Introduction to Cable Cars (Part C): Urban Cable Car Opportunities in New Zealand

Executive Summary

The report outlines the opportunities across New Zealand for the deployment of a cable car systems as a consideration for addition to the public transport network. The cable car offers reliable, efficient, and low emissions mode of transportation, addressing urban congestion and enhancing connection between communities. Cable car routes can be constructed rapidly at a comparatively low cost – and offer the opportunity for significant enhancement in public transport mode share because of the advantages that they give over existing and planned transport infrastructure,

Abley used a three-stage methodology to identify potential cable car routes across New Zealand. Firstly, minimum population densities were identified in urban localities that could be shown to potentially support a cable car system. Secondly, the Abley Accessibility tool was used to identify key demand opportunities in the public transport system - where public transport travel time greatly exceeded private vehicle travel time, to identify potential cable car connection points. Finally, Abley used its expert institutional knowledge of known existing or planned public transport corridors and tested these for cable car potential. This included end-of-transit system deployments (a model that has been successful overseas) and testing in known strategic corridors where other mass transit systems are planned. We also identified new routes such Karori to Wellington CBD, where cable cars could add significant value.

Abley identified a long list of 23 cable car routes through using this tool kit. These were sifted using the Waka Kotahi EAST tool to produce a short list of potential cable routes that warrant further investigation. To assist the sifting process, Abley estimated the economic potential of cable car routes through using a point-to- point demand assessment and an estimate of the benefits profile according to Waka Kotahi Monetary Cost and Benefits Manual (MBCM) procedures. Travel time benefits for cable cars were measured against private car and public transport modes - and an upwards adjustment was made for public transport reliability improvements and congestion relief. The resulting BCR estimate was used as one criteria in the MCA-style process using the EAST tool.

The short list shows some of the key routes that solve major public transport problems in urban centres in NZ using cable car deployment. The Wellington region's topology and urban population density make it particularly conducive to the benefits of cable car solutions, and cable car routes offer a viable alternative to planned Mass Rapid Transit solutions. Likewise, in Auckland, current planned Bus Rapid Transit (BRT) at Airport to Botany could be substituted with a cable car route at far lower cost and alleviate East Auckland private car congestion. We also find merit in the proposition of connecting the Airport to Onehunga by cable car as a cost-effective alternative to light rail, as light rail presents potentially has challenges regarding economic feasibility for this part of the City to Airport route.

We were able to draw some general conclusions about cable car routes in New Zealand through our work.

The key points that bring a strategic advantage for cable systems in New Zealand are:

1. The significantly lower whole of life cost of major improvements to public transport using cable cars: This feature is prevalent across all routes in relation to major mass transit options – with far lower economic disruption during construction, capital expenditure an order of magnitude lower in some cases, and the potential to operate at farebox revenue surpluses.
2. An environmental profile that competes with other mass transit systems: cable car systems have equivalent mode shift potential to other transit modes. However, there are also far lower on-the-ground impacts on the environment compared to all other modes. Cable systems do not need to deploy within or near the road reserve, minimising the need for road improvements, and reducing the embodied carbon of our transport network, if carefully planned.

3. One of the key features of cable car systems in our investigations was an unparalleled improvement in public transport system reliability. In our economic assessments, we noted a near doubling of estimated benefits under current Monetary Benefits and Cost Manual (MBCM) assumptions on our proposed routes. Alongside the theoretical benefit calculation, the predictability and reliable nature of cable cars (arriving every 15-30 seconds for passengers) offers a high level of service which is essential to encouraging mode shift.
4. We have measured limited network effects in this study - but significant mode shift to cable car makes a step change to relieving demand constraints such as congestion. Cable car transit systems do not compete for space on the road reserve unlike Light Rail and Bus Rapid Transit. We anticipate good results from the enhancement of network benefits and predict improvements in the benefits profile in business case development of cable car routes.
5. Cable cars routes have additional features not available in other modes; these include the ability to bypass geographical constraints such as steep or restrictive topography and crossing stretches of water. In addition, subject to overcoming any constructability and resource consent constraints, cable car systems can be built across urban terrain efficiently and more directly. The latter is key point for New Zealand cities owing to great difficulty in deploying new mass transit systems in fast-growing cities like Auckland.
6. Cable cars offer several safety benefits including reduced exposure and likelihood of crashes through complete separation of patrons from other road users, safe start, and end of journey transitions for pedestrians and improved air quality.

Points (1) to (6) are all demonstrated in Wellington and this investigation also includes a comparison and focus on Wellington's proposed mass transit improvements - and shows that a cable car solution could be effective in comparison to the proposed light rail addition in South Wellington (Island Bay to Wellington rail station). We also propose a mass transit cable car solution for South and East Wellington that allows access to Wellington Airport and negates the need for major, planned improvements.

We estimated farebox revenue for the Island Bay to Wellington railway station line and, under Doppelmayr high level assumptions, we found the potential for a full farebox recovery or even a surplus. This is due to the lower operating costs of cable cars owing to features such as the near-autonomous operation of the systems.

Further details of Cable car investigations and the scan for New Zealand Opportunities

Three criteria were used to search for potential cable car routes in New Zealand; an initial screen using the Abley accessibility tool (to identify poor PT travel times compared to private car use), population density scans and looking at key known potential MRT routes.

A long listing process was undertaken whereby key cable car route features were scored +3/-3 in accordance with the Waka Kotahi EAST (Early Assessment Sifting Tool) protocol. A fatal flaw analysis was not carried out. The EAST sifting identified a short list of 10 cable car routes.

An economic assessment and VKT reduction estimate were used to inform two criteria of the EAST tool. The economic assessment was carried out at a high level to estimate an indicative BCR, enough calculations to distinguish between options. Economic viability was assessed by measuring estimated travel time savings for cable car routes and monetising these savings - according to Waka Kotahi Monetary Benefits and Cost Manual principles and values. Travel time reliability was also estimated at 80% of travel time savings. VKT reduction was also monetised as a proxy for network benefits of a cable car intervention. We also calculated VKT reduction in million km to illustrate what contribution cable car configurations could make to a regional VKT targets.

Evidence for demand along cable car routes was found from Tom Tom data embedded in the Abley Accessibility tool. For cable car route connecting to airports, demand estimates around airport precincts

were made by allocating a percentage of airport precinct employees and passenger traffic to the cable car route (these were deduced from various evidence sources such as MRT business case documents). Please note that these are very high-level estimations as generally only the point-to-point connection has been considered, instead of an integrated public transport network.

The short list of 10 options from the EAST tool was established and included Auckland, Tauranga, Christchurch, Wellington, and Queenstown.

Abley has made recommendations for future work including a full economic assessment of some of the short-listed options and to create a full carbon life cycle estimate for a cable car mode. General conclusions of the study include:

- Cable cars offer direct connection that can overcome many geographical challenges and can be inserted into a dense, urban environment with limited environmental impacts.
- From a transport project evaluation standpoint, travel time saving benefits are amplified by the significant increase in public transport reliability (relative to other modes).
- Capital cost of construction compares favourably against other public transport modes owing to the low sqm of construction area – meaning lower land take and construction material quantities.
- Environmental benefits are significant through the multiple factors that contribute to reducing CO2e against other transport modes Aside from the electrically powered nature of cable cars, they also have a much lower environmental impact such as soil sealing (i.e. lower per sq. metre land take requirement compared to other modes such as Light Rail).
- Op ex could potentially be very significantly lower and more predictable than bus rapid transit options. This could be a key distinguishing factor as an MRT option.
- Cable cars should work as part of an integrated public transport network to maximise its benefits. It is the integration and network that shapes the attractivity and ridership numbers.

Abley recommends further investigation of all these key findings.

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Introduction to Cable Cars (Part C): Urban Cable Car Opportunities in New Zealand

Quality Assurance Information

Prepared for	Doppelmayr
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1. Introduction

Doppelmayr New Zealand commissioned Abley to identify possible locations in New Zealand where an urban cable car operation may support regional or local transport outcomes.

This report should be read in conjunction with Abley report Introduction to Cable Cars which considers the nature and operation of cable cars for public transport outcomes.

Cable cars are, in general, still an under-utilised mode when it comes to their suitability as a public transport mode. Research has shown that they can be an effective and feasible way to provide a high-capacity mass transit solution without many of the challenges associated with road and/or rail-based operations.

Urban cable cars have significant flexibility in how they operate ranging from small systems, designed to carry just a few hundred people per hour, to larger systems carrying up to 8,000 passengers per hour. Their modular construction also means they may be suitable for small distances, such as crossing physical barriers such as waterways or valleys through to longer routes providing additional high capacity in congested networks. This flexibility means that there are many locations through New Zealand where they may be appropriate.

There are several benefits of cable car public transport routes over other Mass Rapid Transit options:

1. Environmental – their life cycle environmental impacts, construction through to operation, are significantly less than other forms road-based transport and/or infrastructure solutions such as new roads or bridges.
2. Feasibility & Constructability – with small operational footprints required by stations and towers, urban cable cars are comparatively easy to build compared to BRT and LRT.
3. Cost differential with other MRT – the current cost of cable car routes is$25 - $40m per km and these compare very favourably to key MRT options being considered currently in New Zealand (such as Auckland Light Rail last reported cost of around $600m per km and a project value of $1.4bn for a second Mount Victoria tunnel in Wellington).
4. The time span of construction (at 1-2 years) is much faster than the multi-year projects (5-8 years) referred to in (3) above.

This assessment of potential locations across New Zealand has identified several opportunities, set out in this report. It is not meant to be an exhaustive list, but to demonstrate the variety of situations where a cable car may provide a key service. This report also considers cable car alternatives to projects such as the MRT projects in (3) above.

This is Part C of a three-part analysis which looks at specific opportunities where cable cars may be appropriate. Part A provides a general introduction to cable cars and Part considers B how cable cars may be suitable as public transport service offering.

2. Identification of Potential Opportunities

A five-stage methodology was undertaken to identify potential opportunities for consideration.

1. Due to the initial capital cost associated with urban cable cars a higher-than-average population density, or key trip generator, is recommended to ensure sufficient demand. Figure 2.1 illustrates where the population density may exceed 1,500 people per sqkm. As can be seen this highlight the recognised tier 1 metropolitan areas of Auckland, Hamilton, Tauranga, Wellington & Christchurch, with isolated pockets of high density in other areas such as Whangarei, Rotorua, Palmerston North, Dunedin, and Invercargill.

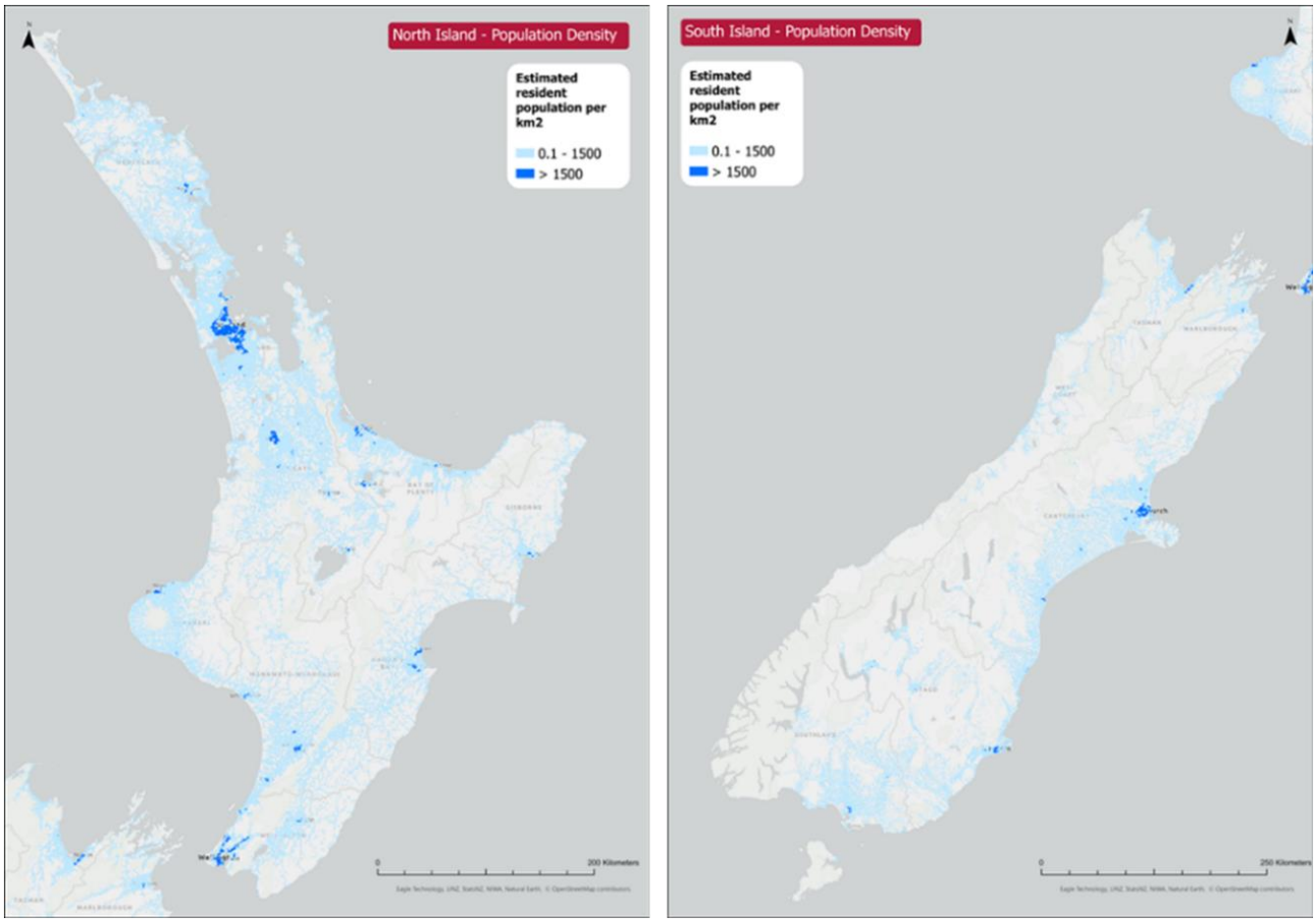


Figure 2.1 New Zealand Population Density

2. There are a range of variables that people consider when selecting their preferred mode of travel such as the available modes, journey distances, travel time, parking availability and costs e.g., petrol, parking, or fare prices. From a public transport perspective, two factors are particularly important: overall journey time and travel time reliability.
3. Using a modified accessibility analysis[1], we identified areas where travel times by existing public transport services were significantly longer compared to private vehicle trips, to destinations

[1] For the purposes of this initial assessment, travel times were calculated from the central point of the StatsNZ SA1 unit for each area to the nearest train or bus station. A nominal 8am Friday departure was selected to reflect a commuter journey and includes consideration of the walk time to the nearest bus stop as well as any wait time required before the next bus trip departs and the journey time. Public transport service times were extracted from the GTFS data service with car travel times estimated using Tom Tom's Multinet-R Driving network which provides robust estimates of driving time, speed limits, and congestion into account.

such as transport hubs (train or bus stations) or central business districts. Figure 2.2 shows an area of south Auckland where the assessed travel time by public transport, from StatsNZ SA1 units was between 10 and 20 minutes longer than the equivalent private car trip. The figure also shows how differing areas of population density may be affected.

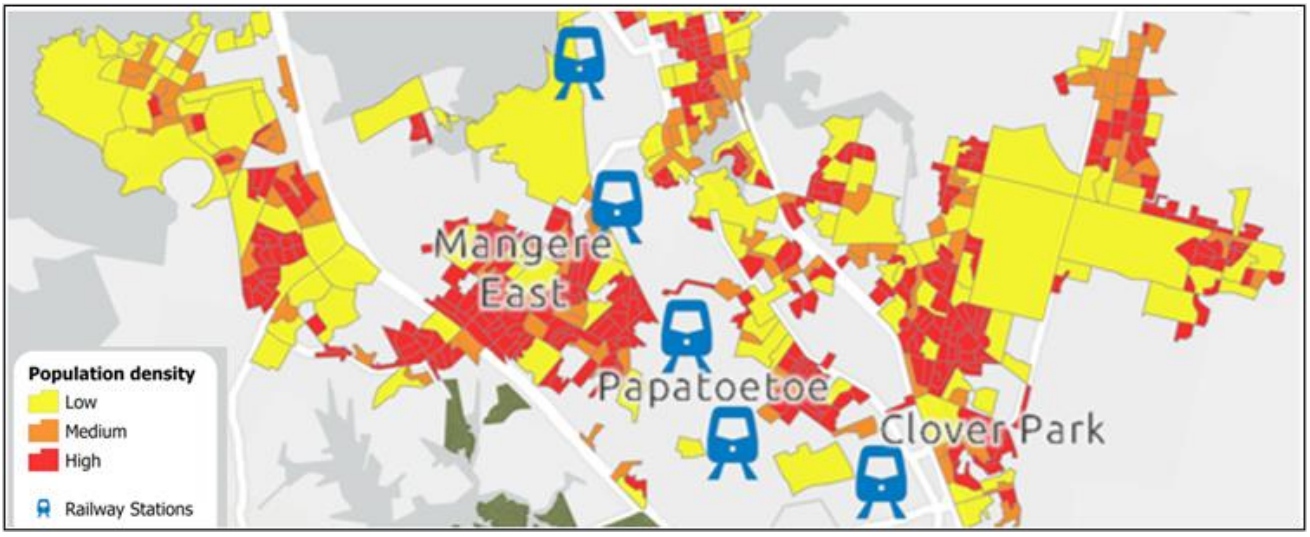
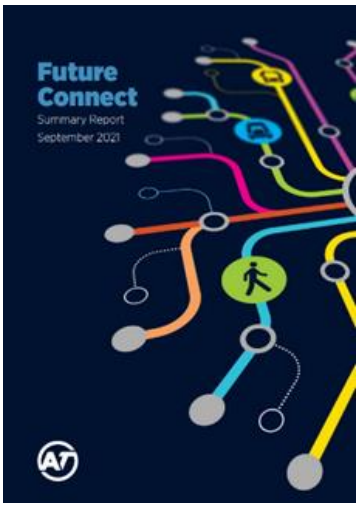


Figure 2.2 Density and Travel Time

4. The patronage potential of different areas was then assessed using the journey to work and journey to education as recorded by StatsNZ. Where applicable, this may also be augmented with trip generation related to key attractions such as airports.
5. Where statistical population or trip generation numbers are not available, i.e., in new development areas, an estimate of the final development density per sq km was used to create a demand scenario based on potential mode share and travel options.
6. Urban cable cars may provide immediate transport solutions to the challenges being faced in urban areas where bottlenecks exist or may be well-placed to mitigate future networks constraints. A high-level review of relevant transport strategy documents has also been used to identify potential locations for consideration. This includes an assessment of the economic efficiency of the cable car options in comparison to business cases that have evaluated routes for MRT or other solutions. We also assess the relative, approximate costs of cable cars to other public transport options.

