Auckland Rapid Transit Plan

Stages 1 – 3 Summary Report

Advice on the integration of the future City Centre to Māngere, Northwest and North Shore rapid transit corridors

May 2021

Auckland Council
Te Kaunihera o Tāmaki Makaurau

NZ TRANSPORT AGENCY
WAKA KOTAHI

Auckland Transport
An Auckland Council Organisation

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1 Introduction

This technical paper outlines work to date by Auckland Transport, Waka Kotahi and Auckland Council to develop a rapid transit plan for Auckland. Auckland's multi-modal transport system is complex and strongly inter-connected, with rapid transit playing an increasingly important role over time.

Rapid transit has the potential to deliver transformational benefits to Auckland, through meeting a large share of growing travel demand, encouraging mode shift to public transport, and shaping the region's urban form and development. At the same time, rapid transit investments are extremely large, complex, and interrelated with each other and other parts of the transport and urban system. This means a rapid transit plan is critical to realising the potential benefits of rapid transit to Auckland and maximising value for money from investments.

1.1 Purpose of the Auckland Rapid Transit Plan

Key rapid transit projects across Auckland are currently in various stages of development, as shown below:

Table 1-1: Key Rapid Transit Projects

Phase of development	Projects
Under construction	▪ City Rail Link ▪ Northern Busway extension (Constellation to Albany) ▪ State Highway 20B transit lanes and Puhinui interchange ▪ Eastern Busway (Panmure to Pakuranga)
Detailed design & procurement	▪ Eastern Busway (Pakuranga to Botany) ▪ Rail electrification (Papakura to Pukekohe) ▪ Third main (Westfield to Wiri)
Business case development (detailed)	▪ City Centre to Mangere ▪ Northwest interim bus improvements ▪ Airport to Botany corridor ▪ Northern Busway enhancements
Business case development (indicative)	▪ Northwest rapid transit ▪ North Shore rapid transit ▪ Upper Harbour corridor ▪ Rail network development plan

Significant funding has been allocated to the development of the RTN. Clear direction is needed to ensure that these projects progress in an integrated way and achieve value for money, and so that subsequent projects can be prioritised.

Without an overall Rapid Transit Plan, individual projects will need to continue to progress individually. This will result uncertainty about the scope, goals and purpose of individual projects. Some projects will be unable to progress without key network-level issues being resolved. The ability to future-proof individual projects for the future expansion of the RTN may also be lost, or conversely could occur in ways that end up being not fit for purpose. This could result in a network that does not maximise the potential efficiencies of shared infrastructure, or where costs have been sunk unnecessarily.

While ATAP, the Auckland Plan and the RPTP provide high level information about Auckland's future rapid transit network, they do not provide a level of detail sufficient to resolve detailed questions around mode, timing and network integration.

The Auckland Rapid Transit Plan will help address these issues by outlining at a network level:

- The role and objectives of rapid transit within Auckland's wider public transport network, and its overall contribution to transport and urban development outcomes
- The future network's corridors and their expected modes,
- High-level operating patterns and capacities to meet expected demands,
- Timing and staging for this network, including any interim improvements, and
- Accessing rapid transit, including land-use integration.

The ARTP will ensure that the development of rapid transit corridors support the strategic objectives, urban form and growth aspirations outlined in the Auckland Plan 2050.

Auckland Council, Auckland Transport and Waka Kotahi have partnered to develop this plan, which also involves the Ministry of Transport, KiwiRail, and other key agencies with an interest in transport investment in Auckland. There are four stages to the development of this plan:

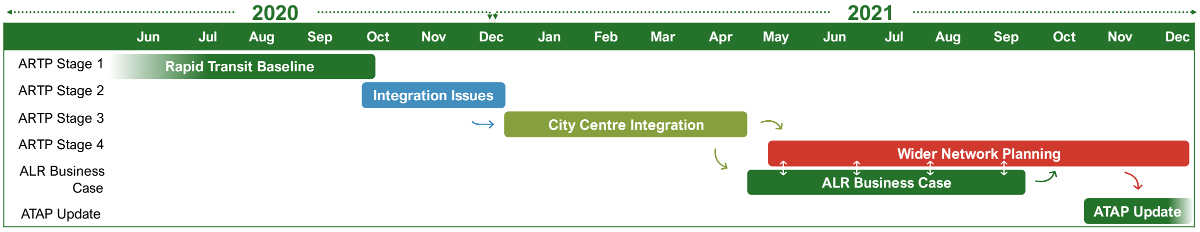

Figure 1-1: Rapid transit plan development stages

Work to date on the Auckland rapid transit plan is captured in two key papers:

1. The Auckland Rapid Transit Baseline – which defines rapid transit in the Auckland context and details its role and objectives within the wider transport and urban development system.
2. The Stages 1-3 Summary Report – which is this document. The Baseline is also summarised in this document.

1.2 Purpose of this summary report

The Government's April 2021 announcements on the next steps for Auckland Light Rail (ALR) underscored the importance of the City Centre to Māngere (CC2M) corridor as the first step in the development of a wider rapid transit network for Auckland. Investment in infrastructure by CC2M, particularly in the City Centre, will be leveraged by future corridors to the North Shore and Northwest corridors. This will complement the heavy rail network, which forms the core of the existing rapid transit network.

The ALR Establishment Unit has been given a 6-month timeframe to report back to the Government on their recommendations for CC2M. This paper is intended to assist the Establishment Unit in meeting this timeframe, by providing guidance on how CC2M could integrate with the future North Shore and Northwest corridors. This will partly depend on the decisions the ALR Establishment Unit makes regarding that corridor's mode, form, alignment and staging.

This paper provides the Establishment Unit with:

- Information about previous work on the North Shore, Northwest and City Centre to Māngere corridors, including the key issues they are seeking to address.
- Objectives to help guide integration of the three corridors in the city centre, to ensure they contribute to desired wider objectives and outcomes
- Options for how the three corridors could be integrated
- Key findings from an initial assessment of these options
- Recommendations to help guide key issues for the Establishment Unit's work to focus on.

The paper details the technical work that has been done, as part of the early stages of the development of an Auckland Rapid Transit Plan (ARTP), which has led to the development of the options for the integration of the three corridors. It is expected that will be used as an input into the ALR Business Case.

The Establishment Unit's work, and work on the ARTP, are closely interrelated. Aligning the work of these two projects will ensure that their outputs are mutually beneficial. Decisions on the CC2M corridor, once available, will feed back into the work of the ARTP to inform the long-term rapid transit network planning for Auckland.

2 Background and context

2.1 Introduction

This section provides an outline of previous work that informed the development of the Auckland Rapid Transit Plan. This includes:

- 'Whole of system' strategic plans like the Auckland Plan 2050 and the Auckland Transport Alignment Project (ATAP)
- Transport demand modelling, undertaken as part of regional planning work or individual project business cases
- Previous project business case development for city-centre focused rapid transit corridors

This previous work provides significant technical information on each corridor. Combined with the 'Rapid Transit Baseline' report, this provides clear guidance about:

- The role each corridor needs to play within Auckland's wider rapid transit network, and the problems driving the need to expand Auckland's rapid transit network into these corridors
- Key choices and decisions that need to be made in planning and design of each corridor

However, project-level analysis for each corridor has been done through a wide variety of different pieces of work over time, often using different assumptions on key issues (e.g. the location of future growth). Creating a consistent set of assumptions is therefore an important step in planning the rapid transit network more holistically, which is described in later sections.

2.2 Strategic planning

30 million passengers were carried on Auckland's existing rapid transit network in the year ending February 2020 (prior to the COVID-19 pandemic). This represents close to a third of the 103 million passengers on the entire public transport network over the same period.

The development and expansion of Auckland's Rapid Transit Network (RTN) is a key focus of long-term transport strategies, including the Auckland Plan 2050 and ATAP (as shown in figure 2.2). These plans set out the rough alignment of future rapid transit corridors, including key destinations that will be served and the expected mode of each corridor. The location of likely future rapid transit corridors has remained consistent across many decades of strategic plans, with changes over time being relatively subtle.[1]

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[1] For example, the 1999 Auckland Regional Growth Strategy, Regional Land Transport Strategies in 2005 and 2010, as well as the 2012 Auckland Plan.

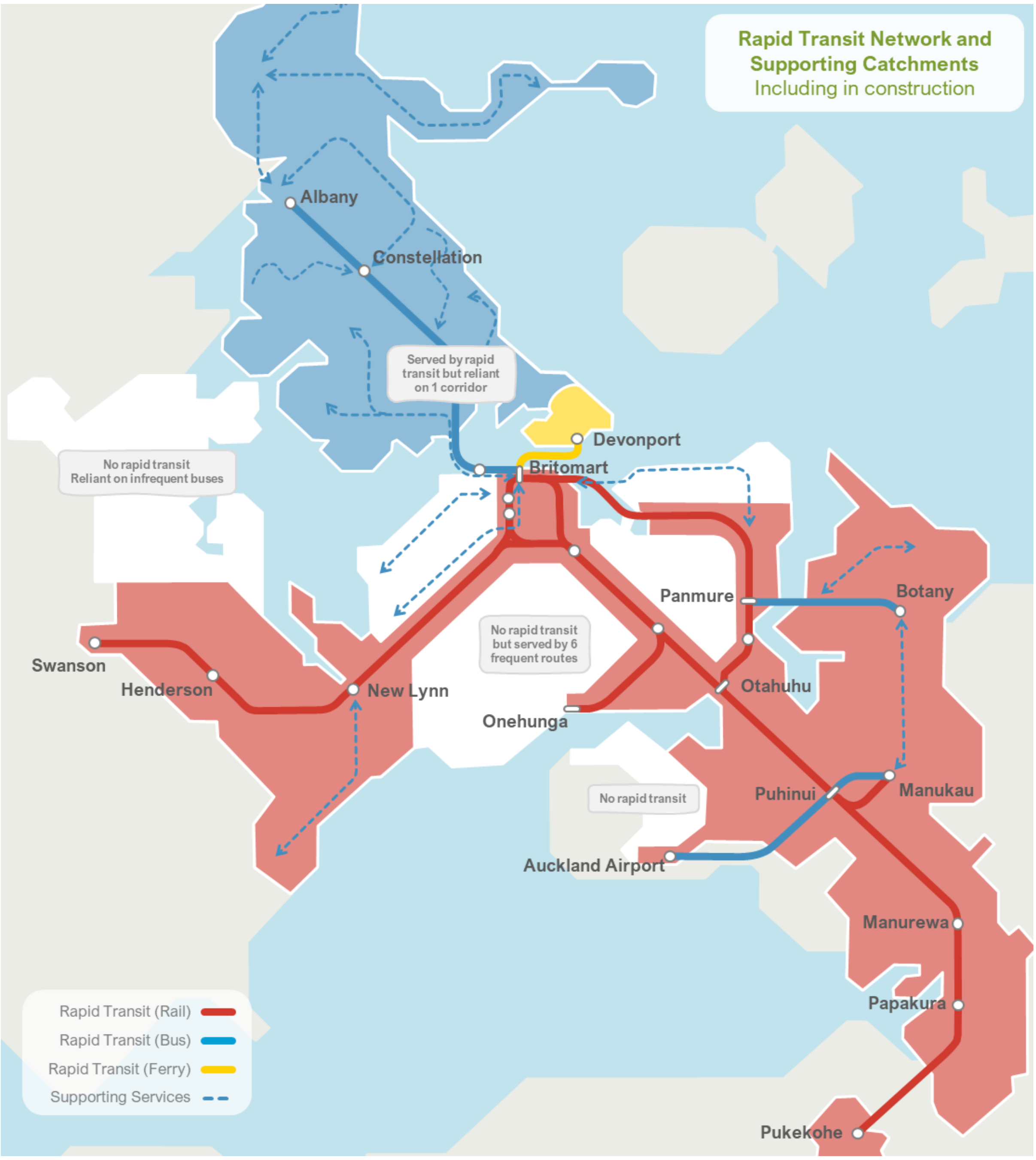
Figure 2-1: Potential future rapid transit network (ATAP 2018)

These high-level plans lack significant detail about the scope, timing and objectives of individual corridors, including identification of issues at a network level. The work required to answer these questions at a corridor level is often duplicative between corridors and difficult to resolve.

2.3 New city centre corridors

Strategic planning work and business case development of the past decade has highlighted how, once current rapid transit projects are completed (including City Rail Link and the Eastern Busway), large parts of the region will be well served by rapid transit (including feeder services). However, four main 'gaps' will remain: the central isthmus, Māngere, the northwest and (because future demand is forecast to exceed capacity of the busway) the North Shore.

This is illustrated below:



Unless these major gaps in the rapid transit network are addressed, key strategic transport and urban development outcomes will not be achieved. Business case work on each corridor (as described below) provides more detail on the implications of not providing new rapid transit connections along the following corridors:

- City centre to Māngere through the central isthmus
- City centre to the North Shore
- City centre to the Northwest via SH16

All three corridors respond to broadly similar issues, although each have their own distinct characteristics. Key shared issues facing the corridors are:

- Population growth is leading to growing travel demand – particularly to the city centre
- All three corridors currently rely on buses to serve these demands
- The capacity of buses to continue to serve this demand is limited
- The city centre's capacity to serve a growing number of buses is limited.

The three corridors must be considered together, to ensure that any changes to planning for one considers the implications for the others. Changes could have significant flow-on implications for wider network planning, including cost, timing, and network operations, which need to be understood as early as possible.

2.4 Forecast growth and travel demand

The Auckland 'Macro Strategic Model' is a transport model that is used to understand likely travel demands in future years. It relies on key inputs relating to the location and timing of population and employment growth, as well as what transport network is expected to be in place in future years. Figure 2-2 and Table 2-1 below summarise the scale of growth projected in these corridors, as well as the modelled peak direction passenger demand in the busiest hour in 2050 at the highest demand part of the three rapid transit corridors.

Table 2-1: Forecast corridor population growth and demand (peak hour, peak direction – 1hr)

Corridor Growth & Demand	City Centre to Mangere		Northwest		North Shore	
	2018	2048	2018	2048	2018	2048
Population	212,000	297,000	125,000	218,000	305,000	400,000
Employment	74,000	99,000	34,000	66,000	122,000	161,000
PT Demand (AM 1hr peak)		5,000 – 7,000		6,000 – 7,000		13,000

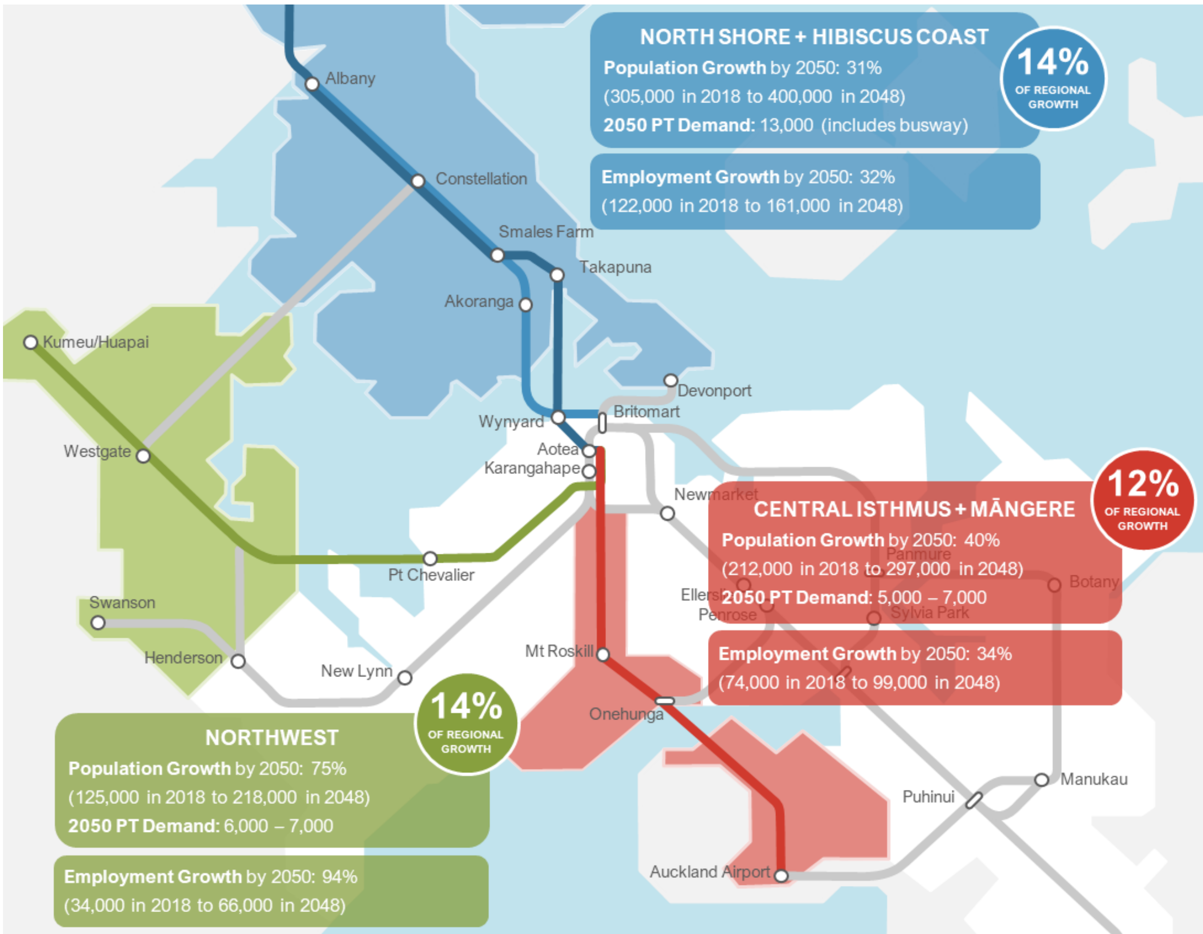


Figure 2-2: Forecast corridor population growth and demand (peak hour, peak direction – 1hr)

Key points to note are:

- The demand across the harbour from the North Shore will be double that of the Northwest or Central Isthmus and Māngere, so is a key factor in planning for the future capacity of the rapid transit network.
- As a percentage of current population, the growth occurring in the Northwest is significant. In absolute numbers though, growth in all three areas is expected to be of a similar magnitude (between 90,000 and 125,000 people).
- These forecasts are drawn from a range of previous work, and therefore are not based on a consistent set of assumptions. They are given here as an indication of the scale of future demand and growth.

Figure 2-3 provides a more detailed view of forecast travel demand on different sections of each corridor, as well as highlighting how different pieces of past analysis have different levels of forecast demand, due to different growth assumptions or different modelled transport solutions.

