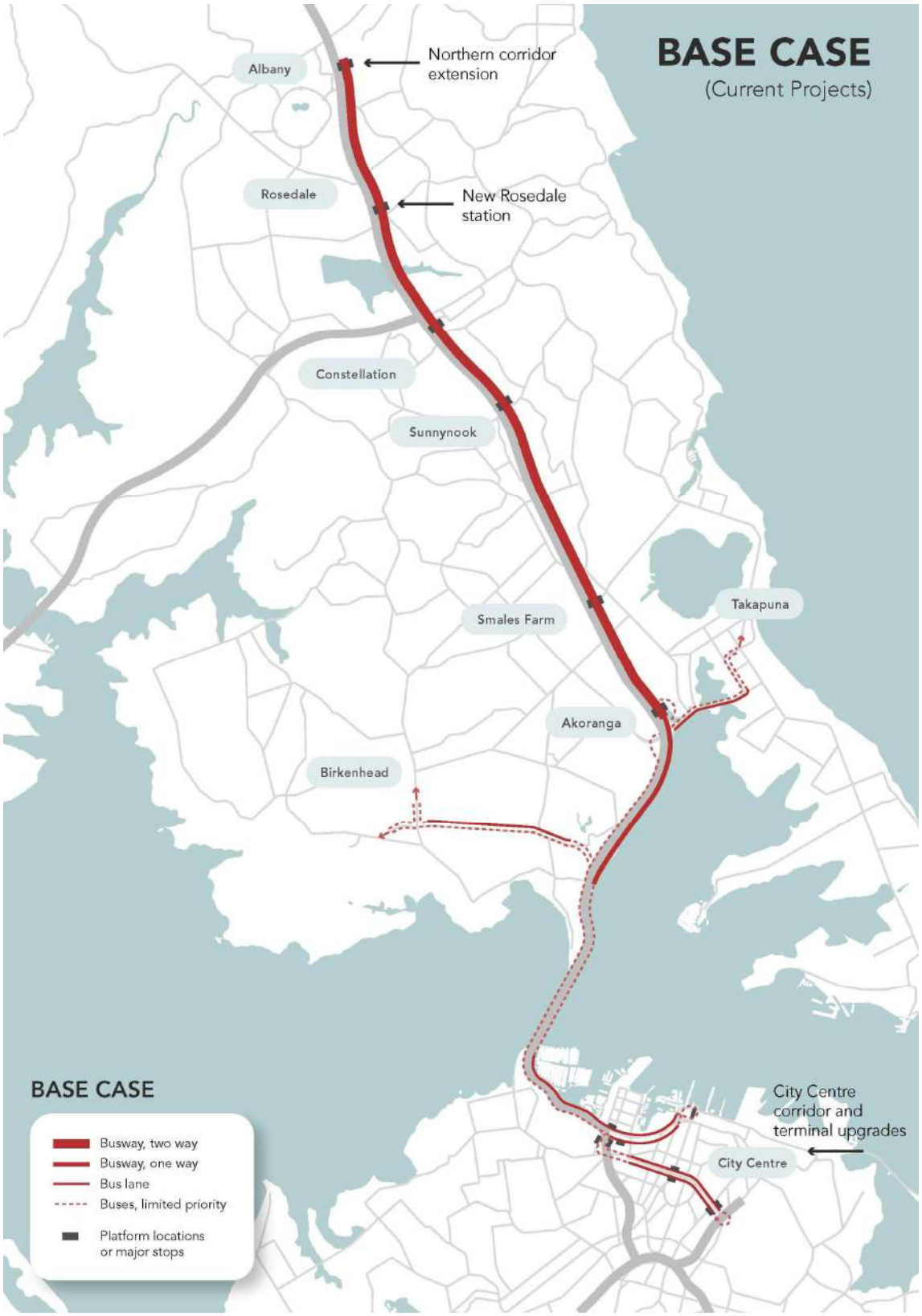
It is important that the Recommended Programme is considered in the context of a number of related investigations in the development of Auckland's mass transit network. Decisions relating to the North Shore RTN will affect and be affected by decisions on other parts of the regional rapid transit network. There is complexity in understanding the connections and interactions of the wider existing and planned transport networks. While some direction has already been established, many decisions will be made in parallel and in conjunction with North Shore RTN planning and development.

Base Case

For context, it is important to note that the **base case** assumed in this PBC and upon which the recommended programme builds, includes some significant, already committed improvements to the Northern Busway operation including:

- Northern Busway extension to Albany as part of the Northern Corridor Improvements (NCI) project, including an offline two-way busway, and new Rosedale station.
- Expanded park-and-ride at Albany station (approx. 400 space extension).
- Introduction of the New Network, with Northern Busway service routed to Britomart (NEX1) and the Learning Quarter (NEX2), frequent service from Birkenhead and Glenfield to Britomart via Onewa Road, and frequent service from Milford to the Learning Quarter via Takapuna.
- Exclusively double-decker buses on the core North Shore to City services—NEX, Takapuna, Birkenhead and Glenfield—and upgraded frequencies as per the Bus Reference Case.
- New City Centre bus terminals and interchanges at Britomart, Wynyard Quarter, Aotea and Learning Quarter.
- Upgraded City Centre bus corridors as per Wynyard–Fanshawe and Wellesley St–Learning Quarter projects, including integrated corridor/stop/routing patterns and extra stop capacity.
- Bus frequency improvements and service changes to meet growth, particularly in growth areas north of Albany (including more frequent NEX service to Hibiscus Coast).
- Minor capacity and frequency upgrades to existing ferry routes to match limited growth.

Figure 31: Base Case



The strategy requires a shift to a rail-based mode, timed and scoped to meet the expected demand to and from the North Shore and northern Auckland. Figure 31 and Figure 32 illustrate the manner in which the recommended programme could respond to forecast demand. Note that catchments would extend beyond the City Centre and connect with Isthmus services and catchments. These issues should be explored in the I/DBC process.

Figure 32: Recommended programme capacity and forecast – Light Rail Strategy

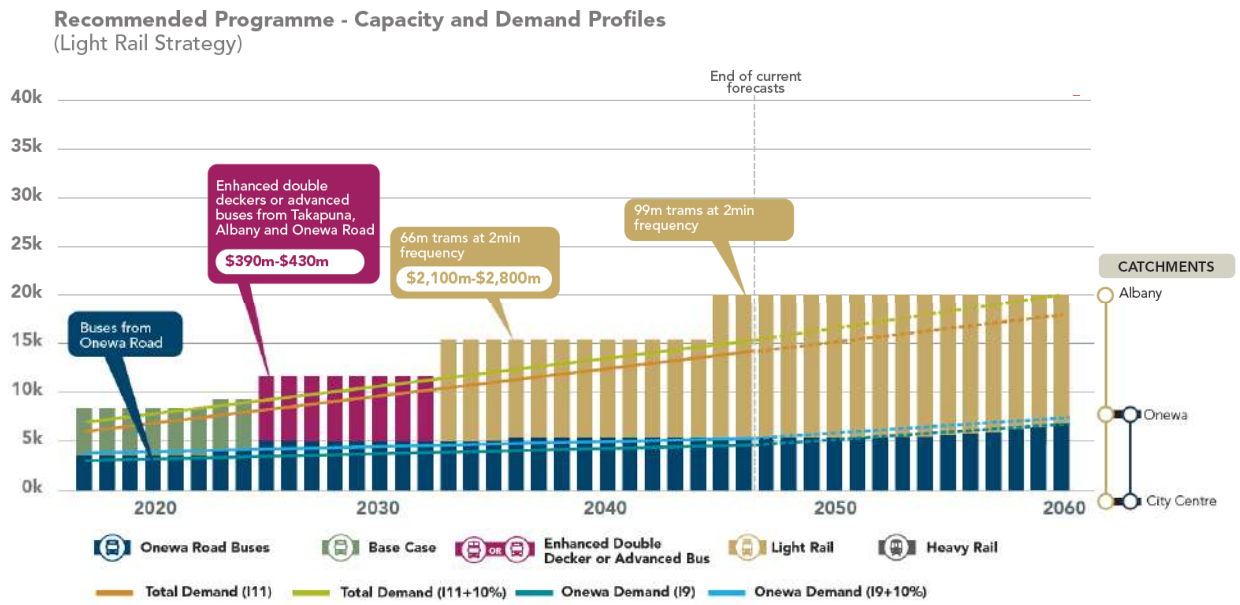
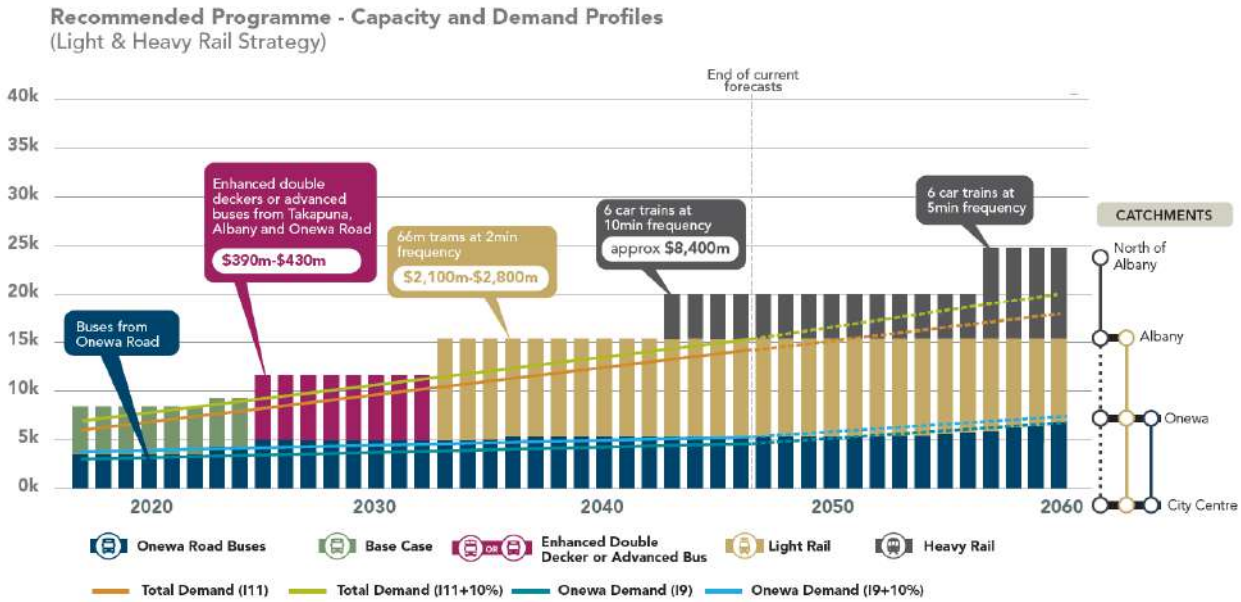


Figure 33: Recommended programme capacity and forecast - Light and Heavy Rail Strategy



These figures illustrate two key dynamics in relation to the Recommended Programme:

Supply and demand

The demand forecast lines show the forecast demand for travel across the Waitemata Harbour from the ART Model (i11 land use scenario) and a sensitivity test with an additional 10%. This is due to the historic 13% under-prediction of the Northern Busway's patronage by ART in the ten years since opening. The figures also show demand for Onewa Road in a similar manner.