3. Auckland

Auckland is New Zealand's largest urban area encompassing the metropolitan area, smaller towns, rural areas, and the islands of the Hauraki Gulf. Auckland is the heart of the North Island economy and is growing rapidly. Historically the city's growth has been managed by converting rural areas of discontinuous topography and waterways into low-density urban environments creating a car dependent transport system of urban sprawl, without intervention, total vehicle kilometres travelled (VKT) is expected to increase in line with population. The rising population and increased VKT is going to increase the pressure on the transport system.



Future Connect

Future Connect is Auckland Transport's network plan that identifies the Strategic Networks and the network's most critical issues and opportunities over the next 10 years through Deficiency and Opportunity Mapping. As Auckland's population is expected to almost double over the next two decades, it is critical that the city's transport network is planned strategically to ensure the efficient flow of people and goods.

To understand the parts of Auckland that would benefit the most from a cable car system, Auckland Transport's planning tool 'Future Connect' was used, identifying areas that indicate key deficiencies pertaining to safety, travel choices, access, and environmental problems see Figure 3.1.

The following have been identified as key challenges for Auckland:

- Access to the city centre provides employment and social opportunities. The immediate surrounding suburban areas will have the greatest access, however underlying land use and network performance contribute to equity differences between suburbs that should have an equal level of access. Although investment in transport projects has resulted in major improvements, deficiencies across all modes remain and access to quality public transport for lower socio-economic areas is comparatively low.
- A lack of competitive travel options is limiting Auckland's ability to solve issues of high car dependency. There is a need for more frequent and faster public transport options to be competitive with private vehicle use, the future connect aspiration for public transport services is for a minimum frequency of 20 minutes across an 18-hour period.
- The transport sector is the biggest contributor to Auckland's Greenhouse Gas emissions with 50% coming from private and light commercial vehicles. Auckland Council has declared a climate emergency with a plan to reduce transport emissions by 64% by 2030. Mode shift through improved transport choices has been identified as a crucial tool in reducing emissions and creating resilience in the transport system.
- Directly and indirectly transportation contributes to negative health outcomes for Aucklanders. Death and serious injury due to crashes and chronic health issues related to inactivity and pollution is exacerbated by a car dependent transport system. Auckland Transport and its partners have adopted a vision zero policy that concludes that no death or serious injury is acceptable in our transport system.

Cable cars as a form of public transport can potentially revolutionise mobility across the Auckland region, addressing several of the challenges outlined by Future Connect.

- Elevated infrastructure can bypass ground level congestion, geographical obstacles and densely populated urban areas reducing travel times and traffic congestion.
- The modular nature of cable cars allows for scalability and flexibility into areas of need to provide equity of opportunity across the growing region.

- Comparatively low environmental impact being electrically powered if renewable energy sources are utilised.
- Offering several safety benefits including reduced expo sure and likelihood of crashes through complete separation of patrons from other road users, safe start, and end of journey transitions for pedestrians and improved air quality.

Figure 3.1 Future Connect (Source: Auckland Transport)

While there are significant opportunities within the Auckland region, additional consideration was given to areas where current public transport service levels may be considered lacking. Figure 3.2 shows the shows an analysis where public transport connection times to the nearest railway or busway station, is between 10mins and 20mins longer than the comparative car journey. In determining their mode of choice, most individuals assess the total travel time on a 'door to door' basis. Where the travel time is significantly greater by public transport, it is recognised that people will choose to travel by car. The

map also shows relative population density. For example, in the highlighted Manurewa area, this is a relatively high-density population area whose access to the Manurewa or Te Mahia train stations by public transport is significantly less attractive than by private car.

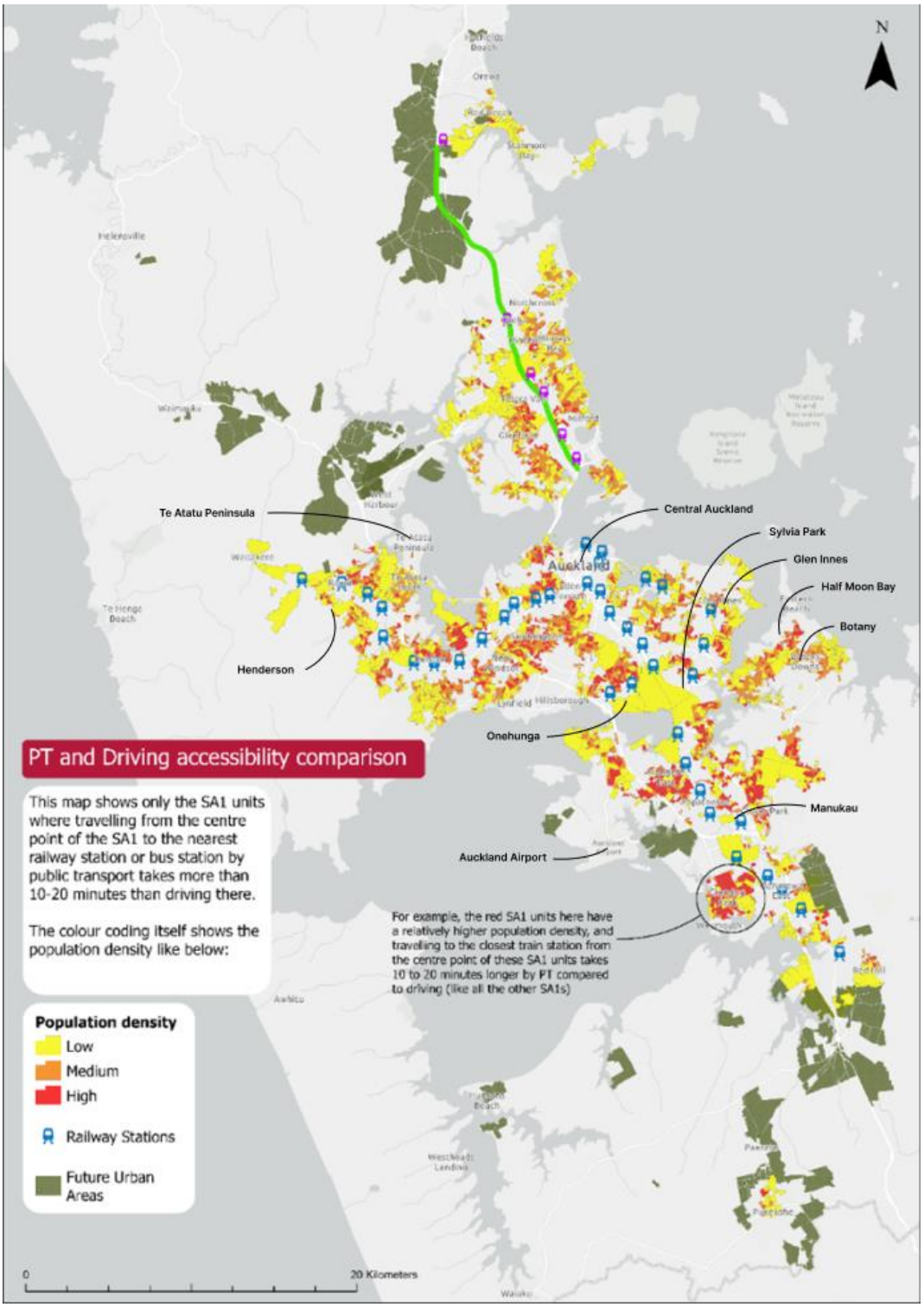


Figure 3.2 Public Transport Accessibility Assessment

Figure 3.2 shows the Public Transport Accessibility Assessment Five areas for consideration that have been identified through the accessibility tool and using Abley's knowledge of Auckland:

1. Auckland Airport to:
    - Manukau and Botany
    - Onehunga and Central Auckland
2. Sylvia Park to Botany
3. Half Moon Bay to Glen Innes
4. Te Atatu Peninsula to Henderson
5. Development Areas
    - Albany to Silverdale
    - Massey to Silverdale
    - Papakura – Drury West
    - 6. Airport to Botany

3.1 Auckland Airport

As noted in Part A, urban cable cars can be utilised in a variety of ways, such as bridging connectivity gaps, network extensions or congestion relief. Implicit is also that due to their completely segregated travel corridor, like heavy rail lines, they have a consistent travel speed as they are not affected by congestion or network delays. This can make them particularly suitable where high-volume people movements may be expected, and a high level of service is required such as to and from airports. Currently the only way to get to the airport if not travelling by private car or shuttle/taxi are public airport bus services that depart from Puhinui Station, Manukau Bus Station and Onehunga (locations are in South Auckland), or SkyDrive which is a non-AT operated bus service that connects the airport to the CBD.

All trips' movements were determined using TomTom vehicle movement data and are shown Figure 3.3. This shows the predominant origin – destination for Airport related trips being to central Auckland with a secondary area of focus being Manukau/ Papatoetoe/ Wiri.

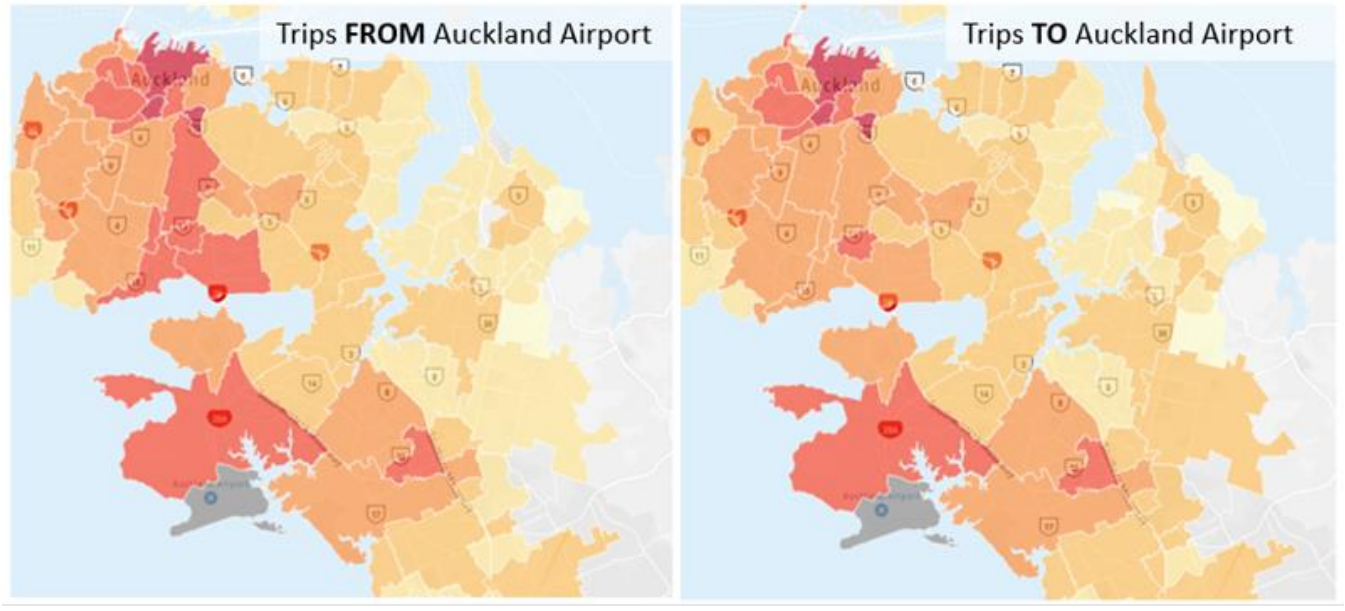


Figure 3.3 Origin - Destination Movements - Auckland Airport

Auckland Airport – Manukau

As shown in Figure 3.1, Auckland Transport has identified the Airport – Manukau connection as a priority deficiency/ opportunity. While this route is currently serviced by the Airport Link bus service connecting the airport with Puhinui train station and Manukau, it can experience significant delays due to network congestion which impacts on service reliability.

Figure 3.3 shows there is a high overall level of trip demand between these areas, including the strong employment connection between Manukau/ Papatoetoe/ Wiri as shown in Figure 3.4, which indicates over 2,400 return trips being made between the indicated regions. The central Manukau area also has strong trip generators such as Westfield Manukau, Manukau Institute of Technology, AUT South campus and Rainbow's End.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 2,484 commuter trips per day and over 11,000 total trip s(including airport demand) daily between the SA2 areas highlighted in Figure 3.4 as shown in Table 3.1.

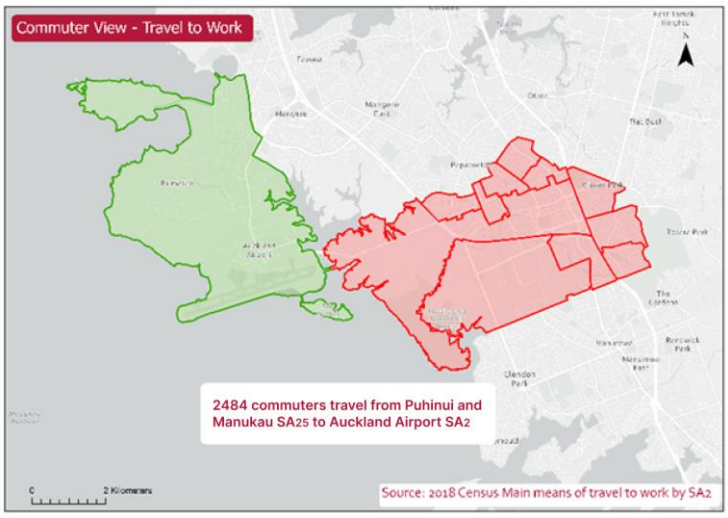


Figure 3.4 Auckland Airport - Journey to Work

Table 3.1 Auckland Airport - Manukau; Trips & Travel times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
11,267	24	27	22

Using a simplified cost-benefit assessment, such as a cable car service would provide:

Table 3.2 Auckland Airport – Manukau: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
8.2km	918	50	410	2.4

The fast connection via State Highway 20B/ SH20 to Manukau means that private car travel times are faster than public transport and the cable car option. Whilst more direct (8.2km vs 10.2km for car travel), these difference in travel time means we expect a lower mode share compared to other airport access options. However, there are still considerable VKT reduction benefits, and we still expect reasonable mode shift if a cable car was installed.

Auckland Airport-Onehunga and Onehunga to Auckland CBD

The Auckland airport to Onehunga and onto the central city is a priority connection as a key commuter and traveller route, with a significant residential population serviced along the corridor. It has been identified in the Future Connect programme as a first ranked deficiency/opportunity area and is being considered under the Auckland Light Rail project. While the need for an improved public transport link has been well recognised, if a road-based solution, with PT priority scheme is implemented, it is

expected to cause significant network disruption during the build phase as well as network displacement when operational due to the reduced on-road space available for other modes. An elevated cable car system would have significant feasibility and could be operational in much reduced timeframe with related cost savings.

Onehunga is situated on the edge of the Manukau Harbour 9 km from the airport and CBD with a strong industrial and commercial area. The Onehunga area has many trips generators such as the Dress Smart shopping centre, Waikaraka Park, Onehunga High School, One Tree Hill College, and Marcellin College with a collective role of approximately 3,000 students and sits adjacent to Mount Smart Stadium, a major outdoor stadium with a capacity of 25,000.

Table 3.3 and 3.4 show the estimated trip demand and travel time savings that may be realised by a cable car compared to the current public transport system. With the total estimated daily trips exceeding 15,000, there is significant potential to provide an attractive public transport connection.

These tables show that although the car provides a good option for travel time, a lack of time competitive public transport options means that existing public transport is not adding value to the Onehunga community. A cable car option nearly halves the time of the same journey on a bus would take and is within a realistic journey time that may encourage the community to take public transport over a private vehicle.