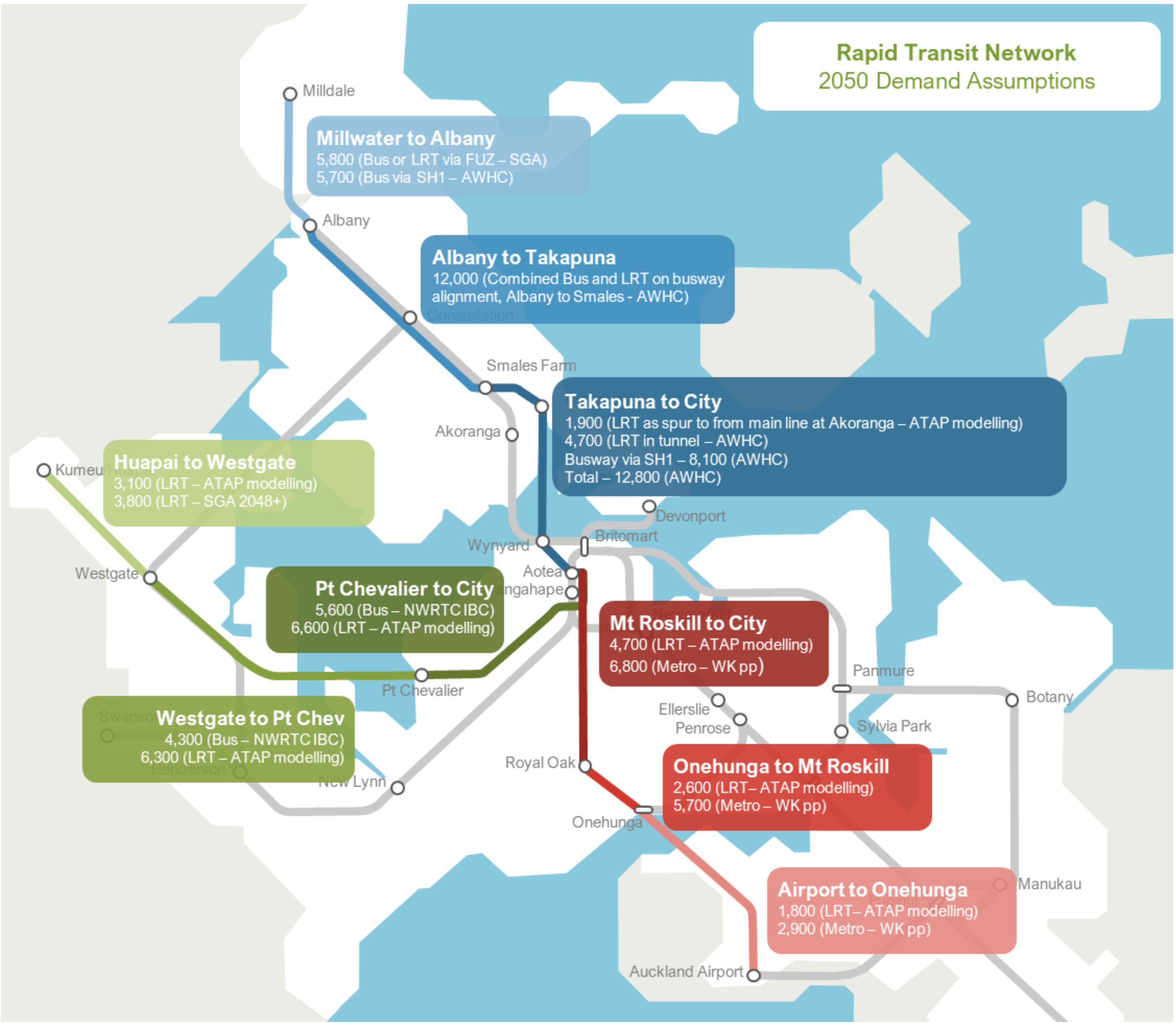


Figure 2-3: 2050 demand assumptions

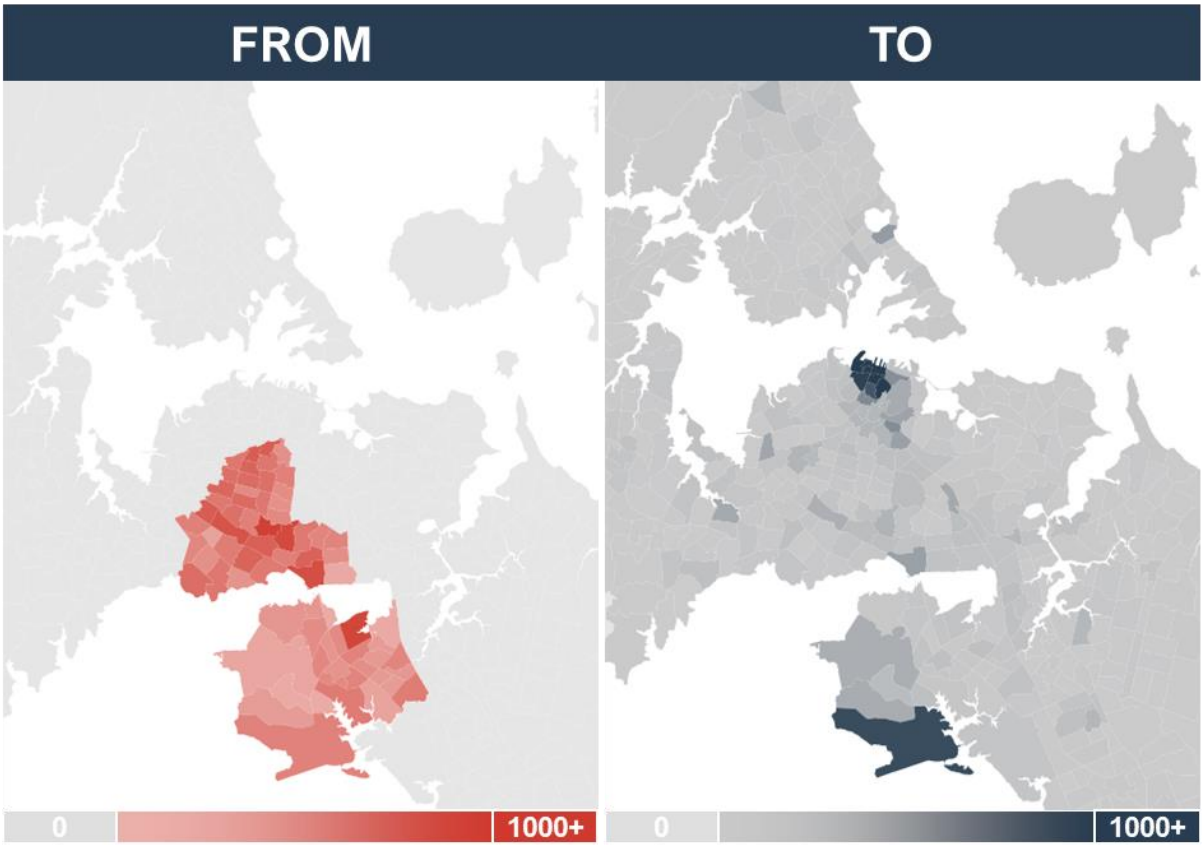
Key insights shown on the map above are:

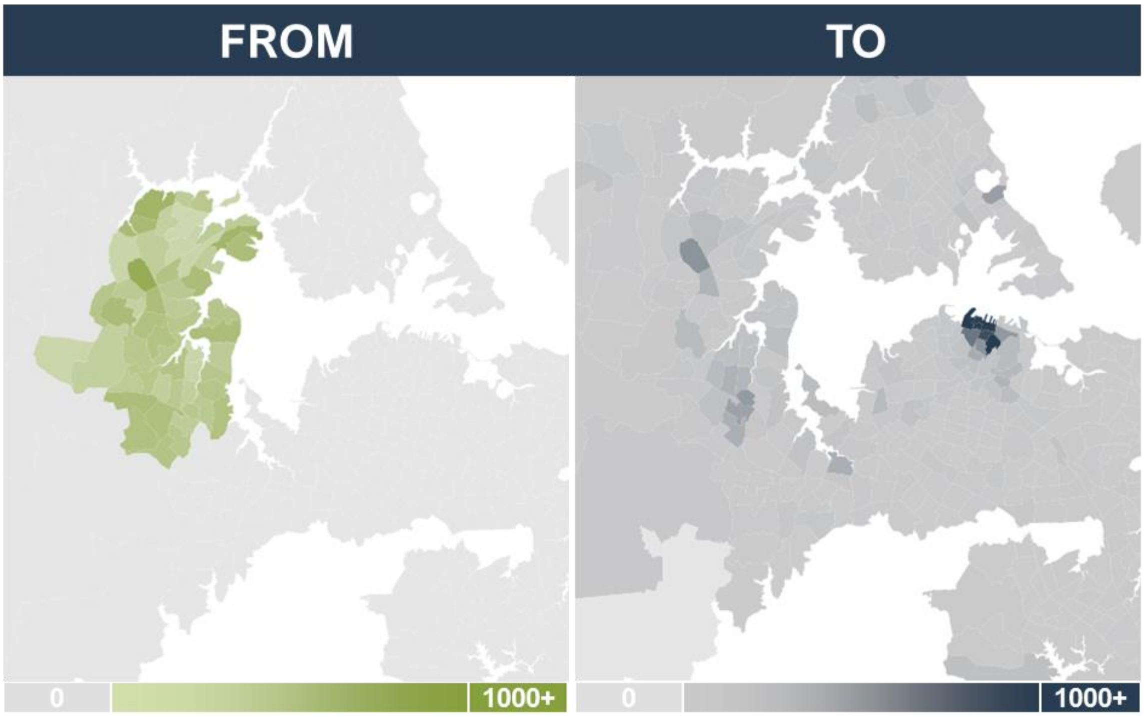
- Demand levels on all corridors get higher as they approach the city centre, indicating that the city centre is a critical destination for many trips.
- Demand on the North Shore and (most especially) the northwest corridors remains relatively high on outer sections compared to inner sections, especially as far as Albany and Westgate – indicating rapid transit in these corridors is playing a key role in serving longer trips.
- Relative demand along the corridors (i.e. North Shore is broadly equivalent to City Centre to Māngere plus northwest) remains broadly true along inner, middle and outer parts of the corridors.

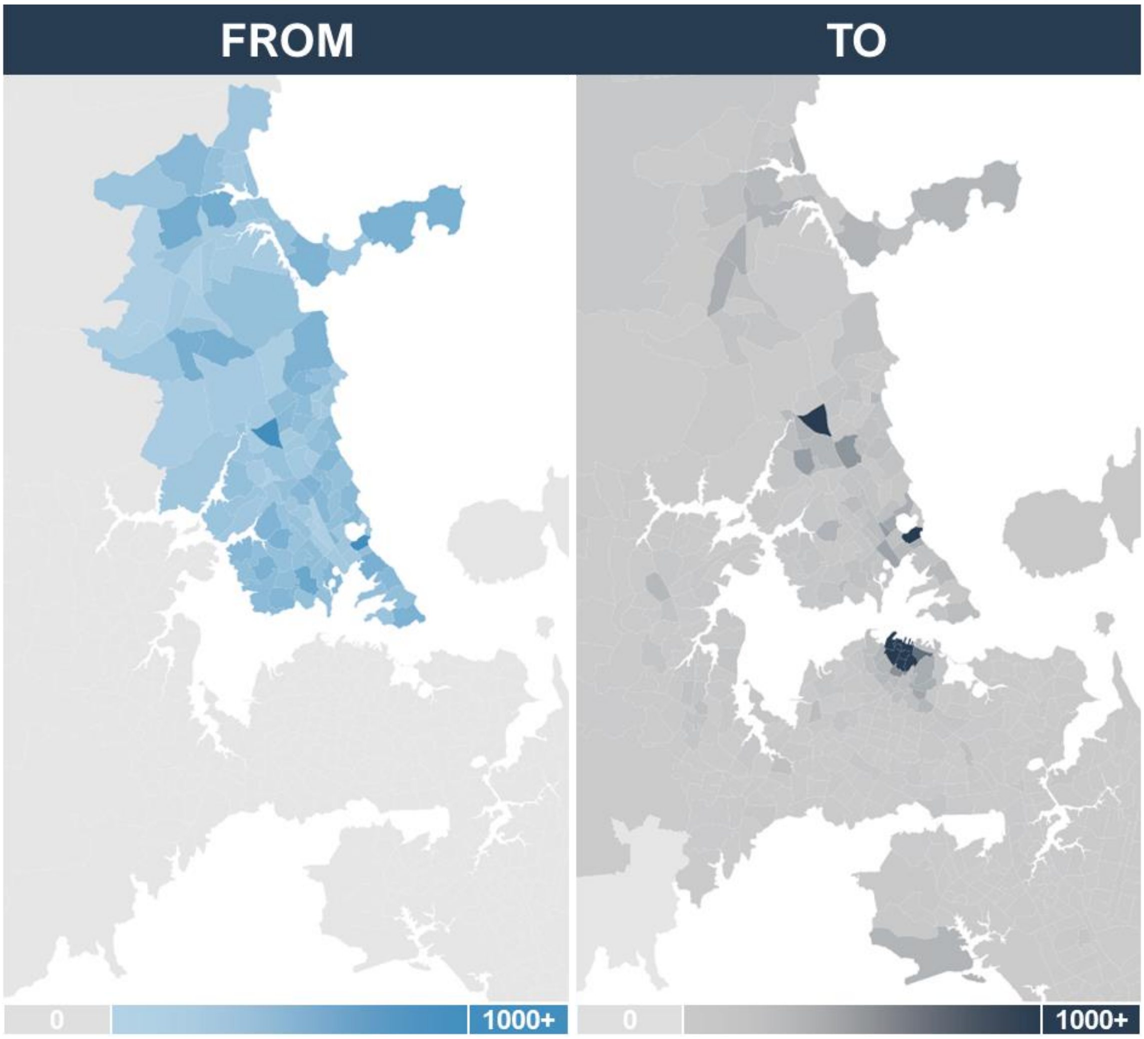
Table 2-2 and following figures below show the AM peak demand for public transport (as per 2048 MSM forecasts). This assumes rapid transit on all three corridors by 2048.

Table 2-2: 2050 public transport demands (origins and destinations by corridor)

Public transport demands – 2050 (2-hour AM peak)		TO					
		Centre City & Fringe	CC2M	North Shore	Northwest	Other	Grand Total
FROM	Centre City & Fringe	7,600 (4%)	1,000 (0.6%)	1,900 (1%)	500 (0.3%)	3,600 (2%)	**14,800**
FROM	CC2M	**13,600 (7%)**	**5,000 (3%)**	1,800 (0.9%)	700 (0.4%)	6,700 (4%)	**27,800**
FROM	North Shore	**16,800 (9%)**	1,000 (0.5%)	**10,500 (6%)**	1,100 (0.6%)	2,700 (1%)	**32,100**
FROM	Northwest	**7,700 (4%)**	700 (0.4%)	2,200 (1%)	3,500 (2%)	2,600 (1%)	**16,800**
FROM	Other	42,700 (23%)	7,900 (4%)	6,400 (3%)	3,500 (2%)	36,100 (19%)	**96,600**
	Grand Total	**88,500**	**15,800**	**22,800**	**9,400**	**51,700**	**188,100** (100%)







The remainder of this section provides more detail on each of the three corridors, drawing from previous business case work.

2.5 City Centre to Māngere

The central Auckland isthmus (between New North and Great South Roads) is well served by frequent bus services. These corridors have a high public transport mode share, particularly for trips to the city centre. While these corridors have bus priority at peak times, there is no rapid transit in the area. Residential intensification is enabled in these areas, which is anticipated to grow in population by 51%.

The existing high demand and forecast growth along these corridors mean that the ability of buses to continue to meet this need is reducing. Even with improved bus priority, the city centre is increasingly unable to cope with very high volumes of buses. A new rapid transit corridor would enable bus services to be reorganised to feed into a higher-capacity mode. This would offer improved travel times and reduce the need for increasing volumes of buses to access the City Centre. Without rapid transit, the local bus services will not be able to cope with growing demand, which will discourage customers from using it. This will result in a failure to achieve goals of mode shift, and worsening congestion.

Before the Covid-19 pandemic, Auckland Airport was also a growing employment hub. While the pandemic currently means there is reduced demand for transport to and from the wider Airport precinct, it is expected that once international travel recovers that access issues around the Airport will return and continue to worsen.

While Auckland Airport important destination to enable a direct connection to, air travellers will only account for a small percentage (~6%) of total trips on the corridor. It is a key destination for workers (a further 9% of overall usage), underlining the importance of enabling access between the Airport and a range of locations.

The corridor has been identified as the first of these corridors to be progressed – meaning it has a critical role in creating the start of the network that the other two corridors need to build from.

2.5.1 Previous work

Planning work on this corridor has been underway since 2010, initially focusing on providing rapid transit access to Auckland Airport before subsequently merging that work with investigations to address city centre bus capacity constraints. Key studies and business cases undertaken include:

City Centre Future Access Study (2012)	The City Centre Future Access Study (CCFAS or Study) was commissioned to develop a robust and achievable multimodal programme for transport into the Auckland City Centre.
Auckland Central Access Plan (2016)	The Auckland Central Access Plan PBC was jointly developed by AT, Waka Kotahi and Auckland Council in 2016 to improve access to the Auckland City Centre.
City Centre to Mangere light-rail draft business case (2018-2019)	A Waka Kotahi led business case, involving AT, Auckland Council and other key partners, progressed a light-rail design for the corridor and considered its implications and relationship to emerging growth plans. The business case was never completed, as the ‘parallel process’ noted below was commenced instead.
Auckland light-rail parallel process (2019-2020)	In 2019, the Ministry of Transport led a ‘parallel process’ that assessed bids from both Waka Kotahi and New Zealand Infra to develop alternative ways to provide rapid transit in the corridor, including considering funding and financing arrangements. Both bids developed were based on a light metro system.

To summarise key findings from previous work:

- The existing high demand and forecast growth along the central isthmus corridors mean that the ability of buses to continue to meet demand while providing a quality and reliable service is reducing.
- There is the potential to unlock significant additional growth potential along the corridor, especially around Māngere, Onehunga and Mt Roskill.
- Even with improved bus priority, the city centre is increasingly unable to cope with very high volumes of buses - a substantial increase in public transport capacity and efficiency is required.
- Without a significant increase in the number of people accessing the airport by public transport, the road network will not be able to function effectively, and the success of this critical employment area will be placed at risk.
- South of Onehunga travel choice is relatively poor. Bus services in the Māngere area struggle to meet the needs of people living in this part of Auckland.
- Rapid transit is needed to support the significant residential growth expected in the central isthmus and Māngere, and buses cannot meet this demand in the long term.

2.5.2 Problems & benefits

Figure 2-4 below shows the problems and benefits for the CC2M corridor as defined in the January 2019 Draft Strategic Case.

PROBLEMS	BENEFITS
Increasingly constrained access to the key employment hubs of the City Centre and Auckland Airport precinct will limit the growth in prosperity of Auckland and New Zealand (40%)	Improved urban amenity and prosperity of Auckland's city centre and communities along the corridor (20%)
Poor urban amenity, access, and travel choice for residents in parts of the corridor is reducing liveability and contributing to sustained deprivation (30%)	Improved economic growth and productivity, particularly in the City Centre and Auckland Airport precinct (30%)
Public and private land in the corridor is not fulfilling its potential to help address Auckland's housing shortage (30%)	Improved access, and travel choice (25%)
	Accelerating delivery of residential growth, particularly at Mt Roskill, Onehunga and Māngere (25%)

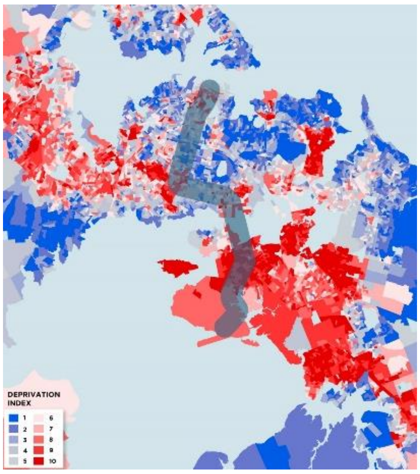
Figure 2-4: CC2M problems and benefits (2018 Waka Kotahi Business Case)

Constrained access for employment hubs

City centre access constraints: Buses from the central isthmus, the North Shore and the northwest are channelled into a few corridors. These buses rely upon limited space within the city centre for passengers to board and alight, and for buses to lay over and turn around before beginning their trips. Over time, a variety of constraints will create major challenges in catering for growth in bus services to meet demand.

Airport access constraints: A combination of forecast growth in air passengers and a significant increase in the number of people working in and around the airport will drive continued strong growth in travel to and from this part of Auckland. Daily trips are expected to double from around 83,000 currently to 170,000 by 2048. Accommodating this growth on existing networks will be particularly difficult, because current infrastructure and public transport services are already struggling to meet the travel needs of people accessing the airport area.

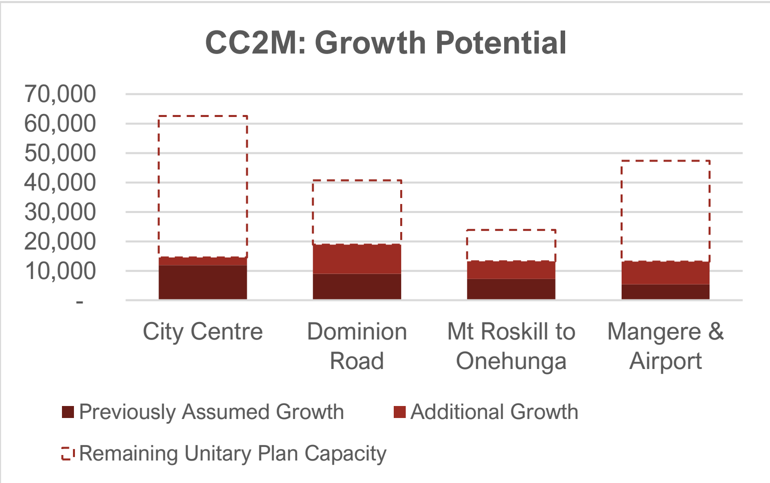
Poor travel choice & deprivation



Poor travel choices and a projected decline in employment access due to congestion and bus overcrowding will also reduce quality of life for people living along the corridor, and make it difficult to lift incomes and reduce deprivation in some parts of the corridor (especially Māngere).

