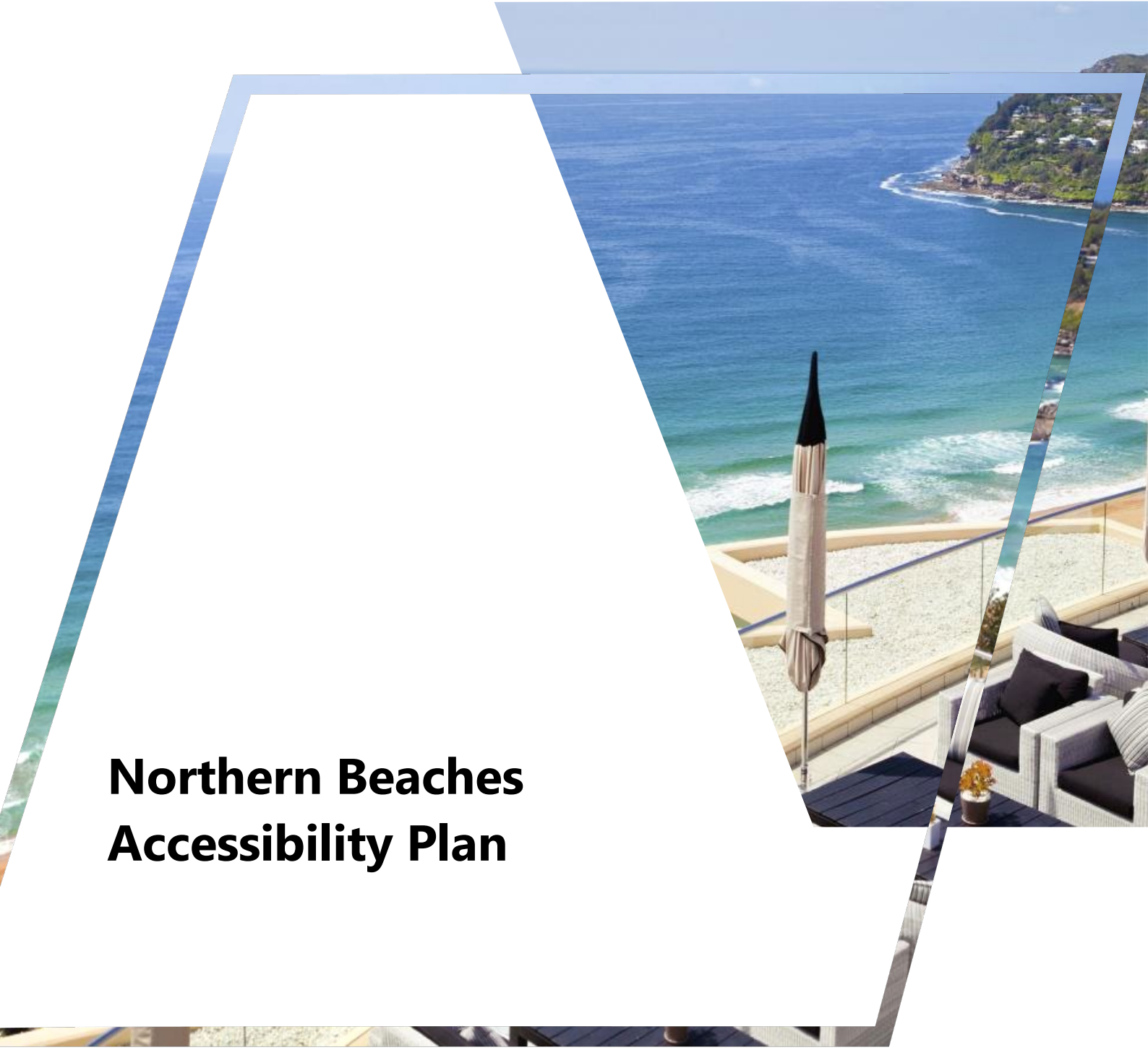

Northern Beaches Accessibility Plan

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Project: Northern Beaches Accessibility Plan

Rev	Description	Authors	Review	Advisian Approval	Date
01	Draft Report	Athena Foo, Daniel Hurwood, Lily Elliott, George Wilkinson	David Hicks, Tobi Krug Victor Prados-Valerio	Victor Prados-Valerio	28/02/2019
02	Final Report	Athena Foo, Daniel Hurwood, Lily Elliott, George Wilkinson	David Hicks, Tobi Krug Victor Prados-Valerio, David Rey (UNSW)	Victor Prados-Valerio	17/06/2019

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Executive Summary

The future of Sydney is envisioned to change drastically over the next two decades, with significant population growth. The Northern Beaches are in a unique position to benefit from economic growth providing future opportunities and a quality lifestyle. However, the region's infrastructure and transport systems are insufficient.

Currently, the primary modes of transport in the Northern Beaches are private cars, active transport and the B-Line buses. The B-Line buses run along coast of the Northern Beaches due to the higher population density in these suburbs. These current transport options have led to poor traffic conditions throughout the three access points to the Northern Beaches:

- Warringah Road;
- Mona Vale Road; and
- Pittwater Road / Spit Bridge.

This current infrastructure and transport systems have led to social, economic and environmental issues including:

- Limited work and study opportunities for younger people and restricted mobility for retirees;
- Increased car dependency leading to congestion; and
- Limited availability of resources such as labour supply and supply chain connectivity, which restricted business growth.

This report is intended as a thought paper proposing two strategic objectives to this challenge:

1. **Strategic Objective 1:** Improvement of the interconnectedness and efficiency of travel within the Northern Beaches Region

2. **Strategic Objective 2:** Connection of the Northern Beaches region to the Eastern Economic Corridor; Macquarie Park, Chatswood and St Leonards

The ultimate objective is to place the Northern Beaches in a position whereby it can take advantage of Sydney's future growth. The following table shows the different options considered:

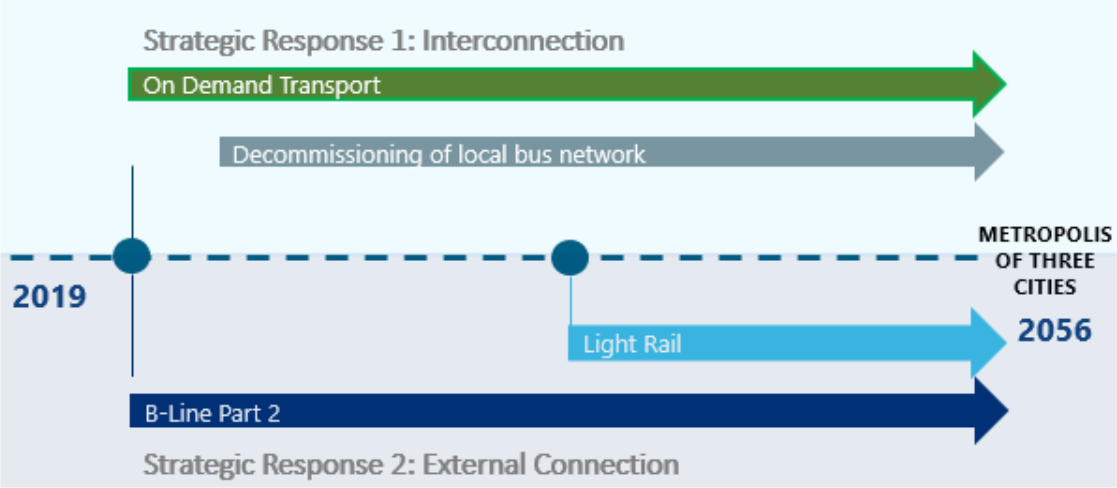
Strategic objective	Option	Description
Strategic Objective 1	1A	Development of bus infrastructure
	1B	Development of bike infrastructure
	1C	On demand transport (on demand transport zones replacing current public bus network)
Strategic Objective 2	2A	Light rail from Dee Why through Frenchs Forest to Chatswood
	2B	Introduction of a further B-Line from Dee Why through Frenchs Forest to Chatswood
	2C	Underground road tunnel from Seaforth to Castlecrag
	2D	Road bridge from Seaforth to Castlecrag

Strategic objective	Option	Description
	2E	Improvement to existing B-Line Service

These options were evaluated through an option analysis with the following criteria and key performance indicators:

Criteria	KPI
Economic	Financial cost Access to economic opportunities Travel time saving
Social	Access to social infrastructure Uptake/usability Social acceptance
Environment	Aboriginal and non-Aboriginal heritage site impacts Biodiversity impacts Greenhouse gas emissions Noise and visual impact
Alignment with Sydney's Future Objectives	Project scope Population and congestion management Potential for expansion Time to completion

Each of the key performance indicators were assigned weightings, leading to the preferred options for strategic objective 1 and 2 of on-demand transport and the introduction of a further B-Line and a light rail, respectively. These would happen in a staged approach as shown in the diagram below.



These on demand transport options would be designed to service low density areas with a large dispersion of trip origins and destinations. The B-Line Buses Part 2 would connect Dee Why to Macquarie Park, along the Eastern Economic Corridor. This route would also allow connectivity to the Northern Beaches Hospital. It is expected that the establishment of these two options in conjunction

would bring about significant precinct activation, leading to a greater influx of commuters into the region. This would set a precedence for a light rail system to accommodate the demand. The proposed light rail route would reflect the proposed B-Line Part 2 bus corridor beginning at Dee Why and terminating at Chatswood.

1 Introduction

Sydney's population is growing rapidly. By 2056, it is anticipated that Sydney would almost double in size from 5 million to 8 million. This creates a challenge for governments in managing population growth while ensuring positive economic, social and environmental outcomes[1].

The NSW Government's strategy for managing population growth (i.e. Future Transport Strategy 2056) involves preparing the Sydney region to become a Metropolis of Three Cities[2], including an Eastern Harbour City, Central River City and Western Parkland City, as outlined in **Figure 1.1**. The vision is that by 2056 residents will be able to access their jobs, education and health facilities within 30 minutes of where they live. Three key targets of the strategy include:

- Developing the Eastern Economic Corridor, from St Leonards to Macquarie Park, as a key economic corridor with metropolitan centres;
- Integrating the mass transit network with the economic corridors, centres, transit-oriented development, urban renewal and health and education precincts; and
- Creating a Greater Sydney Green Grid[3] which would improve access to foreshores, waterways and the coast for recreation, tourism, cultural events and water-based transport.