Capacity is a key trigger point in the timing of investment in modes together with strategic land use and accessibility opportunities that can be enabled with heavy rail.

Catchments and Service Pattern

As indicated in the maps the strategy and demand analysis is based on three strategic catchments which are represented in the service pattern:

- North Shore spine (Albany – Onewa including Takapuna)
- Onewa Road (Birkenhead and surrounding suburbs)
- North of Albany

10.2 FROM 2017- MID 2030S – ENHANCED BUSWAY WITH DOUBLE DECKERS OR ADVANCED BUSES

With the operations improvements and an extension from Akoranga Station to the Harbour Bridge approaches, the busway operating largely in its current physical form, using the existing Auckland Harbour Bridge is expected to be effective until the mid-2030s on current land use and transport demand forecasts. This stage could be operated with either double deckers or advanced buses.

Capex (approx.)	**$390m - $430m**
Opex (approx.)	**$17m per year - $22m per year**
BCR (initial)	**0.95 – 1.12**

Key interventions:

- Upgrading the existing busway stations for greater capacity.
- Extending the two-way busway from Akoranga Station to Onewa Road.
- Constructing a new Onewa interchange station to provide for interchange between Onewa corridor buses and the busway, and to provide direct local access to rapid transit.
- Extending the dedicated busway lanes to the foot of the harbour bridge in both directions, and a new structure to allow transitioning from side bus lanes to two-way busway near Stafford Rd.
- Providing full time bus priority lanes across the harbour bridge in both directions, and partially restricting traffic access to these lanes.
- Providing dedicated full time bus lanes through St Marys Bay northbound (to match the existing southbound lane), and reconfiguring the Fanshawe St on-ramp lane configuration accordingly.
- A busway spur connecting Akoranga Station to Takapuna via Barry's Point.

For Double Decker option:

- Expanding the capacity of the Britomart bus terminus
- Expanding the capacity of the University bus terminus

For Advanced Bus option:

- Convert the Fanshawe St - Queen St corridor to Advanced Bus specifications, and relocating all other buses to the Wellesley St corridor

Figure 34: Enhanced Busway - Double Decker option

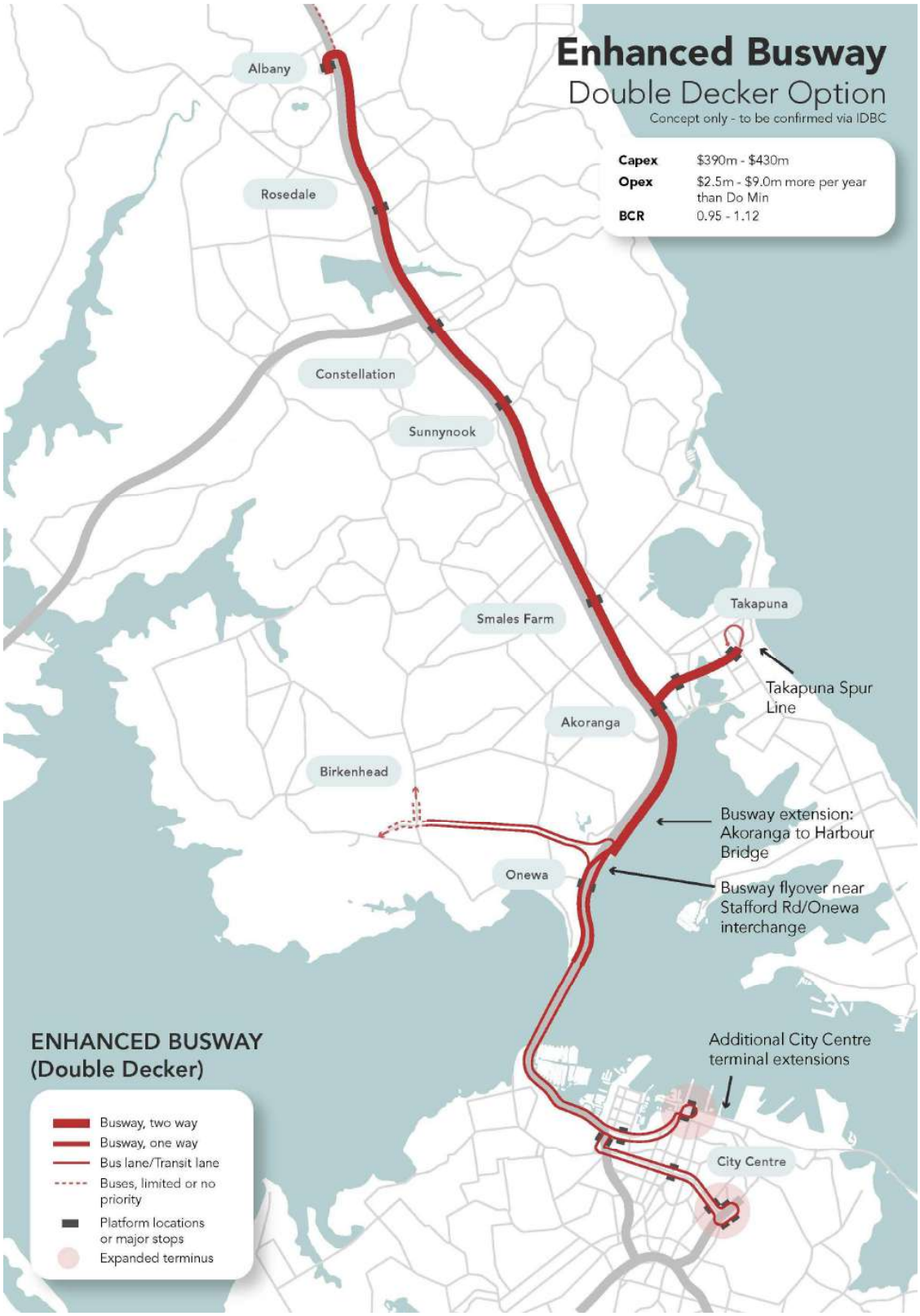
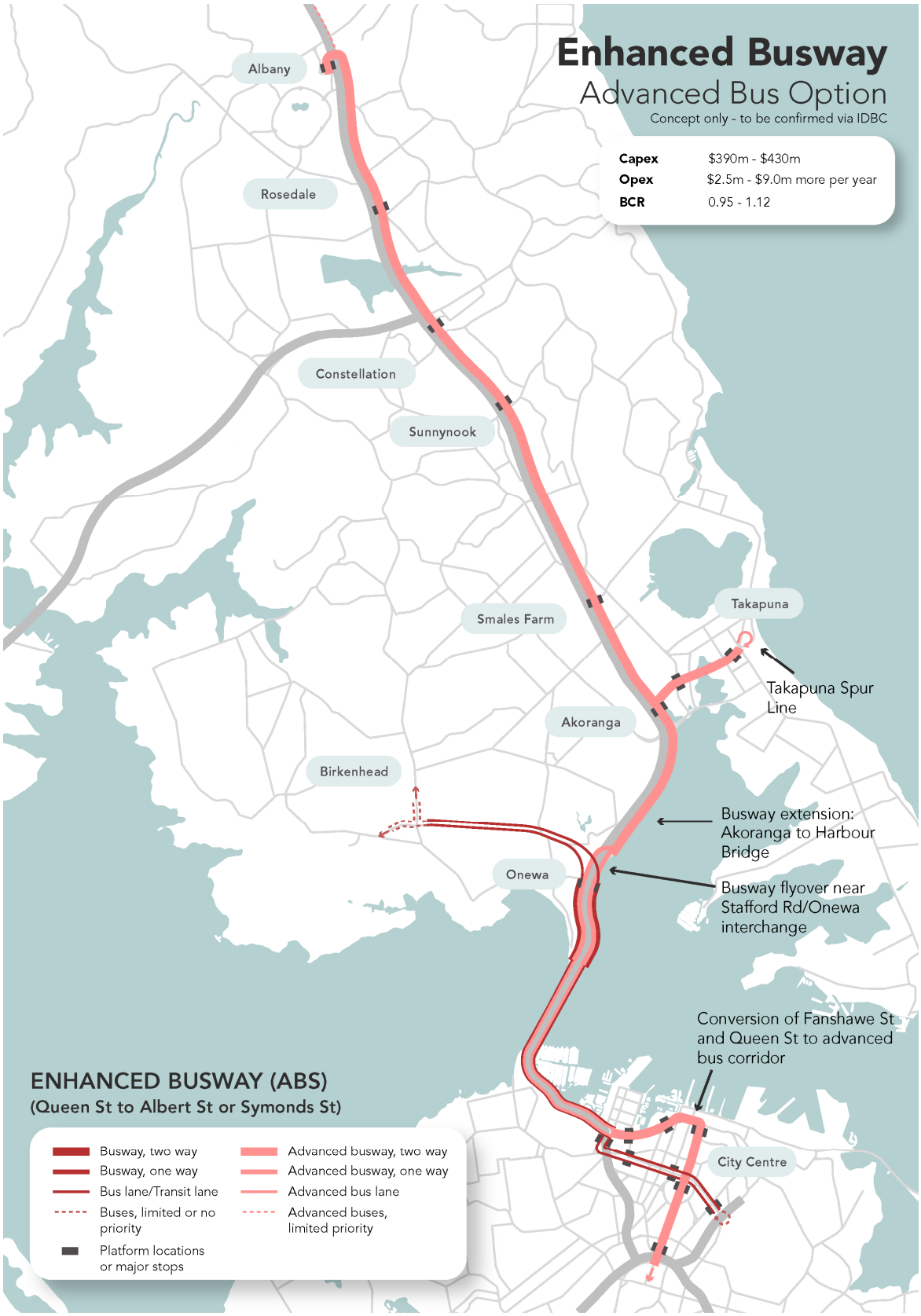


Figure 35: Enhanced Busway - Advanced Bus option



This PBC recommends that an indicative/detailed business case is developed in 2017/18 to identify a programme of interventions to optimise the capacity and performance of the busway, extending the busway from Akoranga Station to the Harbour Bridge, and using the existing harbour bridge.