Over 170,000 people currently live along the City Centre to Māngere corridor and substantial further growth is projected. Urban amenity, access and travel choice vary considerably, with some areas (most notably Māngere) having severe concentrations of deprivation and relatively poor travel choices. Without rapid transit, the quality of life along the corridor is likely to deteriorate over time as access, travel choice and urban amenity decline and vehicle volumes increase.

Potential for growth



Auckland has a severe housing shortfall and significant extra housing supply is needed to both meet current needs and accommodate forecast population growth. With substantial growth capacity enabled by the Unitary Plan and large tracts of publicly owned land, the City Centre to Māngere corridor has potential to play a significant role in helping to address Auckland's housing shortage.

The Auckland Unitary Plan provides redevelopment capacity along the corridor for around 175,000 additional dwellings. Major public landholdings at Mt Roskill, Onehunga and Māngere present significant redevelopment opportunities to address Auckland's housing supply issues and increase the diversity of that housing supply. Rapid transit can increase the viability of more compact and intensive development than currently planned, providing much needed additional homes.

2.6 Northwest

The Northwest's population is currently small (compared to the other sub-regions) but is growing rapidly. The Northwest's population is set to increase by 82% between 2016 and 2048 and based on current forecasts. Half of this growth is anticipated to happen within the next 10 years. This is driven in a large part by growth in areas further west, such as Westgate and Hobsonville and the future urban areas of Whenuapai, Hobsonville, and Kumeū.

The connection between the Northwest and the rest of Auckland is heavily reliant on SH16, and is currently served by infrequent and unreliable buses. Public transport in the Northwest area currently offers a less competitive option both compared to private vehicle use and compared to public transport offerings in other parts of the city. While short-term bus-based improvements are planned, these are intended as an interim solution only. They will have a finite lifespan and will not offer the fast, frequent, reliable travel choice that a true rapid transit corridor would provide.

2.6.1 Previous work

ATAP (2016)	
North West Rapid Transit Corridor IBC (2017)	This Indicative Business Case (IBC) defines and progresses one of the Auckland Transport Alignment Project's - ATAP's - key recommendations: the Northwestern Busway. While ATAP had recommended a busway-based solution, it reviewed all credible public transport modes and did not presuppose a busway solution.
ATAP Update (2018)	
Northwest Bus Improvements DBC (2020)	In 2020 AT progressed the DBC for interim bus improvements. The DBC proposed a combination of new interchanges and bus priority lanes to allow the 'hub and spoke' or 'trunk and feeder' model of bus services introduced elsewhere through Auckland's New Network. These will not fully address resolve the area's poor level of access to public transport, let alone meet long-term demand.

To summarise key findings from previous work:

- The Northwest area has one of the lowest mode shares within Auckland, generally sitting between 0 and 5%. There is a lack of transport choice and poor-quality service of public transport for those travel to and from the Northwest.
- A rapid transit corridor for the Northwest will enable a redesign of the area's wider public transport, significantly improving the level of access it can provide.
- Interim bus improvements are being progressed, but these will not fully address resolve the area's poor level of access to public transport, let along meet long-term demand.
- The preferred mode for the long-term corridor was identified to be either bus or light rail, based on a combination of criteria relating to cost, likely patronage and performance.
  - While a new busway on this corridor could provide a high-quality rapid transit option in this corridor, city centre constraints will ultimately limit capacity and mean bus options struggle to meet medium-to-longer term demands. Light rail would provide a more enduring city centre solution, but is less easily staged over time.
  - Regardless, the mode choice on the Northwest is tied to the decisions made for the isthmus and northern corridors due to the required city centre integration of these corridors.
  - Metro rail options (heavy rail and automated light metro) were discounted in earlier work as they had higher costs than could be justified by expected patronage.

2.6.2 Problems & benefits

Figure 2-5 below shows the problems and benefits for the Northwest as defined in 2017 IBC.

PROBLEMS	BENEFITS
Accelerated growth and rising travel demand will exceed the Northwestern corridor capacity, undermining access to homes, jobs, education and the attractiveness of growth areas (40%)	Better connected city, better math for people, jobs, education opportunities (50%)
Absence of competitive public transport to/ from the Northwestern growth area restricts public transport choices (35%)	Expanded transport choices for the Northwest (35%)
Inefficient PT network and lack of interchanges limit the ability to lift service standards for corridor users (25%)	More affordable access and improved value for money (15%)

Figure 2-5: Northwest problems and benefits (2017 NWRTC IBC)

Northwest growth

AREA	TYPE	2013	2026	2036	2046	GROWTH 2013-2046	%SHARE OF GROWTH
WESTGATE - WHENUAPAI - HOBSONVILLE	Population	38,998	74,612	95,871	110,944	71,946	8.4%
	Employment	6,472	24,207	35,448	45,883	39,411	12.1%

Westgate-Whenuapai-Hobsonville is expected to grow to almost three times its current population, while employment in this area is expected to grow sevenfold. This area is expected to account for 8.4% of Auckland-wide population growth and 12.1% of Auckland-wide employment growth.

Travel demand growth

Total travel from the Westgate-Whenuapai-Hobsonville area to other parts of the city is expected to double over the 2013-2046 period. Public transport demand from this area to other parts of the city is forecast to increase by almost 400%. Approximately 60% of growth in outward public transport demand is expected to be destined for the city centre.

Between 2013 and 2046, AM peak public transport demand from the Te Atatu-Lincoln Road North area to other parts of the city is expected to rise by 86%.

Access to opportunities

Residents of major growth areas in Northwest Auckland are expected to be able to access only 35% as many jobs by PT as the average Auckland resident. The number of jobs that are accessible by PT is expected to rise over time, but not catch up with the Auckland-wide average. This is exacerbated by the fact that access to jobs by car is expected to decline in Northwest Auckland.

Travel choice

Under current arrangements, very little of Northwest Auckland is served by frequent public transport services. To a degree, this reflects the fact that this includes large Future Urban Zone areas where arterial roads have not been established. However, the need to run low-frequency services due to a lack of trunk-and-feeder interchange points along the NWRTC is also a major contributor. This is evidenced by an analysis of the Te Atatu area, where implementation of a Te Atatu Interchange and supporting service changes would increase the share of the area within a frequent bus service catchment from 15% to 74%.

2.7 North Shore

The North Shore will accommodate a significant proportion of Auckland's anticipated growth, with its population anticipated to increase from 306,000 to around 430,000 between 2016 and 2048 (40%). The majority of this growth is expected to occur in future urban areas north of Albany, while most of the anticipated growth south of Albany will occur in Takapuna and Northcote.

The north shore is heavily reliant on the Harbour Bridge and the northern busway as the only PT connection to the city centre and further south. While currently well served by the Northern Busway, this facility will have insufficient capacity to meet demand within the next 15 years (even with currently proposed enhancements), and capacity improvements are limited without an additional rapid transit connection across the harbour.

2.7.1 Previous work

ATAP - Auckland Transport Alignment Project (2016)	
North Shore Rapid Transit PBC (2017)	The focus for the PBC was the rapid transit connection to the North Shore and in particular the connection between the North Shore and the Isthmus.
ATAP Update (2018)	
Additional Waitematā Harbour Connections IBC (2019)	The purpose of this business case was to understand the case for improved transport connections to the North Shore of Auckland and its external northern connections. The scope of the business case was to determine the need, function, form and timing of new infrastructure.
Northern Busway Enhancements DBC (2020)	The purpose of the Northern Busway Enhancements DBC was to develop a programme to enhance the capacity of the busway system to address current and anticipated deficiencies and enable it to meet projected demand to the mid-2030s.

To summarise key findings from previous work:

- The North Shore and northern Auckland is expected to grow significantly through both greenfield and brownfield development. 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, public transport is expected to continue to take nearly all of the forecast growth in travel demand.
- Even with planned enhancements, demand on the Northern Busway will exceed its capacity by the mid-2030s.
- Demand management is not effective as a stand-alone solution but would effectively complement and influence the need and timing of other interventions. A direct connection to Takapuna is more desirable than a spur operation. A tunnel is preferred to a bridge for this rapid transit connection, but more work is required to confirm whether it is light rail or heavy rail and how it integrates with the enhanced busway and the public transport network more broadly.
- Business case work recommended that both an enhanced busway and an additional rapid transit connection are required to meet future demand. Further work is required to determine the details of how these two cross-harbour rapid transit links will integrate with each other.
- The integration of next phases of work with other key initiatives (e.g. The 'Auckland Harbour Bridge Long-Term Plan', Light Rail, Supporting Growth, Road Pricing, City Rail Link and the 'Upper North Island Supply Chain Study') in Auckland will be essential.

2.7.2 Problems & benefits

Figure 2-6 below displays the problems and benefits for the as defined in the 2017 North Shore RTN PBC.

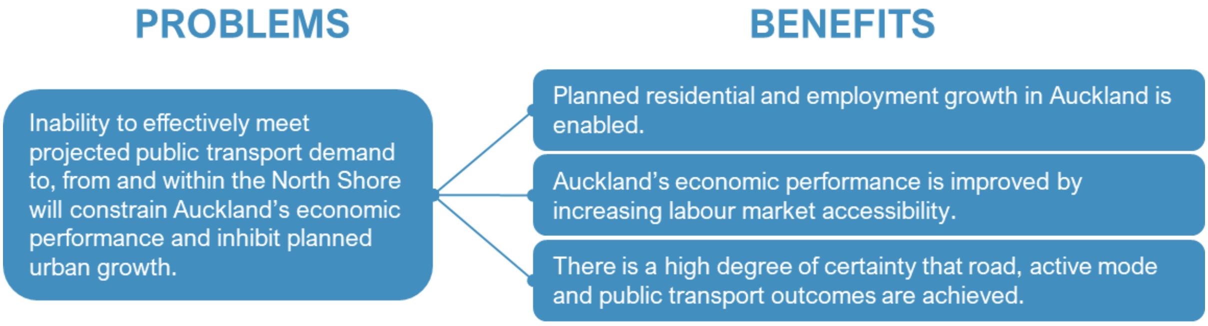


Figure 2-6: North Shore problems and benefits (2019 NSRTN PBC)

Population growth

The North Shore is currently home to around 21 per cent of the region's residential population. The population of the North Shore Corridor is forecast to increase by 160,000 from 337,000 to 497,000, (+48%) by 2048, maintaining the current share of around 20 per cent of the region's population.

Travel demand growth

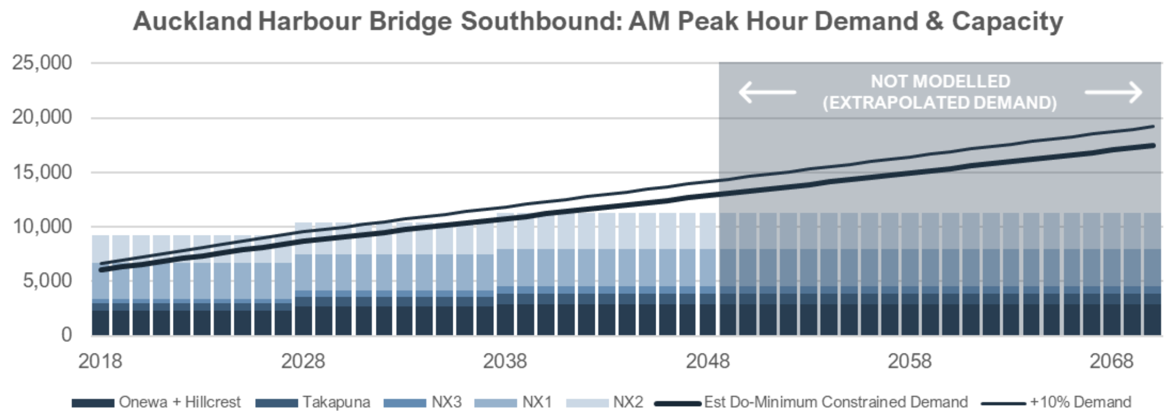


Figure 2-7: Auckland Harbour Bridge: demand & capacity (southbound, AM peak hour)

Figure 2-7 above provides an indication of the scale of the public transport task across the Harbour which increases to around 10,000 passenger trips during the peak hour by 2038 (approximately 18,000 in peak 2 hours). At present, around one third of all trips on the Waitematā Harbour crossing are public transport trips. By 2028 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. Even with increases in bus volumes the busway is expected to exceed capacity by the mid-late 2030s.

Worsening travel choices

With this increase in bus volumes various pieces of busway infrastructure will progressively exceed capacity. This will lead to worsening travel times, travel time reliability and station operations.

Without this increase in bus volumes there would be a short fall of approximately an additional 9,000 trips in AM peak, southbound across the Harbour. This would force people to use other transport modes (namely private vehicles), leading to worsening congestion, and associated environmental impacts.

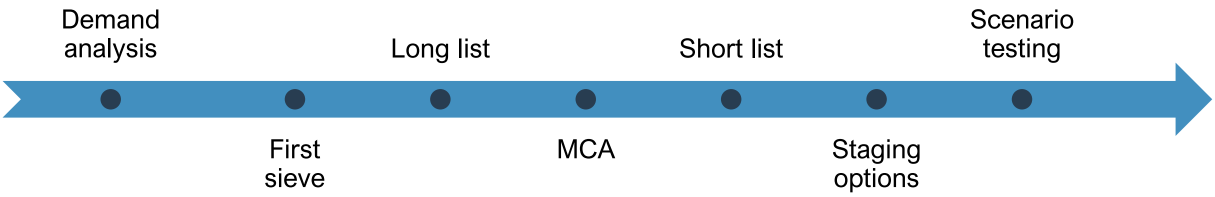
3 Option development and assessment

A range of options have been developed that include different combinations of modes across the three corridors. These account for the core issues related to integrating these corridors, as set out in the section above.

The options are intended to be substantially different from each other, so that through testing their relative benefits, costs and issues can be understood. The process of option development and testing is outlined in the sections below.

3.1 Methodology

Table 3-1: Methodology flow diagram



Step 1 – Demand analysis

Demands on sections of the key corridors were gathered from modelling from previous work (Additional Waitematā Harbour Connections business case work, Supporting Growth Alliance work, ATAP 2018 modelling, and Waka Kotahi inputs into the Ministry of Transport's Auckland Light Rail parallel process).

Step 2 – First sieve

Feasible modes for the key corridors were identified based on demand requirements and mode constraints. This is summarised in section 4.2.2.

Step 3 – Long list

A long list of eight feasible scenarios was developed, based on the considerations in section 3.2 and the key assumptions in section 4.2.

Step 4 – Multi-Criteria Analysis assessment

The long-listed scenarios were assessed against four sets of criteria. Scenarios were assessed in relation to each other (as opposed to against a baseline). Criteria were not weighted.

Step 5 – Short list

From the MCA assessment, four short list scenarios were identified as scoring well, in comparison to others. These scenarios are considered viable, based on the MCA's criteria, and will be progressed for further analysis.

Step 6 – Staging scenarios

Short-list scenarios will be investigated further in regard to their stage-ability. This is to identify key differences and considerations to further differentiate short-listed scenarios.

Step 7 – Scenario testing

Short-listed scenarios that can be feasibly staged will progress to further testing. This will involve new modelling to ensure demand forecasts are based on a consistent set of assumptions. High-level costings will also be developed to assess the relative cost-effectiveness of the scenarios.

3.2 Key assumptions

Key assumptions used in the scenario development process included learnings from previous work on these corridors, as summarised in section 2.

These learnings include the forecast demand across the three corridors, as outlined in section 2.5.1. These demand forecasts have been drawn from a range of different work, and therefore do not share a consistent set of assumptions. They have therefore been used as a guide only, to give a sense of the approximate scale of demands. Further work on the scenarios will include new modelling to establish a consistent set of assumptions, as outlined in section 3.8.1 below.

Sub-sections below detail further assumptions that have been used in the scenario development process.

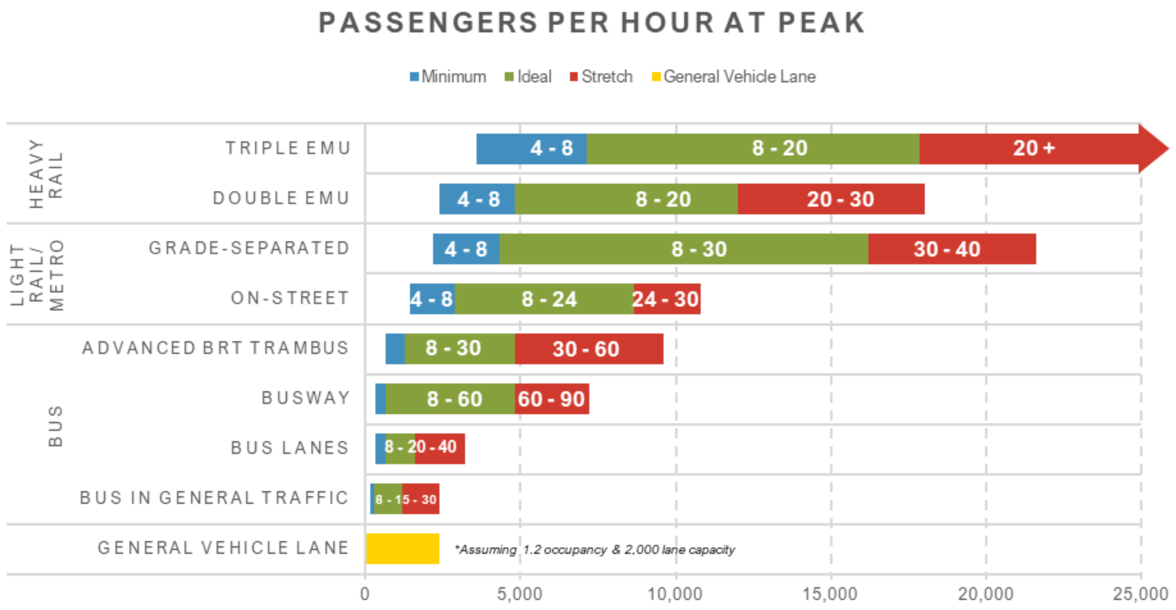
3.2.1 Capacity assumptions by mode

Four different modes are being considered in this work. The assumptions about the carrying capacity of these modes are shown below in Table 3-2.

Table 3-2: Mode capacity assumptions

Mode	Vehicle capacity (passengers)	Maximum vehicles per hour
Bus	100 (double-decker or articulated)	Varies depending on infrastructure
Light Rail	420 (double-unit tram)	24-30
Light Metro	600 (double-unit train)	30-40
Heavy Rail	750 (6-car train) 1,115 (9-car train)	24 (based on City Rail Link)

The ultimate 'corridor capacity' of these modes is shown in the diagram below:



The modes used are described in more detail below.

Table 3-3: Mode Assumptions

	**Bus** High capacity vehicles, such as double-deck or articulated buses ~100 passengers per vehicle Assumed to have a driver
	**Light Rail** Medium-capacity rail system, with ability to operate both on- and off-street (but always with priority) ~400 passengers per vehicle (can vary with design) Assumed to have a driver
	**Light Metro** Medium-capacity rail system, always operating in a dedicated right-of-way (no on-street running) 400-600 passengers per vehicle (varies with design) Assumed to be automated
	**Heavy Rail** High-capacity rail system, as already operating in Auckland. Limited sharing of track with freight trains 750-1,100 passengers per vehicle (based on length) Drivers assumed, potential for future automation

While considered separately, light rail and light metro systems can be designed in very similar ways. Some international systems operate both technologies on the same infrastructure (using drivers) or have light rail vehicles providing metro-style service.

Grade separation is the key differentiator of light rail and light metro systems. Full separation enables automation, which then enables savings on operational costs and higher frequency of service. It generally also enables higher capacity, speed, faster journeys and is safer. A fully-grade separated light rail system could also achieve these characteristics (and would essentially be a metro-style system).