A number of infrastructure projects are being rolled out as part of the Future Transport Strategy 2056. These include light rails, tunnels as well as major road upgrades including the Sydney Metro Northwest, the Beaches Link and Western Harbour Tunnel as well as the Westconnex and Northconnex respectively, as shown in **Figure 1.1.**

Figure 1.1 Sydney Transport Infrastructure Development

[1] Greater Sydney Region Plan – A Metropolis of Three Cities 2018
[2] Greater Sydney Region Plan – A Metropolis of Three Cities 2018
[3] Move: Northern Beaches Transport Strategy 2038 – Northern Beaches Council (2018)

It is evident that the Northern Beaches region is isolated from the rest of the Sydney, as seen visually in **Figure 1.1.** Without changes to the transport network, the 30-minute city will not be possible for these residents. However, this can be achieved if a link is provided between the Northern Beaches and the Eastern Economic Corridor. This corridor runs from Macquarie Park to St Leonards through Chatswood.

As the Eastern Economic Corridor is developed, space for liveable residential development needs to be allocated. The map presented in **Figure 1.2**, shows the relative proximity of the Eastern Economic Corridor to the Northern Beaches. However, the geography of the region means that the Northern Beaches have remained relatively isolated from the Eastern Economic Corridor and the Sydney CBD. This isolation has also resulted in limited work and study potential for young people, restricted mobility of elderly and disabled people, increased car dependency and limited business resources such as labour force and supply chain connectivity[4].

This thought paper explores strategic transport options for integrating the Northern Beaches with the Eastern Economic Corridor. Specifically, ways of improving the connection between the Northern Beaches and the Eastern Economic Corridor as well as interconnectedness within the Northern Beaches. Each transport option is assessed based on it's alignment with the NSW Government's Future Transport Strategy 2056 and ability to provide positive economic, social and environmental outcomes.

An overview of the current transport modes used in the Northern Beaches is provided in the following section.

Figure 1.2 Projected growth areas of Sydney

[4] Move: Northern Beaches Transport Strategy 2038 – Northern Beaches Council (2018)

2 The Current Landscape

In 2016, the population of the Northern Beaches was 253,0005 and is forecast to grow by approximately 14% over the next two decades. The Northern Beaches has a low population density of 10.47 persons per hectare compared to the neighbouring Local Government Area (LGA) of Willoughby, with 35.52 persons per hectare[6].

In the following sections, an overview of current transport infrastructure in the Northern Beaches is provided.

2.1 Transport within the Northern Beaches

The transport options currently used within the Northern Beaches are car, bus and bicycle. Regarding public transport, bus services are the only option.

2.1.1 Car reliance

Cars are the main mode of transport. The high car dependency is due, in part, to limited and inefficient public transport options. This is demonstrated by comparing the time required to commute to Curl Curl, from three alternative hubs within the Northern Beaches. These hubs include Mona Vale, Frenches Forest and Manly. The time taken to reach each of these three destinations by car, bus and bike during Sydney peak hour evening traffic are compared in **Figure 2.1** below.

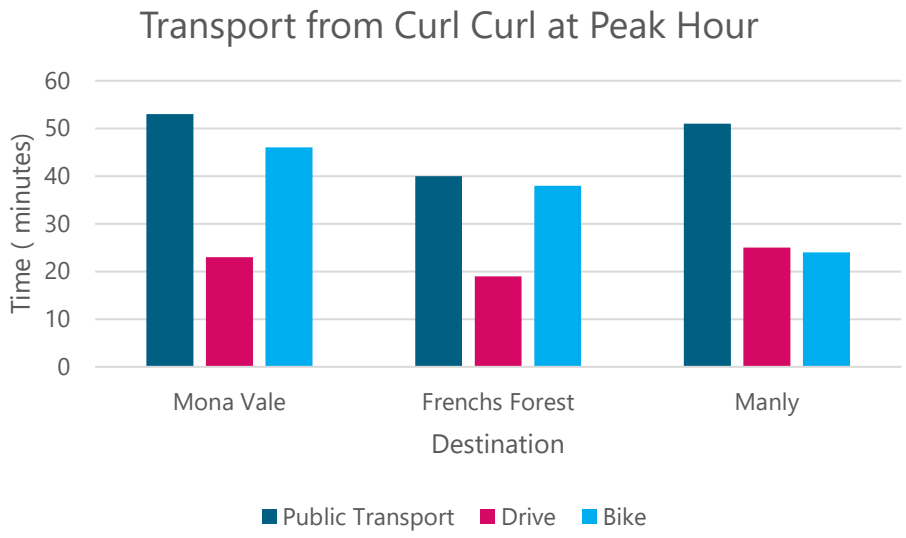


Figure 2.1: Transport Options Within the Northern Beaches

As seen above, in all three cases buses take approximately double the travel time of cars. Bikes are also consistently faster than bus options. This inefficiency has resulted in low patronage and possibly discourages further investment in public transport infrastructure.

[5] Australian Bureau of Statistics – *Northern Beaches LGA*

2.1.2 Public Transport

It can be seen in **Figure 2.2** that these services are relatively extensive through the east-side coast of the Northern Beaches area, reflective of a significantly higher population density in these suburbs compared to the greater region.

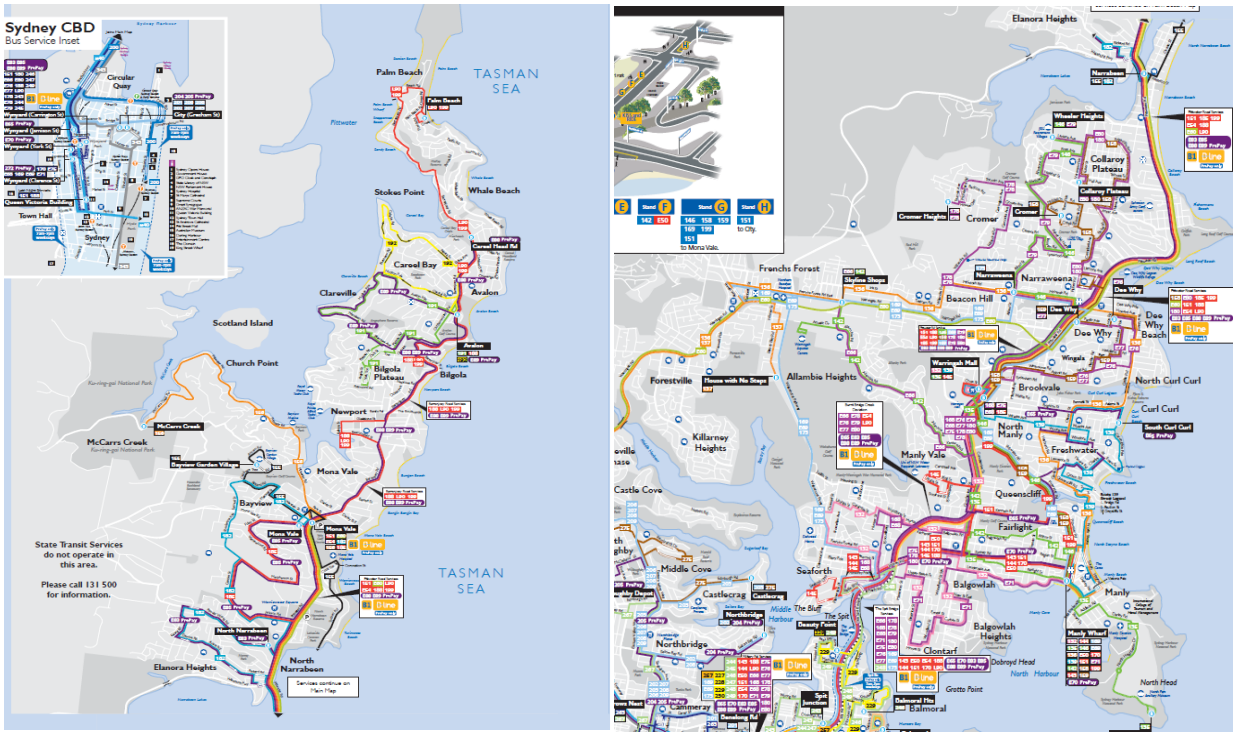


Figure 2.2: Bus Services within the Northern Beaches

A major issue with bus services in the Northern Beaches is the number of services offered. One route, that operates entirely within the Northern Beaches is the 139 – Manly to Warringah Mall via South Curl Curl. This route operates at 30-minute intervals during the morning and evening peaks, limiting rider's flexibility in arrival and departure times and operation without a timetable. Reduced flexibility is a significant disincentive to this public transport option.

The reliability of bus services is also an issue. One of the most regular bus services in the Northern Beaches is the 136- Chatswood to Manly service. While this service runs at regular, 10-minute intervals during the morning and evening peaks, close to 60% of these services are delayed by 10 minutes or more[7].

2.1.3 Active Transport

Investment in share pathways is ongoing, with a $22.3 million upgrade to cycleways, largely focused on pathways leading to B-Line transport hubs (**Figure 2.3**). While active transport options are available, with significant infrastructure already in place, limits exist in terms of distances travelled and ability for all members of the community to utilise such forms of transport. More detail of the trails, dedicated lanes, bicycle-friendly roads and unpaved trails in the Northern Beaches are indicated in Appendix A.