This detailed case should consider the retention of an enhanced double decker bus operation and a possible transition to an advanced bus operation using long articulated road-based vehicles as outlined in the Advanced Bus Study. Customer-serving outcomes of a capacity and quality of LRT could be achieved by other emerging bus-based technologies (as illustrated in the image below of a prototype in China), beyond those previously envisaged by the Advanced Bus study, with significantly lower investment. These should be investigated further in future business case phases.

Figure 36, Example of Advanced Bus Mass Rapid Transit System

The detailed business case should also consider the operation within the City Centre and the potential for inter-lining with other RTN routes such as the Dominion Road-Airport corridor and the North Western RTN corridor, as well as enhancing the capacity and performance of City Centre terminals.

10.3 FROM MID-2030S TO AND BEYOND THE MID-2040S (THE END OF THE CURRENT PLANNING HORIZON) WITH LIGHT RAIL

Despite bus-based improvements, beyond the mid-2030s growth in passenger demand is expected to require a higher capacity mode. Without a higher capacity mode, operational effectiveness is likely to be reduced in terms of journey time, reliability and capacity.

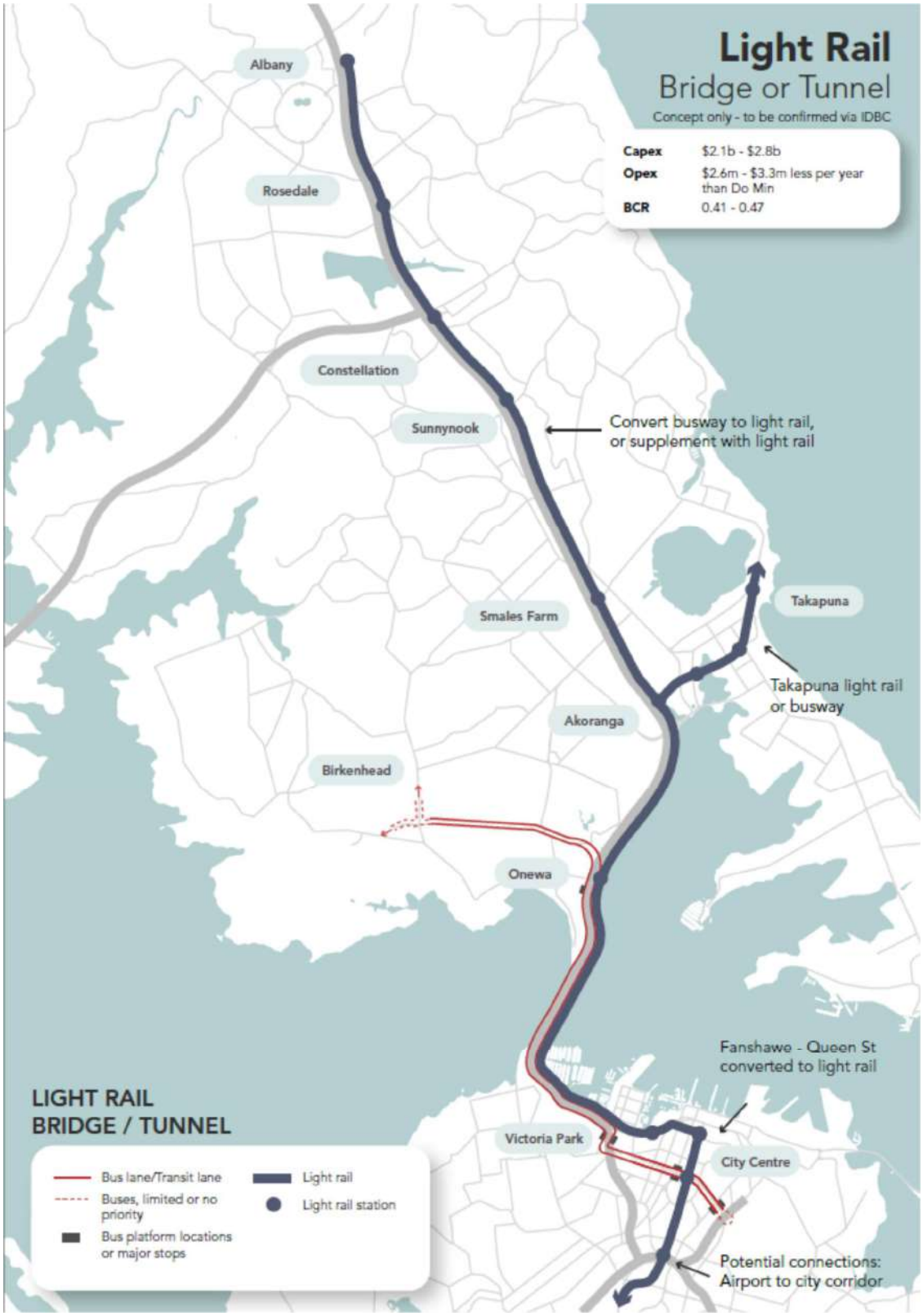
Any higher capacity mode will require a dedicated crossing of the Waitemata Harbour and its own corridor to operate within. There is the option in this stage for the dedicated crossing to be either a standalone corridor or be incorporated into the proposed Additional Waitemata Harbour Crossing corridor.

Capex (approx.)	**$2,100m - $2,800m**
Opex (approx.)	**$14m per year - $17m per year**
BCR (initial)	**0.41– 0.47**

Key interventions:

- A dedicated bridge or tunnel crossing for rapid transit.
- Running on a segregated light rail corridor from Fanshawe St and Queen St (and potentially beyond as service to Dominion Road/Airport to City corridor).
- Extending two bus lanes to Onewa Interchange from Onewa Road
- Takapuna spur line from Akoranga via Barry's Point, and potentially extended further north to Milford and beyond
- Conventional bus service runs from Birkenhead-Glenfield over existing bridge, on limited priority lanes via Fanshawe St to terminus at University via Wellesley Street.
- Conversion of the existing busway to light rail

Figure 37: Light Rail option (post mid-2030s)



While not likely to be required until the mid-2030s, it is important to progress this detailed case at this time because lead times for a project of this scale are likely to be long (at least ten years) as it may involve a new harbour crossing and other major infrastructure.

10.4 BEYOND THE CURRENT PLANNING HORIZON

The Light Rail programme is expected to meet the forecast demands for the current land use projections and have some headroom for growth depending on the accuracy of current forecasts and the ability to run longer 99m trams on streets. Both of these assumptions carry some risk. As a result of this, along with the potential accessibility and regional capacity outcomes could generate, it is suggested that heavy rail should also be considered in more detail.

It is expected that any decision to investigate the nature and timing of a further RTN investment would be led by decisions relating to land use and in particular the future growth of Auckland in the north. It would likely result from a decision to plan for further significant growth in the north of the Auckland Region, and/or stronger than expected passenger growth.

A heavy rail link, connected directly into the existing rail network may open up significant regional capacity and opportunities for fast, reliable cross-regional movement that has not been considered in current land use or transport planning.

The Additional Waitemata Harbour Crossing project being led by NZTA and KiwiRail presents an option to protect the ability to provide and implementation option and a stand-alone pathway alao exists. This outcome would provide the North Shore, and potentially all of Auckland, with a very advanced level of transport capacity that may be required beyond the current planning horizon. However, the alignment, timing and associated constraints may not provide the optimum arrangement for rapid transit development, so alternative crossing options remain. Preserving options for heavy rail presents the opportunity to provide the North Shore and potentially all of Auckland with an advanced for of access.

Heavy rail could provide an *additional* public transport connection, independent of the Northern Busway corridor. The form, mode and timing of this will depend upon decisions made in earlier stages, as well as regional land use planning decisions.