Bus and heavy rail systems already exist in Auckland, as of yet light rail and light metro do not.

3.2.2 International examples of different modes

Sydney Metro

Sydney Metro is a fully automated rapid transit system operating in Sydney, New South Wales.

Sydney Metro Northwest: Sydney's first metro line, the Metro North West, consists of 23 km of new track and eight new stations. In addition, a 13 km rail link has been converted to rapid transit standards and segregated from the existing Sydney Trains network.

Sydney Metro City and Southwest: A 30-kilometre extension of metro rail from the end of Sydney Metro Northwest at Chatswood under Sydney Harbour, through new CBD stations and south west to Bankstown. The project includes a new twin-tunnel rail crossing under the Sydney harbour.

SkyTrain

SkyTrain is a light rapid transit system in the Metro Vancouver Regional District, serving Vancouver, British Columbia, Canada, and surrounding municipalities. SkyTrain has 79.6 km of track and 53 stations along three lines, it carried a total of 151 million passengers in 2017. For comparison, Auckland's heavy rail network is 93.4 km long, with 41 stations and carried 23 million in 2019, less than a sixth of SkyTrain's ridership. The system uses fully automated trains on grade-separated tracks running on underground and elevated guideways.

Seattle Light Rail



Link light rail is a light rail, but metro-style, system serving the Seattle metropolitan area in the U.S. state of Washington. The system is a mix of street running and underground/elevated sections. It carried 25 million passengers in 2019. For comparison, Auckland's entire heavy rail network carried 23 million in 2019. The system directly connects to SeaTac international airport. It opened in 2009 (with recent expansions), and has significant future expansion planned.

Ottawa O-Train (Light Rail)


The O-Train is a light rail transit system in Ottawa, Ontario, Canada. The Confederation Line opened September 2019 and is a fully grade separated light rail system which uses light rail rolling stock. The line runs through a 2.5km tunnel in downtown area. It replaced bus services on a former busway, significantly reducing bus volumes in city centre. Significant network expansion under construction.

Portland Light Rail


MAX Light Rail (for Metropolitan Area Express) is a light rail system in Portland, Oregon, United States. The system is a mix of street running light rail and separated sections alongside motorways. It operates on-street in the city centre. Opened 1986 (with subsequent expansions). Carried 38 million passengers in 2019. It connects to Portland international airport and is investigating a city centre tunnel to improve capacity and reduce travel times.

3.2.3 Corridor and mode assumptions

Table 3-4 illustrates the high-level assumptions for mode feasibility on these corridors. This is based on extensive previous business case work on these corridors over the last decade.

Table 3-4: Initial high-level corridor mode assumptions

Corridor	Bus	Light Rail	Light Metro	Heavy Rail
Northwest	✓	✓	✓	✗
North Shore	✗	✓	✓	✓
Central Isthmus	✗	✓	✓	✗
Māngere	✗	✓	✓	✓

The following assumptions around the suitability of each mode by corridor have been used:

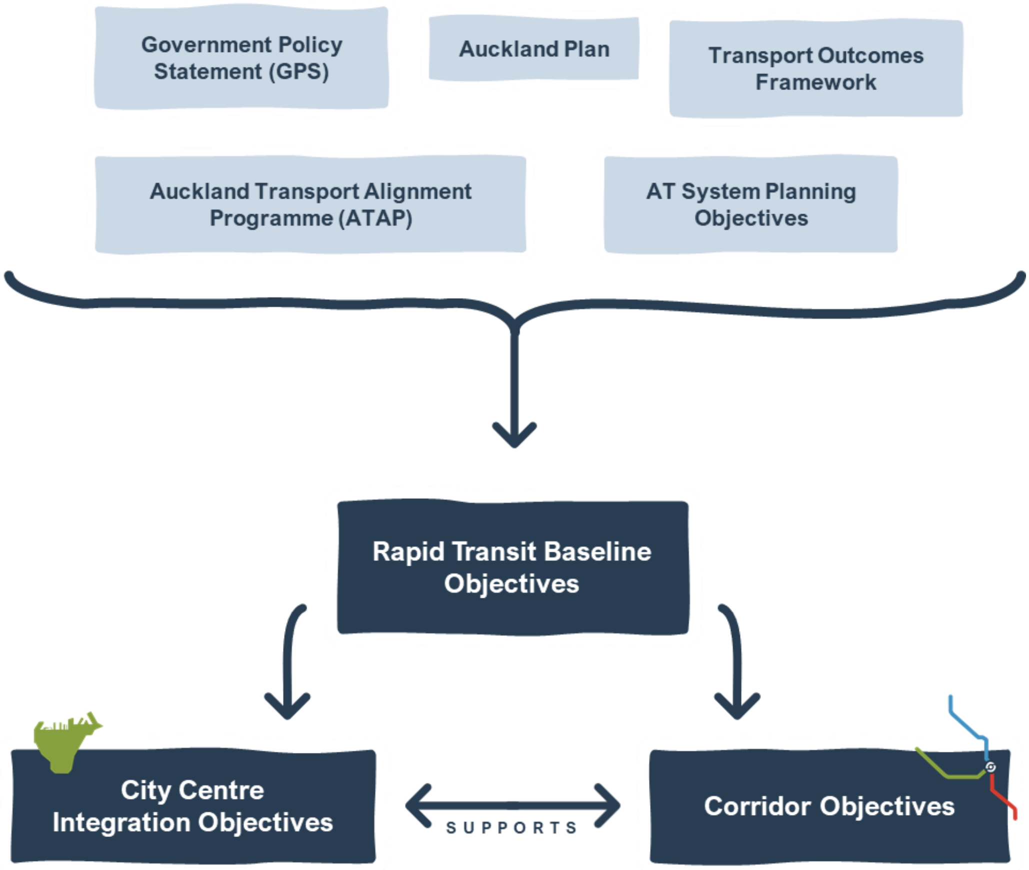
- For the Northwest it is assumed that heavy rail is infeasible for the section of the corridor between Westgate and the City Centre. This is due to the complexity and environmental impact that a heavy rail corridor would have alongside Stage Highway 16. While the Kumeū-Huapai area at the end of this corridor is currently on the North Auckland rail line (and used for freight), this is only a small part of the wider corridor and previous work by the Supporting Growth Alliance has shown that extending passenger rail services to Kumeu-Huapai is not the best way to serve demand for travel from the area to the City Centre in the future.
- For the North Shore previous work has shown a busway alone will be unable to meet demand in the long term. It is assumed that the busway is enhanced over coming years to maximise its performance and capacity, but that an additional RTN service is required. Several other RTN modes are viable, and will be subject to more detailed investigation, including the optimal alignment.
- Based on previous work, it is assumed the Central Isthmus corridor cannot be served by a traditional bus-based solution. Existing bus volumes cannot be significantly increased further without substantial infrastructure investment in both the corridor and a city centre terminus. Even with this investment, the outcomes would not support the strategic intent for land use and transport on this corridor, and therefore is assumed to be inappropriate. Further detailed work on this during a business case will confirm this assumption, however it has not been considered at a network level.
- Buses are not an appropriate long-term solution for the Māngere area, as there would be no bus rapid transit corridor to tie into further North. Other modes are technically feasible on this part of the City Centre to Māngere corridor, although heavy rail has previously been discounted from a cost-benefit perspective.

3.3 Objectives and assessment criteria

A range of objectives guide the assessment of different options for the corridors. These ultimately derive from a range of high-level plans and policies from the Government and Auckland Council, including their respective transport agencies. Key objectives are:

- Overall objectives for the rapid transit network, which focus on outlining the necessary role of rapid transit within Auckland's wider transport and urban development system
- City centre integration objectives, which guide how the three corridors should integrate with each other within the city centre in a way that supports an effective rapid transit network, as well as wider transport and urban development goals
- Corridor objectives, which outline the role each rapid transit corridor needs to play within the wider network, as well as the key benefits expected from delivering each corridor

This is illustrated in the diagram below.



3.3.1 Rapid transit network objectives

These objectives are detailed in the 'Rapid Transit Baseline' working document. They clarify the outcomes sought through the development of rapid transit networks. These objectives will inform future planning work and business case development.

The overarching objective is that rapid transit effectively performs its required role in the transport system, and the public transport network, to support and shape a successful Auckland. The specific objectives that support these roles are:

1. Increase access to opportunities, especially in major and growing employment areas
2. Increase people throughput on Auckland's most critical corridors
3. Increase the share of travel unaffected by congestion
4. Increase public transport's mode share, especially for medium to long journeys
5. Enable an integrated, efficient and effective public transport network
6. Focus most housing and employment growth in centres, nodes, and development areas[2]
7. Support high quality integrated urban communities

3.3.2 City centre integration objectives

These objectives have guided the ARTP's work in Stage 2. They form the basis from which the MCA has been developed to assess options.

Rapid Transit Objectives					City Centre Integration Objectives
	2	3	4	5	Provide a customer experience that maximises patronage on the three corridors
				5	Enable efficient connections between corridors, to the City Rail Link, and to the wider public transport network
		1	5	7	Improve the coverage of the rapid transit network within the city centre, to increase access to opportunities
1	2	3	4	5	Integrate new corridors to enable a network and services that maximises capacity of each corridor and allows for future expansion
				5	Enable services to operate efficiently and cost-effectively
				5	Ensure affordability and value for money
				5	Enable network development to be staged in a way that is cost-effective and retains flexibility for decisions around the timing and form of future stages
		1	6	7	Support existing and enabled land use and integrate with city centre planning and urban form

[2] As described in the Auckland Plan.

3.3.3 Corridor objectives

CC2M

- Improved access to opportunities through enhancing Auckland's rapid transit network and integration with Auckland's current and future transport network
- Enabling and supporting quality integrated urban communities, especially around Māngere, Onehunga and Mt Roskill
- Optimised environmental quality and embedded sustainable practices
- A high-quality service that is attractive to users, with high levels of patronage.

Northwest

- Support substantial growth along the corridor and in the broader northwest part of Auckland
- Address the projected decline in employment access in the west
- Provide an opportunity for travellers to avoid projected congestion along State Highway 16 and to improve the productivity of this corridor
- Improve the poor public transport in this part of Auckland
- Support a more efficient overall public transport system in this part of Auckland.

North Shore

- Provide fast, frequent, reliable and high capacity connectivity along the main north-south 'spine' of the North Shore, and between the North Shore and the isthmus, especially for trips to the city centre.
- Add resilience to the North Shore's transport system and for cross-harbour travel.
- Support the growth of key centres on the North Shore, especially Takapuna and Albany, and the creation of best practice transit-oriented developments in greenfield growth areas around Dairy Flat and Silverdale.

3.4 Long list

This work developed a long list of seven different scenarios. Some minor variations within these scenarios were also identified as sub-options.

The long-list scenarios were high-level and based on mode choice variations on the three corridors. These scenarios:

- Were based on indicative alignments which could vary by mode
- Did not include detail on stop locations (not within scope of this scenario work, except within city centre to the extent of identifying potential terminus locations).

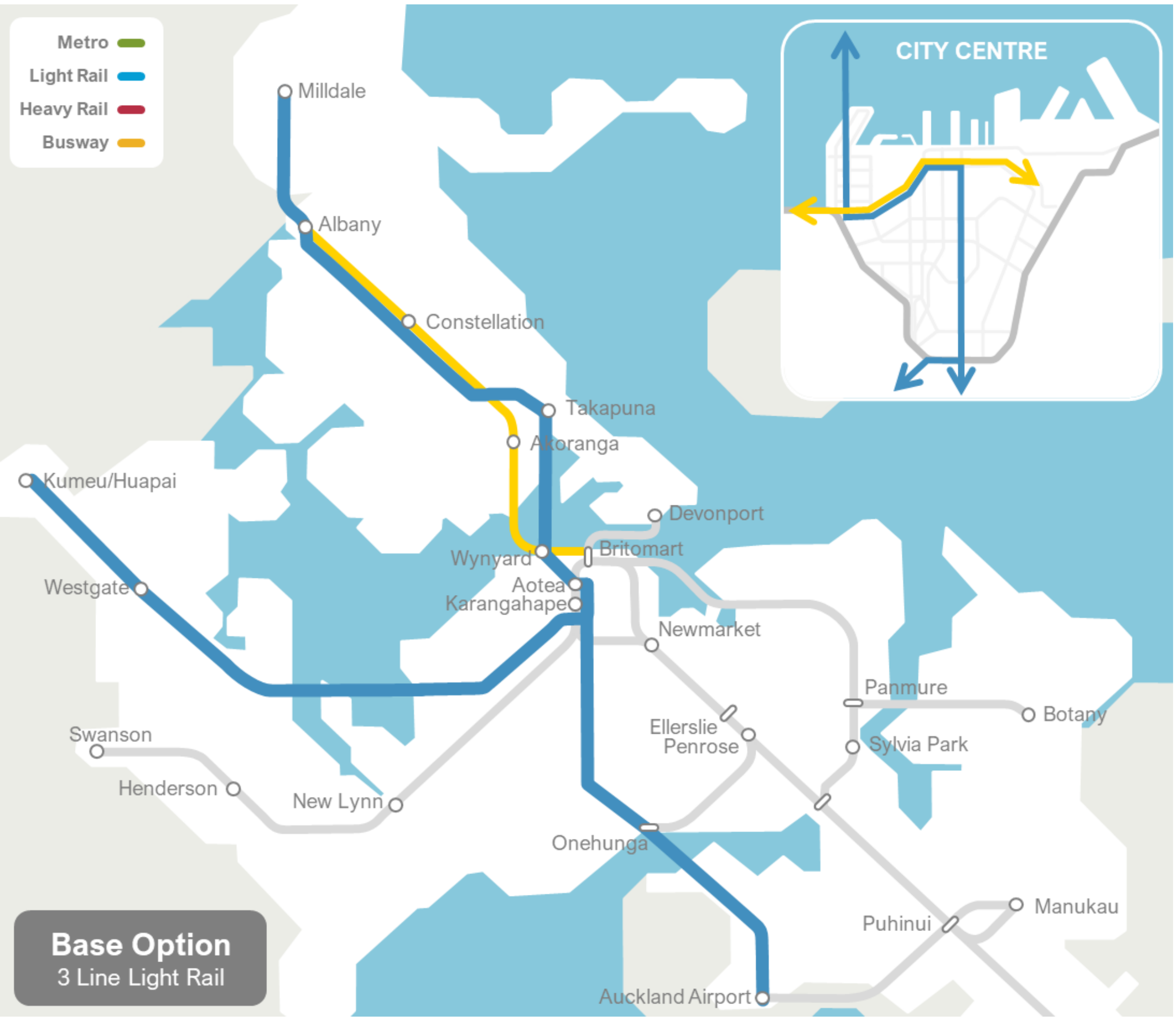
Both of these factors will impact demands, but this is a level of detail that can only be determined at Business Case stage.

Additional Waitematā Harbour Crossing work suggests that a new rapid transit connection and an enhanced Northern Busway are required in the future to meet forecast demand. All scenarios include this assumption.

The long-list scenarios were developed to assess bus, light rail, light metro and heavy rail-based interventions on the three corridors, and hybrids of these as a network. Variations on some scenarios were developed to assess the impacts of different arrangements of city centre operations.

The long-list scenarios were designed to be substantially different from one another, to the point where some could be considered unrealistic. This is designed to allow insights to be draw from their key differentiators. Sub-options were developed during this process, to address some of these learnings. It is expected that the long-list scenarios will be refined and potentially combined in later phases of work.

3.4.1 Base option: three-line light rail

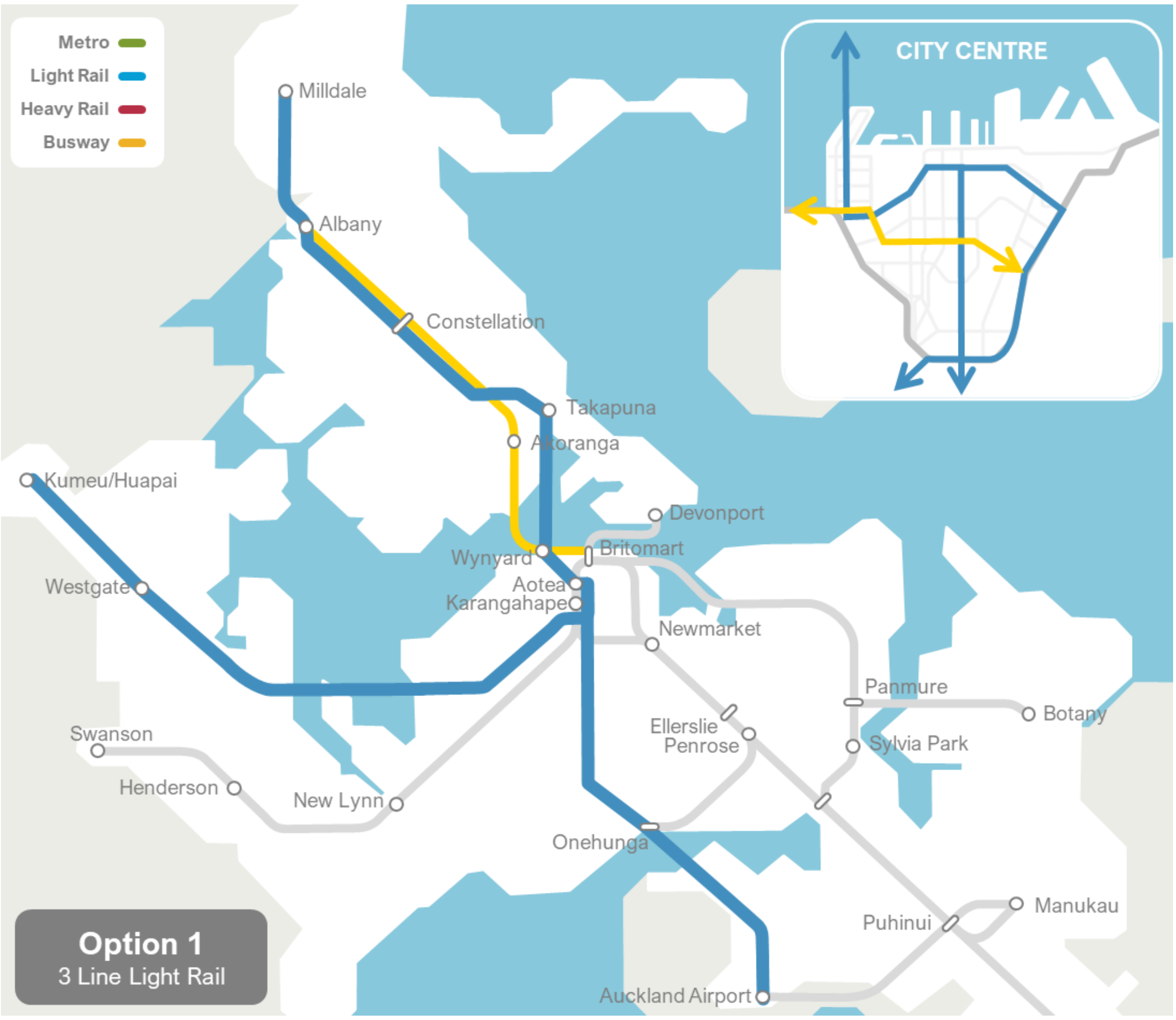


This scenario is the most similar to current plans (in ATAP), with the addition of Northern Busway retention and light rail direct to Takapuna (not as a spur).

The Northwest and Māngere lines would run every four minutes, combining to run to the North Shore at two-minute headways. This operation would combine on-street along Queen street.

Line	Frequency	Capacity to Serve Demand
North Shore	30 trams/hour	30 trams per hour to North Shore caters for majority of demand, and with the retention of the busway would be sufficient to serve the North Shore.
Northwest	15 trams/hour	Would not meet 2050 demand.
Māngere	15 trams/hour	Surplus capacity.

3.4.2 Scenario 1: three-line light rail (second city centre corridor)



This scenario is the most similar to current plans (in ATAP), with the addition of Northern Busway retention and light rail direct to Takapuna (not as a spur). Differing to scenario 1, this option splits city centre operations across two corridors (Queen Street and a corridor in Grafton Gully).

The Northwest and Māngere lines would run every four minutes, combining to run to the North Shore at two-minute headways.