Table 3.3 Auckland Airport to Onehunga: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) and airport passenger traffic	Car	Public Transport (Bus)	Cable Car
15,696	33	44	26

Table 3.4 Auckland Airport - Onehunga: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
9.0 km	1,048	52	468	2.4

Table 3.5 Onehunga to Auckland CBD: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
9,960	28	54	23

Table 3.6 Onehunga to Auckland CBD: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
8.4 km	1,008	50	420	2.6[2]

[2] see section 9 (b) and the discussion section 11 for assumptions and sensitivities. No account was taken of land take for the cable car stations but the per km estimates do include basic station costs and supports every 150 -250m

Airport to Onehunga is a key airport transfer route with knock-on demand on Onehunga to Auckland CBD route. Passenger demand was estimated from gross passenger numbers through the airport with an assigned percentage of airport traffic using these routes via cable car and a number of other gross assumptions. 21.1m passengers use Auckland Airport annually (source: June 2023 Auckland Airport Monthly Traffic Update)[3]. For the purposes of the benefits calculation, we assumed a mode share of 20% of airport trips would be taken by cable car.

For Onehunga to CBD, we have simulated a route from Onehunga Mall to Britomart station, approximately 8.4km in length. For this model (where we are trying to emulate an inner route where access costs would be higher) we use an assumption of $50m per km construction costs and access demand based upon commuting and the last leg of the Auckland airport journey into the CBD. This reveals an estimate of economic efficiency for broad comparison with other MRT options such as the proposed Auckland Light Rail system. There are many points of comparison but in terms of economic efficiency and the impact on the environment, it is our view that a cable car shows superior characteristics.

Manukau to Botany

As identified in the Future Connect study, Auckland Transport is also considering the deficiencies in service between Manukau and Botany via Te Irirangi Drive. A Manukau to Botany connection via Te Irirangi Drive will be a significant connection between East and South Auckland, as Te Irirangi Drive is a key arterial that connects several large, fast-growing suburbs (Flat Bush, Mission Heights, Dannemora and East Tamaki) to nearby Botany Town Centre, Ormiston Town Centre, and Manukau City Centre. A cable car link would provide faster and more efficient access to multiple sports centres, parks, schools, a university campus, an events centre and theme park, and a large Buddhist Temple that is both a community centre and tourist attraction.

Its inclusion as part of the optioneering analysis is to demonstrate how an initial connection, such as Auckland Airport to Manukau, could be the first stage of a larger network of service. As shown in Table 3.7 it would reduce the average public transport travel time by over 50%, making it a faster and reliable service.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 1,300 daily trips made in, and between the Manukau and Botany areas. Airport demand boosts this to more than 5,700 trips per day as shown in Table 3.7.

Table 3.7 Manukau to Botany: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
5,723	22	39	22

Table 3.8 Manukau to Botany: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
9.2 km	412	40	368	1.2

[3] https://storage.googleapis.com/hccproduction-web-assets/public/Uploads/Documents/Content-Documents/Your-City/Economic-Development/Economic_Development_Insight_-_Traffic_Aug22_V3-5_web.pdf

3.2 Sylvia Park to Botany

Sylvia Park is New Zealand's largest shopping mall and business park located 10km southeast of the city centre. It is in the industrial area of Mount Wellington and is surrounded by several residential suburbs. The area serves as a key connection between South and East Auckland, located adjacent to two major interchanges of the Southern Motorway and is accessible by both the Southern and Eastern rail lines. Sylvia Park is a major source of employment for the area, with nearly 3,000 staff employed at the centre alone.

A cable car link between Sylvia Park and Botany would connect two economically important areas and provide a more efficient point of access between East and South-Central Auckland. It can also act as an alternative to a train, which is important as East Auckland is currently only accessible by bus and private vehicle from Sylvia Park. This would also ease congestion in the Pakuranga area, which experiences a daily bottle neck as the closest access point to cross the Tamaki River and enter the central isthmus. As shown in Table 3.9, a cable car would provide a travel time saving of 27mins compared to bus and 3mins faster than personal car travel and there is a change in distance of 4.2km between the 6.9km for cable car length as shown in Table 3.10 and driving distance of 11.1km, making it a competitive travel option for residents, employees, and visitors.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are only 876 daily trips made in, and between the Sylvia Park and Botany areas as shown in Table 3.9 Table 3.8.

Table 3.9 Sylvia Park to Botany: Trips and Travel Times

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
4032	16	48	17

Table 3.10 Sylvia Park to Botany: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
6.9km	197	40	276	0.8

3.3 Airport to Botany

Airport to Botany (A2B) is a key strategic corridor for Auckland public transport development and the subject of a 2021 Single Stage Business Case. It is yet to be funded by Waka Kotahi and Auckland Transport. It is a corridor of strategic significance because of the airport access (for worker commuting and passenger demand) but also as a part of the other PT developments in East Auckland in order to lift the low PT patronage rates. Airport to Botany is a very important strategic corridor for PT as it adds to substantial investments in rail and the Eastern Busway,

Cable car development in East Auckland has a strategic advantage over new infrastructure as the East has developed so fast that the existing roads are at capacity, and it is hard to put in new bus lanes without incurring huge costs. The A2B SSBC has an estimated BCR of 3X but is dated 2021 and we suspect that cost escalation would materially reduce the actual economic benefits to cost efficiency.

There is another benefit of cable cars that is illustrated with A2B. A2B is proposed as dedicated busway with significant roadworks envisaged for the dedicated busway options. Aside from the road widening

not being necessary for a cable car option, the proposed route requires a significant route diversion to get around Manukau City Centre.

Abley has modelled a potential A2B cable car option with gross assumption of 10% of airport passenger demand using the corridor to access Puhinui Station or Manukau, and 10% of commuting demand into/out of the airport precinct. We also measured an indicative route length of 15.1km compared to the proposed separated busway length of 18.2 km. The cable car option can go direct across the terrain north of the estuary to access north Manukau and go on to Botany for a shorter journey length. We believe the land take cost could be significantly lower than working alongside the road reserve proposed for the proposed A2B busway. Abley is also of the view that the is a risk proposed BRT would have a detrimental effect on private car travel time along this key route; the advantage of the proposed cable car route is that it would reduce network congestion.

We note the proposed 15.1km would be a long cable car route, however, this compares to the La Paz cable car network of 31km. Whilst not directly comparable (as the La Paz network comprises of 10 different routes), it shows that cable cars can be adapted to create solutions for long routes. A fatal flaw analysis and concept design would be the next step to confirm the feasibility of A2B.

Figure 3.5 Airport to Botany proposed busway design, A2B SSBC, 2021

Table 3.11 Airport to Botany: Trips and Travel Times

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW & JTE) Return and airport passenger demand	Car	Public Transport (Bus)	Cable Car
11,100	53	56	42

Table 3.12 Airport to Botany: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
15.1km	1,555	60	906	1.8

Please note that our indicative BCR estimate does not evaluate all the benefits evaluated in the A2B SSBC. We also do not have the cost estimates for A2B to make any comparison with the 2021 busway options.

3.4 Half Moon Bay to Glen Innes

Half Moon Bay is a residential suburb situated at the bottom of the Bucklands Beach Peninsula with a strong commuter base of students and professionals. Its relative isolation means that residents travelling to the CBD by public transport must make 3-4 transfers on buses and trains or use a ferry service that has limited operation outside of peak hours.

Glen Innes lies almost directly opposite to Half Moon Bay across the Tamaki River and is one of the closest train stations at 10km away. It has many trip generators such as a large industrial area, five schools, and is host to multiple cultural events throughout the year. A cable car would cut this journey down to 4km by bridging the Tamaki River. It would provide a direct link to Auckland's rail network, while significantly reducing travel time and congestion to and from the peninsula. Journeys from the Half Moon Bay, whether by road or ferry, are often subject to delays as a result of weather and traffic conditions. Increasing transport resiliency and reliability would be a key benefit of a cable car option. A more competitive journey time and reduced transfers may also encourage residents to use public transport over a private vehicle, which is often the preferred mode of travel.

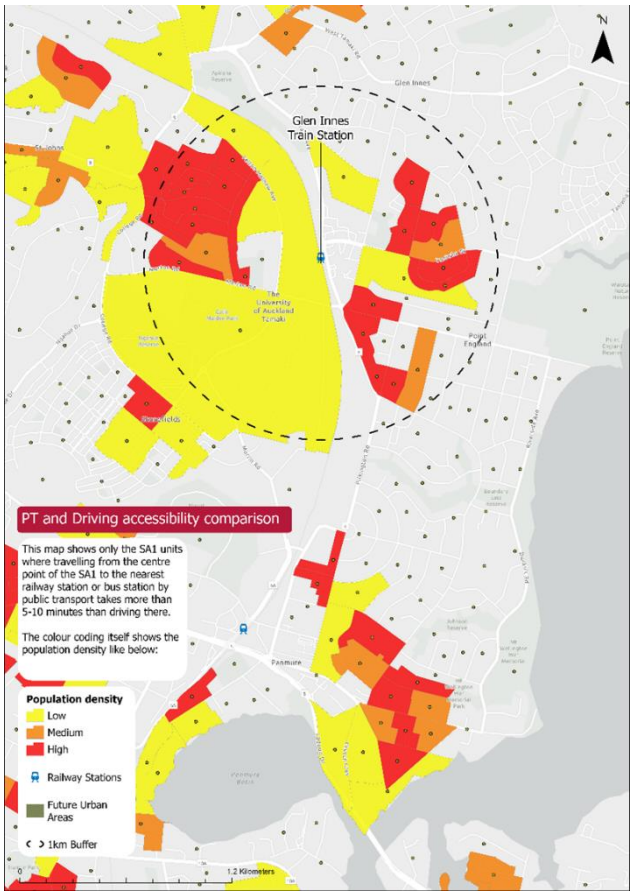


Figure 3.6 Glen Innes Accessibility

Glen Innes station also has identified accessibility issues from nearby areas as shown in Figure 3.6, due to limited crossings associated with the railway line. This could provide an additional opportunity for a cable car to provide greater accessibility to areas west or south of the station.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are around 2,180 daily trips made in, and between Half Moon Bay and Glen Innes areas as shown in Table 3.13. This is unlikely to be representative of demand in the event a cable car solution was put in place – as the surrounding area (Eastern Beach, Howick, Mellons Bay and Half-moon Bay have a population of over 25,000. We estimate at least 2,000 trips per day would be closer to the demand profile for this cable car route.

The problem with a Half Moon Bay cable car route would be the roads connections into the Bay - with only limited 2-lane collector road access, and limited parking on arrival. There is also a competing ferry service. However, the large catchment in East Auckland warrants further investigation. Some 140,000 people live in the greater Howick area with low public transport penetration. This is part of the thesis for the Eastern Busway that is now beginning construction. A connection from East Auckland into Glen Innes (for onwards commuting into the CBD) has potential that should be investigated – given the low PT penetration rates in the East. In our economic analysis, we assumed an additional 1,000 commuters accessing Half Moon Bay from the surrounding area; but this is only because of the bottleneck at Half Moon Bay. A different route with park and ride facilities could transform this into a high-volume route. Therefore, there is potential to explore other cable car options with a view accessing East Auckland. This work would need to take place alongside the expansion of the PT capacity as a result of the Eastern Busway – that is now under construction (Botany to Panmure).

Table 3.13 Half Moon Bay to Glen Innes: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
2,180	25	39	11

Table 3.14 Half Moon Bay to Glen Innes: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
4.0 km	70	50	200	0.4

3.5 Te Atatu to Henderson

The Te Atatu Peninsula has been identified as a deficient area by Future Connect. With only one main access road and an increasing population from its brownfield developments, commuting residents face worsening congestion and travel times in the future. A lack of bus lanes means that travel by car is approximately three times faster than taking the bus. This results in an unattractive PT offering which encourages residents to travel by car- even for short trips.

The Te Atatu Peninsula presents an opportunity for cable cars to provide a competitive transit solution to move people from the peninsula to the Henderson area as shown in Figure 3.7. Such a link would connect residents to nearby workplaces and amenities, such as Sturges Road or Henderson train station and other destinations along the Western Line, Waitakere Hospital, Trusts Arena, food and retail centres, and numerous schools. It would also be possible to provide access to the North-Western busway for connection into the Auckland CBD.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 4,000 daily trips made in, and between Te Atatu and Henderson areas highlighted in Figure 3.7 as shown in Table 3.15. However, there will be a considerable number of CBD commuters for the community of 13,000 residents in Te Atatu and connecting on to the new Northwestern busway (we estimate 1500 per day).

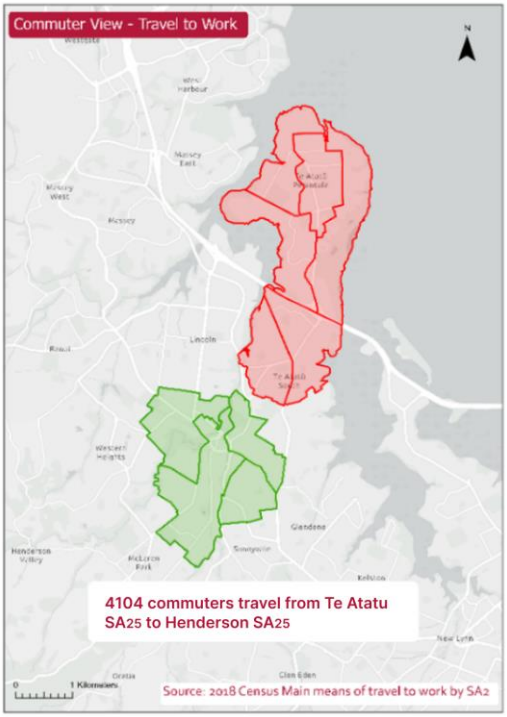


Figure 3.7 Te Atatu – Henderson – Journey to Work

Table 3.15 Te Atatu to Henderson: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
4,104	16	35	11

Table 3.16 Te Atatu to Henderson: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
4.3km	110	40	172	0.7

3.6 Development Areas

Albany to Silverdale

North Auckland has been recognised through Future Connect as a Strategic Network with Albany to Silverdale identified as a deficient area. Key connections for North Auckland such as State Highway 1 and Dairy Flat Highway are identified as the preferred strategic transport network.

An increasing population with further developments through areas of land zoned for housing, commuting residents face worsening congestion and travel times. The Silverdale West Dairy Flat Industrial Area Structure Plan is transforming the Silverdale West and Dairy Flat area into an urbanised industrial area.

With rapid growth on Auckland's North and plans to intensify urban and industrial areas, public transport that meet Future Connects framework between Albany and Silverdale are required. The Albany station is the most northern major station that links to the high frequency busway and its stations, connecting the North to Central Auckland. This could provide an additional opportunity for a cable car to provide greater accessibility and transport choices for residents between Silverdale and Albany.

The preferred option for the North Auckland Supporting Growth business case is a Rapid Transit corridor (most likely with Bus priority) along Postmans Road through Dairy Flat and connecting to Silverdale and the burgeoning Millwater/ Milldale developments. A direct connection from Albany to Silverdale would unfeasible along this route and a direct route would be along the State Highway 1 – and would mean comparing motorway speeds of 100 kmh with a cable car speed of 25kmh (unless an aerial tram option with speeds up to 48 kmh was considered). This would not compare well from a travel time perspective. We note a direct connection to Silverdale from Albany would be significantly lower cost than a dedicated busway which would mean crossing several streams, and therefore would be a prohibitive cost.

Massey Campus to Albany

Future Connect identified Massey Campus to Albany Station as a deficient area.

An increasing population with further developments through areas of land zoned for housing, commuting residents face worsening congestion and travel times. Massey Campus is in Albany which is a key transport hub to greater Auckland. The Campus has grown rapidly as both domestic and international student numbers increased.

With rapid growth and intensification of Albany public transport that meet Future Connects framework between Massey Campus and Albany is required. The Albany station is the most northern major station that links to the high frequency busway and its stations, connecting the North to Central Auckland. This could provide an additional opportunity for a cable car to provide greater accessibility and transport choices for students and employees between Albany Station and Massey Campus.

Whilst this potential route provides greater accessibility to Massey Campus for connecting to the Northern Busway, the existing 4-lane arterials network are below capacity and travel times by private vehicle or buses of 4 min off-peak compared to cable car travel time of at least 6 minutes. Therefore, any cable car configuration is unlikely to compete with the average connection speed of 40kmh by these other modes.

Papakura to Drury West

Future Connect identified Papakura to Drury as a top ranked deficiency and opportunity for public transport. Drury is also identified as a focus area for an integrated (all modes) network.

Papakura is a large southern suburb with a population of approximately 30,000 connected to Drury via the southern line of the Auckland rail network. A fast-growing population has meant an increase in new residential and business areas, all helping make Papakura a vibrant metropolitan centre. The Drury – Opāheke Structure Plan 2019 (the structure plan) shows how over 30 years it is estimated to provide about 22,000 houses and about 12,000 jobs.

The Papakura to Drury West link presents an opportunity for cable cars to provide a competitive transit solution to move people between these areas, there is significant public transport potential. Such a link would connect residents to workplace opportunities and amenities, such as Massey Park and Pool,

Hawkins Theatre, Papakura Art Gallery, Papakura Museum, Papakura Leisure Centre, Bruce Pulman Park, and numerous schools.