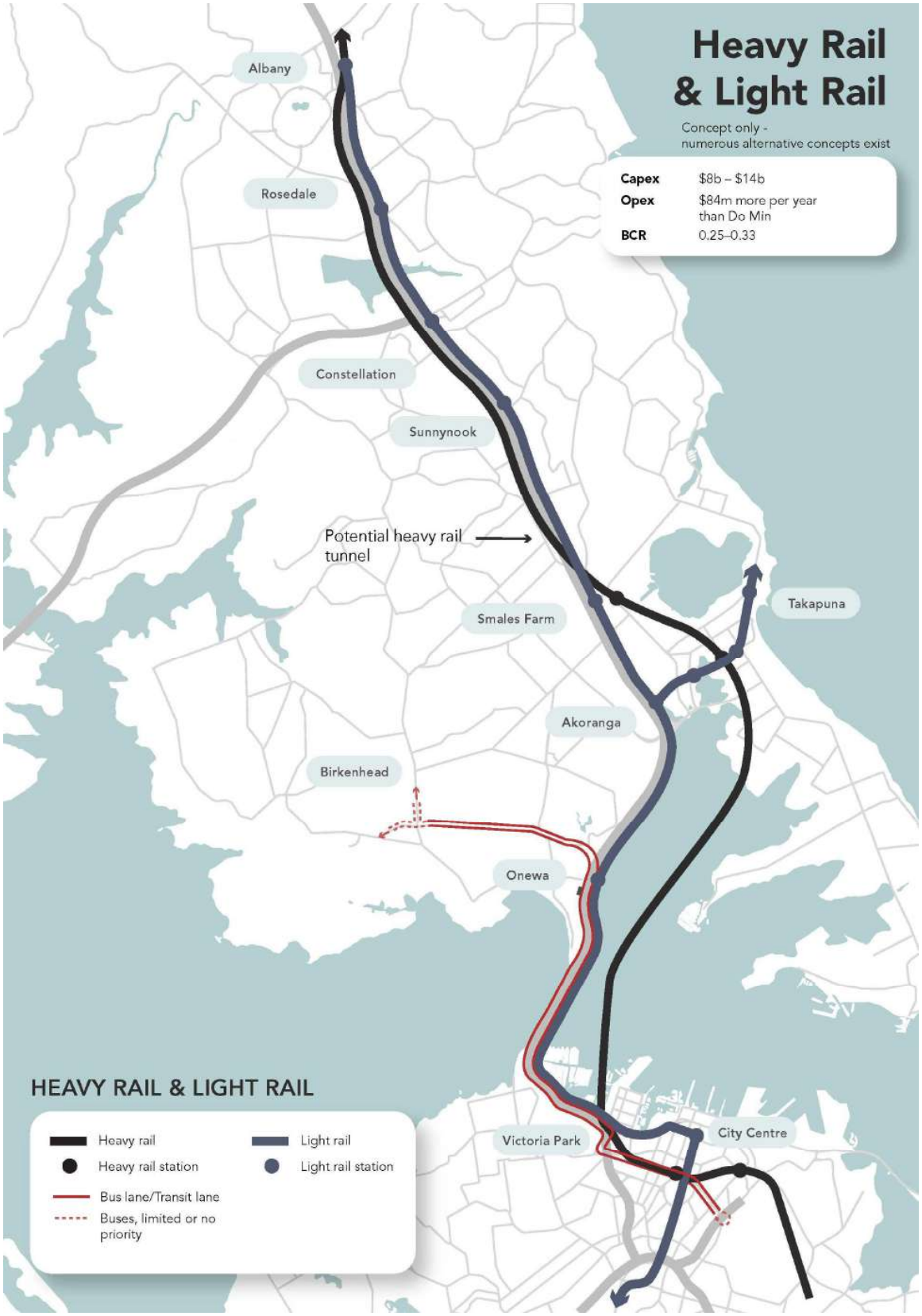
Capex (approx.)	**$8,400m - $14,200m***
Opex (approx.)	**$84m per year / $91m (HR) / $140m (incl NS LRT and bus)**
BCR (initial)	**0.25–0.33**

Key interventions:

- A dedicated heavy rail tunnel crossing the harbour to Takapuna
- Heavy rail in a tunnel between Takapuna and Albany with no intermediate stops
- Extension of the heavy rail line north to serve Hibiscus Coast, and continuing inland to Waitoki, including five new stations
- A crosstown heavy rail tunnel connecting under Aotea Station and linking the new heavy rail line to the existing Southern Line before Newmarket
- Quad-tracking the Southern Line between Newmarket and Ōtāhuhu (assumes quad-tracking delivered from Ōtāhuhu to Papakura by 2046), enabling express heavy rail service between Newmarket and Papakura
- Electrification and two new stations Pukekohe to Pokeno (assumes electrification delivered to Pukekohe by 2046)
- Light rail from Albany and Takapuna to Queen Street (and potentially continuing to the Airport), as per Stage 2
- Conventional bus service runs from Birkenhead-Glenfield over existing harbour bridge, on limited priority lanes via Fanshawe St to terminus at University via Wellesley Street

Due to the timing of some decisions in the development of this PBC, there are some differences between the heavy rail alignment costed and that modelled for the economics. The cost estimate in Appendix B represents an alignment generally following the existing busway between Albany and Parnell. The modelled outcomes, developed late in the process for this PBC consider an alignment via Takapuna and assumed an extended line north of Albany. The 50th percentile cost for heavy rail between Parnell and Albany as formally costed (see Appendix B) is $8.4bn with a 90th percentile of $10.8bn. The costs also do not include consequential modifications to the existing rail network, for example additional lines on the southern line and changes to stations and stabling facilities. As a result, a 70% contingency has been applied in the economics analysis as a sensitivity test resulting in the lower end of the BCR range.

Figure 38: Heavy rail, or other mode (post current planning horizon)



While not currently contemplated by regional land use or transport planning, this concept for a fast, cross-regional heavy rail connection may give rise to significant regional land use and mobility outcomes. From a strategic perspective, a decision to contemplate this stage would need to be land use-led and may have the potential to generate significant changes in Auckland's transport capacity, opportunities for travel and connections between economic centres. With the potential for a trip from Takapuna to Ellerslie in 15 minutes and Albany to Papakura in 43 minutes, there is potential for improved economic outcomes. This concept is likely to be extremely expensive and complex. Any study to consider a concept as significant as this is likely to be part of a wider strategic discussion on the future of Auckland scale, growth and economic performance.

A major potential benefits of this option is the land value uplift resulting in the significantly increased accessibility for several major regional centres. The potential to optimise and capture this value should be an important consideration in development of the option.

The following maps show one potential concept for the Stage 3 alignment, catchment, travel times and integration with regional land uses.

Figure 39 Indicative catchment, am peak demand and travel times for a conceptual stage 3 network with heavy rail and light rail

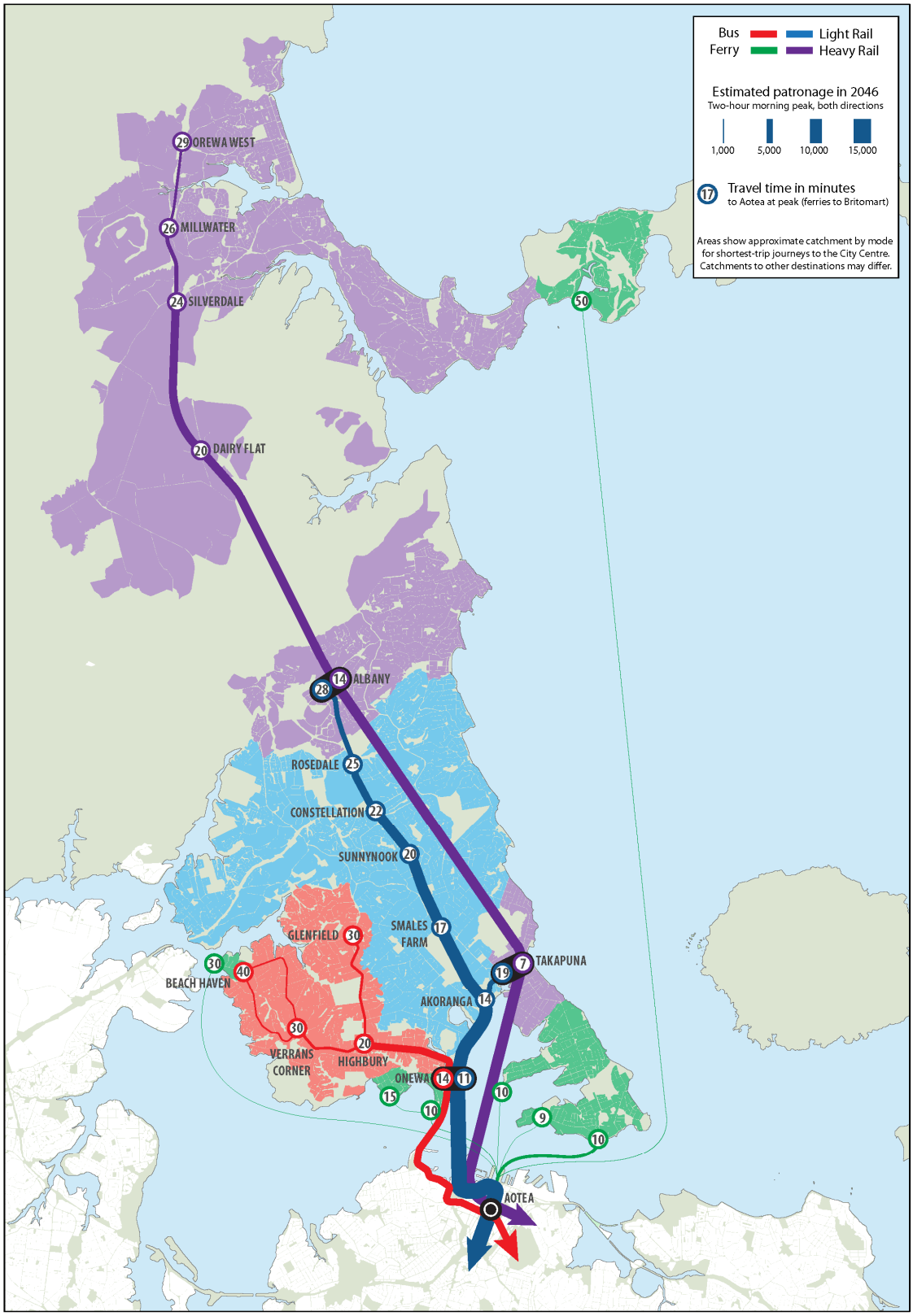
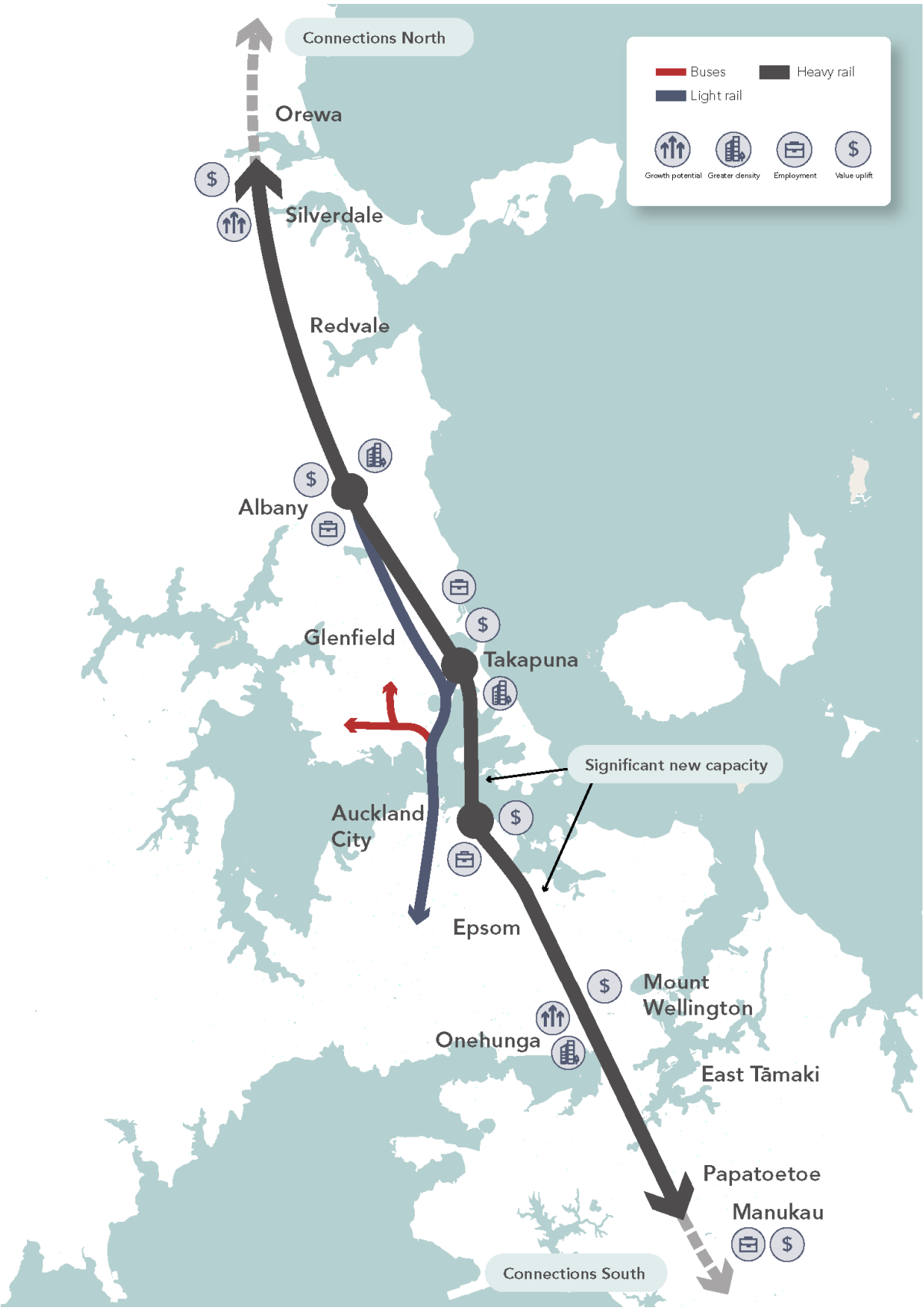