Line	Frequency	Capacity to Serve Demand
North Shore	30 trams per hour	30 trams per hour to North Shore caters for majority of demand, and with the retention of the busway would be sufficient to serve the North Shore.
Northwest	15 trams per hour	Would not meet 2050 demand.
Māngere	15 trams per hour	Surplus capacity.

3.4.3 Scenario 2: two-line metro with northwest busway

This scenario would construct a Metro line serving both the North Shore and the central isthmus. This would require grade-separation along the entire length of the route – including city centre tunnelling. The Northwest would be served with a busway.

The Northwest would require 60 buses per hour to cater for demand. This could through-route to the Northern busway, via city centre. If not through-routed, a large city centre bus terminus would be required. The North Shore would be served by 24 trains an hour. This volume could potentially be lowered with demand balanced between the Northern Busway and Rail. With much lower demands along the CC2M corridor – Mangere would be served by 8 trains an hour. This will require the termination of some trains in the city centre.

Line	Frequency	Capacity to Serve Demand
North Shore	24 trains per hour	Sufficient Capacity
Northwest	60 buses per hour	By 2050, many individual buses would be at capacity (NW) meaning that passengers would be unable to board the first service that arrives.
Māngere	8 trains per hour	Sufficient Capacity

3.4.4 Scenario 3: three-line metro

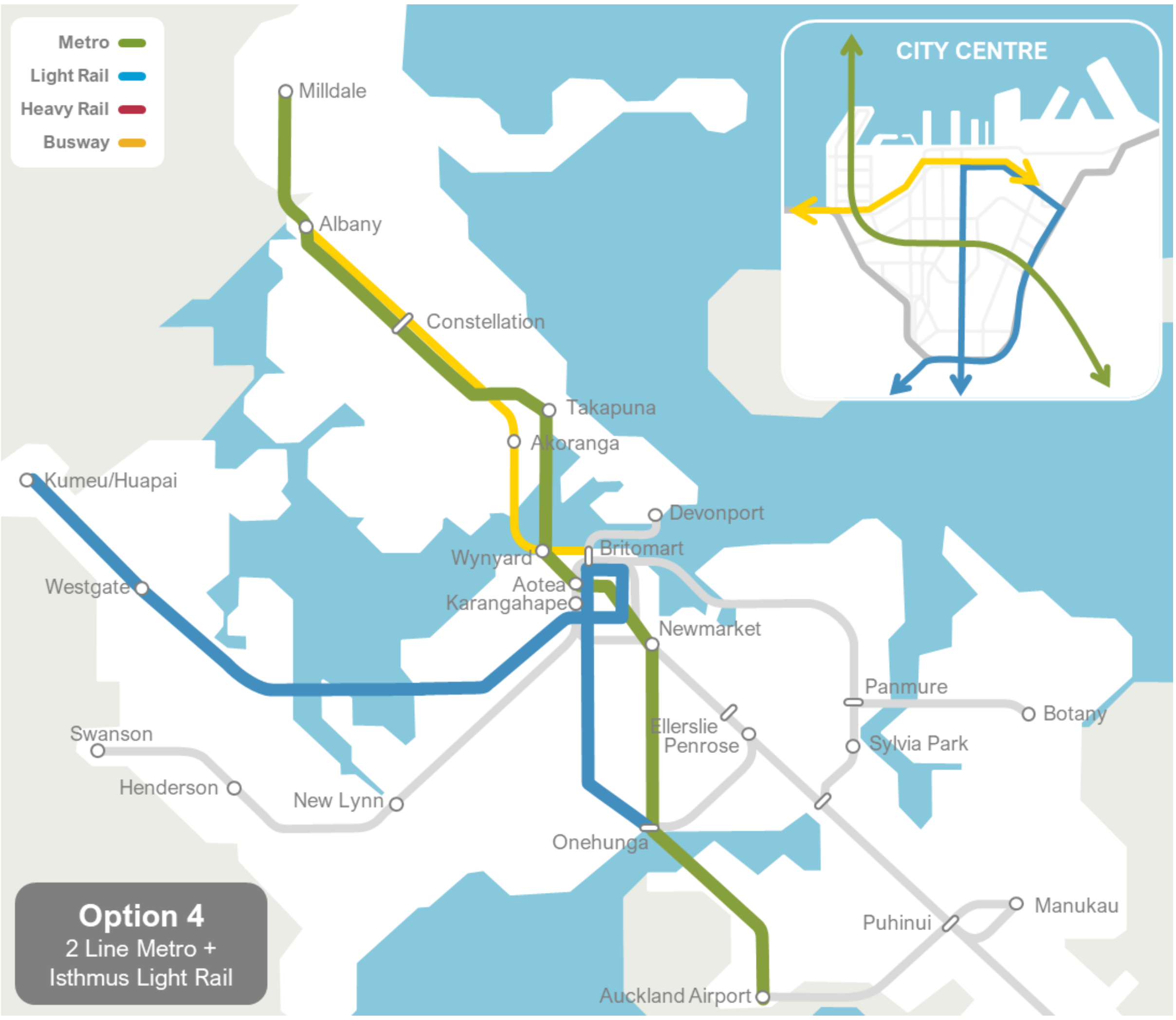
This scenario would construct Metro lines serving all three key corridors. This would require grade-separation along the entire length of all lines – including city centre tunnelling. Trains would run in a tunnel through the city centre from the North Shore before branching south of the city.

The Northwest and Māngere lines would run every five minutes, combining to run to the North Shore at with 2.5-minute headways (24 trains per hour).

Even split of service from the North Shore delivers appropriate capacity to the Northwest and extra capacity to the CC2M corridor.

Line	Operational Frequency	Capacity to Serve Demand
North Shore	24 trains per hour	Sufficient Capacity
Northwest	12 trains per hour	Sufficient Capacity
Māngere	12 trains per hour	Sufficient Capacity

3.4.5 Scenario 4: two-line light rail with two-line metro



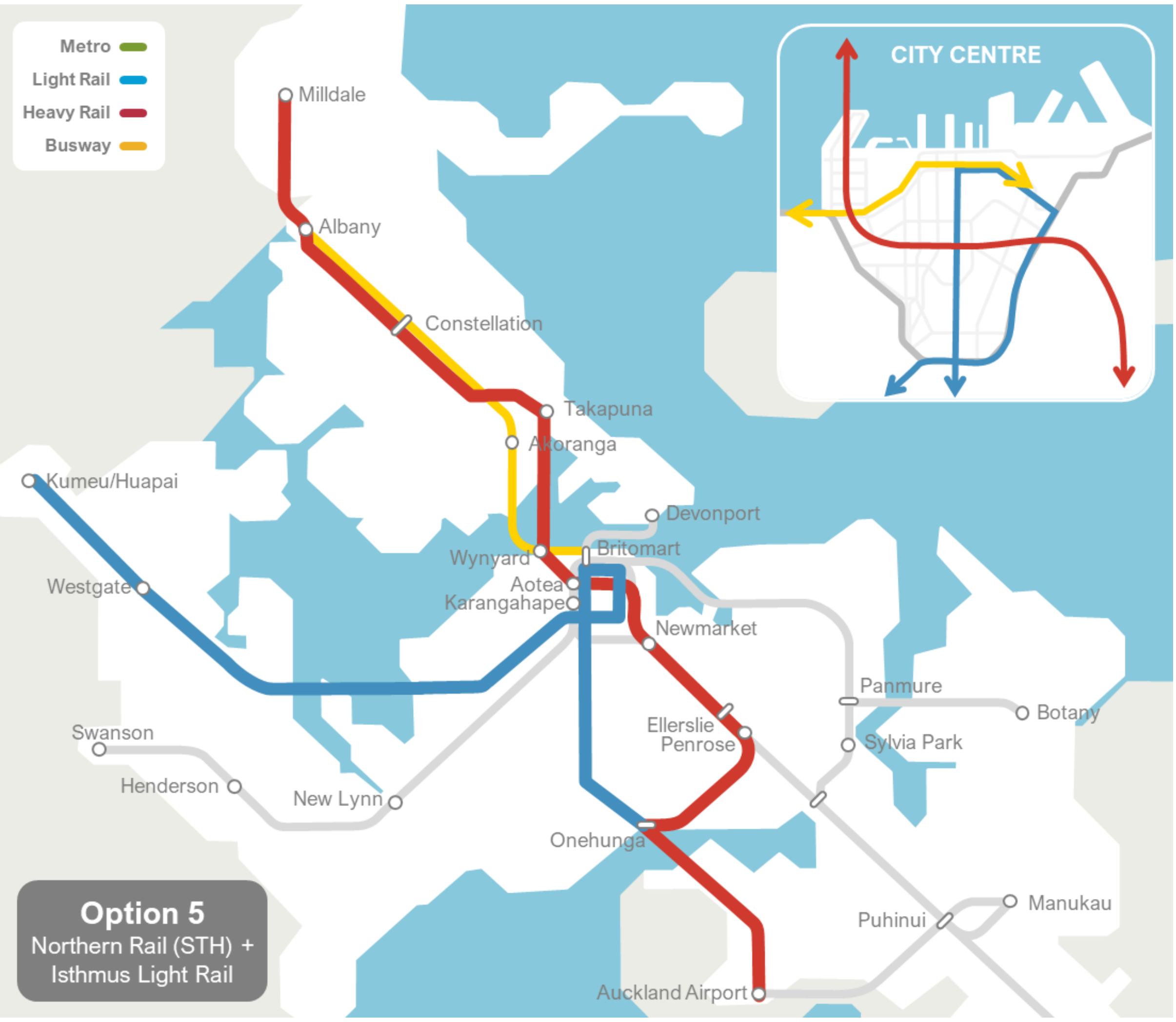
This scenario would construct a Metro line serving the North Shore, Manukau Road, Mangere and the Airport. This would require grade-separation along the entire length of the line – including city centre tunnelling. The Northwest and CC2M corridors would be served by on-street light rail.

Assuming that the Onewa demand continues to be served by buses, and that the metro serves the majority of the remaining north shore demand, the metro could operate 10 trains per hour.

The Northwest would require 16 trams per hour to cater for demand. With lower demands along CC2M – this would be served by 8 trams an hour. This will require the termination of some trains in the city centre.

Line	Frequency	Capacity to Serve Demand
North Shore	10 trains per hour	Sufficient capacity with demand split with busway.
Northwest	16 trams per hour	Sufficient capacity
Māngere	8 trams per hour	Sufficient capacity

3.4.6 Scenario 5: two-line light rail with northern rail (southern line)



In this scenario the Northwest and City Centre to Māngere corridors would be served by on-street light rail. The North Shore would be served by heavy rail –via a new tunnel in city centre, through-routed from the Southern line. This would connect at Newmarket, and then run to the Airport via an upgraded Onehunga line.

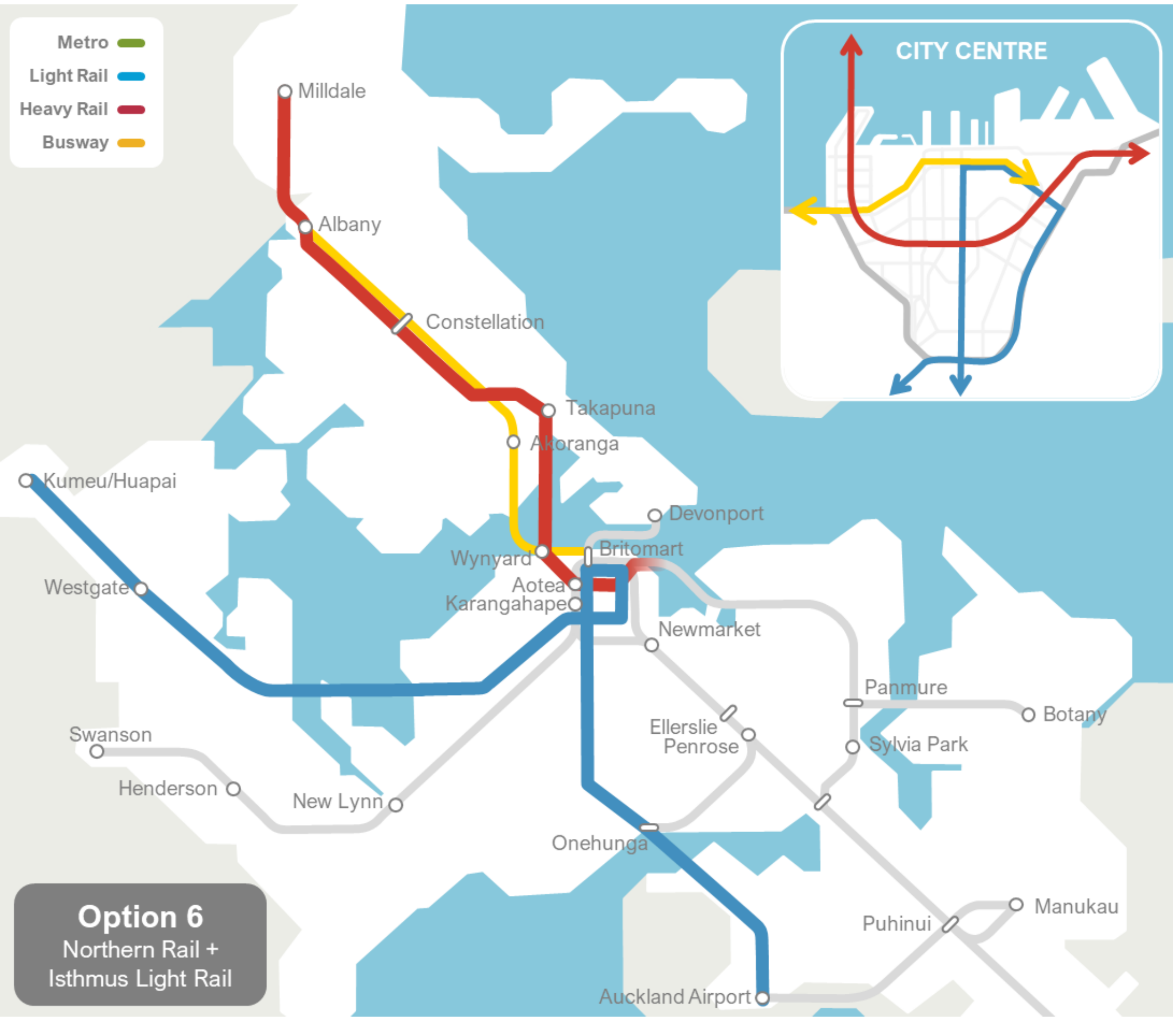
North Shore line frequencies are based on 6-car trains. Roughly 12 per hour if 9-car. Either way, only some North Shore trains continue to airport. Terminus likely needed near city centre.

The Northwest would run at headways of 3 minutes (20 per hour), and Mangere every 6 minutes (10 per hour).

Light rail network would have operational issues given uneven demand. Hard to overcome this without significant change on CC2M corridor.

Line	Operational Frequency	Capacity to Serve Demand
North Shore	16 trains per hour	Sufficient capacity with demand split with busway.
Northwest	20 trams per hour	Sufficient capacity
Māngere	10 trams per hour	Sufficient capacity

3.4.7 Scenario 6: two-line light rail with northern rail (eastern line)



Scenario 6 would extend existing heavy rail to the North Shore via a new tunnel in city centre, connecting at Quay Park and then running via Eastern Line.

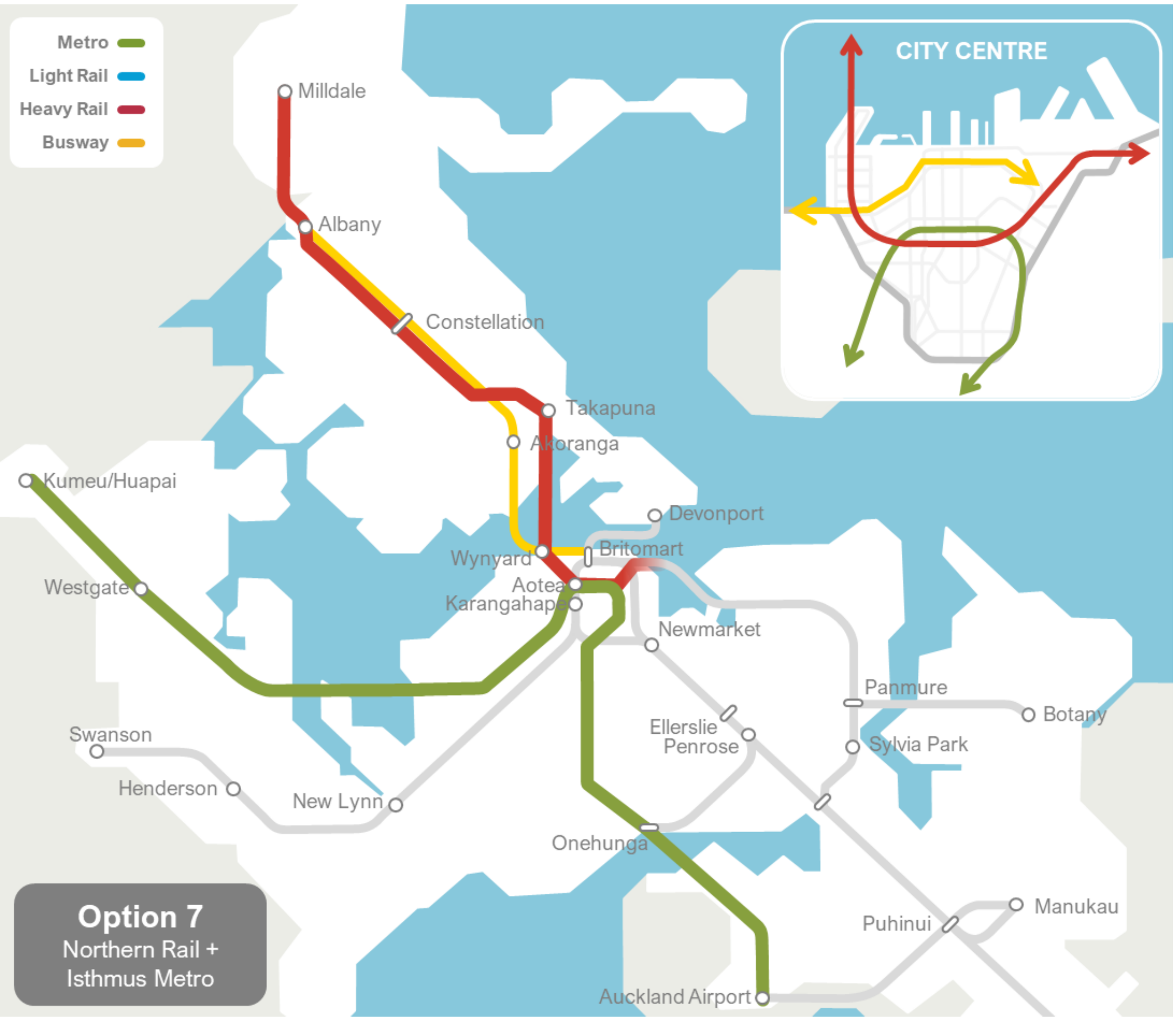
Light rail would serve the Northwest and Māngere.

The Northwest would run at headways of 3 minutes (20 per hour), and Mangere every 6 minutes (10 per hour). Light rail would circulate through the city on two corridors (likely Queen St and Symonds St).

North Shore and Eastern line frequencies are based on 6-car trains. North Shore line frequencies are based on 6-car trains. With this assumption the North Shore would run at 16 trains per hour, it would be roughly 12 per hour if 9-car trains were assumed. Northern Busway arrangements may mean that the required frequency could be lower.