[7] 'Late every time': Sydney's worst bus revealed – Sydney Morning Herald 2018

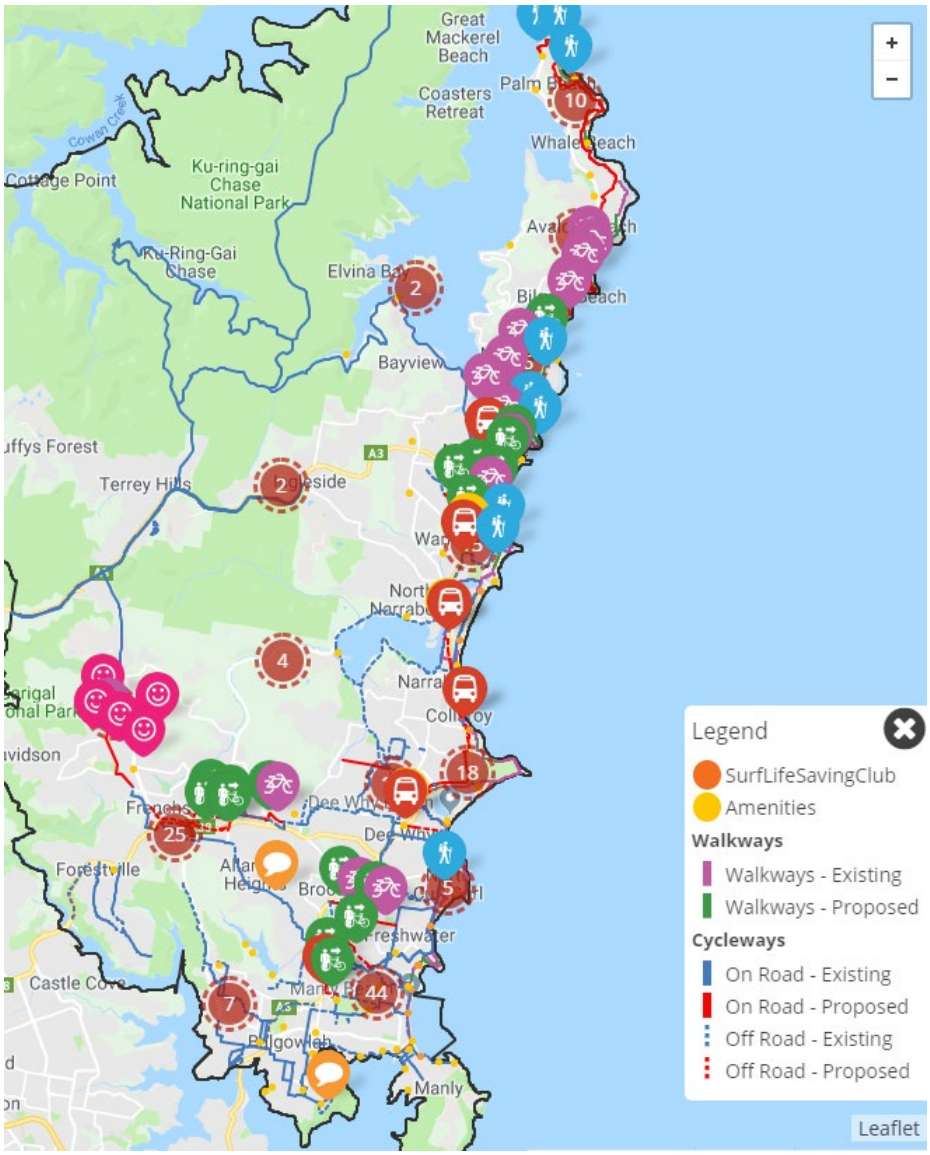


Figure 2.3: Northern Beaches Cycle and Shared Pathways

2.2 Connection to the Northern Beaches

The Northern Beaches community has two main modes of transport into the region; motor vehicles or B-Line bus services. B-Line buses begin in Mona Vale and end at Wynyard between 4:30am and 12:30am, 7 days a week, featuring 10 stops.[8] There are three main roads into the region – Warringah Road, Mona Vale Road and Pittwater Road/Spit Bridge[9], all of which currently face high levels of congestion.

The Spit Bridge is one of the three main ways commuters enter and exit the Northern Beaches Region, particularly the 10% of the region's population that commute to the CBD for work[10]. There are 69,000 vehicles travelling across the bridge with forecasts predicting 80,000 vehicles by 2037 with 43 bus routes[11]. The B-Line bus service has seen significant uptake from the residence of the Northern Beaches.

[8] B-Line Program – Transport for NSW – B-Line Program
[9] Move: Northern Beaches Transport Strategy 2038 – Northern Beaches Council (2018)
[10] Australian Bureau of Statistics - *Commuting to Work - More Stories from the Census*
[11] Beaches Link Project Update – August 2018 – Roads and Maritime Services

The service offers a high-speed, stream-lined service for customers community between the Sydney CBD and the Beaches area, with minimal stops and extensive use of bus lanes.

A similar B-Line bus service does not exist to connect the Northern Beaches with the Eastern Economic Corridor. The bus services that currently connect the Northern Beaches with the Eastern Economic Corridor are typically far slower than commuting by car, as demonstrated by the 2011 Journey to Work Census data from TfNSW, presented in shown in **Table 2.1.** The inefficiency of bus services to the Eastern Economic Corridor has resulted in higher than average car-use by commuters to Macquarie Park as compared with the Sydney CBD, as shown in Figure 2.4**.**

Table 2.1 Statistics of Average Travel Time to Eastern Economic Corridor from the Northern Beaches

Origin	Destination	Peak Time Bus (min)	Peak Time Car (min)	Number of Commuters (per day)	Distance (km)
Mona Vale	Macquarie Park	80	32	500	20
Dee Why	Macquarie Park	70	39	1500	20
Manly	Macquarie Park	70	36	360	20
Dee Why	Chatswood	60	-	-	14

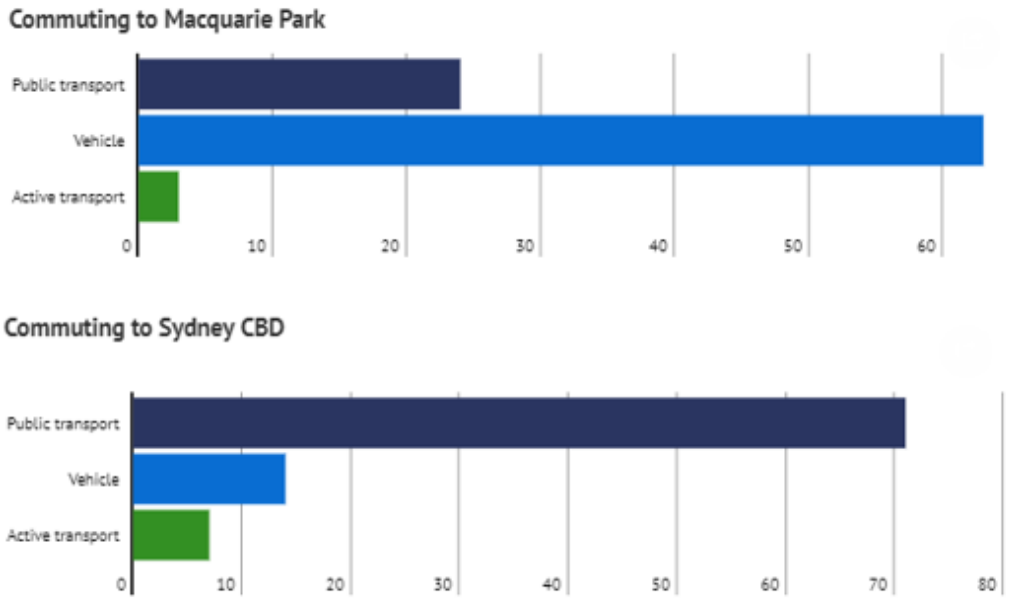


Figure 2.4: Modes of Transport for Commuters to Macquarie Park and Sydney CBD[12].

[12] Half a million commuters on the road to Sydney's four big job hubs – Sydney Morning Herald (2018)

There is a clear preference to drive, stemming from a very poor east to west public transportation connection. This creates significant limitations for people who do not drive themselves, for example the elderly, young and the disabled. While these issues effect all of Sydney, the challenge is exasperated in choke points (such as the Spit bridge) in the Northern Beaches, due to the large proportion of commuters who travel to work by car. If this trend continues with the forecast economic and population growth in the Eastern Economic Corridor, it will quickly become unsustainable to maintain these driving habits.

This problem has a direct impact on the economy and constrains economic growth, as witnessed in the area in recent years[13]. It also impacts the flexibility of the residents of the Northern Beaches in terms of career choices and liveability. Community feedback from the *Move Northern Beaches Transport Discussion Paper* identified 'Better public transport connections to Chatswood and Macquarie Park' as a key concern from participants [14]. Similar to the B-Line bus services between the City and the Northern Beaches, implementing an additional B-Line service from the Northern Beaches to the Eastern Economic Corridor could help improve transport between these destinations, as shown in Figure 2.5.

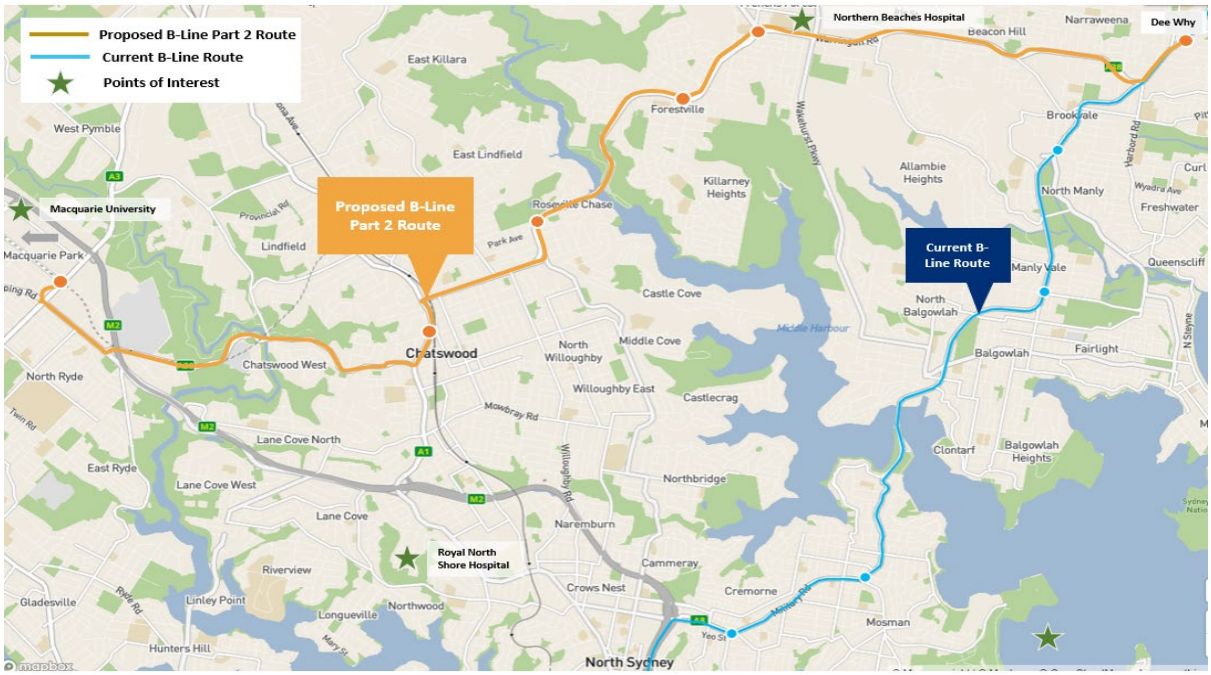


Figure 2.5: Proposed B-Line Part 2 route.