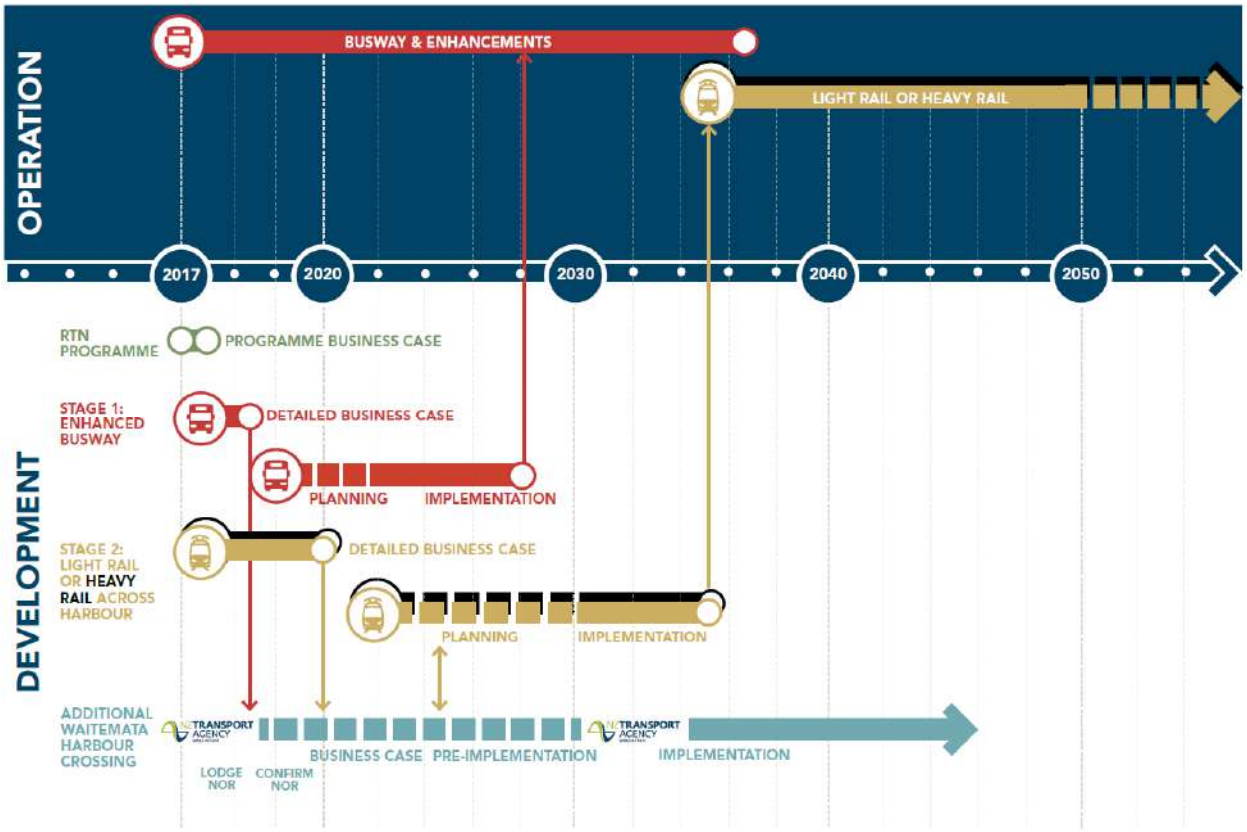
Figure 40: Potential regional land use connectivity of a stage 3 option



10.5 PROGRAMME

To effectively deliver an integrated and right-sized approach to rapid transit to the North Shore and northern Auckland, progress will be required on a number of fronts and in multiple stages. Figure 40 illustrates one possible programme.

Figure 41: Recommended Programme delivery and operation outcomes



Key elements of the recommended programme are:

- Commencement of an indicative/detailed business case for improvements and optimisation of the existing busway.
- Ongoing co-ordination with NZTA to protect the ability to in future provide light or heavy rail, in conjunction with the Additional Waitematā Harbour Crossing project, to keep that option open in case it is necessary.
- Implementation of Enhanced Busway with Double Decker or Advanced Bus between 2020 and 2025.
- Develop an indicative/detailed business case for a rail-based connection – a new mode and dedicated rapid transit crossing to augment or replace the existing busway.
- Additional route protection and pre-implementation required for a rail-based connection.
- Implementation of a rail-based connection commencing around 2030 to be in place by mid 2030s.

The I/DBC process should in parallel assess the optimal network configuration and timing of a light rail system, also considering a potential heavy rail system in the longer term. The output of the I/DBC process could be a delivery programme for busway improvements, as well as a recommended network and timing for a future North Shore light rail system.

11 RECOMMENDED PROGRAMME ASSESSMENT

11.1 PROGRAMME OUTCOMES

The Recommended Programme is effective against the Investment Objectives in the following ways:

Investment Objective 1: The PT network has the capacity to meet forecast demands to, from and within the North Shore.

The Recommended Programme provides

- An enhanced double decker or advanced bus operation that provides a capacity of 12,000 people per hour in the peak direction which is adequate capacity until the mid-2030s.
- A 2046 capacity of 15,000 people per hour in the peak direction. This is enough to deal with forecast demand for travel from the North Shore and Northern Auckland of some 14,000 trips per hour in the peak direction in 2046.
- The opportunity to either enhance light rail with longer trains or introduce a heavy rail mode which would provide capacity for growth beyond current forecasts and significantly enhance cross-regional capacity and interregional connections.

Investment Objective 2: The PT network operates to a level of service that supports planned growth and encourages mode shift to PT.

The Recommended Programme provides:

- Improved reliability and capacity by creating additional fully separated bus way between Akoranga Station and the northern end of the harbour bridge as well as additional bus only lanes northbound through St Marys Bay and improved bus stops and reliability in the City Centre by the mid 2020s.
- Improved station operation and operational performance of the busway, including off-board ticketing by early 2020s.
- A new light rail crossing of the Waitemata Harbour providing greater capacity and reliability by the mid 2030s providing faster travel times and a more reliable operation.

Investment Objective 3: The PT network improves the resilience of the passenger transport system across the Waitemata Crossing to both major and minor disruptive events.

The Recommended Programme provides:

- Bus-prioritisation on the harbour bridge by the early 2020s, meaning buses that operate at a higher capacity than general traffic and, by 2026 are expected to carry 14,000 of the expected 31,000 am peak trips across the harbour bridge, have greater reliability and operational performance.
- By the mid 2030s, a new rapid transit-only crossing of the Waitemata Harbour providing greater overall capacity and resilience across all modes.
- Securing the ability to provide heavy rail to the North Shore as part of the AWHC project, or in an alternative alignment, securing long term resilience of the transport connections to the North Shore.

Investment Objective 4: PT access to opportunities and labour markets in the Auckland region is enhanced beyond expected do-minimum levels.

The Recommended Programme provides:

- Travel time from Albany to the City Centre is reduced from 35 minutes currently to, and maintained at 26 minutes through to 2046 and beyond in a context of rising demand and degrading road travel times.
- In providing this travel time improvement, in a context of declining road network performance the Recommended Programme provides the ability for the current and future population of the North Shore to access jobs and education, particularly in the City Centre and fringes.

11.2 PROGRAMME RISK

The recommended programme is a combination of infrastructure investment, route optimisation and operational improvements.

Technical risks

Infrastructural elements for the stage 1 enhanced busway are not considered particularly risky, involving primarily new bridging and widening to existing motorway corridors. These are solutions that are common in New Zealand and there is considerable understanding of risks, planning constraints and solutions.