Line	Operational Frequency	Capacity to Serve Demand
North Shore	16 trains per hour	Sufficient capacity with demand split with busway.
Northwest	18 trams per hour	Sufficient capacity
Māngere	12 trams per hour	Sufficient capacity

3.4.8 Scenario 7: two-line metro with northern rail



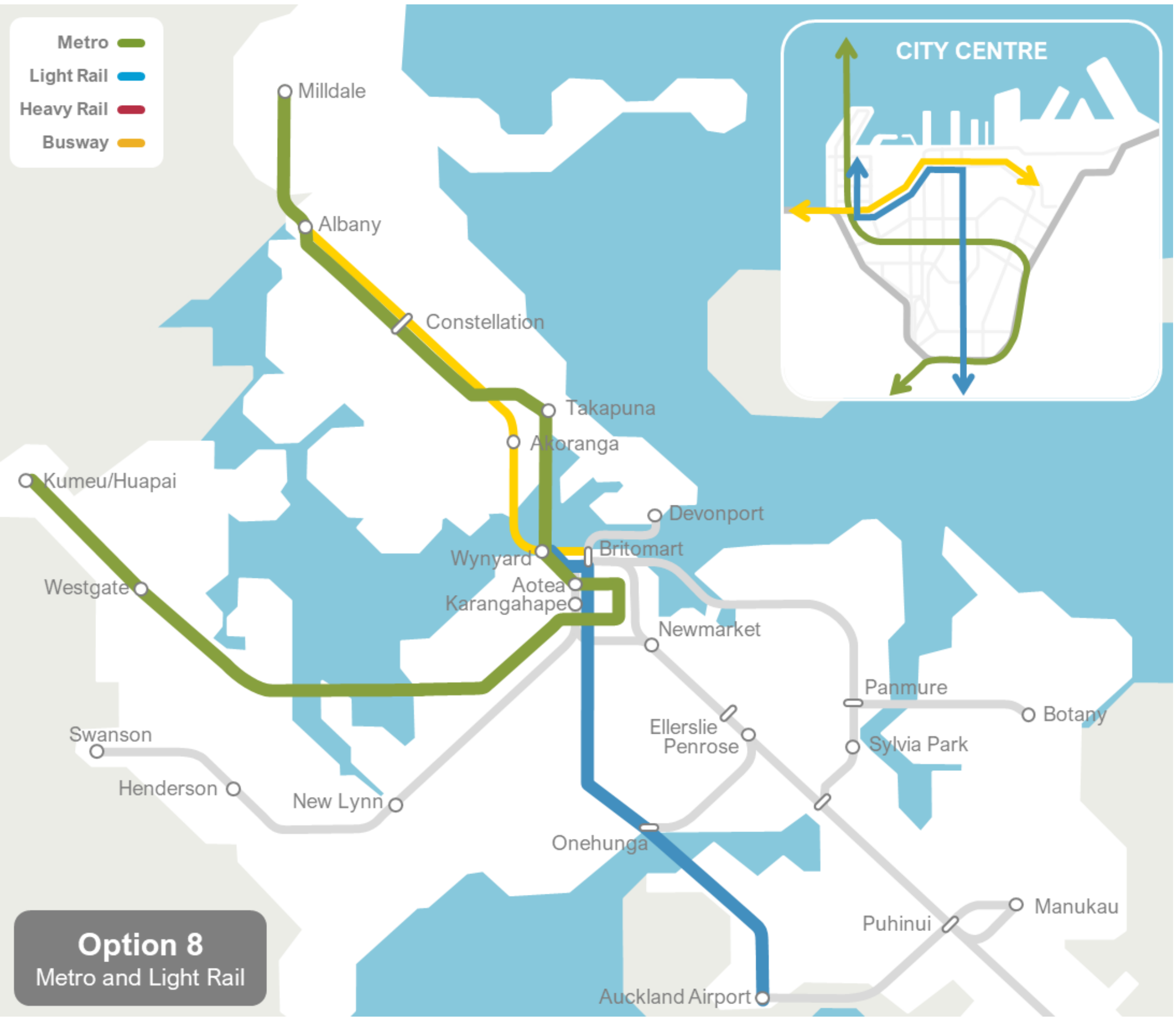
Scenario 7 would extend existing heavy rail to the North Shore via a new tunnel in city centre, connecting at Quay Park and then running via Eastern Line. Metro would serve the Northwest and Māngere. The metro would be through routed between Northwest and Māngere via a new tunnel in city centre – could be complex to fit with heavy rail tunnels.

The metro would run at headways of 5 minutes (12 per hour).

The North Shore and Eastern line frequencies are based on 6-car trains. With this assumption the North Shore would run at 16 trains per hour. It would be roughly 12 per hour if 9-car trains were assumed. Northern Busway arrangements may mean that the required frequency could be lower.

Line	Operational Frequency	Capacity to Serve Demand
North Shore	16 trains per hour	Sufficient capacity with demand split with busway.
Northwest	12 trams per hour	Sufficient capacity
Māngere	12 trams per hour	Sufficient capacity

3.4.9 Scenario 8: two-line metro with city centre to Māngere light rail



Scenario 8 would construct a metro line serving the North Shore and North West. The metro would be through routed between Northwest and the North Shore via a new tunnel in city centre – could be complex to fit with heavy rail tunnels. CC2M Road would be served by on-street light rail.

The metro would run at headways of 5 minutes (12 per hour). The uneven demand between North Shore and Northwest would be balanced by Northern Busway. Would require ~60 buses per hour. Potential to further reduce this by running more trains and terminating these in city centre.

The light rail would run at a five-minute headway (12 per hour).

Line	Operational Frequency	Capacity to Serve Demand
North Shore	12 trains per hour	Sufficient capacity with demand split with busway.
Northwest	12 trains per hour	Sufficient capacity
Māngere	12 trams per hour	Sufficient capacity

3.5 Multi-criteria analysis (MCA)

A multi-criteria assessment was used to weigh up the comparative benefits and implications of scenarios, and aimed to inform on the relative benefits, feasibility and costs of scenarios.

The MCA criteria were developed with clear line of sight objectives defined above in sections 3.3.1 to 3.3.3, as outlined in Figure 3-1**Error! Reference source not found.** below.

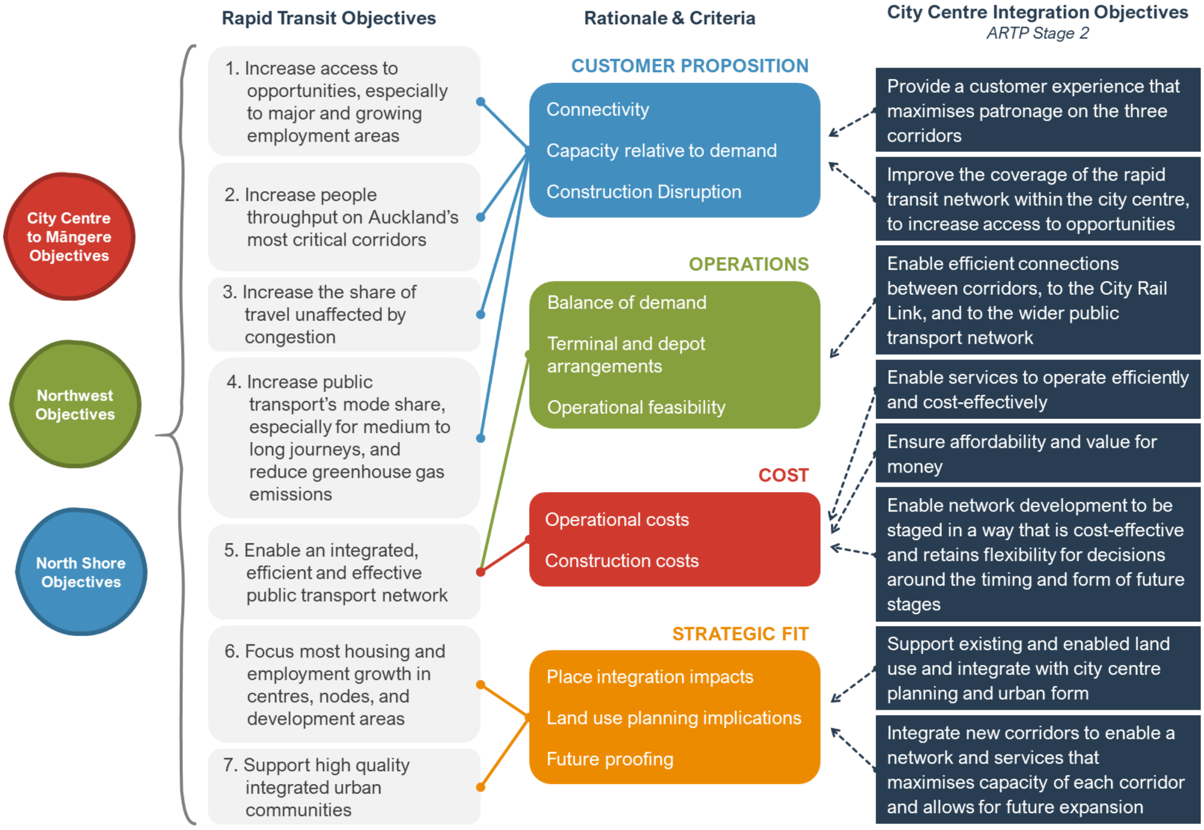


Figure 3-1: MCA criteria - alignment with objectives

Long list scenarios were assessed using an MCA that considered the criteria under four groupings, as set out in Table 3-5: MCA Criteria below.

Table 3-5: MCA Criteria

	Criteria
Customer Proposition	**Connectivity** What level of network wide connectivity does this scenario provide? Will it contribute to a useable, legible network for customers?
	Capacity Relative to Demand Is there sufficient capacity on each line in future to meet demand? What level of service will this lead to for customers (such as crowding, unreliability, and long travel times)?
	Construction Disruption What scale of disruption to the surrounding areas will the construction of this scenario create?
Operations	**Balance of Demand** Does this scenario sufficiently balance the level of demand along different corridors within the network, so that an efficient network can be planned?
	Terminal and Depot Arrangements Are multiple different terminals required, especially in the City Centre? Will multiple depots be required to service multiple modes?
	Operational Feasibility Is this network operationally feasible? Can it be operated effectively given the constraints that are likely to be involved?
Cost	**Operational Costs** How much would this network cost to operate? (This includes drivers, vehicles, maintenance, and station operations)
	Construction Costs How much would this scenario cost to construct? (This includes consideration of relative scales of costs, implications of grade-separation, and station infrastructure, and property acquisition requirements)
Strategic Fit	**Place Integration Impacts** How will the network and infrastructure in this scenario impact the surrounding areas?
	Land Use Planning Implications Does this scenario align with existing land use planning (will in support currently planned intensification and connect key centres)? How feasible is it to alter land use planning to coordinate with this scenario?
	Future Proofing Does this scenario provide enough capacity to provide for growth beyond 2050? How feasible/ complicated would it be to expand on this network in future?

3.6 MCA summary

Table 3-6 summarises the scoring of the long list scenarios, refer to Appendix B for the full MCA.

Connectivity: Not a major differentiator – as all options connected the three main corridors to the city centre and provided opportunities to transfer within the city centre. The best scoring options for this criterion were those who connected all three lines directly (Base, 1 and 3).

Capacity (relative to demand): Larger scale options tended to score better (3, 6, 7 and 8) as higher capacity modes are more easily able to serve demand within operable frequencies. The base option would be operating at maximum operable LRT frequencies by 2050 and were scored more negatively as a result.

Construction disruption: Not a significant differentiator as all options consist of large-scale infrastructure investment and would all have significant impacts. Generally, options with on-street infrastructure are expected to be more disruptive – due to the larger noise and visual impacts, and the requirement to close large sections of the street network to facilitate construction.

Balance of demand: This criterion is critical in the assessment of these options. Options with severely unbalanced operations (4 and 5) were operationally infeasible and for most the land use change that would be required to change that would also be so large that it would also be infeasible.

Terminal & depot arrangement: Not a major differentiator. Options 8 and 4 would require larger scale infrastructure than other options with two additional modes in each option. Options that require termination in the city centre would also be more challenging – and more expensive.

Operational feasibility: The base option and option 1 scored most poorly as they would require frequencies at the maximum on what would be operationally feasible. Option 1 scored better than the base due the splitting of services in the city centre – reduces the risk of bunching and unreliability caused by delays in the city centre.

Place integration/ impacts: The scoring was mainly dictated by two factors, options with CC2M metro (2,3,4 and 7) and/ or high vehicle volumes in the city centre (1 and 2) were scored more negatively. The place impact of the CC2M metro would be dependent on the form of grade-separation and location of above surface structures.

Land use implications: This criterion scored capacity the feasibility and scale of changes land use planning required to coordinate with an option. Options 2, 3, 4, 5 and 7 were scored more negatively due to their imbalances in demand, with options 4 and 5 considered infeasible.

Future proofing: Options with insufficient capacity, or capacity constraints by 2050 (base, 1 and 2) were scored most negatively, with options that could be easily expanded to serve higher demands (3, 4, 7 and 8) scored most positively.

Operational costs: Generally operational costs were scored according to mode with heavy rail being the most expensive and light rail the least.

Construction costs: Options with grade separated rail on both the North Shore and CC2M corridor would be the most expensive to construct – particularly options 7, 3 and 4 which would require large-scale infrastructure on all three (and in the case of option 4, four) corridors. The base and option 1 would be the cheapest to construct requiring minimal tunnelling and underground stations.

Criteria		Options								
		BASE	1	2	3	4	5	6	7	8
Customer Experience	Connectivity	4	4	3	5	3	3	3	3	3
	Capacity Relative to Demand	2	2	3	5	3	3	4	5	5
	Construction Disruption	3	2	5	4	1	2	2	2	3
Operations	Balance of Demand	5	5	3	5	2	1	3	4	4
	Terminal & Depot Arrangements	4	4	4	5	1	3	4	5	2
	Operational Feasibility	1	2	3	5	4	4	4	5	5
Strategic Fit	Place Integration/ Impacts	2	3	2	3	3	5	5	3	4
	Land Use Planning Implications	5	5	2	3	1	2	4	3	4
	Future Proofing	1	1	2	5	4	3	3	4	5
Costs	Operational Costs	4	4	3	4	2	3	3	1	4
	Construction Costs	5	5	2	1	1	2	3	1	3

Table 3-6: MCA summary

The purpose of the MCA assessment was to holistically understand the benefits, constraints, and impacts of the various long listed options, determine critical issues with options and to identify a short list of options to further progress through assessment. Scorings were not totalled as the various criteria were not weighted.

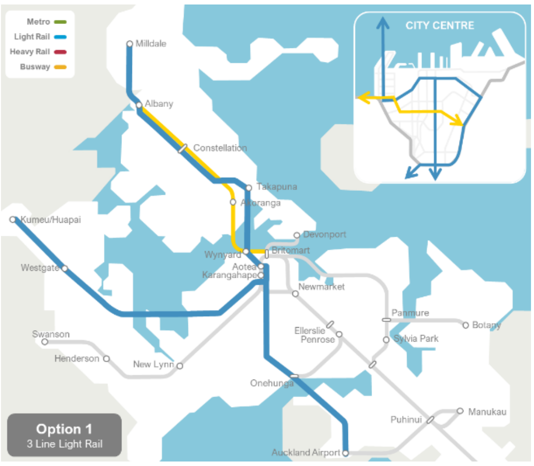
MCA Outcomes:

- Scenarios 4 and 5 discarded due to operational issues (imbalance of demands) and costs.
- Scenarios 2 and 7 discarded – imbalance along metro lines and oversupply of isthmus capacity. Scenario 2 also provides insufficient capacity for northwest demands. The benefits of both these scenarios would be unlikely to balance scenario costs (high).

3.7 Short list

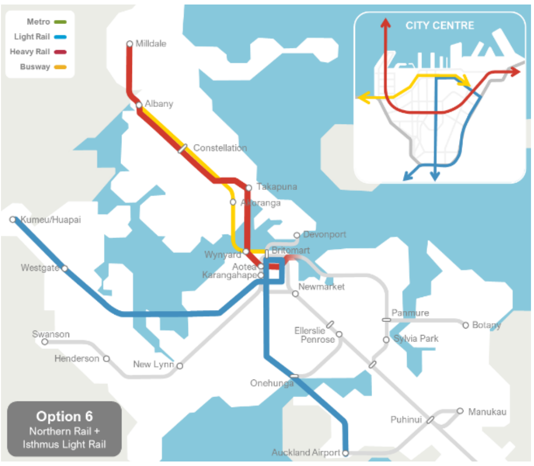
The purpose of the short list was to take the best version of different key choices forward for more detailed investigation. As based on the outcomes of the MCA, four of the nine long-list scenarios were progressed:

- Option 1: was progressed due to its balance between customer proposition and costs. It best aligned with current RTN plans and progressed over the base option as the separation of the city centre lines was better suited to on-street operations at high frequencies. Its ability to be future proofed in future, city centre operations and travel time were the key factors identified for further investigation
- Option 3: would be the best operable network should the CC2M corridor be chosen as light metro. Key for further investigation was costs and stageability.
- Option 6: provided a future proofed network – particularly for the North Shore but required further consideration of the costs expected and to further understand the trade offs of mode choice for the North Shore.
- Option 8: provided a good match of modes to the corridor demands but required the operation of two new modes and networks. Further work was required to understand the viability of its operation.



Scenario 1: Three Line Light Rail

Scenario 3: Three Line Metro



Scenario 6: Northern Rail Line and Isthmus/Northwest Light Rail

Scenario 8: North to Northwest Metro and City Centre to Māngere Light Rail

3.8 Short list assessment

Scenario testing will form stage 2 of the ARTP work. This will include modelling of the short-listed scenarios, to better understand how they influence expected demand and deliver against key outcomes (e.g. mode shift, access to opportunities etc.). This will also ensure modelling results are based on a consistent set of assumptions.

Further work on the costs of each scenario will then help to assess the efficiency as a network.

3.8.1 Modelling

3.8.1.1 Process and assumptions

Four model runs were completed within stage 2:

1. Option 1: three-line light rail
2. Option 3: three-line metro
3. Option 6: isthmus and Northwest light rail with North Shore heavy rail
4. Option 8: Two-line metro with CC2M light rail

Many elements of the short list options have been previously modelled in other projects. These model runs have been based on a variety of different assumptions around land use, supporting network etc. The aim of this stage of modelling was to model options with a consistent set of assumptions:

- All options were based on the ATAP Aug 20 base model
- Options were assessed with the same underlying bus and ferry networks
- Options were modelled against the same land use scenario (i11.6)
- 60 busway services per hour were retained (with midtown or downtown termini, dependent on the location of the rapid transit network)

Refer to Appendix A for full model specifications.

Future modelling will be completed as part of stage 3 work. This modelling will cover further refinement of scenarios and sensitivity testing of the preferred staged scenario with higher land use, congestion pricing, and COVID impact.

3.8.1.2 Results

Figure 3-2 below shows the network-wide public transport boardings by option. There are slight advantages inter-peak for options 3 & 6, due to the travel time advantages of metro in option 3 and the extra rail service run in option 6. Overall, the differences between options are more easily seen at corridor specific level. This is expanded on below.