Papakura has a population density of 2677 per km2 (fitting our criteria for cable car deployment) but Drury West is a much more sparsely populated (c. 156 per km2) and is a future urban development area. However, at the moment, this is not deemed to be worth investigating further at this stage – as an existing rail line from Papakura to Drury exists. An in-fill station at Drury West would probably be lower cost and also have a lower travel time than a cable car option. Therefore, it was not investigated further for inclusion on the long list.

4. Tauranga

Tauranga to Bayfair to Mount Maunganui

Tauranga is a harbourside city in the Bay of Plenty Region. A bridge over the harbour connects Tauranga to Mount Maunganui, a beach town host to the Tauranga Airport and Bayfair Shopping Centre. Tauranga over the New Year period attracts over 20,000 visitors to the coastal town, the existing infrastructure is not capable of meeting such levels of travel demand.

Tauranga is one of the fastest growth regions in New Zealand, with the population projected to double within 30'years. The guiding policy and strategy document, the Transport System Plan, aims to support a projected population of 258,000 residents and 34,000 new homes in Tauranga by 2050. This is expected to result in one million additional transport movements every day. Due to the geographical constraints in the area, particularly the many water bodies, opportunities for road-based network expansion are limited. Work is currently being undertaken on a Public Transport Services and Infrastructure business case that will set out a preferred public transport network structure for the next 30 years.

Figure 4.1 Tauranga PT Accessibility

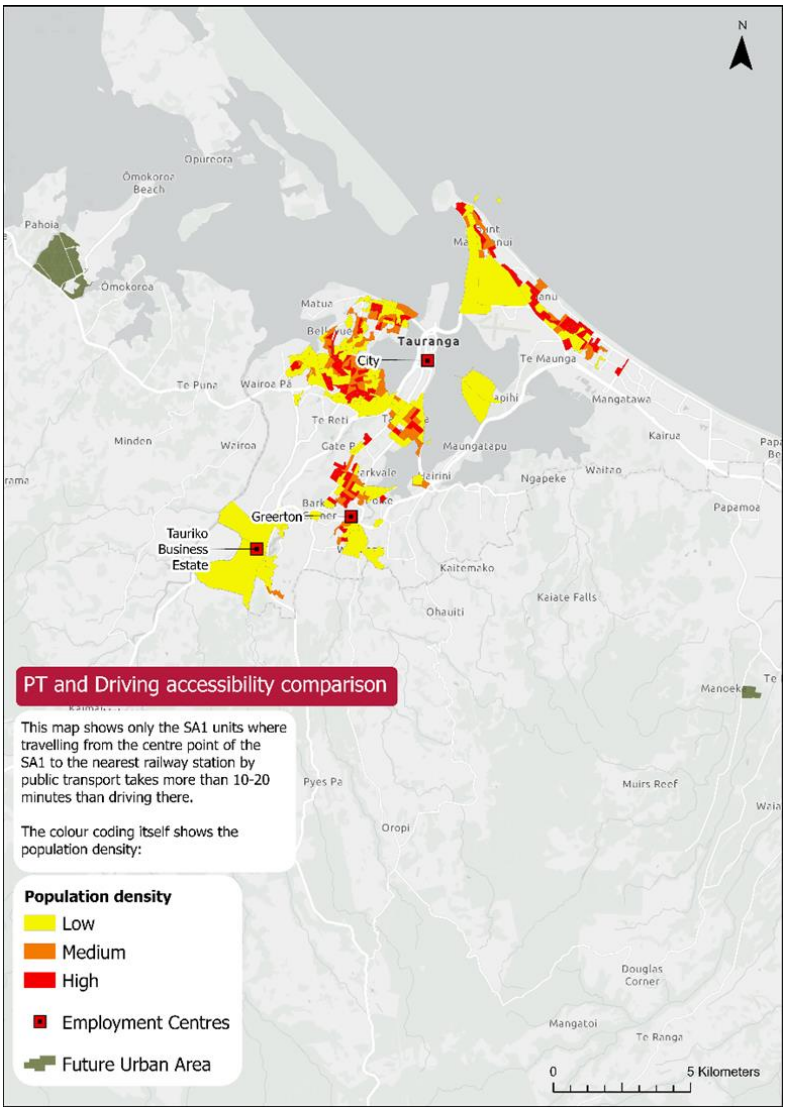


Figure 4.1 highlights some of the deficiencies in current public transport access to the Tauranga city centre area which is relatively poor with public transport journeys from the west, such as the Brookfield or Otumoetai area taking considerably longer than travel by private car. These journeys are approximately 5 kilometres by car, but less than half that if travelled by cable car.

Similarly, the Mount Maunganui – Arataki – Papamoa area, which is home to over 30,000 people, has significant public transport potential if travel times, which currently can exceed 45 minutes or longer were reduced from this area as shown in Figure 4.1.

The green-shaded areas on the map above show areas where travel to the CBD by public transport is less than 30 minutes into the CBD. Population centres such as Bayfair, Sandhurst and Papamoa therefore have limited public transport options into the CBD, and also a bottleneck at State Highway 2.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 2,200 daily trips made in, and between Tauranga and Bayfair areas as shown in Table 4.1.

Table 4.1 Tauranga – Bayfair – Mount Maunganui: Trips and Travel Times

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW & JTE) Ret.	Car	Public Transport (Bus)	Cable Car
2,232	22	24	14

Table 4.2 Tauranga – Bayfair – Mount Maunganui: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
5.3km	69	50	265	0.3

Tauranga is an interesting long list option as it has future demand and potential bottlenecks that can addressed with a cable car option. The bottleneck is the SH2/SH29A access between Mount Manganui and Tauranga. This can be relieved with a cable car solution that could then be extended to access the future growth areas in the Western Corridor around Tauriko.

5. Hamilton

Since 2017, Hamilton has experienced higher levels of population, GDP, and job growth than the national average. It's location as part of the 'Golden Triangle', where, along with its adjacent Auckland and Tauranga areas, has over 50% of New Zealand's population. This proximity has resulted in increasing demand for transport services as roading improvements, and new development areas has led to increasing sprawl and congestion. Hamilton City Council transport data shows that half of Hamilton's peak hour traffic (7am – 9am) is made up of commuters from outside the city.

There has also been a decentralisation of employment away from the central city area as commercial, industrial and logistics activity has increased at the Waikato Innovation Park and the Te Rapa Precinct. In late 2022, the Ruakura Inland Port was also opened where an expected 6,000 – 12,000 jobs are likely to be created over the next 10 years.

While overall population densities remain generally low, as shown in Figure 5.1, Hamilton City Council has been undertaking Plan Change 5 – Peacock Structure Plan which will see the re-zoning of approximately 700 hectares of land, within 5 kilometres of the city centre, rezoned from general residential and a special character zone, into a medium density residential zone. Once fully completed, this area is expected to house about 20,000 people.

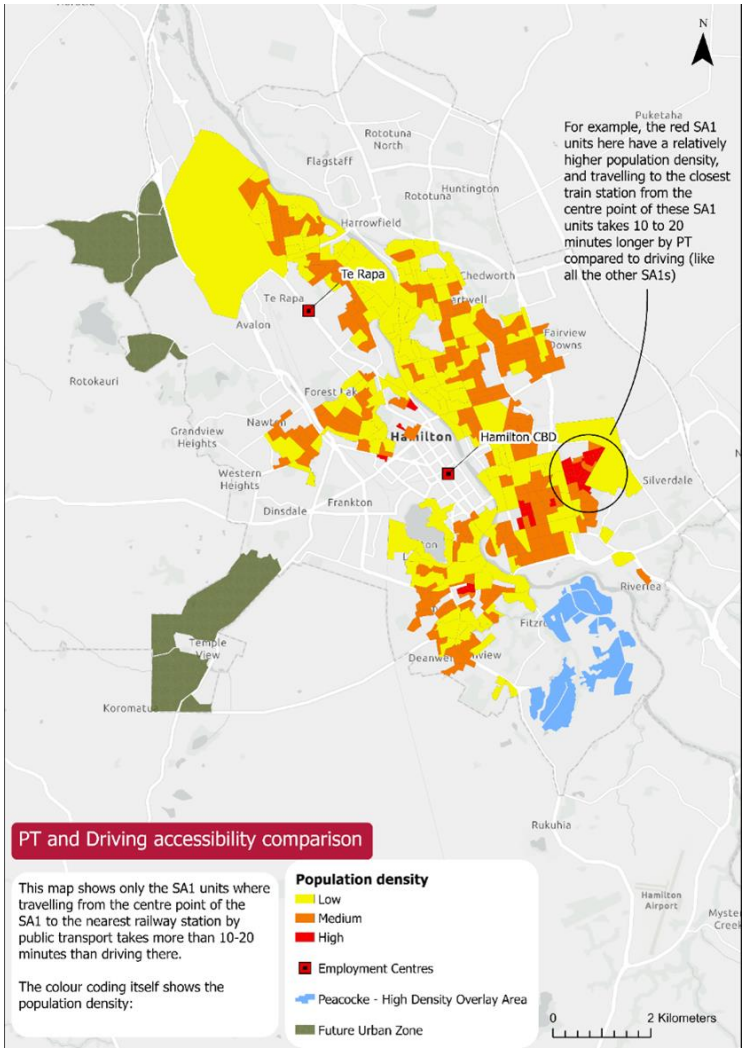


Figure 5.1 Hamilton Accessibility Assessment

As a development site, there is a lack of detailed information about how the area will develop but with its proximity to the central city area, the under-developed roading network and the limited crossings points on the Waikato River.

The Peacocke development has a structure plan and transport infrastructure intervention that is well advanced including the construction of a new bridge that will open in early 2024 – and future proofed for light rail. Therefore, a cable car route is very unlikely in the foreseeable future.

6. Wellington

Wellington Airport

Cable cars may be used in a variety of ways as discussed, making this travel mode particularly well suited for airport access where high-volume movements may be expected, and a high level of service is required.

All trip movements from and to Wellington Airport were determined using TomTom vehicle movement data and are shown Figure 6.1. This shows the predominant origin – destination for Airport related trips being to central Wellington.

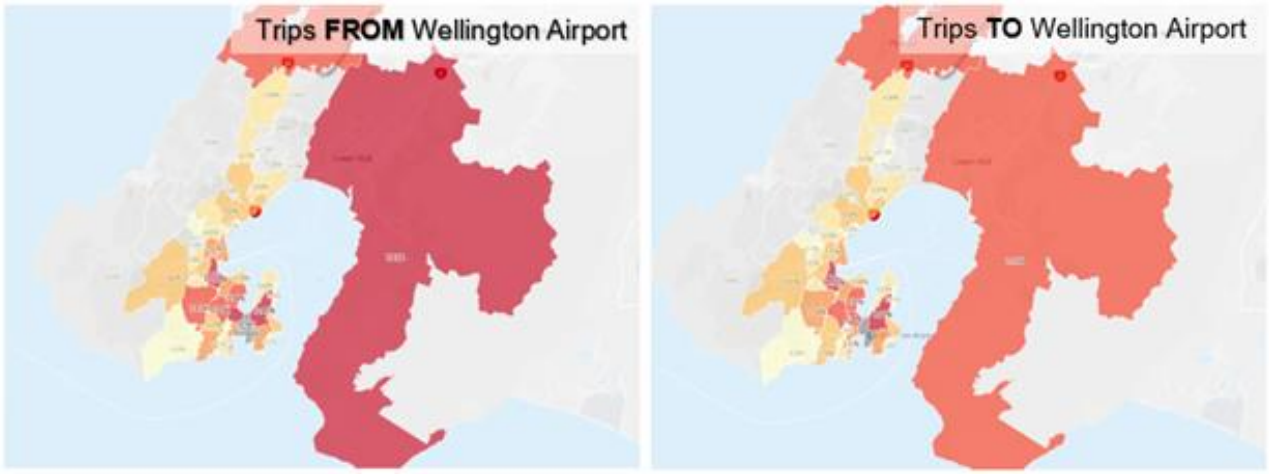


Figure 6.1 Origin – Destination Movement – Wellington Airport

Wellington Airport to CBD

The Wellington airport to the central city is a priority connection as a key commuter and traveller route, with a significant residential population serviced along the corridor. The Wellington Regional Land Transport Plan (RLTP) 2021 has three headline targets for the next ten years, 40% reduction in DSI deaths and serious injuries), 35% reduction in transport emissions and 40% increase in active and public transport mode share. While the need for an improved public transport link has been well recognised, a road-based scheme is expected to cause significant network disruption during the build phase as well as network displacement when operational due to the reduced on-road space available for other modes. An elevated cable car system would have significant feasibility and could be operational in much reduced timeframe.

A cable car option would compete on whole of life cost with alternatives such as a second Mount Victoria tunnel. The publicly available information on a second Mount Victoria tunnel suggests a cost of around $1.4b. This compares to a more reliable cable system of the order of $360m. In our very high-level cost estimate for a cable route for Wellington airport to CBD, we increased the cost to $60m per km (from an estimated range of $25-40m quoted by Doppelmayr) to allow for airport access to the Wellington terminal.

The position of the airport terminal means that a cable car system would have to run underneath the main runway (as it could not run above ground because it would cross the runway flight path). Doppelmayr believe this is feasible and we have allowed effectively an additional $100m in additional costs for airport access via an underground cable car terminal.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 5,800 daily trips made in, and between The Airport and CBD areas as shown in Table 6.1.

Table 6.1 Airport to CBD: Trips and Travel Times

Trip Movements	Estimated Travel Times (mins)		
Est. Trips (JTW &JTE) Ret and airport passenger traffic.	Car	Public Transport (Bus)	Cable Car
9,548	36	36	22

Table 6.2 Airport to CBD: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
7.0 km	663	60	420	1.7

In our economic analysis of the Wellington airport to CBD route, we have added additional demand from airport passengers (arriving and departing the airport) that (according to publicly available information about Wellington airport) currently amount to 5.5m per annum. In our modelling, we assume an immediate uptake of 25% of passenger demand from the new cable car route. In reality, it is our view, that over time, the uptake could be higher as the position of the airport on the western end of the Miramar peninsula means that a high proportion of airport traffic flows towards the CBD.

We also note the significant, positive network effects of the reduction in demand along SH1 at Evans Bay and the known bottlenecks at the two large roundabouts close to the airport. We have generated a proxy for network effects in our economic analysis by monetising VKT (Vehicles Kilometres Travelled) according to Waka Kotahi values for VKT reduction for new Public Transport initiatives (in the Monetary Benefits and Costs Manua, Table 9.2).

The full network effects are likely to be higher as congestion relief (from the cable car intervention) at the two roundabouts at Evans Bay would significantly improve bus throughput along a high-volume corridor for public transport commuting. Abley recommends further investigation of these network effects including regional 4-stage modelling to elucidate the full economic value of the proposed cable car network. In our view, it shows promise as it is tackling several issues along the CBD to Miramar corridor.

Any cable route from airport to CBD would need to traverse Mount Victoria. We understand there are significant resource consenting problems with crossing the town belt. However, if these could be overcome, then a potential additional revenue opportunity could be created – potentially by premium cable car fares for international tourists enjoying the spectacular views overhead Mount Victoria of Wellington City and Evans Bay. Abley recommends this is also analysed to elucidate the commercial opportunity alongside the commuting demand into the airport precinct.

Karori to CBD

The Wellington Regional Growth Framework identified a need for improvements for the west-east multi modal connection which would provide alternative transport modes and improved resilience.

Karori is located 4km to the west of Wellington CBD and is one of New Zealand's most populous suburbs with a population of approximately 15,000. Karori is home to Wellington's iconic parks and amenities, including Zealandia a protected nature reserve, Karori swimming pools, public library shopping centre with several schools and early childcare facilities.

Figure 6.2 Karori to CBD: Journey to Work

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 12,500 daily trips made in, and between Karori and CBD areas highlighted in Figure 6.2 as shown in Table 6.3.

Table 6.3 Karori to CBD: Trips and Travel Time

Trip Movements	Trip Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
12,540	20	33	8

Table 6.4 Karori to CBD: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
3.2 km	261.7	60	192	1.8

The length of the trip into the CBD is significantly reduced from 5.6km by car – to 3.2m by cable car.

Newlands to Johnsonville

Newlands is one of the northern suburbs of Wellington, New Zealand. It lies approximately 8.1 km north of the city centre and to the east of its nearest neighbour Johnsonville. The Wellington Regional Growth Framework includes a regional action plan to reduce greenhouse gas emissions and transition to a net-zero carbon and regeneration economy, with 40% of emissions in the Wellington region coming from transport a low emission public transport option, such as cable cars provides a unique opportunity to help reach its goal.

Newlands has several green spaces adjacent to the Wellington Harbour which attracts recreational activity. Johnsonville is home to Keith Spry Pool and Alex Moore Park as well as a large shopping Centre. Existing Metlink bus services connect Newlands with the nearby Johnsonville, where further transport options are available. A connection from Newlands to Johnsonville would also allow Newlands commuters to access the Johnsonville rail line for a connection to Wellington CBD.

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 3,000 daily trips made in, and between Newlands and Johnsonville areas as shown in Table 6.5 with a further 2,244 people travelling from this SA2 region into Wellington CBD (Figure 6.3).

In theory, this cable car route could connect commuters in Newlands to buses for State Highway 1 or to Johnsonville rail station – for the Johnsonville line into the CBD. However, the demand profile is not strong enough to justify even this short cable car route as cable car travel time is not significantly better than for the private car.