Stage 2 light rail involves the implementation and operation of a new technology to Auckland, which will have new training requirements and teething issues. Light rail will involve either a new bridge or tunnel – either separately or potentially shared with the AWHC tunnel. Either of these are major projects with considerable technical risk. Such projects are not uncommon internationally and risks are likely to be manageable with the appropriate skills, controls, standards, design and procurement.

A significant risk with light rail is the need to convert the existing busway corridor to light rail. This would likely result in significant service disruption and loss of capacity in the corridor. This risk may affect the timing of any decision to invest to ensure that the project can be delivered in a manner that retains adequate capacity, which may increase the duration of construction or that it is delivered before demand rises to the point that it exceeds the ability to manage during construction.

Stage 3 heavy rail will require additional tunnelling under the City Centre and the North Shore and would be a considerably larger, and as a result, significantly riskier project. In addition, a heavy rail option would need to be tied in to the existing rail network which will add significant technical risks.

Operational risks

The Recommended Programme requires significant operational changes in both public transport and road environments. Of particular note are:

- The need to remove one lane of capacity northbound on SH1 through St Mary's Bay and the issues this may create on state highway operations.
- The allocation of a lane each way on the Waitemata Harbour Bridge to bus and St Marys Bay traffic only and the impact this may have on state highway operations.
- Inexperienced staff operating and maintaining new technology can lead to delays in operation.
- Enhanced Busway solutions run in higher frequencies of up to 90 buses/hour. This may cause accumulation of buses caused by delays especially in the city centre.
- The enhanced busway using double deckers has considerable operational risks associated with it in the Downtown and Learning Quarter areas due to the large number of bus stops required and the number of buses required to meet demand operating in this area. Risks include pedestrian amenity, permeability and safety along with reliability of the service itself.
- The rail-based options propose tunnels to cross the harbour. This limits the number of evacuation routes, which then limits the maximum number of trains that can run through the tunnel. This leads to longer head times than usual rail operation.
- There are risks associated with the interrelationships between the service patterns in the City Centre, involving a number of key regional rapid transit lines. A lack of interconnecting of rapid transit services

has the potential to create excessive terminal requirements in the City Centre and reduced urban amenity and function as well as reduce reliability and operating efficiency.

- The introduction of specialised rights of way for either advanced buses or trams in the city centre is likely to result in removal of space for traffic, pedestrians, loading, parking and other uses. While potentially effective, there may be wider operational risks associated with this reallocation of space and time.

Financial risks

The estimated cost of the Recommended Programme is $390m - $430m in the early to mid-2020s and an additional $2.1b – 2.8b in the early to mid 2030s. NZTA provides 50% of AT's gross share, while Auckland Council provides the remainder of Auckland Transport's share. There is a risk that either Auckland Transport and/or NZTA is unable to find the expenditure to implement the programme.

Operational costs are an Auckland Transport responsibility, although this is subsidised by NZTA. The Recommended Programme results in a small saving on the do-minimum and as a result financial risks associated with operational costs are considered low.

Stakeholder risks

The physical interventions in the form of additional overpasses and a station in the vicinity of Onewa Road are likely to generate some public opposition, particularly from nearby residents.

Additional bus traffic in the CBD may have negative effects on the urban environment which could result in stakeholder or public reaction risks, especially when buses accumulate due to operational delays.

The Double Decker option could further affect public perception negatively. The terminus situated in downtown would occupy an area that has recreational character leading into the CBD and for some visitors it is the first impression of Auckland.

The recommended programme indicates that a rail option may need to be in place before the AWHC is planned. This may raise the impression of lacking inter organisational coordination.

The North Shore is expected to experience significant growth in demand for public transport, which the last ten years has reinforced. As a result, the investment programme proposed to introduce multiple modes over the next 30 years. There may be a risk that the replacement or augmentation of a mode that has been invested in within a decade to two decades of initial implementation is viewed negatively as the region not achieving value from the investment.

A new bridge across the Waitemata Harbour is likely to be a controversial issue that would need to be mitigated through sympathetic design. There is a history of public demand to protect the harbour and the proposition of any additional structure in the harbour could create public perception risks.

Environmental risks

Due to the proximity of all options to the coastal marine area in the vicinity of Onewa Road, all options present significant environmental risks. Environmental management and risk assessment, along with working closely with Iwi will need to be a key element of ongoing project development.

11.3 VALUE FOR MONEY

The Recommended Programme has a capital requirement of $390m-$430m in the first ten years. This is considered aligned with the scale of the problem at this time. With BCRs in the vicinity of 1 this stage represents relatively good value for money in the context of rapid transit projects.

The second stage is intended to provide strategic outcomes and future proof North Shore accessibility is expected to cost in the vicinity of $2.1b – $2.8b. While necessary in terms of meeting demand, the high cost means the BCR is relatively low at this stage. This is based on current land use assumptions and is a PBC-level assessment. More detailed assessment and a more comprehensive view on supporting land use and value uplift may yield an improved BCR. The BCR for heavy rail is relatively low, again due to the very high cost of the option.

It should be noted that more detailed investigations are likely to develop enhanced financial models and consider wider economic value of the improved accessibility as well as related land use changes.

Table 18: Cost benefit summary table

Option	Total project costs (present value, $000s)	Total project benefits (present value, $000s)	Net benefits ($000s)	BCR
Lower Northern Busway improvements	$164,369	$194,801	$30,433	1.19
Lower Northern Busway upgrade to ABS	$147,047	$151,051	$4,004	1.03
Convert busway to light rail (bridge)	$587,509	$329,293	-$258,216	0.56
Convert busway to light rail (tunnel)	$781,459	$379,911	-$401,549	0.49
Takapuna light rail spur*	$124,252	$30,929	-$93,323	0.25
Convert busway to light rail (bridge) + Takapuna light rail spur	$711,760	$360,222	-$351,538	0.51
Heavy rail from Silverdale via Takapuna	$7,527574	$2520,157	-$5,007,416	0.33

Enhanced Busway

Assumptions:

1. The BCR is based on a construction start date of 2023, in order for the busway enhancements to be operational by mid-2020s. A later start date would provide a higher BCR, with BCR for the Enhanced Busway options peaking around the mid-2030s.

2. The opex saving is based on the annual cost to run the North Shore PT network between 2026 and 2036; the saving is negative because more frequent service is provided under the Enhanced Busway options than the Do Minimum, resulting in a higher operating cost.

Capex (approx.) $390m–$430m

Opex Saving (approx.) −$2.5m per year to −$9.0m per year

BCR (2023) 0.95–1.12

Light Rail

Assumptions:

1. The BCR is based on a construction start date of 2030 for converting the busway to light rail and 2035 for starting construction of the Takapuna light rail spur, in order for the light rail to be operational by mid- to late-2030s. A later start date would provide a higher BCR. Furthermore, the BCR for converting the busway to light rail is slightly higher if the Takapuna spur is not included (0.42–0.51).

2. The opex saving is based on the annual cost to run the North Shore PT network (including light rail and remaining bus services) between 2036 and 2046, relative to the opex for the Do Minimum network in those years.

Capex (approx.) $2,100m–$2,800m

Opex Saving (approx.) $2.6m per year to $3.3m per year

BCR (2030) 0.41–0.47

Heavy Rail

Assumptions:

1. The BCR is calculated on a construction start date of 2046. As ART modelling is not available beyond 2046, Statistics New Zealand's long-range population projections were used as a basis to growth in benefits beyond this period.[8] As congestion (and hence decongestion benefits) is likely to grow more rapidly than population over this period, scenarios for faster future growth in benefits were also tested.

2. Indicative operating costs were estimated based on the net service and network operating costs for the Waitoki to Pokeno heavy rail line, less the savings from no longer running the base case Southern Line service from Papakura to Pukekohe and from no longer running the NEX service from Hibiscus Coast to Albany. All other rail service costs were maintained as per the base case CRL network for 2046. The net operating costs arising from the new heavy rail line are summarised in the table below.

Component	Peak vehicle requirement		Service-hours		Service-kilometres		Total Annual Cost
	Vehicles	Cost	Annual hours	Cost	Annual km	Cost	
Savings southern line	9	$4,800,000	33,040	$3,964,800	1,535,885	$15,389,566	$24,154,366

[8] Auckland's population is expected to grow more rapidly than New Zealand's population due to higher birth rates and inward migration. Hence we have scaled national population growth rates up to reflect the average difference between Statistics New Zealand's forecast growth for Auckland and New Zealand in the 2013-2043 period.

Component	Peak vehicle requirement		Service-hours		Service-kilometres		Total Annual Cost
	Vehicles	Cost	Annual hours	Cost	Annual km	Cost	
Papakura to Pukekohe							
Savings NEX bus Hibiscus Coast to Albany	14	$606,667	39,178	$1,525,983	2,309,507	$4,619,014	$6,751,664
New line Waitoki to Pokeno	31	$16,000,000	102,120	$12,254,400	5,991,040	$60,030,221	$88,284,621
Depot and network maintenance							$27,000,000
Total:							**$84,378,591**

Capex (approx.)	$8,400m - $14,200m*
Opex (approx.)	$84m per year / $91m (HR) / $140m (incl NS LRT and bus)
BCR (initial)	0.25–0.33

11.4 SENSITIVITY ANALYSIS

The cost-benefit analysis model was set up to enable sensitivity testing on a range of parameters:

- Discount rate: The EEM recommends a standard 6% rate for discounting future costs and benefits of a project back to present value. Higher and lower values were sensitivity tested.
- Evaluation period: The EEM recommends a standard analysis period of 40 years for the 6% discount rate. Longer and shorter evaluation periods are included as sensitivity tests.
- Value of conventional transport benefits: In the base scenario, transport user benefits and other categories of benefits, such as health benefits and emissions reduction benefits, were assumed to be constant in real terms – ie they were not assumed to rise over the evaluation period. However, transport evaluation guidance published by Transport for New South Wales (2013) recommends sensitivity testing a 1.5% annual real increase in the value of conventional transport benefits, reflecting expected productivity and income growth. Thus, real increases in the value of conventional transport benefits were sensitivity tested in this analysis.
- Productivity growth: Modelled agglomeration benefits, imperfect competition benefits, and tax wedge benefits for future years were scaled up to reflect expected productivity growth throughout the modelling period. Per ART3 model assumptions, productivity is assumed to grow at 1.5% per annum, but lower values were sensitivity tested.
- Growth in transport demand: Previous observations of actual and predicted growth in public transport demand suggest that transport models consistently under-predict future public transport demands on rapid transit networks. Thus, an accelerated demand profile was applied with demand brought forward by 5 years. Sensitivity tests were conducted with lower demand growth rates to model the impacts of slower growth in population in Northern Auckland leading to reduced growth in transport demand and travel time delays for PT and road users.