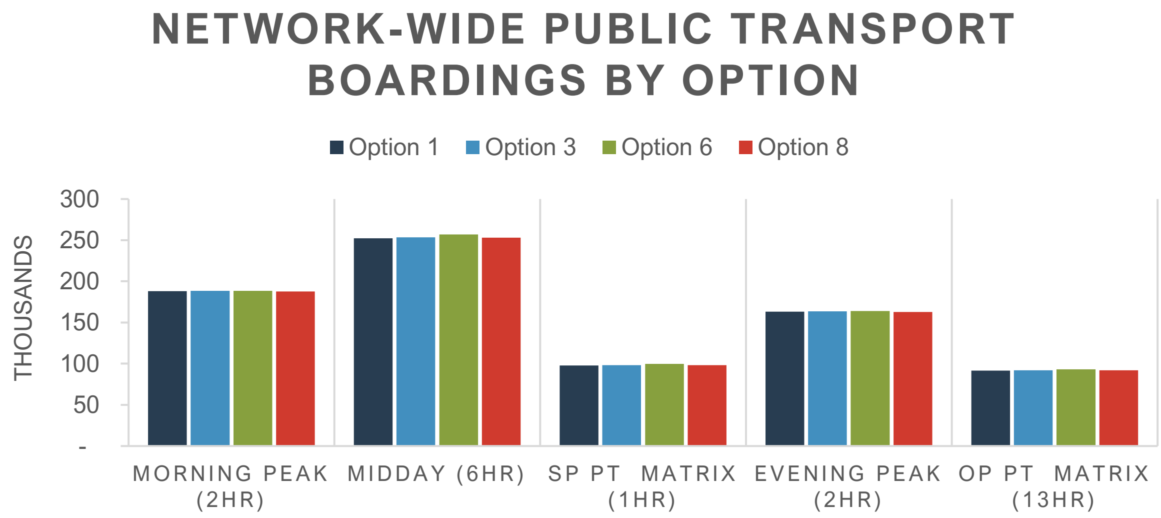


Figure 3-2: Network-wide public transport boardings

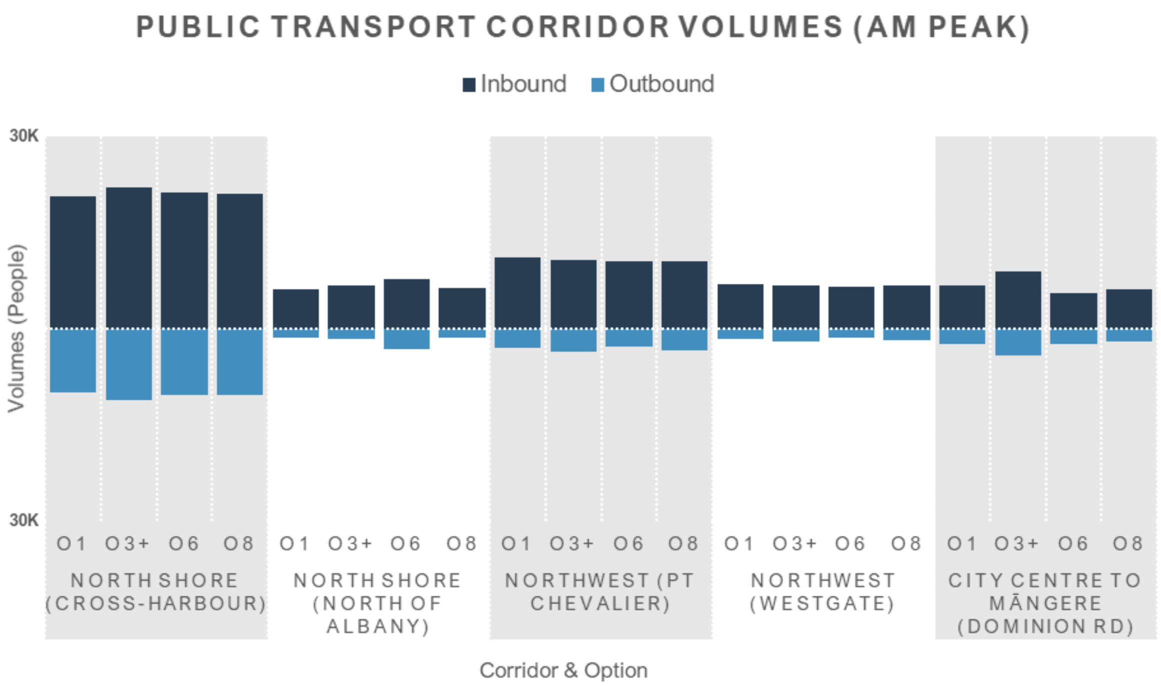


Figure 3-3: Public transport corridor volumes (AM peak)

Figure 3-3 above shows the public transport corridor volumes in the AM peak at various points throughout the network. Table 3-7 below displays the mode share expected for the northwest and north shore.

Key Findings:

- The split of usage on the North Shore (busway vs new mode) changes between scenarios. This is a key issue to be investigated in future work, to further understand the impact on busway and RTN alignment on demand.
- For the northwest corridor, demand is approaching full capacity in 2048 in options 1 & 3 – this can be solved by providing extra capacity but is not possible under option 1 without changes in service operating design.
- Modelling of flows at key points of each corridor showed that all options perform similarly, with Option 3 generally the best (especially cross-harbour and for Māngere).
- Some advantages (e.g. Option 3 performing better on CC2M) are where corridors are drawing patronage from other services (in that case, there is lower use of the heavy rail network).
- Option 1 performs best for Northwest, as it offers the best connectivity to other lines and to the wider city centre.
- The largest difference can be seen on outbound services north of Albany in options 6 and 8, due to changes in speed and regional access.

Table 3-7: Public transport mode share (AM peak)

Peak Direction Mode Share (2048 AM Peak)				
North Shore	**Option 1**	**Option 3+**	**Option 6**	**Option 8**
Cross harbour PT	20706	22067	21184	20949
Cross Harbour Vehicles	25547	25646	25544	25596
Mode Share (%)	44.8%	46.2%	45.3%	45.0%
Northwest	**Option 1**	**Option 3+**	**Option 6**	**Option 8**
PT North West (W of PC)	11031	10678	10556	10434
Car North West (W of PC)	16736	16692	16735	16723
Mode Share (%)	39.7%	39.0%	38.7%	38.4%
City Centre to Mangere	**Option 1**	**Option 3+**	**Option 6**	**Option 8**
Dominion Road PT	6702	8823	5510	6092
Dominion Road Vehicles	634	1812	635	638
Mode Share (%)	91.4%	83.0%	89.7%	90.5%

Figure 3-4: PT catchments within 45 minutes - key centres

Figure 3-4 above shows the MSM forecasted catchments – the estimated volume of population and employment within 45 minutes on public transport from key centres (Albany, Downtown, Midtown, Māngere and Westgate).

Option 3 out-performs other options in terms of access to employment and other opportunities. This is for two reasons:

- Light metro is assumed to have faster travel times than light rail on CC2M (by 10-15 minutes)
- Option 3 has a single mode on all three corridors, which makes transfers easier – this is why it performs better than Options 6 & 8 (which also feature lines with faster travel times to North and West)

This advantage does not result in significantly higher use of public transport at the network level though – people benefit from faster journeys, but not to the point where more people actually travel. This makes sense, as speed is not the only factor that influences usage – customers value rapid transit's reliability and convenience highly as well. Light rail assumptions (Options 1, 6, 8) include an indirect alignment in Māngere (as per the 2018 design) which increased travel time to the Airport (while Option 3 was a more direct metro). This explains the advantages Option 3 has in Māngere, and also the CBD. Future work should look to optimise the alignment in Māngere to achieve these benefits.

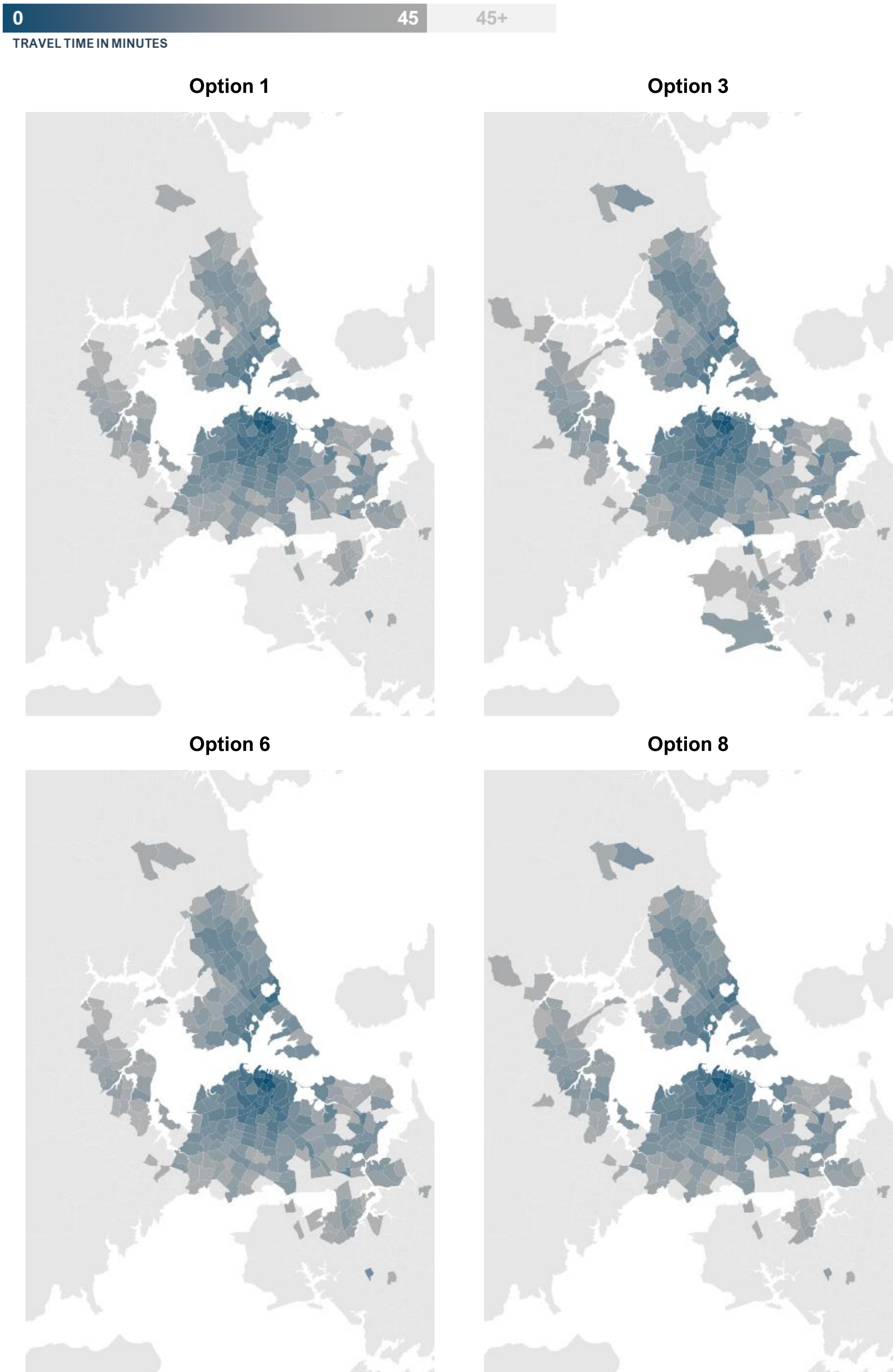


Table 3-8: PT catchment with 45 minutes of the city centre (midtown)

3.8.2 Cost comparison

High-level cost estimates have been developed, using information from a range of local and international projects. This has allowed us to benchmark the costs of each mode by alignment type. These high-level costs are **intended to illustrate differences in the scale of costs between options**. They are **indicative only** and subject to variation.

Each corridor was costed by mode and scenario, to get a scenario cost. This relied on assumptions about the corridors from previous work. High level cost estimates are based on benchmarks and expressed in current value. Costs do not include potential escalation and will be impacted by delays. As costs are based on general benchmarks, costs do not include corridor specific traffic management, urban realm/streetscape, utilities diversions, or property acquisition costs. Costs will be impacted by procurement strategy / approach. Processes such as property acquisition and consenting are significant risks to both the timing and costs of projects.

Assumptions

Table 3-9 below contains the per km cost rate assumptions assumed per mode and level of grade separation. To estimate high-level costs for scenarios these rates were applied along the assumed alignments. These rates have been estimated from a selection of other projects, providing a cost benchmark for costing the scenarios. For all options that include LRT between Customs St and Hayr Rd, $1.8 billion was applied as the section cost.

Table 3-9: Estimated Project Rates

Estimated Rates		$M/km
Light Rail	At grade LRT	$100
	Elevated LRT	$200
	Cut and cover LRT	$300
	Tunnelled LRT	$500
Light Metro	At grade metro	$200
	Elevated metro	$300
	Cut and cover metro	$450
	Tunnelled metro	$650
Heavy Rail	At grade rail	$250
	Elevated rail	$400
	Cut and cover rail	$900
	Tunnelled rail	$1,000

Based on the assumed costs above, Table 3-10 shows the likely cost range of each component corridor of each option, and the overall scenario's cost range. They are for **comparison purposes only.** Business case work for each corrdior will need to refine these costs to account for a range of issues that high-level work cannot consider, including:

- Property purchase
- Numbers and types of stations
- Preferred alignments

- Depot and rolling stock arrangements
- Contractual arrangements

Given the above, the costs for each corridor and potential stage have been rounded and given as a range, using results from this step as the mid-point to illustrate that these are high-level only.

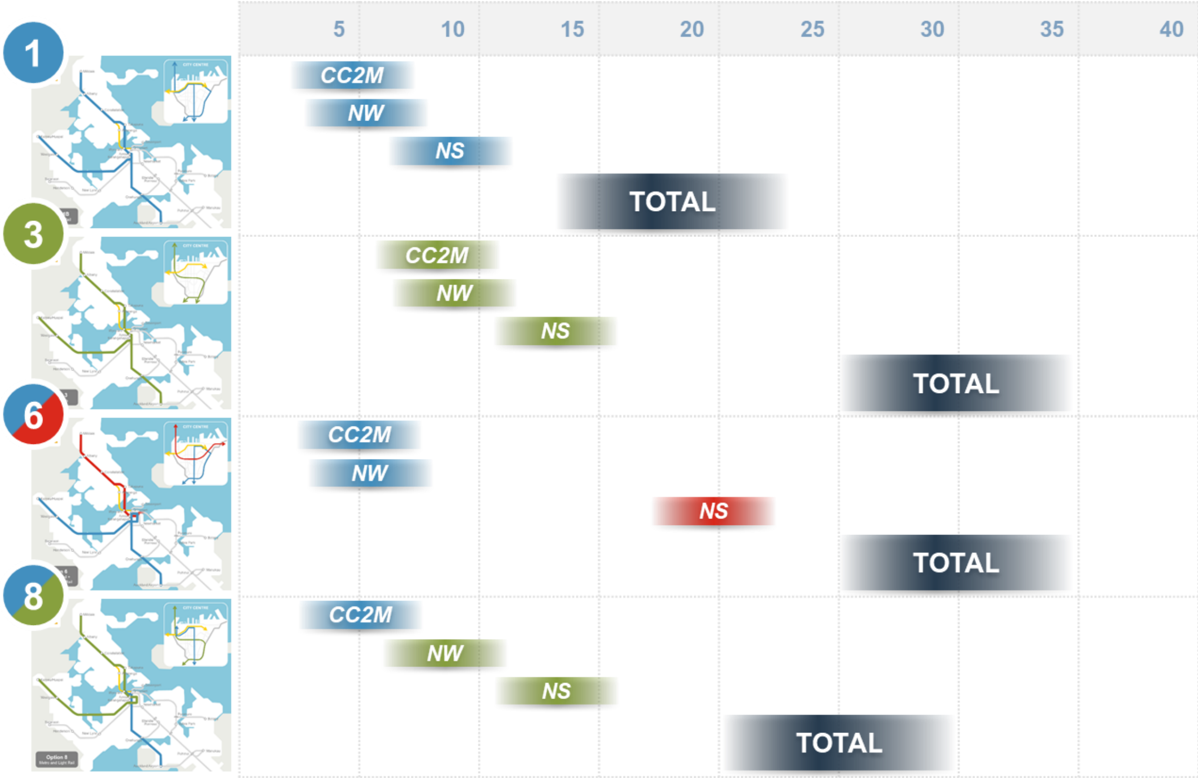


Table 3-10: Estimated Cost Comparison

The scale of investment in Option 1 is significantly different to the other three options. Options 6 and 8 are expensive given they require two new city centre corridors (one above and one below ground). The cost for North Shore heavy rail (option 6) is very high, given the expense of a second heavy rail tunnel in the city centre (same scale as CRL) and across the harbour, plus the technical design requirements of heavy rail.

Refer to Appendix C for further information on project benchmarks, costs calculations and assumptions.

3.8.3 Staging

Understanding how the different short-listed options might be staged over time is a key component of assessing their strengths and weaknesses. The short-list scenarios have been investigated further with regard to their stage-ability to help to identify if and how there is a realistic pathway from the existing network to the complete network envisaged in the scenarios.

Each scenario has different viable stages, which differentiate the scenario's ability to meet expected demand within an appropriate cost.

Table 3-11: Short list option staging

Options	Option 1	Option 3	Option 6	Option 8
Stage 1	CC2M (Queen St)	CC2M (city centre tunnel)	CC2M (Queen St)	CC2M (Queen St)
Stage 2	Northwest	Complete CC2M Initial sections of Northwest	Northwest	Northwest + city centre tunnel
Stage 3	North Shore	Complete Northwest	North Shore + city centre tunnel	North Shore
Stage 4	Additional city centre corridor	North Shore added	Additional city centre corridor	-
	Most flexible option, in terms of timing and sub-stages. Likely lowest cost of each stage.	Requires new city centre tunnel for first stage. This is a large upfront investment, but an enduring capacity solution.	Similar flexibility for light rail to Option 1, but cost and complexity of heavy rail tunnel to North Shore likely to delay its introduction.	Investment in second city centre corridor likely to delay implementation of Northwest and North Shore.

Staging of short-listed options was considered, based on likely demand and when additional capacity is needed, the capacity of market to deliver stages of each project, **indicative** costs, possible spread of cashflow and design and construction timeframes.

The chart shows **potential** staging of each option based on those factors. More work will be needed at business-case level to investigate this in detail.

The CC2M corridor has been identified as the first of these corridors to be progressed – and as such, the staging of the corridors have all assumed that the CC2M corridor is constructed first. It has a critical role in creating the start of the network that the other two corridors need to build from. The scale of infrastructure required for this corridor differs significantly between options. Option 1, 6 and 8 all assume on-street light rail which is far less infrastructure heavy than option 3 which would construct the CC2M corridor as light metro.

As such, Option 3 requires the construction of a city centre tunnel directly after the construction of the CRL. It also requires the full grade separation of the city centre to Mt Roskill section, in order to be viable first stage. Critically, the first stage of construction of option 3 would be far more costly and take significantly longer, than for the other options.

This leads to knock on impacts on the secondary stages of the RTN network construction. All options have assumed the Northwest would be the next critical corridor - given the current lack of public transport service and choice in the northwest.

Option 3 would need to delay construction far longer than the other options due to the dependency on the city centre tunnel. It would either need to construct the corridor after or at the same time as the central isthmus section of the CC2M corridor – either leading to significant delays for the corridor or large amounts of investment and labour force needed.

For all options the majority of the northwest corridor would need to be grade-separated. For this reason, the staging of the corridor itself is not expected to differ significantly. However, option 8 would require city centre tunnelling at this point – and due to this would cost more and take longer to construct. Option 1 and 6 may differ in the timing of the construction of the second city centre corridor but it isn't expected that this would need to be constructed at the same time as the northwest corridor.

All options have assumed that the north shore would be constructed as the last of the three corridors. Option 1 assumes this is light rail, Options 3 & 8 assume light metro and option 6 would construct the supplementary connection as heavy rail. All options would need to tunnel under the harbour and would be largely grade separated (assuming an alignment along the busway north of Smales Farm). Heavy rail along this alignment would require much larger sections of tunnelling and structures than the other modes and as a result would be significantly more costly, complex and time intensive to construct.

It is expected that the current busway will exceed demand by the mid-2030s. Considering the scale of investment needed in the earlier stages of construction, it is will be challenging for any option to meet this timeframe – with larger scale options like option 3, 6 & 8 very unlikely to meet it.

Key takeaways:

- Option 1 would be the most flexible option, in terms of timing and sub-stages with the likely lowest cost of each stage.
- Option 3 requires a new city centre tunnel for first stage and cannot construct an operable network until this is complete and a significant section of grade separated corridor is also constructed. This is a large upfront investment, but an enduring capacity solution. The delay on this first stage will push out the timing for the other corridors – delaying the northwest and increasing the pressure on the northern busway. Should this option be progressed further, consideration of further interim busway improvements should be considered for both the Northwest and North Shore.
- Option 6 has similar flexibility for light rail to Option 1, but the cost and complexity of heavy rail tunnel to North Shore is likely to delay its introduction and increase pressure on the norther busway.

- The investment in a second city centre corridor for the construction of the northwest corridor is likely to delay implementation of rest of the Northwest corridor and the North Shore.
- Some decisions can be made that could evolve over time to other areas, but other decisions will be long-lasting.
- The next stages of work will need to consider tunnelling requirements further – particularly the timing of major tunnelling and the impact that will have on funding availability, required interim investment and delays for investment in the wider network.

In addition to the staging of the shortlisted options above, the staging of these options could be further optimised. For example, there is a potential staging pathway whereby option 1 could be successively staged into an option 8 style option and operation. This is pictured in Figure 3-5 below.