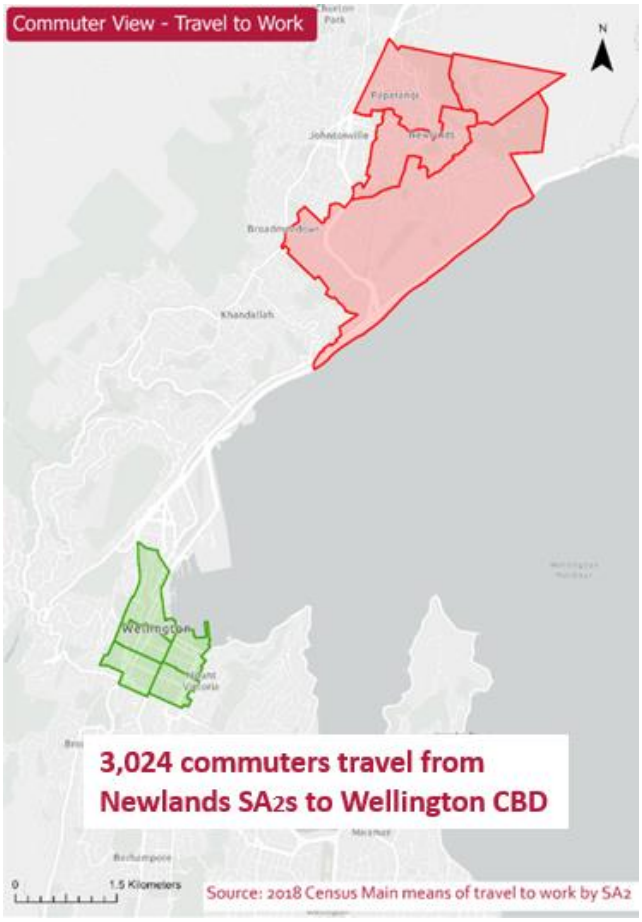


Figure 6.3 Newlands to Wellington CBD commuter demand

Table 6.5 Newlands to Johnsonville: Trips and Travel Time

Trip Movements	Trip Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
3,024	5	12	6

Table 6.6 Newlands to Johnsonville: BCR

Route Length (km)	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
2.0	58	40	80	0.8

Wainuiomata to Melling

The Wellington Regional Growth Framework identified Melling as part of the transport initiative to explore transport options including multi-modal options, station access and public transport service improvements alongside planning for greater intensification (in line with the National Policy Statement - Urban Development).

Wainuiomata is a large suburb in the Lower Hutt with a population of approximately 19,000, Melling is a suburb of Lower Hutt which is straddled by State Highway 2 and the Hutt River and is host to the Melling Station that connects Lower Hutt to Petone and Wellington CBD

An expanded analysis, using StatsNZ Journey to Work (JTW) and Journey to Education (JTE) data has indicated that there are over 9,800 daily trips made in, and between Wainuiomata and Melling/Hutt Valley areas highlighted in Figure 6.4 as shown in Table 6.7.

There are several routes that can be envisioned for the cross-valleys cable car solution. It could have stops at Waterloo Station and then go onto Queensgate/ Melling railway station (for connection on into the Wellington CBD). Alternatively, there are other combinations including accessing Alice town Station for Petone and The Esplanade.

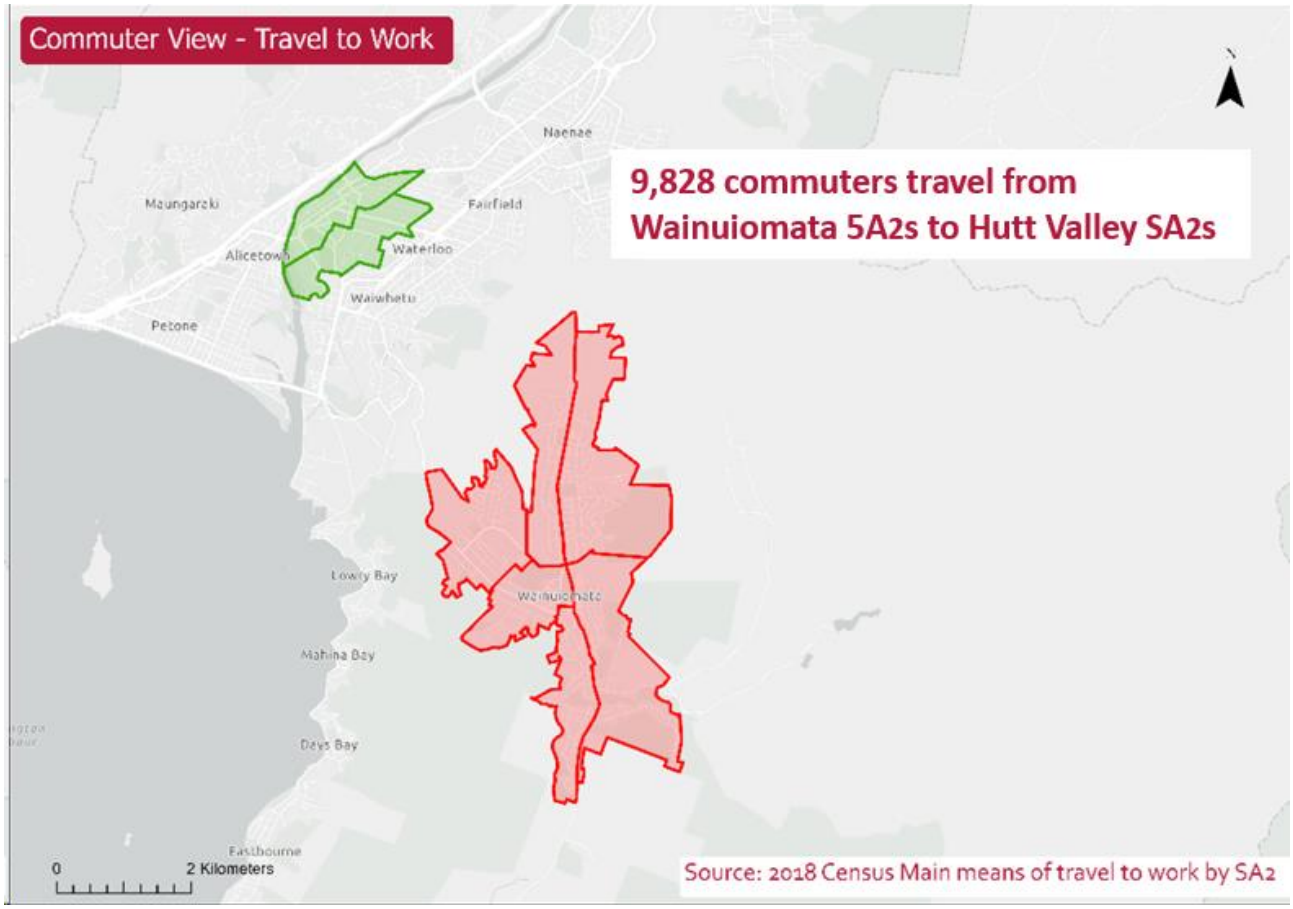


Figure 6.4 Wainuiomata – Melling – Journey to Work

This route shows potential as there are two additional factors to consider:

1. There is tourism potential as the cable car route would go over the Wainuiomata hills and could potentially offer access to the Mountain – and also tourism potential owing to the views over the Wellington Bay area and Somes Island
2. There are several potential routes connecting to the Hutt rail line as well as the Melling line. And offering a potential cable car station at Petone Esplanade.

This potential should boost the economic value of this cable car route.

Table 6.7 Wainuiomata to Melling: Trips and Travel Time

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
9,828	17	47	18

Table 6.8 Wainuiomata to Melling: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
6.8km	310	40	272	1.2

Island Bay to Pipitea (Wellington Rail Station)

The Let's Get Wellington Moving programme has identified[4] a possible MRT system to connect Wellington Railway Station with Wellington's Regional Hospital, Newtown, Island Bay, as well as Wellington International Airport and Miramar. This system aims to change the way people get around and through the city and promote new housing, urban development, and neighbourhood growth.

Figure 6.5 MRT Catchment zone for South and East Wellington

[4] source: https://lgwm.nz/all-projects/mass-rapid-transit/)

According to publicly available information, the indication is that a Light Rail solution is being considered from Wellington Railway Station, along the waterfront, through the central city and then along the southern corridor to Island Bay. For access to the East, bus priority options such as a Bus Rapid Transit system are being evaluated. In order to facilitate access to East Wellington, a second tunnel through Mount Victoria would be required.

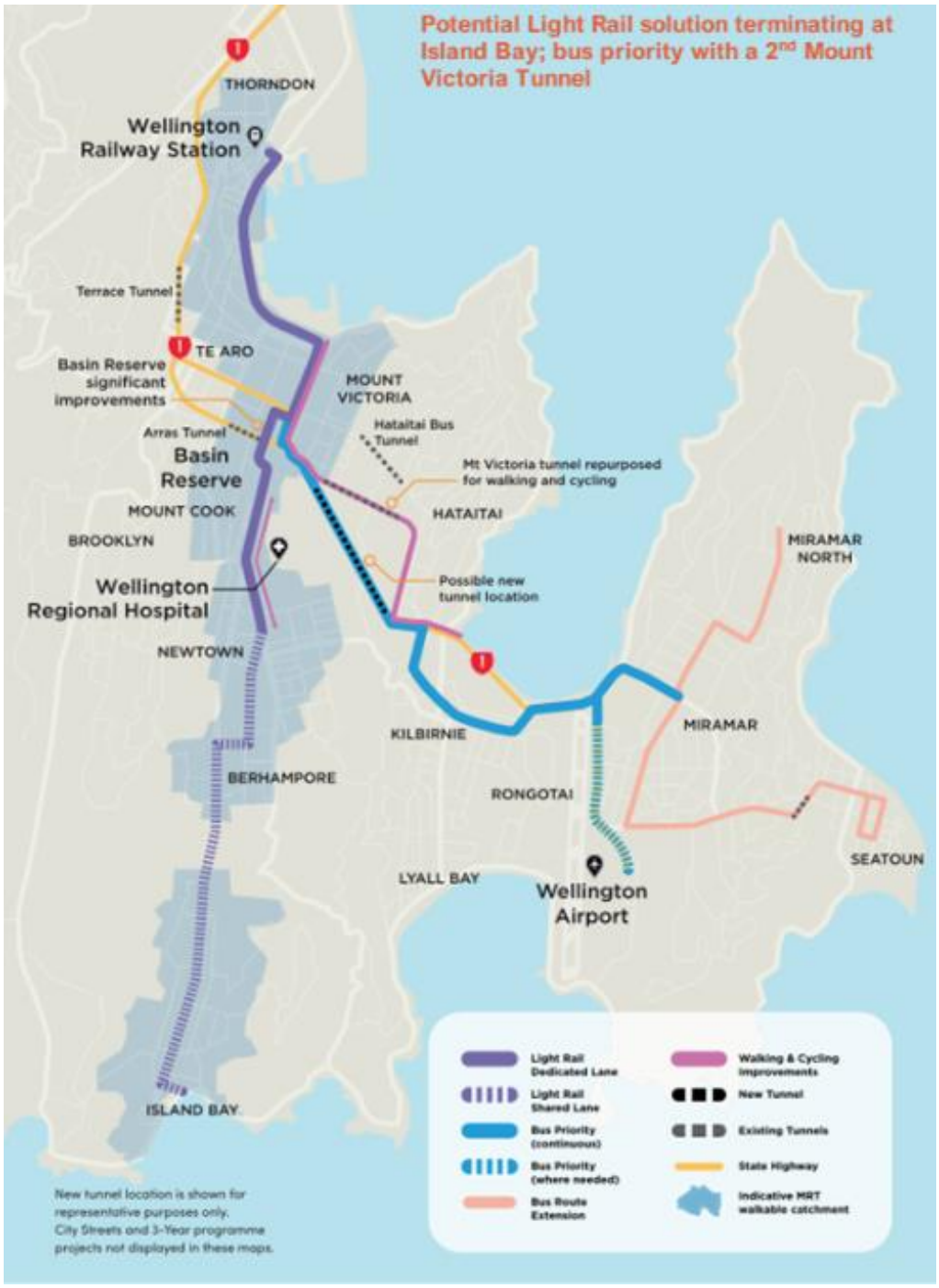


Figure 6.6 Potential Light Rail and bus priority options for southern and eastern Wellington access

A cable car alternative is possible along the proposed southern corridor to Island Bay.

Some key comparison between Light Rail and a cable car solution are shown below:

Table 6.9 Comparators against a light rail solution

Factor for MRT Vehicle	Light Rail Vehicle	Public Transport Cable Car
Capacity (pax per hour)	High: Up to 12,000 √√√	High: Up to 8,000 √√√
Vehicle passenger capacity	Up to 300 √√√	Up to 200 √√√
How does it share the road? Does it affect private vehicle trips?	• Runs on steel tracks XX • Cars can in theory share the LRT corridor but bikes cannot X • Requires light rail priority; negative effects on general traffic XX	• Cable car towers every 150-200m; not necessarily confined to the road reserve √√ • No cable car priority required; no negative effects on general traffic – but frees up capacity. More capacity for private vehicles and active modes √√√√
Does it work for Wellington topography?	• Expensive to access difficult terrain XXX • Large land take and disruption to road reserve XXXX	• Cable cars can scale Wellington terrain theoretically scale hills and other difficult terrain enabling more access options √√√ • Low land take compared to LRT with 4 -20 msq tower base for towers and limited impact in the road reserve √√√√
Does it encourage housing development?	Encourages development along the route. Several key international examples bear this out √√	We expect a similar housing development profile around the cable car stations. √√
Cost and time to install	Very expensive; >NZ$250m per km XXXX	NZ$40-60m per km across dense urban terrain; This includes some allowance for land take for the cable car stations X
Installation time and disruption	Construction period of 5 – 8 years; very significant disruption along the route with some buildings needing to be removed XX	Construction period of 1-2 years with less disruption provided 20m urban corridor width is available. √√
Environmental impact	• Electrically powered • Large excavation and construction impact • Mode shift from private car reduces emissions • Large scope 3 emission profile • Good recycling profile (92% recycling rate) √√√	• Electrically powered • Lower impact that LRT as much lower land area required • Similar mode shift characteristics to LRT • Medium scope 3 emission profile • Good recycling rates owing to metal construction materials √√√√√
Speed and travel time	Fast; estimate Island Bay to WGTN station travel time of 24 mins √ (but similar to car travel time)	Fast: cable car travel time of 25 min assuming 7 stops on the route √ (but similar to car travel time)

Benefits Rating Key:

√: Least beneficial impact - √√√√√: Most beneficial impact

X: Least negative impact - XXXXX: Most negative impact

Economic Profile of Island Bay to Pipitea

We estimated trip movements from SA2 data for JTE and JTW as per our point-to-point cable car evaluation methodology.

We estimated the benefits and costs for two potential cable car routes:

1. Island bay line: A replica of the proposed light rail route from the station, along the Quays, down Cambridge Terrace, Basin Reserve, Adelaide Road and terminating at The Parade in Island Bay.

The cable car stops would closely emulate our view of the likely light rail stops and catchments, our stops are around a 1km apart consistent with a typical cable car arrangement:

- Island Bay – Behrampore – Newtown – Basin Reserve – Cambridge Terrace- Te Papa -Jervois Quay-Pipetea for Wellington Station

2. Cable Car network: Island Bay line and additional Eastern line to Wellington Airport

Please refer to the Appendix B to this report for a fuller explanation of the options and the economic analysis of the Island Bay cable car lines.

The second configuration envisages using the Island Bay line plus a second cable car line extending East from the Basin Reserve cable car station to an airport access point slightly north of Wellington Airport. There would a fast shuttle service for airport access by commuters and airport passengers.

We give a detailed explanation of this line and its potential benefits profile in Appendix B.

- Eastern line cable car stops: Basin Reserve- Mount Victoria summit – Hataitai – Kilbirnie – Wellington Airport

Economic Results

A. Island Bay line

Table 6.10 Island Bay to Pipitea: Trips and Travel Time

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
24,518	24	42	20

Table 6.11 Island Bay to Pipitea: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
7.2 km	537	40	288	2.0

B. Southern and Eastern Access: Island Bay line with Eastern route to Airport (a second route from Basin Reserve to WGTN airport, see Appendix B)

Table 6.12 Island Bay to Pipitea PLUS airport access from Basin Reserve: BCR

Total Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
10.7 km	1,229	50	535	2.5

Farebox recovery rate for the Island Bay cable car line

Doppelmayr asked Ableyto estimate a farebox recovery rate based upon Wellington public transport zone fares. Under the Wellington fare structure, we estimate annual revenues of $4.43m per annum based upon current demand using a 3-point model. Demand estimates for Island Bay-Newtown – Wellington CBD from the Wellington Transport Strategic Model (WTSM) were used to make the estimate.

Under Doppelmayr assumption of operating expenditure of 1% of capital expenditure, we estimate a *surplus* of $1.6m per annum. This is a farebox recovery of around 150% compared to current public transport rates (in a post-Covid 19 environment) of significantly less than 50% in Wellington. The low operating costs of cable routes is derived from their energy efficiency and also the almost-autonomous nature of the cable car operations.