- Construction costs: P50 construction cost estimates were assumed to be the most likely outcome, but the impact of P95 construction costs were included as a sensitivity test.
- The following table summarises the results of sensitivity testing on four of the NSRTN options for a construction start year of 2035.
- The sensitivity analysis shows that in isolation each of the sensitivity tests applied do not markedly change the expected BCR outcomes associated with each option. The busway options are likely to have a BCR around 1.0 under a range of likely possible scenarios, although a combination of favourable or unfavourable circumstances may push the BCR further above or below 1.0, respectively. The BCR for the light rail options remains below 1.0 for each of the sensitivity tests applied below, but the BCR may reach or exceed 1.0 with a combination of a longer evaluation period and a 1.5% annual increase in the real value of conventional transport benefits.

Table 19: Sensitivity analysis summary table (bus and light rail)

Sensitivity Test	Lower Northern Busway improvements	Lower Northern Busway upgrade to ABS	Convert busway to light rail (bridge) + Takapuna spur	Convert busway to light rail (tunnel) + Takapuna spur
Base assumptions (6% discount rate, 40 year period)	1.19	1.03	0.51	0.45
4% discount rate, 60 year evaluation period	1.65	1.56	0.67	0.54
8% discount rate, 30 year evaluation period	0.95	0.82	0.57	0.55
1.5% annual real increase in value of conventional benefits (in line with productivity growth assumption)	1.81	1.56	0.68	0.59
0% annual real increase in value of WEBs (reflecting no productivity growth)	1.24	1.08	0.52	0.47
Central demand growth rate (I11 land-use scenario)	1.08	0.95	0.48	0.44
P95 construction cost estimate (approximately 17% higher)	1.04	0.89	0.47	0.43

For the heavy rail economic assessment, construction costs comprise 90% of the total project costs. More than one-third of project benefits come from agglomeration benefits, which arise from reduced journey times between businesses and workers. This suggests a large portion of the benefit of the heavy rail option is due to connecting the city centre and other metropolitan centres, such as Takapuna and Albany, with an express rail service. Another quarter of the benefits come from benefits to public transport users, including faster travel times, reduced crowding, and better quality of service.

Sensitivity testing was conducted on key costs and benefits to understand how these results may change under alternative assumptions. The results of sensitivity testing are summarised in Table 20.

Table 20: Heavy rail sensitivity tests

Sensitivity test	BCR
4% discount rate, 60 year period	0.50
Faster growth in benefits post 2046, reflecting increasing transport capacity constraints during evaluation period – benefits grow 2.5% faster than population	0.48
P95 cost estimate – construction cost is 70% higher than P50 estimate	0.25
Extreme bounds analysis – P50 cost; faster growth in benefits; 4% discount rate, 60 year period	0.83

Due to the long time period over which this project must be evaluated, there is a high degree of uncertainty about these indicative estimates of benefits and costs. Sensitivity testing reveals that the project is likely to become more viable if:

- Congestion and public transport crowding increases more rapidly than population, resulting more rapid growth in benefits in the out-years
- The project can be delivered in a more cost-effective manner, including delivering lower ongoing operating costs
- The project is evaluated over a longer time period, with a lower discount rate.

Finally, this analysis does not investigate opportunities for land use change, which may be significant. By relieving transport capacity constraints at the core of the network and significantly reducing public transport travel times to new urban growth areas, it may catalyse broader locational and economic changes. These opportunities may strengthen the rationale for the project or create opportunities to capture funding from land value uplift.

11.5 ASSESSMENT PROFILE

The Transport Agency's Investment Assessment Framework requires a Programme Business Case to provide "confirmed" Strategic Fit assessment and indicative effectiveness and Benefit Cost Appraisal assessment.

Strategic Fit

The strategic fit assessment looks at the relevance and significance of the issue in relation to desired transport results.

The Recommended Programme aligns well with organisational priorities of the partner organisations as outlined in detail in the Strategic Case.

There is strong alignment with ATAP. The ATAP project indicated that "Waitemata Harbour crossing improvements including mass transit upgrade of the Norther Busway" should be carried out in Decade Three. This PBC recommends enhancements to the current busway in Decades One and Two with the need to invest in mass transit late in Decade Two or early in Decade Three.

In terms of PIKB requirements, a high rating is justified as the programme business case addresses journeys for employment to New Zealand's most significant City Centre and addresses capacity and resilience issues on a nationally significant route (SH1).

The overall strategic fit is **High (H)**

Effectiveness

The PIKB requires an assessment of effectiveness against a range of criteria outlined below:

Outcomes focused:

- Tangible change in addressing the problem, issue or opportunity identified in the Strategic Fit assessment
- Consistency with levels of service in an appropriate classification system

Integrated:

- Consistency with the current network and future transport plans
- Consistency with other current and future activities
- Consistency with current and future land use planning
- Accommodates different needs across modes
- Support as an agreed activity across partners

Correctly scoped:

The degree of fit as part of an agreed strategy or business case

- Has followed the intervention hierarchy to consider alternatives and options including low cost alternatives and options
- Is of an appropriate scale in relation to the issue/opportunity
- Covers and/or manages the spatial impact (upstream and downstream, network impacts)
- Mitigates any adverse impacts on other results

Affordable:

- Is affordable through the lifecycle for all parties
- Has understood and traded off the best whole of life cost approach
- has understood the benefits and costs between transport users and other parties and sought contributions as possible

Timely

- Delivers enduring benefits over the timeframe identified in the justified strategy or business case
- Provides the benefits in a timely manner

Confidence

- Manages current and future risk for results/outcomes
- Manages current and future risk for costs

Overall:

- Assessment based on lowest rating of all components

Table 21: Effectiveness Assessment

Criteria	Assessment	
Outcomes focus	The programme provides a clear and measureable effect on the defined problems through a demonstration of addressing the deficiencies in capacity over time. The programme also provides evidence of effects on reliability and the extent to which this can impact mode share and economic performance of the Auckland Region.	**H**
Integrated	The programme provides an understanding of the problem on the North Shore from a public transport perspective. The programme provides an integrated view of all modes to the North Shore from a demand and supply perspective. There are opportunities to provide a consistent and integrated approach with other planned activities such as the AWHC and other RTN projects. These issues and opportunities are raised in the programme, but not fully resolved. The programme is consistent with current land use planning. Demands are based on i11 land use forecasts and there is a strong connection to supporting the City Centre, Metropolitan Centre and proposed greenfield growth in the north of Auckland. There has been engagement with NZTA in its role planning the AWHC project. Integration potential has been acknowledged and provided for. Overall, this is considered High (H) as while integration potential has not been fully defined at this stage, it is a complex issue and this programme provides a programme that defines the needs and timing of needs for the North Shore that is capable of providing a defined input to further work on integration of activities.	**H**
Correctly Scoped	The PBC considered a wide range of potential interventions including demand management and productivity, along with various supply-based pathways. While a large scale programme, the scale of the problem is also very large and as a result it is considered appropriate. Some additional work is required to better understand downtstream effects, particularly in relation to the City Centre terminal capacity and inter-lining with other RTN corridors.	**H**
Affordable	The Financial Case addresses the affordability. The programme is of a significant scale that should be addressed through further planning and prioritisation processes. The timing and scale however, is not out of line with that expected in the ATAP process.	**M**
Timely	The recommended programme is achievable in the timeframes recommended in the PBC. The programme is time-bound and aligned with the forecast demands.	**H**
Confidence	Being a programme case for a very large scale investment, over a long time period, there remains considerable uncertainty as to costs and demands. However, the likely demands are reasonably certain and have a solid history of strong growth.	**M**
Overall	The recommended programme is considered **Medium** in its effectiveness based on NZTA's guidance that the Effectiveness rating is based on the lowest rating.	**M**

Benefit Cost Appraisal

The second stage is intended to provide strategic outcomes and future proof North Shore accessibility are expected to cost in the vicinity of $2.1b – $2.8b. While necessary in terms of meeting demand, the high cost

means the BCR is relatively low. This is based on current land use assumptions and is a PBC-level assessment. More detailed assessment and a more comprehensive view on supporting land use and value uplift may yield an improved BCR.

As the BCR for Stage 1 (Enhanced Busway) is between 1 and 2.9, according to NZTA's Investment Assessment Framework, the rating is **Low (L)**

Summary

The Strategic Assessment profile as assessed against the NZTA's Investment Assessment Framework is shown below:

Component:	Assessed as:
Strategic fit	**High**
Effectiveness	**Medium**
BCR	**Low**

12 PROGRAMME FINANCIAL CASE

12.1 INDICATIVE COST

The estimated23 capital and operational costs of the Recommended Programme are outlined below:

Table 22: Programme Capital and Operational Costs

Programme Costs				
Programme Element	**Decade 1($m)**	**Decade 2 ($m)**	**Decade 3 ($m)**	**Future Stages ($m)**
Enhanced Busway	$390 - $430			
Light Rail		$2,100 - $2,800		
Heavy Rail				Approx. $8,400
Total Capex	$390 - $430	$2,100 - $2,800	$0*	Approx. $8,400
Opex	$17 - $22	$14 - $17	$14 - $17	Approx. $84,378

** Assumes that light rail is delivered late in decade 2 and enhanced to continue beyond 2046 and heavy rail is not commenced until after the third decade. Further refinement of the enhanced busway and understanding of forecasts may influence timing by decade.*

12.2 FUNDING ARRANGEMENTS

It is expected that further investigation and implementation of the programme would be funded in the usual manner with Auckland Transport funding the investigations, subsidised by NZTA. Capital investment would need to be determined.