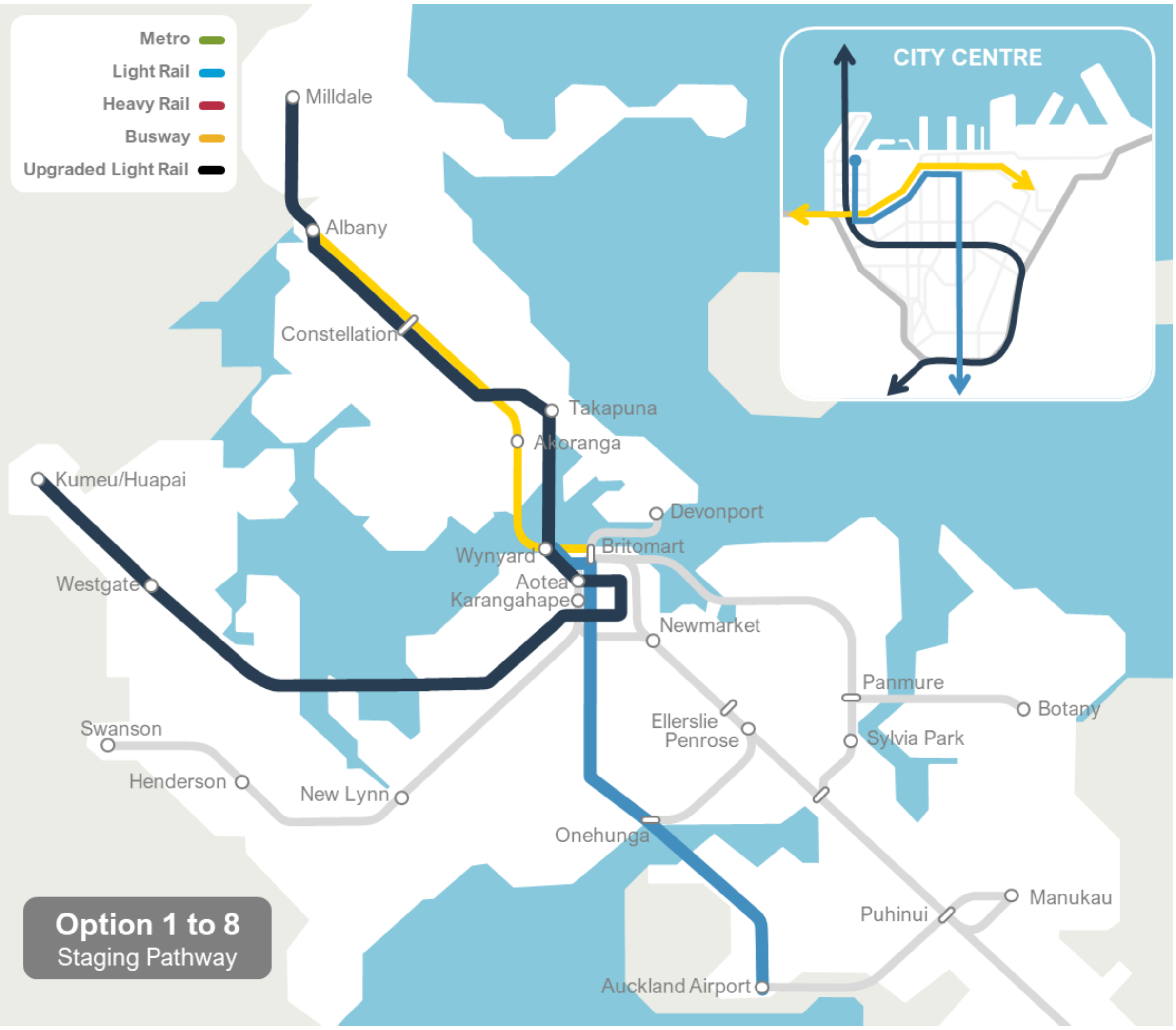


Figure 3-5: Option 1 to 8 staging pathway

This staging pathway would deliver appropriate capacity over the next three decades through efficient staging. It would avoid the longer-term capacity issues associated with Option 1 but does not require significant up-front investment. This option would start with all three corridors operating as light rail and sharing Queen St. The Northwest and North Shore would be developed as grade-separated corridors that could later be operated as an automated system with metro-style operation. Conversion of these lines to metro-style operation would be enabled through the introduction of a new city corridor. This would enable longer vehicles, higher frequency, and possible automation of services using the existing infrastructure and converted rolling stock.

Regardless of the mode chosen for the CC2M the next stages of work should investigate the optimisation of:

- Alignment through Mangere
- Airport terminus and integration with A2B
- Alignment of the busway and RTN on the North Shore, retained function of the busway
- Connections with wider network
- Possible further extensions to the network (other isthmus corridors etc)

Table 3-11 above describes a theoretical staging of the options. However, there are a range of factors that will shift the staging of the network and are likely to lead to delays and cost escalations – particularly if they are not considered from the beginning of network/ corridor design.

Land use implications

This stage of ARTP was limited in its ability to consider the impact of land use. However, an option's staging and associated costs will be critically tied to land use. The following factors should be considered in more detail in future work:

- Options that can be implemented faster will be better able to address existing growth pressures (particularly on the Northwest and Māngere corridors). The more stageable and flexible an option, the better the system can be developed progressively in future so that capacity issues can be avoided.
- Slower implementation could lead to land use change occurring well before rapid transit was in place to support it. This would risk the land use not maximising its potential capacity, both in line with the Auckland Plan's vision and with further potential capacity that could be introduced in response to the rapid transit investment. This would result in the corridors under-performing, and likely additional transport investment being required in areas that growth occurred in instead.
- There is also potential for improved land use integration with all options to increase the value of the investment in the rapid transit network. Further work will be required to optimise land use in response to any recommended option (and understand required changes in relation to the National Policy Statement on Urban Development, which requires up-zoning around planned rapid transit stops).
- All options allow for improved density within brownfields area, and high-quality city centre access. However, land use uptake will look fundamentally different depending on the mode choice and alignment – particularly along the CC2M corridor where the land use is not already shaped by adjacent motorways. Metro and heavy rail requires clustering of high density around stations, at grade light rail allows for more consistent up-zoning of a corridor. The Northwest corridor unlikely to change significantly in land use patterns regardless of busway, light rail and metro – excepting the scale and timing of the feasible growth. The North Shore land use response will be highly dependent on the alignment chosen for the future corridor, and the staging of the corridor.
- The number of stations will also have a significant impact on land use. Fewer stations will create the need for growth to be clustered in a few locations, whereas a system with more stations means that growth can be spread out across more areas.

Stage 3 of ARTP work will further investigate the impact of land use assumptions on network patronage.

3.9 Sensitivity testing

Three versions of Option 3 (light metro) were tested. These varied the frequency of service and the capacity of each vehicle. These were:

a) Low frequency, high capacity vehicles

b) High frequency, lower capacity vehicles

c) High frequency, high capacity vehicles

Table 3-12 below shows the impact these options had on PT patronage for the three corridors.

Versions A & B had equivalent overall capacity, to test if frequency alone would generate increased patronage. Version C tested the model's response to both characteristics combined. "Option 3" in the earlier section of the report represent the B version of the light metro option. "Option 8" assumed a A version of the light metro option. This ensured a fair assessment of a key potential advantage of light metro compared to other modes (i.e. high frequency for no extra operating cost) without over-supplying capacity relative to both demands, and the other options assessed.

Table 3-12: Sensitivity Testing Patronage

Option/ Comparison	Northwest	CC2M	North Shore		3 Corridor Total
			Rail	Bus	
Option 1 – Light Rail	12,827	7,715	9,771	10,985	41,298
Light Metro (A) Long/less frequent	11,407	9,512	11,623	10,421	42,963
Light Metro (B) Shorter/frequent	11,458	9,622	11,727	10,340	43,147
Light Metro (C) Long/frequent	13,738	10,329	11,730	10,157	45,954
A vs C	2,331	817	107	-264	2,991
%	20%	9%	1%	-3%	7%
Light Rail vs Light Metro (C)	911	2,614	1,959	-828	4,656
%	7%	34%	20%	-8%	11%

Versions A & B produced similar results, with version B having a slight advantage. Version C generated additional patronage (7% greater at the network level than A/B). Version C is not considered realistic though, as it involves significant over-supply of capacity (double versions A & B) relative to demand and a higher overall cost (for the additional rolling stock needed). It was only used as a sensitivity test of the model.

High frequencies and long trains for light metro are needed to achieve higher ridership than light rail for the northwest. This suggests that light-rail is a good choice for this corridor but also highlights the value of connecting the northwest to Britomart directly.

Based on model outputs light metro options deliver substantially more ridership than light rail for the CC2M corridor. This will be partly due to the circuitous route that light rail is assumed to take between Onehunga and the Airport. Further work should investigate the impact of alignment on light rail travel times and resultant patronage.

Total North Shore ridership across bus and rail is reasonably consistent for all the options (between 20,700 and 22,000). Light metro seems to attract quite a bit more use than light rail. Future work should investigate the impact of alternative alignments on patronage and how to best optimise the corridor.

4 Limitations

The following section covers the work scope, exclusions and limitations of the work completed. The resultant recommendations for further work is included in the following section (section 5).

4.1 Work scope

This project is intended to produce a Rapid Transit Plan for Auckland. In scope for this Plan is:

- Building on current high-level plans for the rapid transit network while incorporating the latest thinking from business case development and best practice
- Interfacing with MoT's ALR process, advising on future network integration and implications of decisions
- Specifying appropriate future mode of corridors given required operating characteristics, and clarify where integration is required or where there are critical interdependencies
- Identifying and prioritising the preferred sequencing and staging of individual corridors and the overall network, including timelines for implementation and outlining any interim improvements before full introduction
- Testing the network's sensitivity to changed land use at stations, and outlining any potential changes to enable better integration of future land use and rapid transit
- Identifying key interactions with the rest of the transport network
- Clarifying the roles and responsibilities of the different agencies involved in the planning and delivery of rapid transit, including recommended funding arrangements.

This work is not intended to:

- Determine specific operational elements of future corridors (including locations of stations and depots, timetables, and related elements) or supporting public transport services (high-level consideration of these elements may occur where required to address in-scope elements)
- Recommend ways of financing, procurement, or contracting future corridors
- Recommend changes to existing operations of the rapid transit network
- Undertake work of, or replace the need for, detailed business cases
- Complete any work not specified in the scope, even if not listed as an exclusion, without agreement by the Steering Group.

4.2 Exclusions & limitations

Stage 1 and stage 2 of the ARTP have been completed within very short timeframes and as such, have been required to limit the work scope and make a series of exclusions:

- This work has relied heavily on the previous work done on the various corridors – as such is reliant on the quality and scope of that work.
- Modes/options not considered:
  - Bus-based solutions were not tested on the CC2M corridor – this has been investigated in previous stages of work and has been eliminated.
  - Advanced bus solutions were not considered.
  - Heavy rail was not considered for the Northwest corridor. The 2017 Northwest IBC eliminated heavy rail as a suitable option due to the costs associated and lower demands. Busway on Northwest however was considered, in long list optioneering. It was not progressed to the short list because of the operational impacts of this solution, and its connections with the wider RTN network (when assuming 2050 demands).
  - North Shore – did consider light rail, metro and heavy rail as supplementary connections (as based on previous work recommendations).
  - A bus-based supplementary connection on the North Shore was not assessed. As determined in previous work – a large portion of the constraints on the current busway originate in the city centre, and the city centre does not have the capacity to serve significantly higher volumes of buses. In addition, considering the scale and growth of demand on the north shore it is unlikely that another bus-based solution would be a future proofed solution.
  - Onehunga to Airport heavy rail option (serving Māngere) was tested – in option 5. Heavy rail was not considered for the central isthmus corridor because of the cost of heavy rail, difficulty of grade restrictions and comparatively low demands for the corridor.
- Timeframes – all options assumed and were designed for expected 2050 demands. As such the options were limited by timeframe. Options were assessed against their ability to serve demands beyond this point, however, considering the timeframes of the impact of the investment – further work should be completed to understand the adaptability of any system beyond 2050.
- The ARTP has not tested the impacts of different land use scenarios during this stage. Land use responses would vary by mode; this has been explored by previous work on light rail, but not light metro. We therefore did not have assumptions to rely on, nor the time or scope to develop these for light metro. Creating assumptions around the level of change at the ARTP's high-level of analysis would not enable a fair comparison. This detail would best be considered through business case investigations, which should look at land use as part of optimising the network's performance.
- Modelling
  - All assumed same underlying bus & ferry networks – and were not tailored to match options (station locations, alignments etc)
  - Consistent land use assumptions were used when modelling the options, in order to enable a fair comparison.
  - Similar alignments assumed between options – as based on previous work completed
- Given the limited timeframes for this work, the amount of sensitivity testing on options was limited.

- Other influences on demand, such as congestion and carbon pricing, were not tested. These also need to be assessed in future work.
- No technical design work – cost and feasibility assessments were very high-level and relied on previous work completed on these corridors.
  - Costs – only intended to get a measure of high-level difference between different options - based on a range of NZ and international examples.
- Staging – the stageability assessment is this stage of work was high level and a comparative assessment of option stageability. It did not take into consideration:
  - Integration and co-ordination with other current/ planned/ future infrastructure initiatives
  - Funding availability
  - Capacity and experience in delivering projects
- More in-depth assessments of stageability should be completed in further stages of work on the individual corridors – but should consider the impacts on the staging of the wider network.
- No engagement with mana whenua, or public consultation, is currently planned during the development of the ARTP. This is because the ARTP is investigating in more detail the development of the rapid transit network envisaged in strategic plans, such as the Auckland Plan 2050, that have already been extensively engaged on. The ARTP is not expected to significantly change the direction of those previous plans, but rather to develop them in more detail. Once finished, the ARTP will be used to inform other documents and projects which will are engaged and publicly consulted on, including future versions of the Auckland Plan and RLTP. Feedback from those processes can be used to inform changes to the ARTP as needed. Once finished, the ARTP will be used to inform other documents and projects which will are engaged and publicly consulted on, including future versions of the Auckland Plan and RLTP. Feedback from those processes can be used to inform changes to the ARTP as needed.

5 Key Findings and Recommendations

5.1 Introduction

Overall, the most critical finding of the work is that all three corridors are deeply integrated, with key decisions on mode, timing and alignment of any one corridor having significant impacts on the other two. This means that future work on three corridors needs to be integrated. With more detailed work on the City Centre to Mangere corridor progressing through the Auckland Light Rail Establishment Unit, it is important for the next phase of investigation and design for the North Shore and Northwest corridors to also progress.

There is also an ongoing need for integration between project-level analysis (including that undertaken by the Establishment Unit) and further development of the ARTP. Particularly important integration points will be:

Phase of project work	Key integration requirements
Problem definition and benefit identification	Ensuring individual projects are focused on delivered the outcomes required from the corridors that make up Auckland's overall rapid transit network Ensuring consistency between project measures/KPIs and overall rapid transit network objectives
'Do minimum' development	Ensuring individual projects use consistent assumptions for their 'do minimum', especially in relation to growth projections and what is assumed for the rest of the transport network Ensuring consistent methodologies for assessing key network deficiencies (e.g. public transport crowding functions in models etc.)
Option development	Ensuring appropriate consideration of other corridors, including detailed integration requirements for different mode/route choices Ensuring consistent approaches to adjusting wider networks (e.g. feeder bus routes) across different projects and options
Option assessment	Ensure consistent assessment methodologies across projects Test scale of impact and cost-effectiveness across different projects, to support achievement of network goals

Assessment through the long-list and short-list process outlined above indicates that that further work should focus on short-list options 1, 3 and 8. This should include consideration of how an initial light rail system could be staged towards operating as a light metro-style system in the future.

Further work should also optimise the short-list options that are progressing. This will need to consider:

- Alignments of the corridors
- Station spacing and location
- Land use change around stations

Other factors that could influence the timing and scale of demand, such as congestion pricing

Further recommendations at each level (network-wide/city centre, and by corridor) are set out in the following section. They are presented alongside the relevant findings of Stage 2 of the ARTP. This phase of work is not specifying a recommended option but rather a short list of options (as above) and a collection of recommendations for further work. These recommendations are intended to guide the next stage of the ARTP and also the business case work on all three corridors, including the work of the Auckland Light Rail Establishment Unit. The recommendations provide further guidance about key matters for further work to focus on. This includes network and city centre integration issues that will be progressed through remaining work on the ARTP, as well as corridor specific recommendations that help guide upcoming business cases.

5.2 Network and city centre

Key findings:

- The previously planned network with all three corridors as light-rail, sharing Queen Street, is likely to face significant capacity issues by 2050. A second city centre corridor would be required to address these issues.
- Mode and alignment choice for any of the corridors affects decision-making for the other two, meaning that critical route and mode decisions must be made with reference to the network perspective.
- At a regional level, different options perform similarly on key metrics. Light metro has some advantages due to underlying assumptions. Further work on light rail may be able to replicate these to an extent.
- Metro and heavy rail options are considerably (50-80%) more expensive than light rail, due to the anticipated need for extensive tunnelling in the central isthmus and in the city centre.
- A potential hybrid option/staging approach has merits. This would see the network begin as light rail, and then transition (parts of) corridors to metro-style operation. This warrants further investigation.

Recommendations

- Confirm the implications of any decision about the mode and alignment of one corridor for the other two corridors
- Develop and progress a strategy for the timing and detail of investigations into all three corridors
- Progress with and further refine the light rail and light metro options tested in the ARTP
- Investigate additional corridors in the city centre, other than Queen Street, including the alignment of an underground tunnel
- Assess potential land use responses to different modes, alignments and station locations to understand impacts on demand
- Assess the impacts on demand of potential interventions, including congestion pricing and carbon (emissions) pricing

5.3 City Centre to Māngere

Key findings:

- Light metro results in significantly higher ridership and accessibility than light rail, but this is due to assumptions that light rail route is indirect
- This corridor has the lowest long-term demands of the three corridors, but this could be improved through land use optimisation given this corridor has significant concentrations of publicly owned land nearby
- The lack of an off-street corridor through the central isthmus means that initial mode and alignment choices will have significant, long-lasting, network-wide implications
- The alignment of the corridor between Mt Roskill and the airport will not change significantly as it is likely to be primarily off-street regardless of mode

Recommendations

- Optimise the potential light rail and light metro alignments before they are compared through a business case
- Investigate the form and alignment of the corridor between the City Centre and Mt Roskill as its first priority
- Consider how the other two corridors will interface with CC2M, particularly in the city centre, including how this will be staged over time
- Investigate additional corridors in the city centre, other than Queen Street, including the alignment of an underground tunnel
- Consider how best to serve the isthmus in the long-term, with either a single metro line or potentially multiple light rail lines
- Assess the impacts on demand of possible land use responses to the options, based on refined alignments and station locations

5.4 North Shore

Key findings:

- This corridor has the highest demand, roughly equivalent to Northwest and CC2M combined
- This corridor is likely to require a high-capacity rail mode (such as light metro) in future, given the level of demand
- There are multiple options for the future alignment of the new rapid transit corridor
- Determining the balance of demand between the busway and new corridor is critical
- Heavy rail can be discounted as a future mode. The Additional Waitematā Harbour Connections business case work suggests this should be discounted unless required for network reasons, and the ARTP’s work suggests this need does not exist (and that heavy rail would have similar performance for a much higher cost)

Recommendations:

- Progress the next stage of the Additional Waitematā Harbour Connections (AWHC) business case and integrate it with the ARTP, and the CC2M and Northwest business case work

- Develop both light rail and light metro options in more detail, as part of the AWHC business case, including the potential to evolve from light rail to light metro over time. Heavy rail can be discounted unless other modes are shown not to be feasible
- Progress current work to enhance the busway, including a focus of providing more clarity on the future role of the busway in relation to the timing and planned catchment of the additional rapid transit corridor

5.5 Northwest

Key findings:

- There is high forecast demand in this corridor, which could lead to capacity issues in future. A rail-based mode is the mostly likely solution for this corridor
- Previous business case work identified a busway as best solution but did not resolve how this would work in the city centre issues. The ARTP's work suggests a busway would struggle to meet long-term demand effectively and would result in extremely high bus volumes in the city centre, which is not desirable
- This corridor must be urgently progressed, given the existing access deficiency and the rapid population growth in the Northwest. Interim bus improvements will have an important but relatively minor impact on this issue
- How this corridor will connect to the others in the city centre needs significant work to ensure feasibility

Recommendations

- Urgently progress the next phase of business case work for the full rapid transit corridor
- Focus on light rail and light metro solutions, including the potential to evolve from one to the other over time
- Assess the value of any further bus-based improvements against the likely future of a rail-based mode

Appendices