7. Christchurch

Greater Christchurch is the second largest metropolitan area in New Zealand and is projected to have a population of over 700,000 people in the next 25 years. With a relatively flat topography, the city and surrounding urban areas, have a low population density with relatively low levels of congestion. Figure 7.1 shows peak hour travel speeds from key locations into the city centre via private car and public transport. The figure also shows an approximate equivalent travel speed by cable car with key opportunities noted along the Riccarton to CBD and Papanui to CBD corridors.

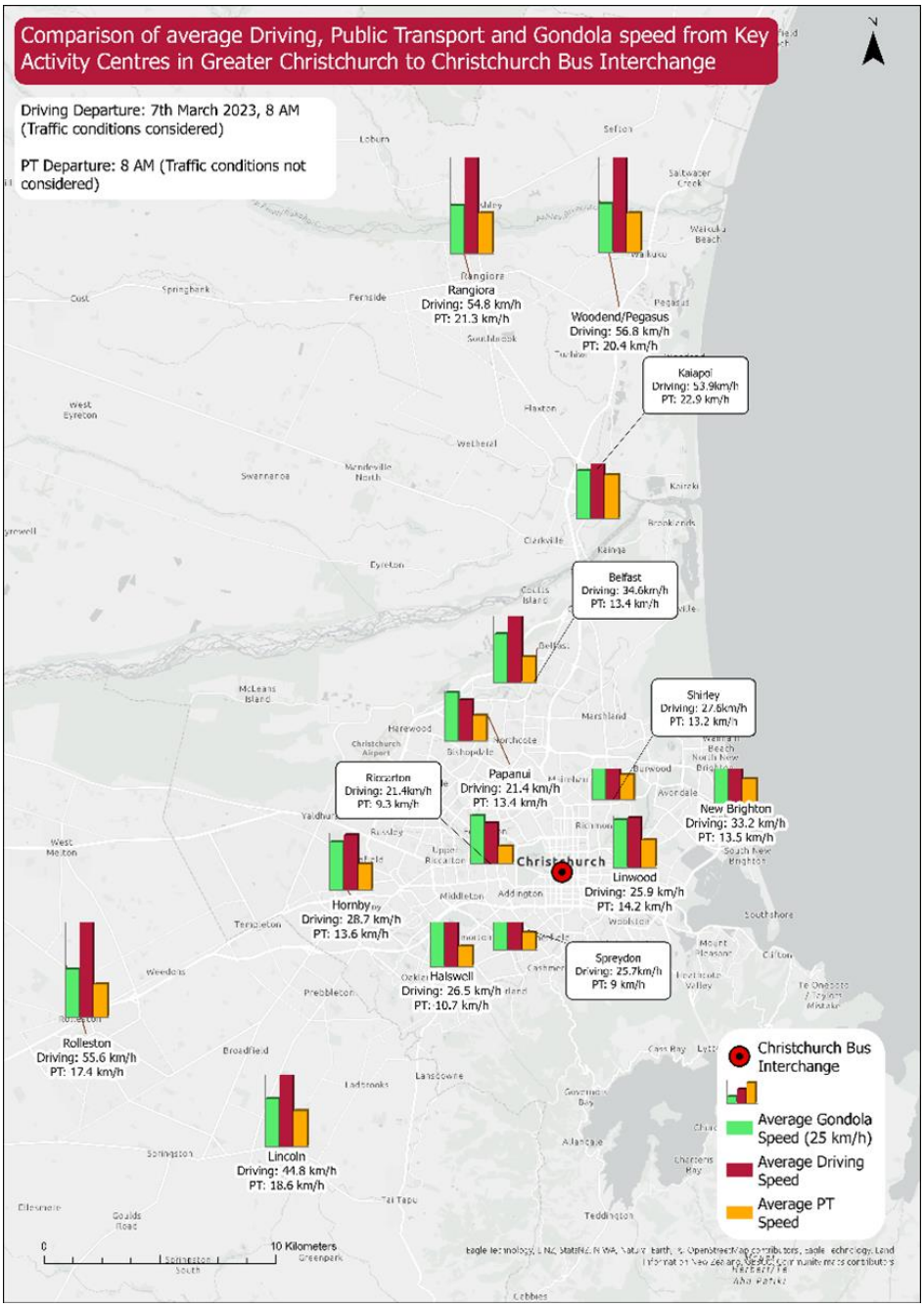


Figure 7.1 Christchurch Driving Times

The Riccarton and Papanui Road corridors, in addition to providing key access routes to the central city also connect a number of key attractions and workplaces.

- Papanui Road has two prominent shopping (Northlands Mall and Merivale Mall) as well as access to five high schools, private hospitals, and medical facilities.
- The Riccarton Road corridor, including consideration of the corridor from Hornby to Church Corner, has two regional attractors (The Hub and Westfield Riccarton), seven high schools, the University of Canterbury and Christchurch Public hospital.

Although this section of MRT was anticipated to have the highest demand, the model demonstrated that this route showed limited economic efficiency, therefore it was decided not to continue with CBD to Hornby leg of the Christchurch MRT.

7.1 Christchurch Mass Rapid Transit (MRT)

The future development of public transport in Christchurch has been guided by the PT Futures Programme which is aimed at increasing the mode share of the public transport network in Christchurch. The programme had two components focused on the short term, within 10 years, and a longer-term considering mass rapid transport (MRT) in Greater Christchurch. The short-term programme has entered its delivery phase and the MRT option, as shown in Figure 7.2, is being developed further.

The mode assessment process determined that light rail or a bi-articulated bus solution were the preferred options, however this would be refined in the detailed business case.

The proposed phasing will see the street running solution travelling between Church Corner in the west, the central bus interchange in the city centre and then north to Papanui. Future phases would see the service extended to Belfast in the north and Hornby in the west. The termini of the MRT route would be incorporated with interchange facilities to other bus or active travel modes.

Figure 7.2 Indicative MRT route and station location

Expected Outcomes

The IBC has estimated the following outcomes:

1. Increased intensification of 15,000 households and 54,000 additional jobs between 2021 and 2051 within the 800m of the station catchments
2. Reduce end-to-end public journey times which will improve household access to the Central City within 30mia via PT by 9%.
3. Increase daily patronage on the total network by 150% compared to the 2021 baseline and 19% more than that 2051 do-minimum.

Abley modelled only part of the Christchurch MRT route: Belfast to CBD because it offers the greatest public transport throughput potential and access to the Northlands shopping centre.

Table 7.1 Belfast to CBD: Trips and Travel Times

Trip Movements	Trip Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
5,628	28	32	23

Table 7.2 Belfast to CBD: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
9.1 km	183	40	364	0.5

Christchurch Airport

We have done some preliminary modelling in Christchurch airport to investigate its attractiveness. Christchurch airport has nearly 6m passenger throughput per annum and 7,000 employees in the airport precinct. A modelled route into the city centre (and possibly on to the new Te Kaha Stadium) measures 8.3km and would cost around $305.4m. We estimate a BCR of around 0.8. We envisage consenting and other technical difficulties with this route including airport access with the runway alignments, crossing Hagley Park to get into the CBD and avoiding the power lines. A fatal flaw analysis is required before further consideration should be given to this cable car route option.

Table 7.3 Christchurch Airport: Trips and Travel Times

Trip Movements	Trip Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
10,319	30	37	26

Table 7.4 Christchurch Airport: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
8.3km	444	40	332	1.5

8. Queenstown

The Queenstown area is one of New Zealand's fastest growing regions, driven by population growth, the tourism industry and supporting activities. This growth is placing increasing pressure on the infrastructure of the area and, in particular, the transport system. While the resident population is approximately 50,000, visitor numbers can increase this to over 100,000 people per day during peak holiday season. By 2035, it is estimated that the total day time population in Queenstown will exceed 160,000 people – all moving around in a compact area where the road network is heavily constrained.

As a result of this, Waka Kotahi NZ Transport Agency (Waka Kotahi), Queenstown Lakes District Council (QLDC) and Otago Regional Council (ORC) commissioned a business case to consider the transport challenges facing the area. The primary focus of this business case was around the development of options, particularly along SH6A (between Frankton and the Queenstown Town Centre).

The endorsed business case identified a High-Capacity Passenger Transport system that would progress from lower capacity single decker buses through to high-frequency and capacity options such as trackless trams or a cable car.

The cable car option was further assessed due to it providing good network resilience and travel time reliability with minimal construction impacts.

Due to network capacity issues, an off-road option, most likely to be a Cable car, was identified in the longer-term programme, but was not taken forward to the preferred programme as it was outside the next funding National Land Transport Programme[5] period. It was agreed however that any interchange locations would be future proofed by considering their ability to be serviced by a cable car.

Table 8.1 Queenstown: Trips and Travel Times

Trip Movements	Trip Travel Time (mins)		
Est. Trips Ret.	Car	Public Transport (Bus)	Cable Car
9,108	23	24	20

Table 8.2 Queenstown: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
7.8 km	316	40	312	1.1

Please note the following features of the potential Queenstown cable car intervention:

1. There are potential alternative routes to the main option – as additions or separate cable car lines – to the development at Jack's Point and Ladies Miles.
2. Queenstown offers tourism revenue potential owing to the surrounding scenario and popular domestic tourist destination. Queenstown offers limited international arrivals as well.

[5] The National Land Transport Programme (NLTP) sets out the Government's land transport funding expectations in three-year tranches. As the short – medium term (<10years) did not require the move to an off-road (Cable car) solution, it was not included for funding consideration.

We have modelled Queenstown based upon a 7.6km cable car route from airport to Frankton and then along the Lake Wakatipu front – allowing local resident commuting and also accounting for a mode share of 20% of arrivals transferring into Queenstown centre.

For Queenstown resident and visitors, the reliability of the cable car mode should offer additional utility for tourists. The Abley cable car model includes a factor for PT reliability that we think will be material for cable cars compared to other transport options in Queenstown and elsewhere.

9. Assessment of Opportunities

9.1 Economic Analysis

Economic benefits for the long list of NZ cable car opportunities were evaluated using a methodology akin to the methodology used to assess public transport options in a New Zealand government and local authority context. Benefits were estimated from a first principals basis using only the main relevant factors according to the New Zealand 2021 Monetary Cost and Benefits Manual (MBCM). The approximate estimates have a wide potential error as they are based upon significant assumptions without a firm evidence base – because New Zealand has no examples of comparable cable car interventions for the use cases and options explored. And the scope of our analysis (as agreed with Doppelmayr) only seeks a high-level analysis – and does not include a Willingness-to-Pay assessment, consultation, or surveys to support a pricing model. However, the economic analysis does allow to distinguish between certain options and draw conclusions about the strengths, weaknesses, opportunities, and threats of the options explored.

Evidence for a cable car intervention for long list options

Demand estimates were obtained for origin-destination pairs from the Stats New Zealand 2018 census data for work and education trips. Origin-destination pairs deemed attractive for long-listing were identified in the following ways:

Scans of New Zealand cities using the Abley Accessibility Tool (AAT) that searches for travel time differences between public transport (PT) and private vehicle (PV) use. Where PT travel times are significantly less than PV, there was deemed to be Level of Service gap for PT that could be potentially filled by a cable car connection. AAT scans were run for Travel Time gaps of 5, 10, 15, 20 min intervals.

An Abley estimate of breakeven economic viability for cable car connections based upon a certain population density – again this was assessed for travel time savings via cable car at intervals of 5, 10, 15 and 20 mins. This backed-up the opportunities spotted by the AAT and also provided a means to assess new developments that could be connected to the transport network via cable car.

Institutional knowledge by Abley public transport Subject Matter Experts (SME) - by way of comparing known public transport pinch points, or where Mass Rapid Transit (MRT) solutions were envisaged, with a cable car option. This comparison was made by a comparison of travel time savings and/or capital cost differentials.

Table 9.1 Population density required to justify cable Car Intervention

Change in TT (min)	Annual TT Savings ($/pop)	Population Density/sqkm
5	979	6953
10	1959	3476
15	2805	2422
20	3917	1734

Modelling approach

Abley developed a point-to-point model for evaluating the high-level economic performance of a cable car route; this means that demand on each half of the cable car route was measured to evaluate the transport benefits. This simple model was assumed to capture the demand profile along the route making the most of readily available sources of data (i.e. journey-to-work, journey-to-education and pools of known potential demand at certain sites such as airport precincts and shopping centres). This model does not account for the full demand created by the inter-route cable car stops. However, where a cable car route was extensive (e.g. Airport to Botany, Wellington Airport to CBD), travel time delay at cable car stops was included (1 min travel time increase per cable car stop). The overall approach is considered to be high-level producing an economic "snapshot" of the cable car route - enough to evaluate an indicative BCR measure for the purpose of prioritising the cable car routes and add to a long- and short-listing process. The approach should be conservative as it will not account for inter-route demand and also does not evaluate network effects – that could be considerable around busy airports and other heavily-congested areas being considered for cable car interventions. The use of 2018 data is approximately consistent with post-covid demand levels for public transport.

At the next stage of evaluation, Abley recommends that network modelling using at least meso-simulation level analysis, if not a full 4-stage regional model for evaluation – supported by a full mode shift assessment of demand for the new cable car system.

Economic Assessment

Economic benefits were estimated using changes in travel time and monetised value of time estimates from All Users values in $/hr/person in Table 14 of the Waka Kotahi MBCM. The demand estimates were based upon traffic counts by Tom Tom at 8am Friday (AM peak).

Travel time reliability was considered to be an important addition – as cable cars offer very reliable, regular, and predictable pick-up and journey times. Under MBCM, these are monetised as a reduction in travel time variability (measured as the std deviation of travel time). This would be very significant for cable cars nearly doubling the initial travel time benefits. For the purposes of this analysis, an 80% uplift in benefits was assumed to account for the improved reliability.

The Abley cable car model measures point-to point demand for a cable car route based upon SA2 area within an 800m of the theoretical cable car stations. We adjust the length of the cable car route (for the purposes of the cable car economic assessment) to the centres of the estimated demand with the 800m catchment (800m is a known viable access distance for MRT solutions). The approach allows a high-level assessment of the economic benefits of the cable car route that can be compared to a per km cable car costs. For the longer cable car routes, we added station stop travel time at 1 min per stop.

Costs were estimated at $30m per km for crossing normal terrain after discussion with Doppelmayr. This was increased to $40m per km for an inner-urban environment or if the proposed cable car route crossed water or another geographical feature. We used $60m per km for Wellington City to Airport to account for the additional costs of a proposed underground cable car station – to access the Wellington Airport terminal building.

Do Minimum

The Do Minimum is a Do Nothing and uses the SA2 mode share data from the 2018 census. We use the mode share data to estimate an average travel time for each route that is then subtracted from the cable car travel time to get a potential travel time saving.

Other assumptions:

- Discount rate of 4% and a 40-year evaluation period.
- An initial mode share assumption of 20% of total commuter trips is assumed as the cable car would attract considerable ridership for commuting. Airport passenger mode share assumptions

were made on the basis of the position of the airport and varied between 10 -25%. This was based upon analogy with other international airport mass transit market shares.

- Mode share between private vehicles and public transport were obtained from 2018 census data. This influenced the economic calculation through evaluating travel time against all modes relative to cable car performance.
- Cable car capital costs were assumed to be $30m/km for most of the cable car routes with $40m for difficult, urban environments and over-water crossings. No opex was accounted for.
- Growth of 2% per annum in demand.
- Environmental benefits were measured as a reduction Vehicle Kilometres Travelled (VKT) against private vehicle travel and monetised as per MBCM as a contribution to network effects.
- Cable average speed of 25 kmh-1 and cable car stop time at stations of 1min. We note that a tri-cable system can reach 30kmh-1.
- No other benefits were accounted for, we comment on this below in our Discussion section.

Table 9.2 First cut economic assessment and VKT reduction estimates.

Link	$M Benefit Total	Notional Cable Car Length (km)	Capital Costs ($ million)	BCR	VKT (million km reduction)
Auckland Airport - Onehunga	1,047	9.0	468	2.4	52.2
Onehunga - CBD	1,007	8.4	386	2.6	52.8
Auckland Airport - Botany	1,586	15.1	906	1.8	110.2
Half Moon Bay – Glen Innes	70.0	4.0	200	0.4	25.0
Te Atatu - Henderson	110	4.3	172	0.7	26.6
Manukau - Botany	457	9.2	368	1.3	30.4
Slyvia Park - Botany	197	6.9	276	0.8	37.4
Tauranga – Bayfair- Mt Maunganui	69	5.3	243.8	0.2	21.1
Wellington Airport - CBD	663	7.0	420	1.7	32.5
Karori – Wellington CBD	313	3.2	192	1.8	51.5
Newlands - Johnsonville	58	2.0	80	0.8	6.4
Wainuiomata - Melling	310	6.8	272	1.2	113.5
Christchurch MRT	183	9.1	364	0.5	63.3
Christchurch Airport	243.3	8.3	305.4	0.8	83.5
Queenstown	320	7.8	312	1.1	82.7
Island Bay to WGTN Rail Station	537	7.2	288	2.0	86.4
Island Bay to WGTN Rail Station + airport access	1,229	10.7	535	2.5	165.2

9.2 Multi-Criteria Analysis – EAST Tool

The Long List of potential opportunities was assessed using the sifting tool recommended by Waka Kotahi – Early Assessment Sifting Tool (EAST) which is a simple multi-criterion analysis table for eliminating fatally-flawed options and providing basic data to begin a short-list selection procedure.