[13] Economic Development and Tourism: Strategic Reference Group Directions Paper – Northern Beaches Council (2017)
[14] Transport priority for Northern Beaches residents – Northern Beaches Council (2018)

3 Thought Paper Objectives and Methodology

3.1 Methodology

The approach taken to address this challenge involves 5 key phases, outlined in **Figure 3.1.**

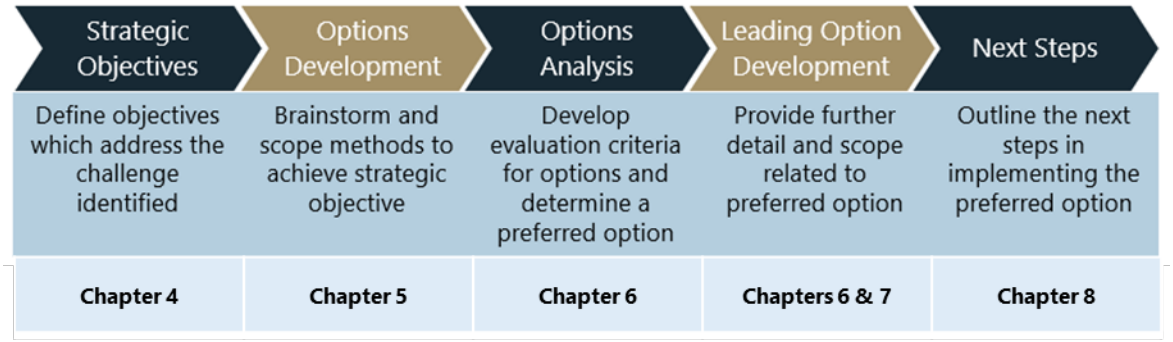


Figure 3.1: Methodology Outline

3.2 Problem Statement

As the St Leonards, Chatswood, Macquarie Park, 'Eastern Economic Corridor'[15] is developed, space for liveable residential areas must be allocated to support quality growth. For the Northern Beaches, ongoing isolation has resulted in limited work and study potential for young people, restricted mobility of elderly and disabled people, increased car dependency and limited business resources such as labour force and supply chain connectivity. Hence the problem is twofold:

- The current Northern Beaches transport infrastructure is insufficient to access projected growth hubs.
- The projected Eastern Economic Corridor through Chatswood is being developed without connection to liveable areas.

3.3 Strategic Objectives

The first objective is to improve connectedness and efficiency of travel within the Northern Beaches itself. The aim of addressing this challenge is to provide greater access to all areas of the Northern Beaches in an inclusive and environmentally sustainable way. This is achieved by assessing options for last mile transportation from potential future hubs to improve access and travel time within the region.

The second objective is to 'open up' the Northern Beaches to the projected key economic corridors. By addressing this challenge, the Northern Beaches region would be positioned to benefit from spreading economic growth while providing access to liveable areas for these growth regions, aligning with the city's Future Transport Strategy 2056. In summary these strategic objectives are:

1. **Strategic Objective 1:** Improvement of the interconnectedness and efficiency of travel within the Northern Beaches Region

2. **Strategic Objective 2:** Connection of the Northern Beaches region to the Eastern Economic Corridor; Macquarie Park, Chatswood and St Leonards

[15] Greater Sydney Region Plan – A Metropolis of Three Cities 2018

4 Options Development

4.1 Strategic Objective 1 - Improvement of the interconnectedness and efficiency of travel

Strategic Objective 1 considered several different cases outlined below. Developing bus infrastructure, active transport infrastructure and on demand transport were all discussed briefly and compared to the base case of 'Do Minimum'.

4.1.1 Base Case – Do Minimum

This would involve reliance on the current transport options within the Northern Beaches of car, bus and active transport described above. As the population of the Northern Beaches continues to grow, with a 14.68% population growth predicted from 2018-36[16], the number of cars on the road and therefore congestion will continue to grow similarly, resulting in further constrained population and economic growth opportunities.

4.1.2 Option 1A: Developing Bus Infrastructure

Developing the existing Northern Beaches bus systems would involve increasing the frequency of services, the addition of routes and reliability improvements to existing services. Increases in service frequency would include moving to a more regular timetable, for high ridership services to 5-minute intervals during morning and evening peaks and to 15-minute off-peak intervals.

Efficiency may be increased through technology upgrades, including providing riders with more transparency on bus arrival times and maintaining timeliness of services. This would be a significant initial step in increasing the ridership of existing public transport options in the Northern Beaches. These upgrades would require significant capital and operating expenditure on increasing fleet capacity and ongoing cost of running the service.

4.1.3 Option 1B: Developing Active Transport Infrastructure

The active transport infrastructure development option involves upgrading key routes between residential, commercial and social infrastructure centres, as well as supporting existing transport infrastructure, such as B-Line stops. Improving the availability and quality of on and off-road cycleways would provide an ease of experience and reduced travel time for users.

[16] Economy ID: Northern Beaches Council

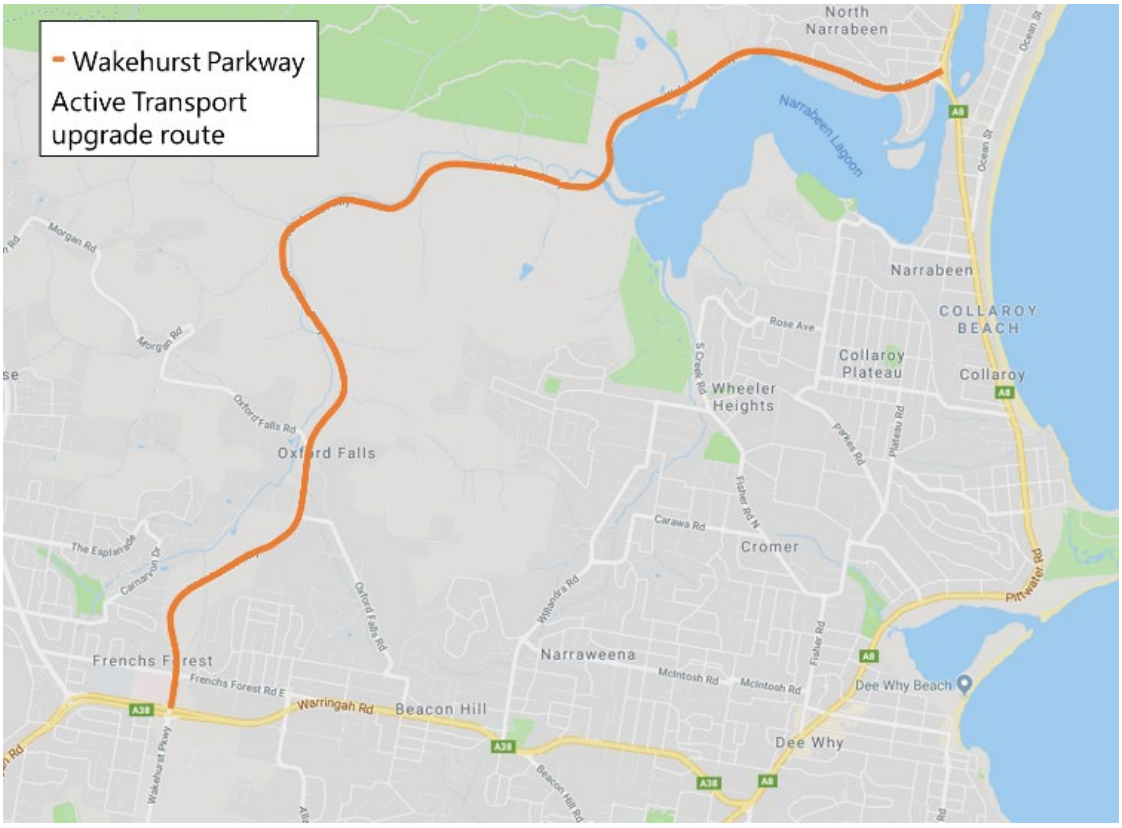


Figure 4.1: Active Travel Upgrade Route

A key route for potential upgrade is the Wakehurst Pathway, which has been nominated through community involvement programs to obtain user feedback[17], as outlined in **Figure 4.1.** Upgrading the bike lane facilities to connect north-eastern regions of the beaches with Frenches Forest, a key social infrastructure hub.

4.1.4 Option 1C: On Demand Transport

The low population density of the Northern Beaches region is a limiting factor in the implementation of standard transport options to improve interconnectedness. Current travel within the Northern Beaches region is reliant on low frequency, fixed bus routes which limit commuter's ability to 'show up and go'. Demand Responsive Transport (DRT) is designed to service low density areas with a large dispersion of trip origins and destinations. This provides a more frequent transport service where a conventional high frequency transport service would be inappropriate.

The transport service is defined over an area rather than a fixed line arriving at stops when needed or at pre-arranged times, minimising wait times. There are several key enabling technologies in establishing a DRT system, including:

- Booking and reservation systems to manage customer requests;
- Regular public transport information for DRT operators to avoid conflicts with existing transport;
- Dispatching software to allocate trips and optimize DRT resources, and;
- In-vehicle units to provide booking and GPS information to drivers.

To apply this technology to the Northern Beaches there should be a focus on supporting the current and proposed transport systems. Currently, this is being trialled in an area spanning Narrabeen to

[17] Northern Beaches Council: Social PinPoint

Barrenjoey in support of the B-line system. Despite the failure of these trials in a number of areas around NSW, there has been significant uptake in the Northern Beaches, as shown in **Figure 4.2.**