Based on current practice (referencing in particular the current extension of the Northern Busway from Constellation to Albany, enhanced busway stage), being within a state highway corridor would be expected to be funded by NZTA, with Auckland Transport funding stations and supporting works on the local network. Auckland Transport would also be expected to fund the operating requirements of services and stations, funded by NZTA in the same manner as the rest of the network.

The latter stages of the programme, being light rail and potentially heavy rail would need to be the subject of

further agreement between Auckland Transport, Auckland Council, NZTA and Treasury. It is expected that Auckland Transport would fund the investigation phases, subsidised by NZTA, and would investigate and enable funding mechanisms through strategic and statutory planning documents.

12.3 AFFORDABILITY

While not considered outside of the ability of both NZTA and Auckland Transport to fund the Recommended Programme, it is not currently part of either agency's programme. A mass transit connection in associated with an additional Waitemata Harbour Crossing is anticipated in the ATAP programme. This signals the intent to consider making financial provision for the programme at the appropriate time.

PART C – DELIVERING AND MONITORING THE PROGRAMME

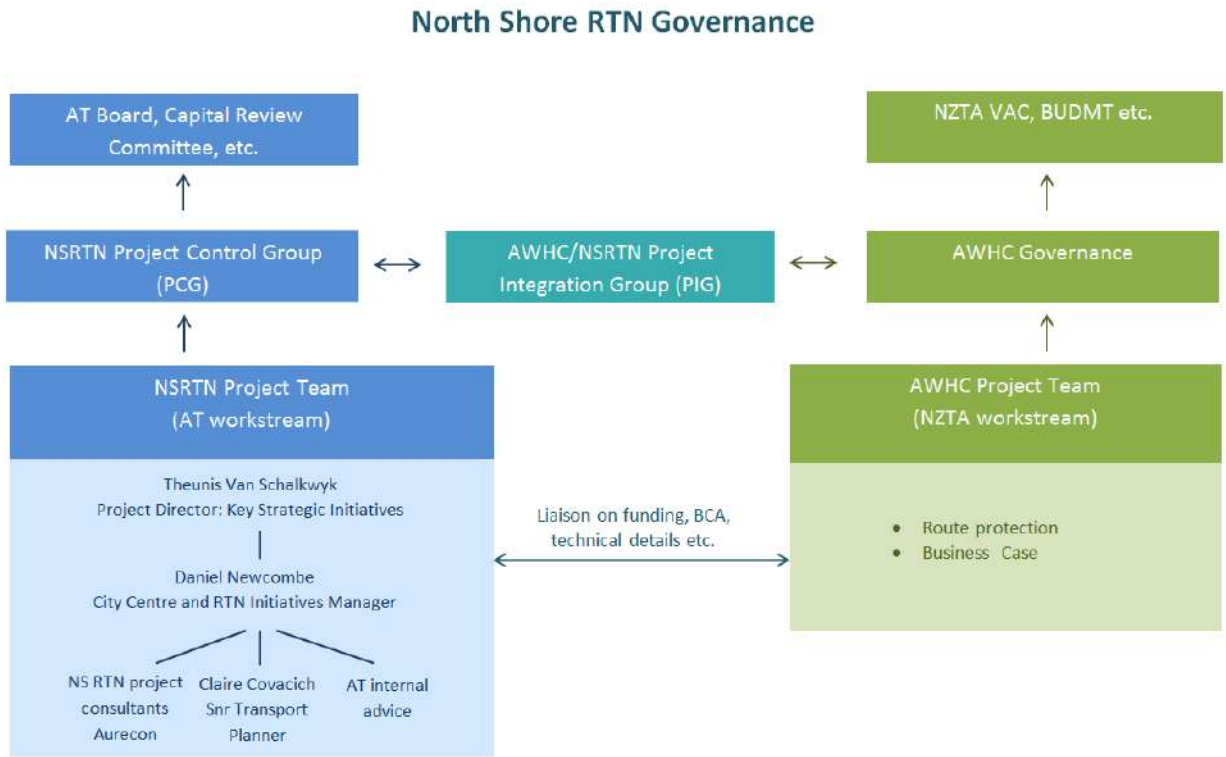
13 MANAGEMENT CASE

13.1 PROGRAMME GOVERNANCE AND REPORTING

Planning and operation of rapid transit corridors is the responsibility of Auckland Transport and as a result Auckland Transport has commissioned this programme business case and remains responsible for the outcome and next stages. The North Shore RTN however, is a strategically significant project that is connected to NZTA's AWHC project both in terms of location and potential project development, but also in terms of strategy and communication.

As a result, the immediate next steps for developing the Recommended Programme rest with Auckland Transport. These next steps should be carried out in an integrated manner with the development of the AWHC project. To achieve this, a joint governance structure has been developed and should be maintained to co-ordinated the two projects. Figure 41 outlines the joint governance arrangements from the North Shore Rapid Transit Strategic Case.

Figure 42: Proposed Governance Structure (source: NSRTN Strategic Case)



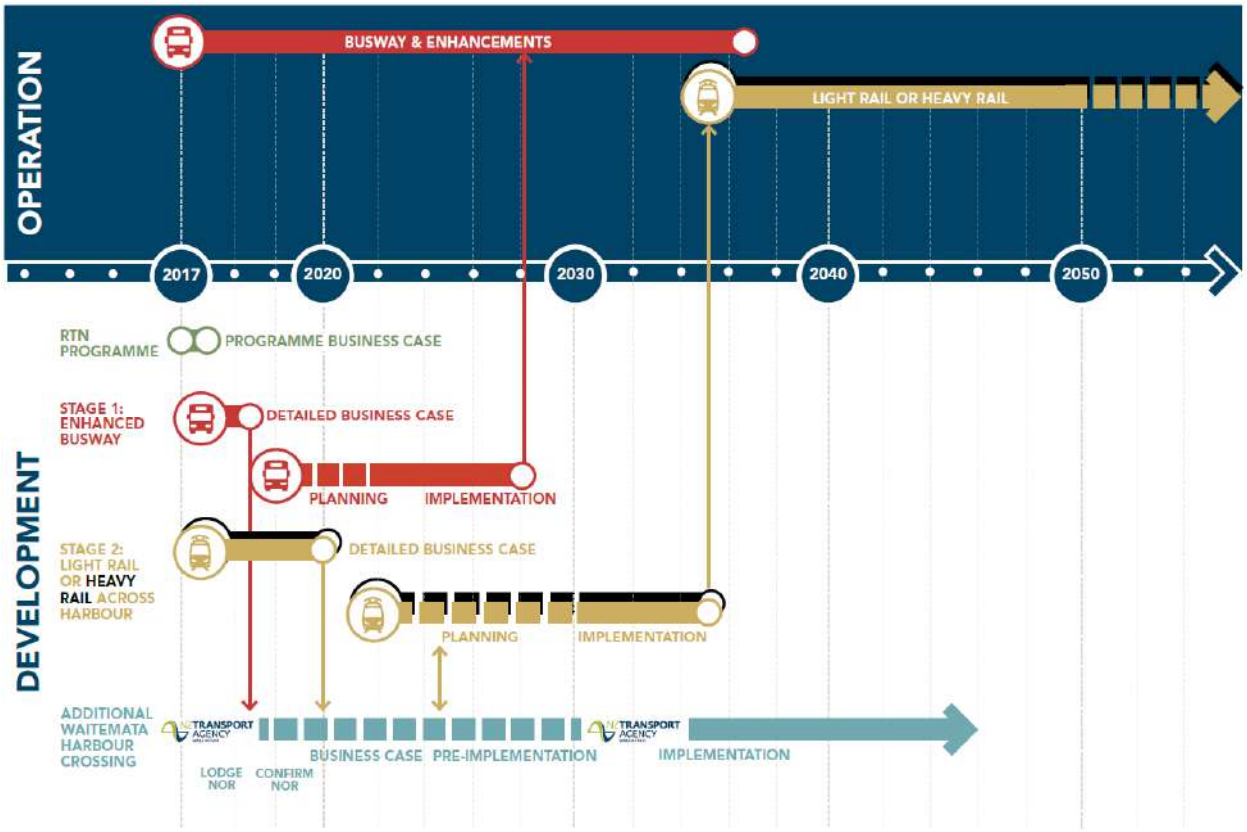
Auckland Transport proposes to take responsibility for the next stages in accordance with its mandate and usual

project management, internal reporting and governance processes. In addition however, Auckland Transport will continue to develop a joint project governance covering both the AWHC and North Shore RTN projects to align work and ensure that value and decision making is optimised. Within Auckland Transport, responsibility rests with the Director, Key Strategic Initiatives.

13.2 WORK BREAKDOWN AND NEXT STEPS

Given the potential lead-times to implement major elements of the enhanced busway, it is recommended that an indicative/detailed business case is commenced in 2018 following approval of this programme case. This workstream should investigate the improvements and options in the first stage of the Recommended Programme, including comparing an enhanced double decker operation with an advanced bus operation or the timing of a migration between the two.

Figure 43: Recommended Programme sequencing and alignment



It is recommended that an indicative/detailed business case be commenced to outline the form, function, timing and case for a rail connection to the North Shore. While current analysis indicates that the light rail connection is unlikely to be required until the mid 2030s, given the potential scale of the project and potential for integration with the AWHC project, carrying out the indicative/detailed business case early is expected to both highlight risks and opportunities and allow for integration potential to be fully realised. This will also allow for any land use, demand management and optimisation measures to be scoped early.

While not expected to be required until beyond the current planning horizon in 2046, the Recommended Programme includes the preservation of the opportunity to provide heavy rail to the North Shore at some time in the future. This could be done stand-alone or through, or in close association with the AWHC project, noting that a decision regarding RTN in the AWHC project has yet to be made.

The need for a heavy rail connection is likely to be driven by land use and a decision by Auckland Council to provide growth in the north of Auckland beyond that already envisaged. The implementation of heavy rail to the North Shore would also provide significant new capacity and opportunities for movement in the wider regional transport network. This increase in accessibility may drive further land use decisions in parts of Auckland other

than the North Shore.

The Recommended Programme suggests that the discussion and work supporting this should be led by an integrated land use and transport approach and should involve a joint governance structure with Auckland Council when the time is appropriate.