The following criteria were used to score the different options in a range of +3 to -3:

- Improved access (travel time and reliability, essentially the economic analysis criteria. BCR >2 = +3, BCR 1-2 scores +2, BCR <1 scores +1. Vice versa for negative BCRs.
- Activate PT patronage (mode shift from private car use) in urban environment.
- Substitution proposed MRT solution with lower cost proposition.
- Solve Special situation (e.g., City to airport, geographical obstacle, reduce cost).
- Potential Tourism benefits.
- Minimise environmental impact, a subjective measure based upon the analysts view of environmental factors, VKT reduction, and overall amenity.
- Strategic alignment to regional plans / priorities.

Consent ability and constructability were not assessed given the early / strategic nature of the optioneering analysis.

The EAST assessment of potential opportunities is shown overleaf in Figure 9.1 Long List of cable car options from Ableys process

	Alternative or option details			Investment objective							
	Name of alternative/option	Unique identifier	Description of alternative/option	Improve Access (travel time and reliability; based upon BCR)	Activate PT patronage (mode shift from private car use) in urban environment	Substitute proposed MRT solution with lower cost proposition	Solve Special situation (e.g. City to Airport, geographical obstacle, reduce cost)	Tourism	Minimise environmental impact	Consentability	EAST Score
1	WGTN Airport to Rail	City to Airport: Wellington	Gondola connection from WGTN airport to WGTN Central rail staion. Stops at Kilbernie-Hataitai-Basin Reserve-lambton Quay- Beehive- Wellington Central	2	3	3	3	3	3	-2	15
2	HMB link to CBD	Auckland: Activate Auckland Eastern bays for PT	HMB to Glen Innes rail station	1	2	1	3	1	1	-3	6
3	Auckland airport to south auckland (Onehunga and connection to LRT)	Onehunga to Airport: Auckland	Access to airport precinct for employees; tourist connection onto LRT that terminates at Onehunga under this option	3	2	3	2	1	2	-1	12
4	Maraetai to Waiheke Island	Tourism: Auckland	Bay views and wine trail access; alternative to Waiheke island ferries	0	0	0	2	3	-1	2	6
5	Christchurch shopping centre access/ northern MRT substitute	Christchurch:Belfast/ Northlands to CBD	Connect CBD to Northlands shopping centre	1	2	3	0	0	2	-2	6
6	Manakau to Botany	City to Airport: Auckland 3	Airport to Botany: alternative to proposed MRT option	2	3	3	1	2	3	-1	13
7	Cross valleys connection	East-West link: Wellington	Link towns with geographcial obstacles to WGTN rail. Wainuiomato - Melling - Petone (Esplanade) - Grenada	2	2	2	3	1	3	2	13
8	Sylvia Park to Botany	Shopping Centre link: Auckland	Link Sylvia Park shopping Mall to Botany downs shopping centre and bus hub (and Eastern Busway)	1	2	3	1	1	2	-1	9
9	Tauranga CBD to Bayfair	CBD - shopping centre: Tauranga	Link Bayfair to Tauranga CBD across waterway	1	2	0	2	1	1	-2	5
10	Newlands to Johnsonville	Link suburbs: WGTN	Link Newlands to Johsonville line for CBD: alternative to SH1	1	2	0	1	0	0	-1	3
11	Karori to WGTN CBD	Link suburbs: WGTN	Link very large suburb to WGTN CBD	2	3	0	2	0	1	-1	7
12	Te Atatu to Henderson	Link suburbs: Auckland	Cross town link from Te Atatu peninsula to Henderson town centre	1	2	1	2	0	2	-2	6
13	ChCh MRT route	Substitute MRT: Christchurch	CBD - Belfast (possible 2 cable car routes)	2	2	3	0	0	2	0	9
14	ChCh airport to CBD	City to Airport: ChCh	ChCh aiport - Burnside - Fendalton - Hagley Park - CBD - Te Kaha	1	3	0	0	3	2	-2	7
15	Tauranga airport to CBD/ Western growth areas	City to Airport:Tauranga	Tauranga airprot access from CBD and on into the western growth areas of Tauranga	-	3	0	1	2	0	-2	2
16	Albany to Silverdale	Extend Northern Busway	Extend MRT from Albany at a fraction of the cost of a separated busway	-1/0	3	3	-1/0	0	2	0	8
17	Papakura/ Drury West to Drury	South Auckland Access	Alternative to Pukekohe Electrified rail route and the planned new rail stations.	-1/0	2	1	-1/0	0	1	1	5
18	Peacock Development to Hamilton CBD	Access Hamilton from periphery	Future, low carbon connection from a satellite development to Hamilton CBD	1	2	1	1	0	2	1	8
19	Massey University to Albany	Improve access to Place of Interest	Connect Massey University to Albany bus station	0	1	0	1	0	1	-1	2
20	Airport to Botany BRT route	Alternative to proposed 2021 SSBC BRT solution	Airport access from Botany and centres on the way including Sylvia Park, Manakau, Puhunui Station.	2	3	3	2	1	3	2	16
21	Island Bay to Wellington Rail Station	Light rail alternative	Appraise Cable Car alternative to proposed MRT solution in south Wellington corridor	3	2	3	2	1	2	0	13
22	Island Bay to Wellington and eastern access leg to Wellington Airport	MRT network as a subsitute for south coast light rail, 2nd Mount Victoria Tunnel and bus priority to East Wellington	Appraise cable car network for South and East Wellington	3	3	3	3	3	3	-2	16

Figure 9.1 Long List of cable car options from Abley process

10. Shortlisting

Based on the economic and MCA analyses the cable car opportunities most favourable for further analysis in the short term are:

- Auckland Airport to Onehunga, and Onehunga to CBD
- Airport to Botany (A2B)
- Wellington Airport to CBD
- Karori to CBD
- Wainuiomata to Lower Hutt/ Melling
- Island Bay to Wellington railway station

Table 10.1 MCA assessed options: BCR.

Cable Car Route	$M Benefit total	Length – Construction (km)	Cost/km Estimate ($ million)	Capital Cost ($ million) NPV	BCR	East Score	Strategic Alignment
Auckland Airport - Onehunga	1,047	9.0	52	430.6	2.4	12	Auckland Light Rail
Onehunga – CBD	1,007	8.4	50	386.4	2.6	-	Auckland Light Rail
Airport – Botany	1,586	15.1	60	833.5	1.8	16	Airport to Botany SSBC 2021
Wellington Airport – CBD	663	7.0	60	386.4	1.7	15	Let's Get Wellington Moving
Wellington: Island Bay to Pipetea	537	7.2	40	334.9	2.0	13	Let's Get Wellington Moving Transformational Project
Karori – CBD	313	3.2	60	176.6	1.8	7	New commuter
Wainuiomata - Melling	303.8	6.8	40	250.2	1.2	13	Three Valleys Project, Petone to Grenada East-West Link

Each of these potential opportunities will present different consenting, constructability, and feasibility challenges, which will need to be addressed in more detailed option assessments.

Please note that we did not short list South- East Wellington MRT network option (Option 22 of the long list in fig. 9.1); this is because the two components of Option (WGTN airport to CBD, and Island Bay to BCD) are also short-listed. We note the potential cost savings of combining the two options as part of Option 22 overlaps for the final leg into the CBD from Basin Reserve. See Appendix B on the Island Bay line.

An initial view of likely consenting, constructability and feasibility challenges for these shortlisted opportunities are:

Table 10.2 Shortlisted Option Challenges

Opportunity	Likely Consenting, Constructability & Feasibility Challenges
Auckland Airport to Onehunga, and Onehunga to CBD	• Able to meet peak demand. • Able to integrate with other MRT services. • Line of sight amenity & Privacy
Auckland Airport to Botany	• Able to meet peak demand. • Able to integrate with other MRT services. • Line of sight amenity & Privacy
Wellington Airport to CBD	• WGTN Town Belt (Mt Victoria) crossing. • Able to operate in area Wind conditions. • Line of Sight amenity & Privacy. • WGTN Airport access & proximity.
Wainuiomata to Lower Hutt/ Melling	• Able to operate in area Wind conditions. • Line of Sight amenity & Privacy.
Karori to CBD	• Able to operate in area Wind conditions. • Line of Sight amenity & Privacy.
Island Bay to Wellington Rail Station	• Able to meet peak demand • Cable car network options • Able to operate in area Wind conditions. • Line of Sight amenity & Privacy • Requires within 20m urban corridor

11. Next Steps

Suggested next steps in further exploring the shortlisted opportunities include:

1. Actions to enhance Economic Analysis including 4-stage regional modelling to elucidate the full benefits of key cable car routes.
2. Economic calculations do not take into account the full network effects that could result in a material increase in benefits; they also do not take into the potential uplift in economic activity and land prices around the cable car stations. We recommend full modelling of these factors to ascertain the full economic value for certain of the short-listed options.
    - Cable car uptake and mode shares are assumed with limited or no evidence – WTP analysis and commercial market validation required.
    - Capital costs are for cable car structures and stations only; some allowance for land take costs and station costs included in our per km rates.
    - Refinement of opex estimates. Opex is a distinguishing factor against other MRT options and a comparison with busways in particular could be persuasive for cable car options.
    - Further work on environmental evaluation in a New Zealand context would help the investment case.
3. Concept Design & Costing
    - Development and assessment of initial route options.
    - Development of concept designs for preferred route(s).
    - Initial costing of cable car system.
4. Investigation of Consenting, Constructability & Feasibility Issues
    - Initial discussion/ assessment of Consenting issues with city / regional council.
    - Investigation of specific feasibility issues, e.g., Wellington wind resilience.
5. Delivery structures and Funding
    - Funding structures and private and public sector delivery options should be evaluated.

Appendix A.

A1. Cable Car Route Assumptions & Methodology

Abley developed a point-to-point methodology whereby SA2 (Census) data was aggregated within 800m radius of cable car station route. Only starting and end point demand was counted. There were two cases where additional demand was added; firstly, for airport access options, passenger demand was added to the Journey-to-work and Journey-to-education demand skims (as it large and not accounted for in the JTW and JTE estimates). The second addition was for airport precinct employee demand. Abley's view is that a large proportion of airport workers would use the cable car mode as it would greatly assist airports in reducing their Scope 3 carbon emissions and reduce the need for parking.

Please note that Abley methodology does not include:

1. Inter-cable route demand.
2. Full network effects (that we think could be very material in some instances).
3. Other conventional, monetised transport benefits such as VOC savings and CO2 emission savings.
4. Wider Economic Benefits (WEBs) and the uplift in land prices around the cable car stations.
5. Full carbon lifecycle analysis.

A1.1 Common Assumptions

- Commuter (JTW) and JTE mode share of 20% (Source: Census 2018 SA2 data)
- We double JTW+JTE for all routes to represent other types of demand.
- Airport precinct data/ employee numbers: AKLD, WGTN, CHCH airport annual reports
- Car travel time has 13 min added to it for airport transfer to car time, 10 min for other airports.
- Cable car speed of 25 kmh
- Dwell time at cable car station = 1 min
- PT reliability = 80% of travel time savings
- Cap ex of $40m unless otherwise stated, no opex used in analysis.

Table A1.1 Route Assumptions

Route	Assumptions	Notes
Airport to Onehunga	4 stops, 1 min dwell time. 20% airport passenger mode share.	Less market share than WGTN because of position of airport in SW Auckland, meaning connecting journeys from airport more dispersed.
Onehunga to CBD	4 stops, 1 min dwell time 10% airport passenger mode share.	Reduced airport traffic as further downstream from the airport (8% mode share). $50m per km capital costs as cable car route navigates central Auckland.

Route	Assumptions	Notes
Airport to Botany (related routes, Botany, Manukau)	2 stops for Airport to Manukau as stop at Puhinui Station likely.	Airport and commuter demand peters out from 20% to 5% along the proposed cable car route.
Sylvia Park to Botany	No cable car stops	This cable car route has demand that builds up from the east from the imminent Eastern Busway, and to the west from the Airport to Botany corridor. Our point to point demand estimates were raised to reflect this. There are 13m to Sylvia Park annually mostly currently forced to access the shopping centre via SH1.
Wellington Airport	5 stops, one min dwell time 5.5m WGTN passengers per annum with 25% using the cable car route. 25% cable car mode share for airport passengers	WGTN has the highest mode share because of its position on the Miramar peninsula. We think over time up to half of all passengers could go via cable car, but our assumption is 25%. There are a variety of routes that could be formed.
Wainuiomata to Melling	2 stops (top of the hills and then Melling station).	No tourism activity in economic calculation. Abley thinks this route could induce much greater tourist activity.
Island Bay line	7 stops, 1 min dwell time	The Island Bay line follows the proposed LRT route for South Coast rail
MRT network for Southern and Eastern Wellington	Island Bay line + airport access from Basin Reserve 12 stops, 1 min dwell time 25% tourist market share and overhead Mount Victoria cable car stop offer tourism potential	The eastern leg terminates at WGTN airport
Queenstown	2 stops (Frankton) with dwell time of 1 min and then on into QTN centre.	20% airport passenger mode share Airport route heads north to Frankton then dog legs west to Queenstown centre.

MCA scoring key:

Improved Access (first column):

3: BCR > 2

2: BCR <2 but >1

1: BCR <1

Substitute MRT (third column)

3: Cost saving > $100m

2: Cost saving <$100 > $50m

1: Cost saving <$10m

Appendix B.

B1. Further Information to Support the Island Bay to Wellington Rail Station Cable Car Route

This additional note supports the information in Part C of the Abley reports for Doppelmayr to give some additional concepts and information for the Island Bay to Wellington CBD line (the Island Bay line).

B1.1 Add-in option to create a cable car network for South and East Wellington

LGWM is considering a second Mount Victoria tunnel and ways of achieving bus priority to the airport and the Miramar peninsula. An alternative to these very large transport interventions is a connection from the Island Bay cable car line to the airport.

Airport access could potentially be obtained by a cable car route branching off the Island Bay line from the Basin Reserve, going overhead Mount Victoria and then accessing the airport at the Northern end of the runway. See Figure B1.1 below for a potential cable car route to the airport. Abley has named this cable car route the Miramar Skyway.

Doppelmayr advised Abley that a such a network connection from the airport into a junction at Basin Reserve was technically feasible – essentially it would be constructed as two ropeways but sharing gondola towers from Basin Reserve into Wellington CBD. Services would be timetabled to match demand along the two routes on the two, overlapping cable car lines – alternating between terminating at Island Bay and the airport.

Abley have also prepared a concept design for this cable car network that could potentially be a complete solution for MRT access from the south and east Wellington. See Attachment 1 to this Appendix and B1.3 The concept design envisages the connection joining the Island Bay line at Basin Reserve and running along the same route as the Island Bay line.

Such a cable car junction exists for ski gondolas such as the 3-way junction Trittkopfbahn in Austria (https://de.wikipedia.org/wiki/Trittkopfbahn) so should be technically feasible.

This branch from the Island Bay line connects from the Basin Reserve to the airport at the northern end of the airport runway. A rapid bus shuttle service would carry passengers and luggage from the cable car station to the airport terminal along a 1.3 km route to get access to the airport. An alternative access point is the Wellington airport tunnel where Doppelmayr have a concept design for an underground cable car station. The northern cable car station has the advantage of being lower cost and allows buses to terminate from SH1 (inbound from Miramar) at a proposed cable car station park and ride facility.

There are various access points to the airport for a cable car station from the Island Bay line. The exact location of the cable car station would be dependent on feasibility constraints such as the Obstacle Limitation Surfaces (OLS) around the airport; as well as obtaining resource consents for a cable car station inside the airport perimeter.

The following access points are possible for Wellington airport by cable car:

- Northern runway access – as per the Abley design. This involves a cable car station adjacent to SH1 at Cobham drive between the two large roundabouts. A cable car station would be accompanied by a car park (Park and Skyride) for buses from East (Miramar and Seatoun) to terminate at the Park and Skyride – for cable car access into central Wellington. The airport is accessed via a shuttle service, around 1.3km via the Wellington Airport tunnel.
- An underground cable car station built in the Wellington Airport Tunnel. The Wellington airport tunnel is about 750m south of SH1, just before halfway point of the airport runway length Doppelmayr has a concept design for an underground tunnel (see Figure B1.2. below).
- If airport access was not possible so close to the airport, another option is to find a suitable location for a cable car station in Kilbirnie. The ideal location for a cable car station is to get as

close to the airport as possible (to reduce the transfer penalty as far as possible for airport traffic) but also as close to the bus routes that provide access to the CBD from the Miramar peninsula; the latter allows buses to terminate at the Cable Car station for commutes in and out of the Wellington CBD.

According to the Let's Get Wellington Moving website; bus priority is planned via a potential Bus Rapid Transit (BRT) system along SH1/ Rongotai Rd/ Kilbirnie Ave and through a proposed second Mount Victoria tunnel. A suitable location for a cable car station and Park and Skyride could mean any bus priority improvements could be terminated at Kilbirnie or the Airport – and negate the need for a second tunnel.

Abley recommends modelling using the Wellington Transport Strategic Model (WTSM) to ascertain if the proposed cable car alignments for South and East Wellington provide the predicated benefits and negate the need for expensive improvements including full bus priority in East Wellington and a second Mount Victoria tunnel.