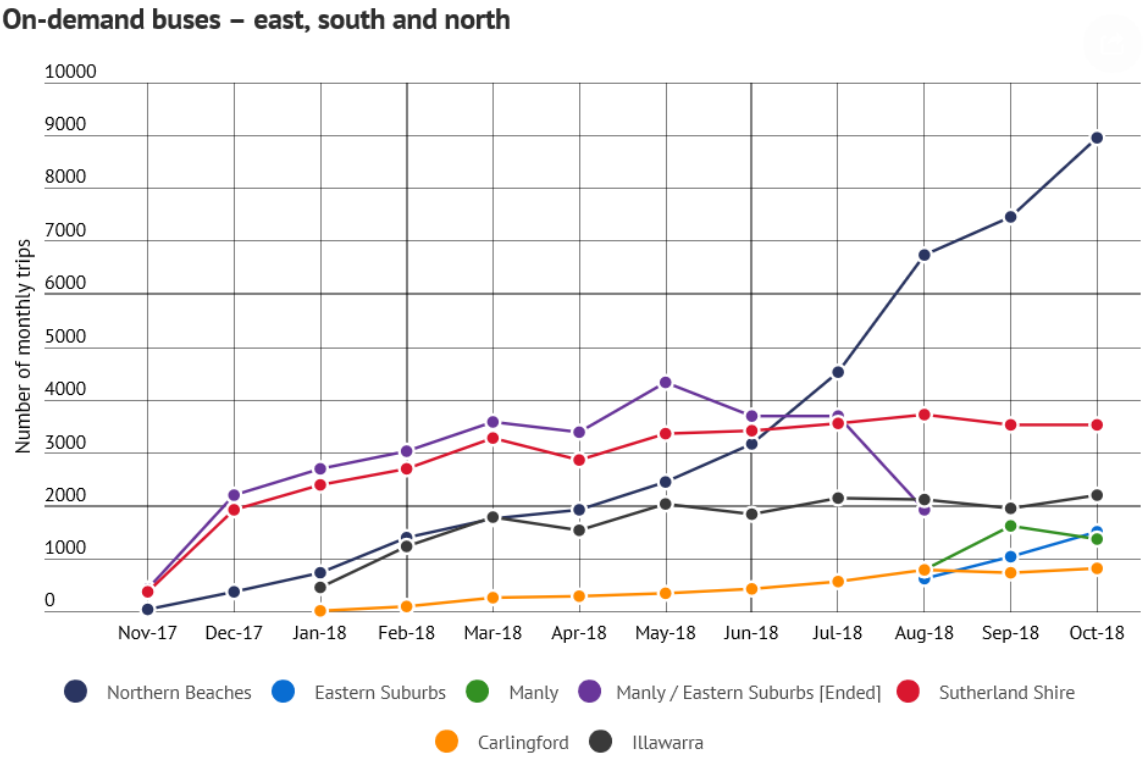


Figure 4.2 Usage of On-demand Bus Trial

Expanding on this, there are a few key points that should be considered about the Keoride trial. Firstly, the Keoride trial currently does not accept Opal Card payments. Further, Pick-up and drop-off locations are still yet to be fully optimised via integration the service with the existing infrastructure[18]. Based on this, it is expected that future social acceptance would be relatively high if this option is further explored, and that the deployment of a full-fledged on-demand service may lead to substantial uptake. South of this area there are currently a range of low frequency scheduled bus services following inefficient loop paths to achieve area coverage. DRT services would achieve the same area coverage in a simplified manner, as seen in **Figure 4.3.**

In the context of Sydney's planned future, the flexibility of this system poses significant benefits to the Northern Beaches accessibility. As new hubs are developed and transport demand changes, this technology can respond and adapt with minimal system disruption. Additionally, DRT is easily scalable (yet requires increasing expenditure due to driver and fleet operating costs) by the addition of more vehicles or the establishment of conventional bus lines in response to density increases. Substantial upgrades to routing and scheduling algorithms would also be required to scale-up to allow for efficient matching of vehicles to user requests[18].

[18] D. Rey (personal communication, 14 May, 2019)

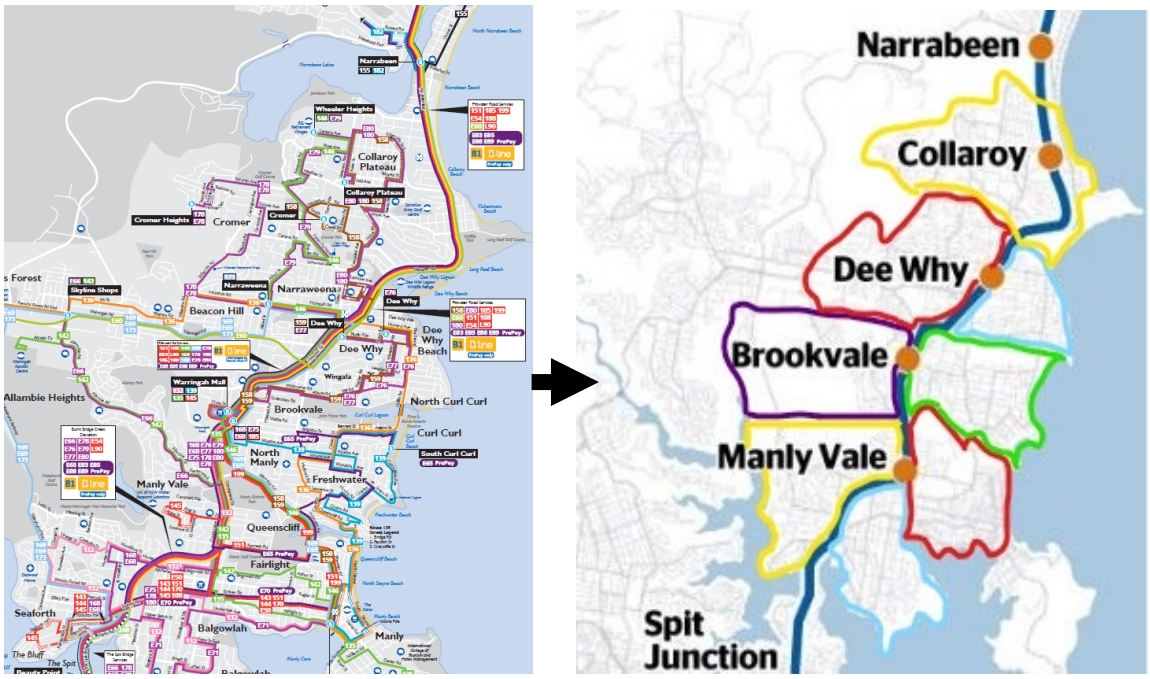


Figure 4.3 Simplification of Northern Beaches bus networks into DRT zones

4.2 Strategic Objective 2 - Connection of the Northern Beaches region to the Eastern Economic Corridor

4.2.1 Base Case – Do Minimum

This option would involve reliance on the current connections of motor vehicle transport and the B-Line to the areas outside of the Northern Beach. Projected Northern Beaches population growth of approximately 14.68% predicted from 2018-36[19] would also have to rely on the existing transport connections. Under this course of action, projected economic corridors through Chatswood and Macquarie Park would remain without a reliable or efficient connection to liveable areas and a potential workforce.

4.2.2 Option 2A: Light Rail

A light rail line in Northern Beaches would involve a connection to the end of the Sydney Northwest Metro Line at Chatswood**.** The rail line would consist of a 13km connection beginning from Dee Why, into Frenchs Forest, Forestville and ending at Chatswood. The proposed map for this light rail is shown in **Figure 5.5.**

This option provides the Northern Beaches community an efficient, high capacity transit option into the growing hubs of Sydney. Rapid travel to Chatswood would also allow commuters to travel to Sydney CBD or other central hubs via the upcoming Sydney Metro City line. The projected flow on effects of establishing this northern metro line are:

- Reduced congestion on Spit Bridge/Pittwater Road, Mona Vale Road and Warringah Road;

[19] Economy ID: Northern Beaches Council

- Reduced air pollution as car dependency is expected to decrease, and;
- Improved connectivity to the Northern Beaches Hospital located in Frenchs Forest, allowing for improved access to a valuable health infrastructure to Sydney.

The development of a metro line would have a profound impact on areas surrounding the line. Increased accessibiltiy of these regions would spur residential demand and economic activity.

The key connections nominated are Dee Why, the Northern Beaches Hospital in Frenchs Forest, Forestville and Chatswood, with the route to be defined fully after a complete impact assessment for various routes has been undertaken.

4.2.3 Option 2B: B-Line Part 2

This option involves an extension of the B-Line rapid transport service from the Northern Beaches to the Eastern Economic Corridor. The proposed route would start in between Dee Why and Brookvale and run from the original B-Line stop, offering connection further North along the existing route.

The bus would begin west to Frenchs Forest, connecting the Northern Beaches with rapid transport to the Northern Beach Hospital. It would then join the commercial corridor at Chatswood and continues north-west to Macquarie Park to provide the connection with the commercial centre and the University of Macquarie. A proposed service line is shown in **Figure 4.4.**

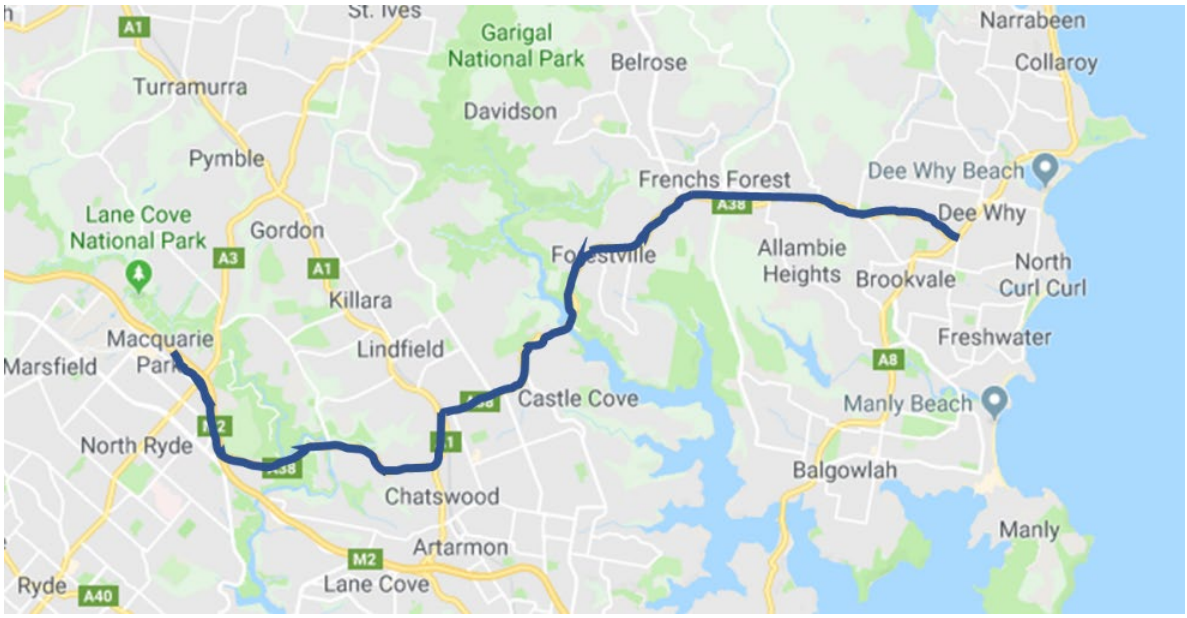


Figure 4.4 Proposed B-Line Part 2 Route

Precinct activation would be expected in the suburbs along the route, as they would also be further connected to key economic, social infrastructure and recreational areas. The implementation of a rapid-transport bus service can offer increased flexibility and relatively lower infrastructure investment requirements, as compared to large-scale infrastructure options such as Option 2A, Option 2C and Option 2D. This would also allow the service more scalability, dependant on the growth of the Beaches and economic areas and ridership.

4.2.4 Option 2C: Underground Tunnels

Currently, there is a tunnel link proposed under Middle Harbour connecting the Gore Hill Freeway on the southern side to Balgowlah in the Northern Beaches, as shown in **Figure 4.5**. The project aims to provide a motorway link between the Northern Beaches and the rest of Sydney to relieve congestion on the North Shore and improve Northern Beaches accessibility[20].

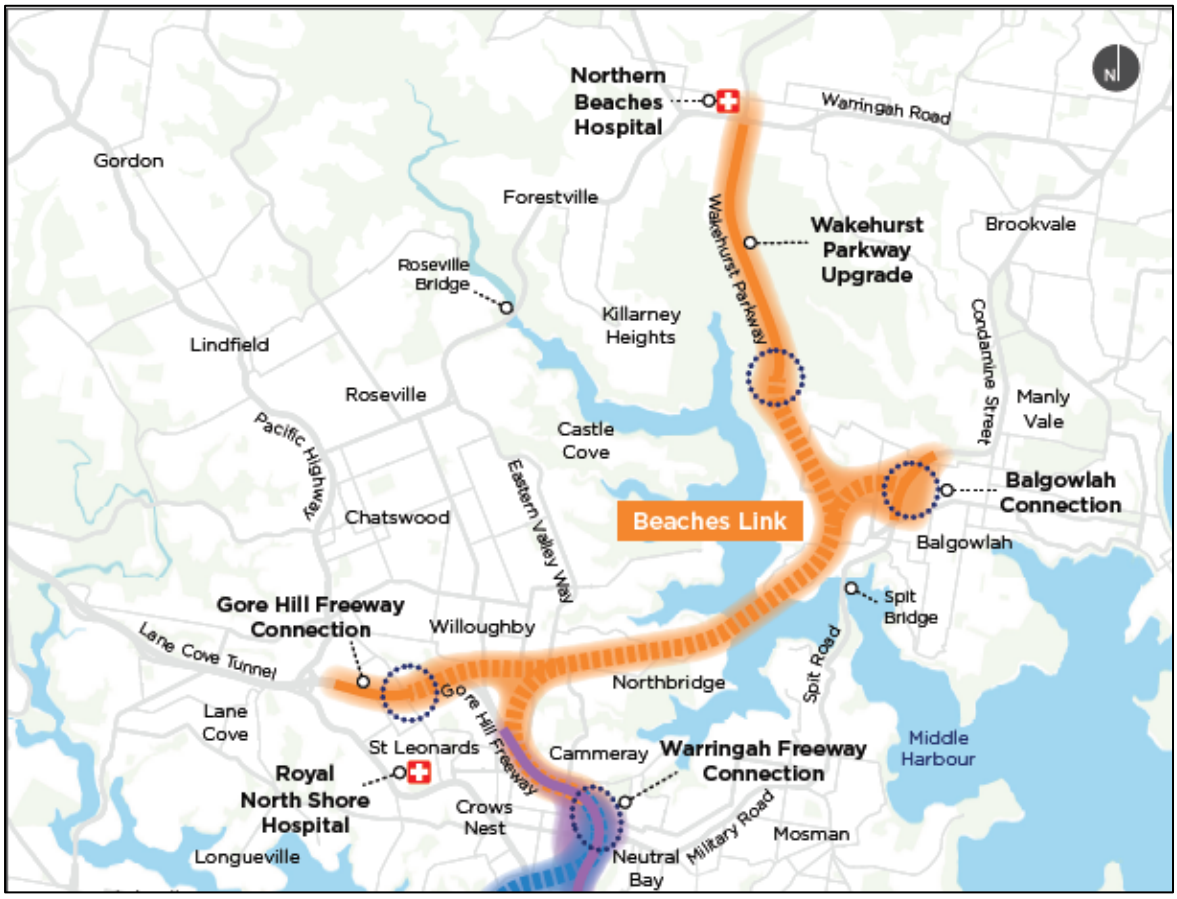


Figure 4.5 Proposed tunnel location

Alternative tunnel corridors were considered throughout the planning process however these were rejected due to geological constraints and environmental concerns[21]. As such, this option would be included as the leading option for an underground connection. Additional road capacity would allow more cars and buses to operate on less congested route from the Northern Beaches, until the proposed tunnel reaches capacity.

4.2.5 Option 2D: Additional Bridge

This option explores the possibility of constructing an additional bridge from Seaforth to Castlecrag, easing congestion on the Spit Bridge. Similar to Option 2C, this would increase road capacity for cars and buses in a key bottle-neck area, resulting in reduced travel times.

The placement of an additional bridge intersects with a number heritage listed sites along the proposed corridor, as shown in **Figure 4.6**. This could pose difficulties in the environmental planning stage and in achieving community support. Financially, this option requires significant expenditure to

[20] Beaches Link Project Update – August 2018
[21] Beaches Link and Gore Hill Freeway Connection Scoping Report – October 2017

undertake investigations, design and construction and would operate over a longer timeline than alternate options.

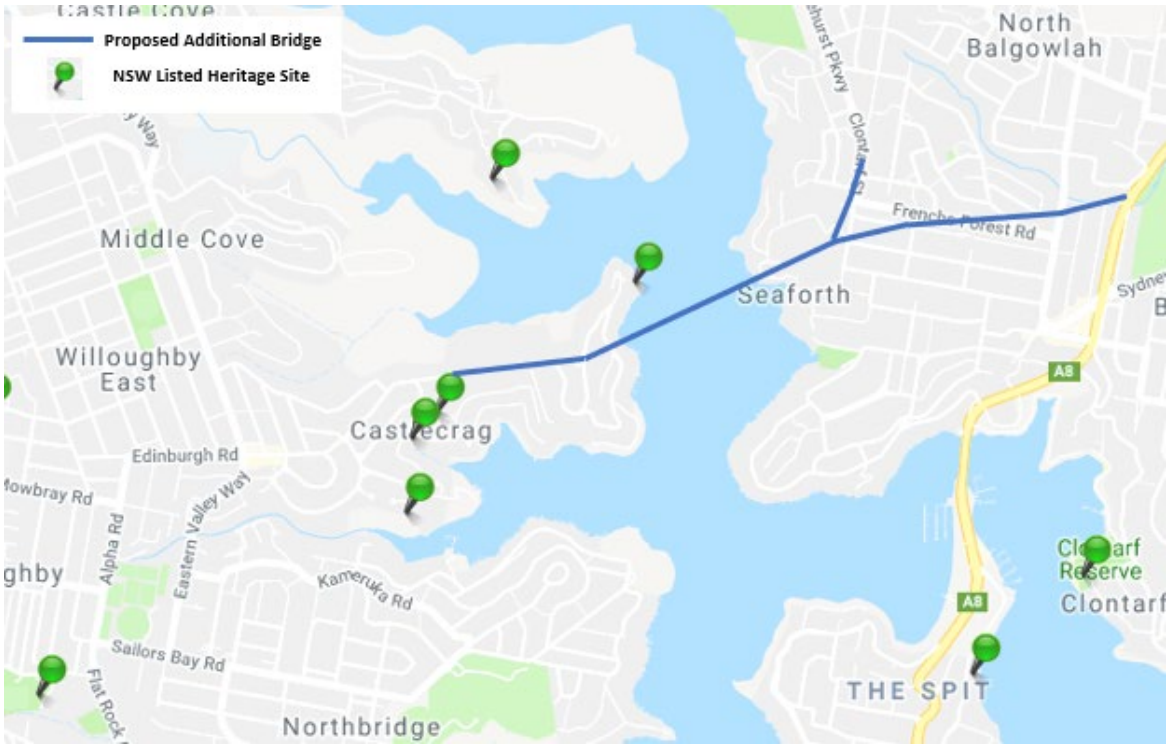


Figure 4.6 Heritage Listed Sites in Proposed site area

4.2.6 Option 2E: Utilisation of the existing B-Line service

Individual buses are subject to different delay controls throughout their travel route causing some buses to progress faster relative to others until there is no spacing between them, a concept known as bus bunching.

To remedy this inefficiency and improve the connecting service to the Northern Beaches, 'system slack' and bus-to-bus coordination could be implemented. System slack involves responding to diminishing distances between two buses by having the trailing bus stop at a pre-determined control point to re-establish the headway.

Bus-to-bus coordination involves buses altering their speed to maintain spacing. As bus spacing becomes greater than the target, the trailing bus would react by accelerating or the bus that is ahead would reduce their target cruising speed, minimising headway from the front end. In doing so, buses retain optimal spacing along the set route and stop configurations.

It is anticipated that this solution would only provide minor efficiency improvements to the current B-line service and not address the projected population growth in both Sydney and the Northern Beaches. Further, this solution provides no connection to the growth Chatswood economic corridor. As such, this option would not be considered in the options analysis below.

5 Options Analysis

5.1 Methodology

The Options Analysis is categorised into 4 main criteria:

1. Economic;
2. Social;
3. Environmental; and
4. Alignment with Sydney's Future Objectives.

Economic, social and environmental represent the triple bottom line of sustainability growth, with a weighting of 30%, 25% and 20% respectively, with the remained of weighting on the alignment of Sydney's Future Objectives.

Alignment with Sydney's Future Objective is a separate criterion because the ultimate objective is to select an option which meets the needs of Sydney's future, in line with the strategies of the current government. With the aforementioned forecasted population growth in Greater Sydney, there is a vision to create a city that is liveable, productive and sustainable. This criterion is categorised into 4 Key Performance Indicators:

- Project Scope;
- Population and congestion management;
- Potential for Expansion; and
- Time to completion.

Each option was provided a score between 1 and 3, where by 1 represented a negative or undesirable outcome, 2 a middle ground and 3 represented a positive and desirable outcome. These ranking of various outcomes are defined for each criterion in **Table 5.1**. This analysis ultimately aims to ensure the selection of an option which would allow the Northern Beaches to be in a position to not only support Sydney's Metropolis of Three Cities, but also be able to realise maximum benefits from the connectivity.