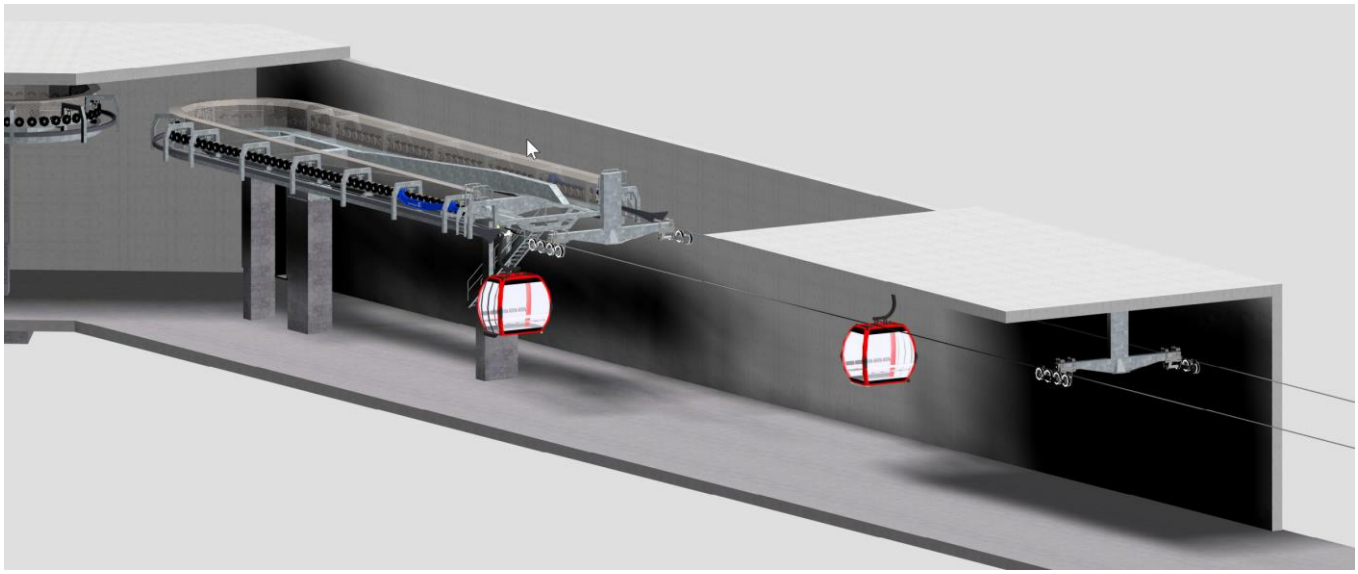


Figure B1.1 Doppelmayr concept for underground cable car station – Wellington Airport tunnel

B1.2 Economic assessment – Island Bay to Wellington City

We carried out an economic analysis of both the Island Bay cable car line and a network, dual cable car route with both Island Bay and airport access. Concept Design 1, Figure B1.3, shows this potential dual cable car solution for southern and eastern access from Wellington City.

B.1: Island Bay line: Abley used its point-to-point cable car methodology under similar assumptions to the other cable car routes evaluated in the main part of the Part C document. The key difference for Island Bay line is that the route was divided into two parts for the purposes of the economic evaluation: Island Bay to CBD and CBD to Wellington Rail Station. This in keeping with the AM and PM tidal flows that follows from the observed demand data.

We assumed 7 cable car stops in keeping with our views where the light rail stops would be – according to the catchment optimisation along the LRT route.

Cable car travel time along the full Island Bay route (including stops) is estimated at 26 mins assuming an average cable car velocity of 25 kmh-1. This compares to an expected LRT travel time of 24 mins, assuming 7 LRT stations and if Light Rail is given full priority through. Wellington CBD. In our experience, the latter is unlikely especially in the AM and PM peaks so it the cable car travel time on average is likely to be faster. Whilst cable car travel time is very constant, we expect LRT travel time to much more variable especially through Wellington CBD (reducing the benefit profile through reduced PT reliability).

BCR Results for Island Bay Line

Table B1.1 Island Bay to Pipetea: Trips and Travel Time

Trip Movements	Estimated Travel Time (mins)		
Est. Trips (JTW &JTE) Ret.	Car	Public Transport (Bus)	Cable Car
24,518	22	42	20

Table B1.2 Island Bay to Pipetea: BCR

Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
7.0 km	537	40	280	2.0

Key assumptions and data sources for Island Bay line economic assessment:

- Demand estimates were taken from the Abley Accessibility tool that relies on SA2 data from the 2018 Census. SA2 data was compiled for both halves of the line to arrive at inbound and outbound demand estimates in AM peak (8am Friday)
- Demand data was cross-checked and refined with current demand estimates from the Wellington Transport Strategic Model (WTSM). In this refined demand skim, demand estimates were aggregated for Island Bay region, Newtown-Berhampore and Wellington City – a 3-point model.
- Mode shift of 20% is assumed for cable car demand from day 1 of operation.

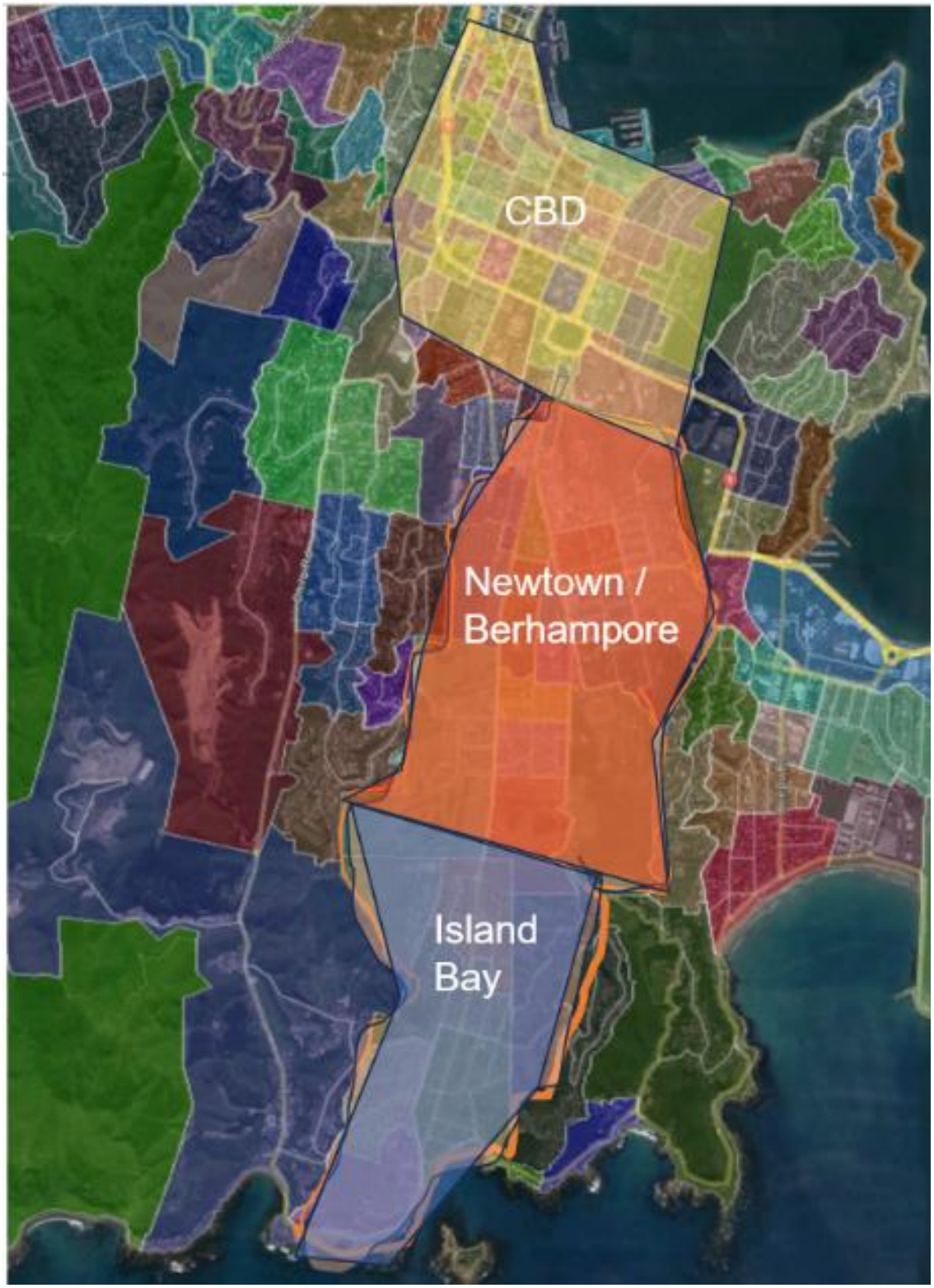


Figure B1.1 WTSM demand model for Island Bay line

Abley aggregated demand around three points, as per the diagram. An adjustment was made to cable car travel time to account for 7 stations expected for a cable car route into Wellington rail station.

Important consideration of the analysis to date is:

a) No future year analysis is included

b) Further mode shift is likely to occur over time (with or without congestion charging scenarios)

c) The better resolution of the WTSM would allow modelling of the demand profile of all the cable car station stops (no inter-stop demand is modelling in our analysis)

d) No network effects are considered (e.g., the reduction of network capacity for other modes as a result of the mode shift to cable car)

e) No effects on development and the uplift of property prices along the cable car route are factored into the economic appraisal

Consideration of (a) to (e) would likely result in an increased benefits profile - mode share away from private car use along the corridor would be almost certain to occur with the improved access. In addition, inter-route demand is likely to significant.

At the end of Appendix B, we give some information about potential future iterations of the modelling and further use of data from the Wellington Transport Strategic Modelling (WTSM). Using WTSM, better resolution of the demand data is available, and a full economic analysis could take place to assess network effects. Scenarios could also be considered that consider the development potential around the cable car stations, and also to consider the congestion charging effects on mode share.

B1.3 Economic Assessment – South and East Wellington Connection

Abley carried out an economic assessment of the combination of the Island Bay line and the Miramar Skyway depicted in figure B1.3. The assessment is carried out in a similar fashion to the other cable routes and under similar assumptions. The key improvement in economic performance comes from the sharing of the cable car tower structures from Basin Reserve through the Wellington CBD where the two line combines for the final leg; there are substantial cost savings in comparison to the two individual routes.

Table B1.3 Island Bay to Pipetea PLUS airport access: BCR

Total Route Length	Benefits ($ million)	Construction Costs/km ($ million)	Capital Costs ($ million)	Benefit: Cost Ratio
10.7 km	1,350.5	60	695.5	1.9

B1.4 Potential Infrastructure Savings

The proposed MRT cable car solution for South and East Wellington has the potential to remove the need for large infrastructure improvements under a light rail/ BRT solution. A second Mount Victoria tunnel is planned to facilitate access to Wellington Airport and the Miramar peninsula. Improved access via Cable Car and bus priority from Miramar to the cable car terminus could negate the need for a new tunnel.

Table B1.4 below shows a cost comparison between southern LRT, MRT for the South and East Wellington (based upon Abley's high-level assumptions in the table):

Table B1.4 Cost Comparison

	Assumptions	LRT ($m)/MRT ($m)	Cable Car ($m)	Comment
Southern Island Bay line	$250m/km LRT cost $60m/km Cable car cost	1,800	432	$60m/km contains allowance for land take and scaling Mt Victoria Cable car solution 24 % of LRT capital cost
MRT network for south and east Wellington	$250m/km LRT $60m/km cable car 2nd Mt Victoria Tunnel $1.4bn (Arras tunnel extension $800m) SH1 improvements/BRT through Kilbirnie $1bn Limited bus priority on SH1 for new cable car solution in the East $250m Park and sky ride at airport cable car station $50m	3,200 (4,000 with Arras Tunnel)	756 (1,056 with limited bus priority and park and sky facility at the airport)	Cable car network potentially negates the need for massive infrastructure improvements such as a 2nd Mt Victoria tunnel and the Arras tunnel – needed under current network improvement plans. Savings validated through WTSM modelling.
Economic and environmental disruption	Not modelled	Heavy restructure build required in the road reserve of key Wellington arterials. Long (5–8-year construction period)	Much reduced owing to light touch on surface (towers and cable car stations only) Short construction period (1-2 years)	Much shorter construction periods and lower economic disruption is a very substantial benefit in favour of cable car options.

In theory, a cable car MRT solution for the south and east Wellington costs less than 25% of the current solution costs.

The above raw cost data does not fully consider the differences in economic disruption profile of the two modes. Any light rail through the Wellington CBD would take 5-8 year to construct and would cause very significant economic disruption (cf. CRL excavation works through Auckland CBD).

New cable routes can be constructed in less than 2 years and with a much lower economic disruption effects, and also less damage to the environment (see B 1.x below).

B1.5 Funding Model for Cable Car Transport Projects

Government Funding Models

The Island Bay line could be funded via a conventional combination of local authority (WCC, GWRC) funding and National Land Transport Fund (NLTP) route. However, this conventional route usually at least 10 years to complete.

A quicker and more capital efficient route is to invite private sector participation. This is possible because the public transport modes generate revenue via the ticketing. For the Island Bay line, this is likely to operate via the Wellington Metlink Fare zone structure and the Snapper Card. Cable car operating costs are lower than other modes (around 1% of capital costs; an operating surplus); however, there is still likely to need subsidisation on a whole of life (capital plus operating costs) basis.

A Public Private Partnership (VPN) model could still apply whereby a pension fund or alike could achieve a return in excess of their cost of capital and lower the initial capital injection required for a large cable car project. This might be a potent incentive in the current funding environment especially if risk sharing can be negotiated into the PPP structure. International pension funds would be interested in the lower risk profile of this type of investment in combination with helping to meet their Environmental, Sustainability and Governance (ESG) requirements – given the low environmental impact of cable car operations.

Private funding models; potential capital structure for East Wellington airport connection (Miramar/ airport skyway)

The Miramar skyway has the opportunity to generate additional revenue from the cable car stop at the top of Mount Victoria. An additional charge could be applied to international arrivals (and potentially departures) using the line to access the airport and stopping at Mount Victoria. A public transport-type ticket fare would most likely be applied to airport precinct commuters and other Wellingtonians.

Airport access from tourists could be significant with 5.4m airport passengers per annum going through Wellington airport revenues from this cohort could be $80m. It is possible that this would provide a reasonable operating margin and a rate of return that would attract a pension or infrastructure. This would then require only the balance of the Island Bay line to be funded by public funds.

This is a very attractive structure for solving a significant portion of Wellington transport access issues and spurring on intensification along the cable car routes.

Speed and ease of Cable car route build; economic and environmental disruption

Cable car routes take 1-2 years to build compared to 5-8 years predicted for the Light Rail system.

A cable car system has a much lower environmental impact with cable car stations, drive system housing and tower bases having a much lower per sqm impact than light rail.

This would mean a much lower economic and environmental disruption. Economic and environmental disruptions are very high for sizeable transport improvements like MRT solutions.

Greenhouse Gas (GHG) Emission Profile

Both Light rail and cable car systems are electrically powered and so have a low operating carbon profile.

Downstream (Scope 3) emissions from the manufacture of the materials and MRT vehicles are approximately proportional to the mass of the infrastructure – that is lower for cable cars. However, this should be more formally estimated to establish the whole-of-life (WoL) carbon profile. Both Cable cars and light rail vehicles have a good recycling profile.

The overall CO2 emission is likely to be slightly better for cable cars – but this should be measured.

Modular Nature of Cable Car Construction

Cable car system can be built in stages as cable cars are modular – if extensions are known in advance of building the first stages. The proposed extension to the airport (Miramar Skyway) could be built later once the Island Bay line is built (especially as the extension to the airport is essentially a second ropeway). This also assists in minimising the economic disruption as difficult parts of the ropeway alignments can be deferred, if necessary.

Next steps: Future modelling work to refine the benefits profile of Island Bay line (and other cable car routes)

- **Approximate mode share analysis**

  With the detailed zone system and mode choice data available from WTSM, we can estimate a model of mode choice as a function of travel time between zones and demographic parameters. This will allow a more plausible estimate of the true "utility" benefit of the additional mode (which should be greater than the pure travel time savings offered, because of random variation in trip types and preferences). We can apply this same model to WTSM forecasts out to 2053. This work would be assisted by Willingness to Pay (WTP) analysis and also in-market validation of cable car concepts and pricing (via a consultation process).

  Because of the fine-grained nature of the WTSM zones, at this stage we could also start refining the number and location of stations to optimise travel times and catchment.

- **Full WTSM scenario modelling**

  With the assistance of Wellington Transport Analytics Unit (WTAU), full four-stage modelling of a proposed route and station locations can be carried out. This would give the best idea of mode shift, VKT reduction, and user benefits – including interactions with potential future transport projects, and with varying land use (intensification) scenarios.

- **Measurement of economic and environmental disruption during construction**

  Abley recommends modelling of the economic and environmental disruption as it will be required to measure the true cost of the new cable car routes. Some comparison against other MRT modes such as LRT and BRT would assist showing the strengths of a cable car proposition in our opinion.

- **Whole of life carbon emission analysis**

  Just like environmental, we believe comparative analysis against other MRT modes would assist determining the strength of a cable car proposition.

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