Table 5.1: Option Analysis Scoring Methodology

Score		Weighting	Positive = 3	Medium = 2	Negative = 1
Criteria	KPI				
Economic	Financial Cost*	15	<100 million	100-500 million	>500 million
	Access to Economic Opportunities	10	Provides convenient and appropriate connections to economic hubs, facilitating economic growth	Provides connections to economic hubs	Does not facilitate economic opportunities
	Travel Time Saving	5	Travel time equivalent or less than a private vehicle	0 – 30% increase in travel time compared to a private vehicle	30% or greater increase in travel time compared to a private vehicle
Social	Access to Social Infrastructure	5	Significant improvement in ability to commute daily to leading schools, hospitals and universities	Improves current connection to health and education services	Provide little to no improvement to services within the Northern Beaches or beyond
	Uptake/Usability	10	Highly convenient at a low personal cost	Improved convenience	High personal cost or overlapping with current functioning services
	Social Acceptance	10	Satisfies key community needs and encouraged by stakeholders	Competing community view or overall indifference	Actively resisted by the community and against key community values
Environment	Aboriginal and Non-Aboriginal Heritage Site Impacts	5	No heritage sites are involved/impacted	Some sites are impacted, with appropriate management would not impact project delivery/outcome	Heritage site impact would cause critical problems for project, needing significant management if possible to overcome
	Biodiversity Impacts	5	No biodiversity impact	Biodiversity impact, with appropriate management would not impact project delivery/outcome	Biodiversity impact would cause critical problems for project, needing significant management if possible to overcome

Score		Weighting	Positive = 3	Medium = 2	Negative = 1
	Greenhouse Gas Emissions[22]	5	0 emissions	<50 gCO_2/km per person	>50 gCO_2/km per person
	Noise and Visual Impact	5	No change to the ambient noise levels or visual amenity	Visual and noise impacts, with appropriate management would not impact sensitive receivers	Significant noise levels and visual disturbances
Alignment with Sydney's Future Objectives	Project Scope	10	Supports/encourages future growth hubs.	Based on medium term projections of Sydney's growth.	Only focuses on current business hubs and transit corridors.
	Population and congestion management	5	Designed for projected population levels and reduces pressure on current high-density areas	Offers future relief to transportation systems based on projected population levels.	Unsupportive of projected growth areas.
	Potential for Expansion	5	Significant potential in developing further infrastructure/systems.	Small potential for increases to capacity or availability.	No beneficial potential for expansion.
	Time to Completion	5	0-5 years	5-10 years	10+ years
	Total	**100**			

* According to the Infrastructure NSW Act 2011, a *major infrastructure project* is defined as *a project to provide infrastructure that has a capital investment value of more than $100 million.* This capital investment value refers to *all costs necessary to establish and operate the project (including design and construction costs, but not including land costs or GST).* Therefore, $100 million was selected as the dividing value between score 2 and 3.[23] Any project above the value of $500 million was significantly large.

[22] Climate Council

[23] Infrastructure NSW Act 2011 No 2

5.2 Transportation within the Northern Beaches

Table 5.2 shows the options analysis undertaken for Strategic Objective 1: Interconnectivity within the Northern Beaches. The rationale / assumptions behind this analysis are described in following **Sections 5.2.1** to **5.2.4.**

5.2.1 Base Case

As outlined in **Section 4.1.1,** the base case would involve no change to current transport infrastructure. Overall, this option had poor results due to the inability of current infrastructure to provide economic opportunities, reduce emissions from car dependency and support projected population growth in the Northern Beaches. The advantage of a 'do nothing' case is in avoiding financial outlay as well as limiting heritage and biodiversity impacts.

5.2.2 Option 1A: Developing Bus Infrastructure

Section 4.1.2 describes the alternative of increasing current bus frequency and adding new routes in the Northern Beaches suburbs. The advantage of this approach is that it is expected to receive community support and would be quick to deliver. Increasing the numbers of public buses and adding more routes is forecast to be the most expensive solution to transport within the Northern Beaches.

5.2.3 Option 1B: Developing Active Transport Infrastructure

As outlined in **Section 4.1.3**, local travel could be enhanced by further development of bike/ shared paths throughout the Northern Beaches and connecting the wider community to B-line services. This option performed well in environmental indicators due to the low environmental impact of cycling or walking as a transport alternative. However, active transport is limited in its uptake due to physical requirements and transport preferences generally. Improving active transport networks is not predicted to significantly reduce travel times or improve access to economic activities in the Northern Beaches.

5.2.4 Option 1C: On Demand Transport

This report has discussed moving from the current local bus network to a demand responsive bus network. The option scored well economically as it would involve the eventual roll back of subsidised public bus infrastructure with privately or semi-privately operated on-demand buses. The direct nature of demand transport would also reduce travel times and provide convenient connections to a range of economic hubs. Based on trial usage further north, as shown in **Figure 4.2**, it is anticipated that uptake and acceptance would be strong. The on-demand alternative aligns with Sydney's future objectives as this technology is readily adaptable to changes in populations and new growth areas.

Table 5.2 Transport within the Northern Beaches - Options Analysis

Criteria	KPI	Weighting (%)	Base Case Do Nothing	Option 1A Bus Infrastructure	Option 1B Active Infrastructure	Option 1C On-Demand
Economic	Financial Cost	15	3	2	3	3
	Access to Economic Opportunities	10	1	2	1	3
	Travel Time Saving	5	1	2	1	3
Social	Access to Social Infrastructure	5	1	2	2	3
	Uptake/Usability	10	N/A	2	1	3
	Social Acceptance	10	2	3	2	2
Environment	Aboriginal and Non-Aboriginal Heritage Site Impacts	5	3	3	3	3
	Biodiversity Impacts	5	3	3	3	3
	Greenhouse Gas Emissions	5	1	2	3	2
	Noise and Visual Impact	5	3	2	3	2
Alignment with Sydney's Future Objectives	Project Scope	10	1	2	2	3
	Population and congestion management.	5	1	2	2	3
	Potential for Expansion.	5	N/A	2	1	2
	Time to Completion	5	N/A	3	3	3
	Total	**100**	**1.88**	**2.25**	**2.10**	**2.85**

5.3 Connection to the Northern Beaches

Table 5.3 shows the options analysis undertaken for Strategic Objective 2: Connection to Chatswood / Macquarie Park. The rationale / assumptions behind this analysis in described in following sections.

5.3.1 Base case

As outlined in **Section 4.2.1,** the base case would involve no change to current transport connections from the Northern Beaches to Greater Sydney. Overall, this option had poor results due to the inability of current infrastructure to provide economic opportunities, reduce emissions from car dependency and support projected growth areas. The advantage of a 'do nothing' case is in avoiding financial outlay as well as limiting heritage and biodiversity impacts.

5.3.2 Option 2A: Light Rail

Section 4.2.2 proposes a light rail connection from Dee Why in the Northern Beaches to Chatswood. This would be the first rail connection established in the Northern Beaches providing significant time savings and access to economic opportunities. Community attitude has been mixed, although support has been voiced for rail infrastructure in the area[24] and as the economic corridor through Chatswood develops, uptake could be significant. The environmental impact of establishing the line may be significant however this is partially offset by the effect of rail uptake reducing car reliance. A large capacity transit solution which is scalable in response to patronage and connects future economic hubs is in complete alliance with Sydney's future objectives. As with any large-scale infrastructure project, the cost and time to completion are significant.

5.3.3 Option 2B: B-Line Part 2

As described in **Section 4.2.3,** a rapid bus service would connect Dee Why to Chatswood and Macquarie Park passing through Frenches Forest and Forestville. A second B-line rollout would come at a lower financial cost and time to completion than a major transport infrastructure project. It would provide social benefits of increased connection with social infrastructure, such as the Northern Beaches Hospital and the University of Macquarie. The environmental impact of a rapid bus service would be limited as much of the required infrastructure is already in place. This alternative is restricted by road infrastructure in its ability to respond to significant increases in commuters to new growth areas and as such, does not fully align with Sydney's future objectives.

5.3.4 Option 2C: Underground Tunnel

Section 4.2.4 outlines an existing proposal to establish the 'Beaches Link', a road tunnel under Middle Harbour. The tunnel would provide a road connection to existing infrastructure and reduce travel times for those using private vehicles. The proposal has faced resistance from the community and its uptake is contingent on the cost of road tolls. Environmentally, the tunnel would disturb aquatic ecosystems and encourage continued car reliance. While this proposal satisfies a number of future Sydney's objectives, the focus remains on connections to the CBD rather than decentralising these strained areas.

[24] Move: Northern Beaches Transport Strategy 2038

5.3.5 Option 2D: Additional Bridge

An additional bridge connection from Seaforth to Castlecrag is described in **Section 4.2.5**. The bridge would provide a connection to existing road infrastructure and reduce travel times for those using private vehicles. The bridge would face significant resistance from the community as similar proposals have been stopped in the past. Bridge construction would likely have a range of environmental impacts and once completed encourage continued car dependency. While this proposal satisfies a number of future Sydney's objectives, the focus remains on connections to the CBD rather than decentralising these strained areas.

Table 5.3 Connection to the Northern Beaches - Options Analysis

Criteria	KPI	Weighting (%)	Base Case Do Nothing	Option 2A Metro	Option 2B B-Line	Option 2C Tunnel	Option 2D Bridge
Economic	Financial Cost	15	3	1	2	1	2
	Access to Economic Opportunities	10	1	3	3	2	2
	Travel Time Saving	5	1	3	2	3	3
Social	Access to Social Infrastructure	5	1	3	3	2	2
	Uptake/Usability	10	N/A	3	3	2	2
	Social Acceptance	10	2	2	2	1	1
Environment	Aboriginal and Non-Aboriginal Heritage Site Impacts	5	3	1	3	2	1
	Biodiversity Impacts	5	3	2	3	1	2
	Greenhouse Gas Emissions	5	1	2	2	1	1
	Noise and Visual Impact	5	3	2	2	3	1
Alignment with Sydney's Future Objectives	Project Scope	10	1	3	2	1	1
	Population and congestion management.	5	1	3	3	2	3
	Potential for Expansion.	5	N/A	3	2	1	2
	Time to Completion	5	N/A	1	3	1	2
	Total	**100**	**1.88**	**2.25**	**2.45**	**1.55**	**1.75**

5.4 Summary of Options Analysis Results

From the option analysis undertaken in the above sections, the results realised are shown in **Table 5.4** and **Table 5.5.**

Table 5.4 Transportation within the Northern Beaches – Option Analysis Results

Strategic Objective 1		
Option	**Score**	**Rank**
Option 1C: On-Demand	2.85	1
Option 1A: Bus Infrastructure	2.25	2
Option 1B: Active Infrastructure	2.1	3
Base Case: Do Nothing	1.88	4

Table 5.5 Connection to the Northern Beaches – Option Analysis Results

Strategic Objective 2		
Option	**Score**	**Rank**
Option 2B: B-Line Part 2	2.45	1
Option 2A: Light Rail	2.25	2
Base Case: Do Nothing	1.88	3
Option 2D: Additional Bridge	1.75	4
Option 2C: Underground Tunnel	1.55	5

6 Implementation Approach

Strategic Objective 1 and 2 would work in conjunction with each other as a single solution to achieve the connectivity within the Northern Beaches, and to place the region in a position ready for Sydney's future. This is envisioned to be implemented in the following 3 stages, as shown in **Figure 6.1.**

1. On Demand Transport
2. B-Line Part 2
3. Light Rail

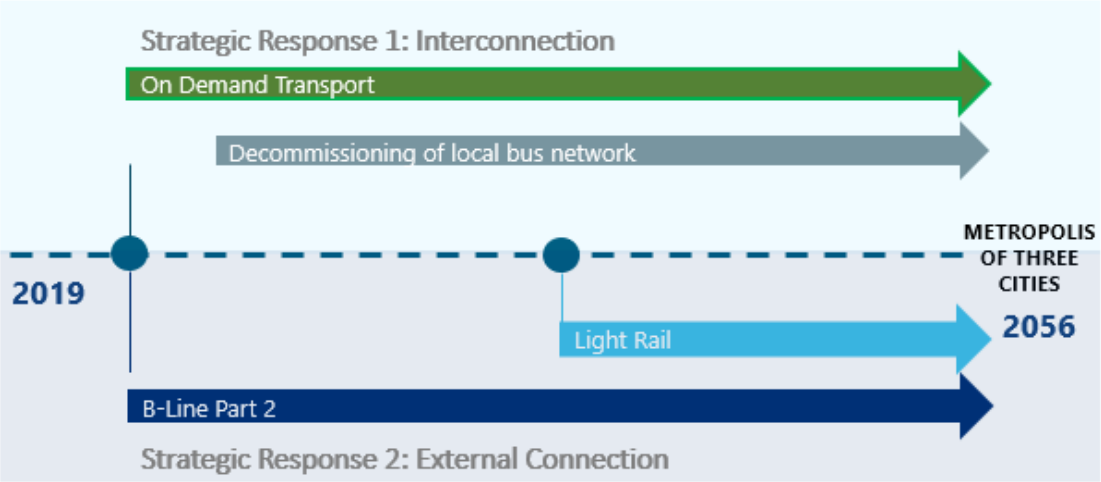


Figure 6.1 Preferred Option – Implementation Timeline

In the short term, on demand transport would be implemented within the Northern Beaches Region to achieve connectivity within the area. In conjunction, there would be further development of the B-Line buses as an initial strategy to connect the region with the Eastern Economic Corridor. It is anticipated that the implementation of a second B-Line would support job opportunities, residential development and social activities. As the population density throughout the transit corridor and associated regions increases it is proposed that a light rail be introduced to support the added capacity requirements. The details for this are outlined below.

6.1.1 On Demand Transport

In planning on-demand services in the Northern Beaches the zoning, integration, cost, technology, ownership and adaptability were considered and are outlined below.

Zoning and Integration

The proposed DRT service would be based on the successful Keoride trial currently offered in the Narrabeen to Barrenjoey area[25]. This northern area has been split into two zones which support passenger stops on the current B-Line service. The service zones for the remainder of the Northern

[25] Keoride – About Us, (2018)

Beaches would be allocated similarly, incorporating the effect of a second B-Line service while supporting the current city bound services, as seen in **Figure 6.2.**

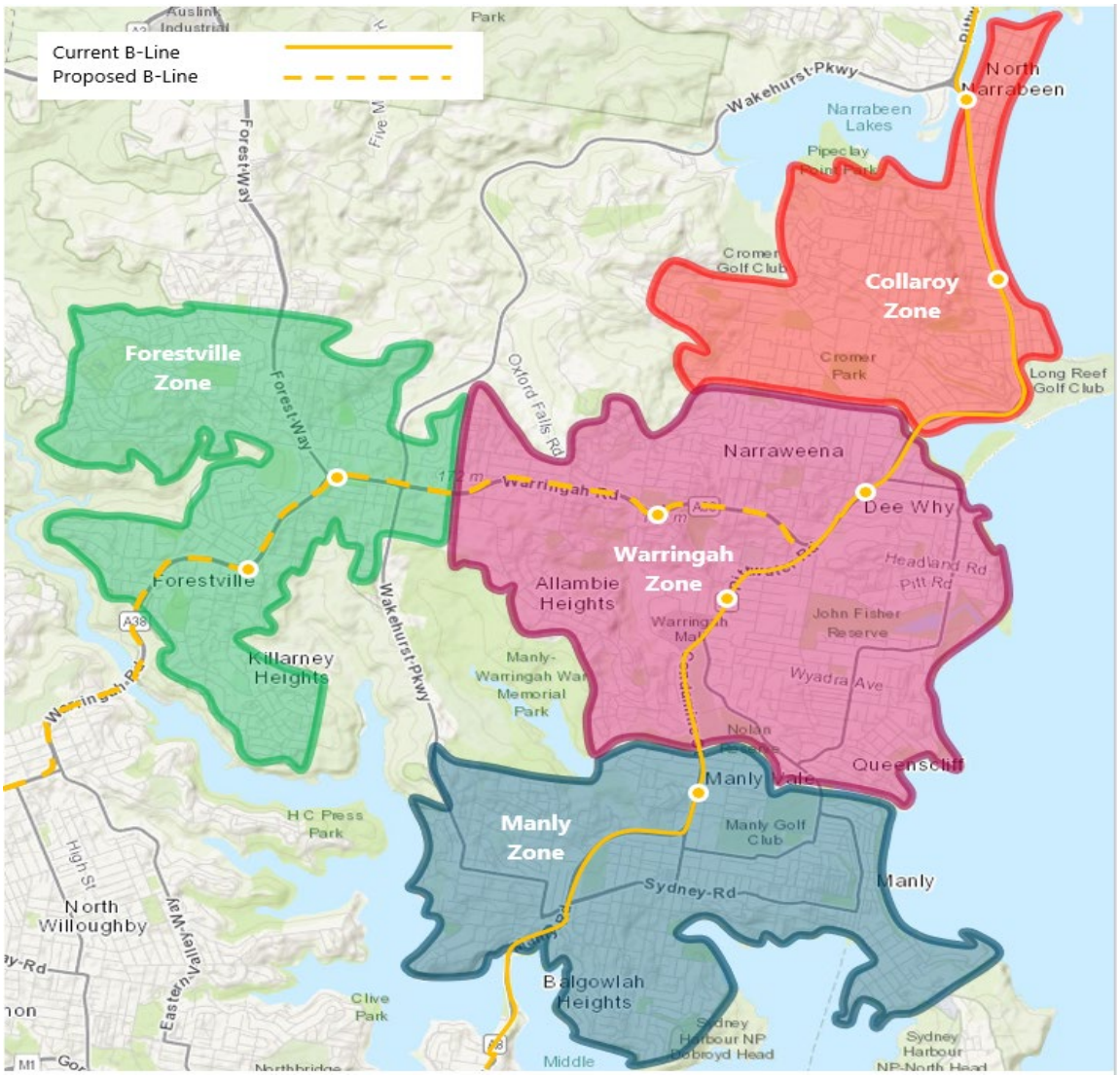


Figure 6.2 On Demand Transport Zones

It is proposed that major bus routes are continued in these zones as on-demand services are introduced. Following the establishment of on-demand services, a patronage assessment of state transit bus routes would be undertaken and those with low patronage or frequency are removed. It is predicted that the on-demand services would make redundant indirect and infrequent suburban buses currently operating as end-of-trip services.

Cost

The current one-way fares for Keoride are indicated in **Table 6.1** and relate to travel within a single zone. Due to the size of the zones and their intended use as an end-of-trip connection, it is anticipated that most trips would be less than 4km. This shows that the fare prices are generally consistent with current bus services in the area to ensure no residents are price excluded.

Table 6.1: Passenger fares[26].

Fare	On-Demand Cost	State transit cost
Standard One-Way	$3.10 (per zone)	$2.80 (0-3km) $4.40 (3-8km)
Concession One-Way	$1.55 (per zone)	$1.10 (0-3km) $1.83 (3-8km)

Technology and Functionality

Services would be ordered through an app and can be done in advance or when needed (see **Figure 6.3**). The vehicle would pickup other passengers throughout the journey as scheduled or as their requests come in. Charges would be settled via an opal tap card.

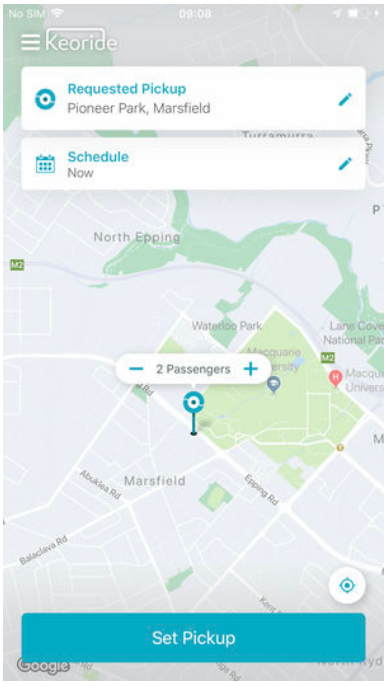


Figure 6.3 On-demand app display

Ownership

To deliver a service of this scale and complexity, the trial by Keoride indicates that a partnership between Government and several technical services provides the most feasible method of delivery. The current Northern Beaches trial uses GoGet as their fleet provider, while Via provides mobile applications, passenger connection/maintenance and dynamic routing of vehicles. Promoting a relationship between these businesses means that the technology and functionality required to serve the Northern Beaches already exists. There is likely substantial improvements required for facilitation between companies and successful implementation of these features.

Financially, funding would be required from the state government to subsidise the service. These funds would come from the savings associated with ending current state transit bus services in the area. Part ownership between private and public entities would ensure efficient operation of the on-demand services.

Adaptability

These services are highly adaptable to changes in the surrounding transport infrastructure. As population dynamics shift and commuting corridors change, the capacity of on-demand transport can easily shift to facilitate such changes. In-line with this report's suggestions for external connections to the region, well-zoned on-demand services would complete the picture off easy and efficient transportation between homes and the Eastern Economic Corridor.

6.1.2 B-Line Buses Part 2

B-Line Buses Part 2 would be implemented simultaneously with On Demand Transport. This would involve the stops shown **Figure 6.4**. The final stops would be along the Eastern Economic Corridor, specifically Chatswood and Macquarie Park. Along this route is a total of 7 stops beginning at Dee Why and ending at Macquarie Park train station. The first stop at Dee Why is the same stop used by the current B-Line, allowing commuters from Mona Vale to use this stop as an interchange. This

[26]Northern Beaches On Demand service, (2018). Transport for NSW. NSW State Government.

proposed route also allows for connectivity to the Northern Beaches Hospital, shown in **Figure 6.4.** These stops are intended to provide a guideline for the light rail stops proposed in **Section 6.1.2.**

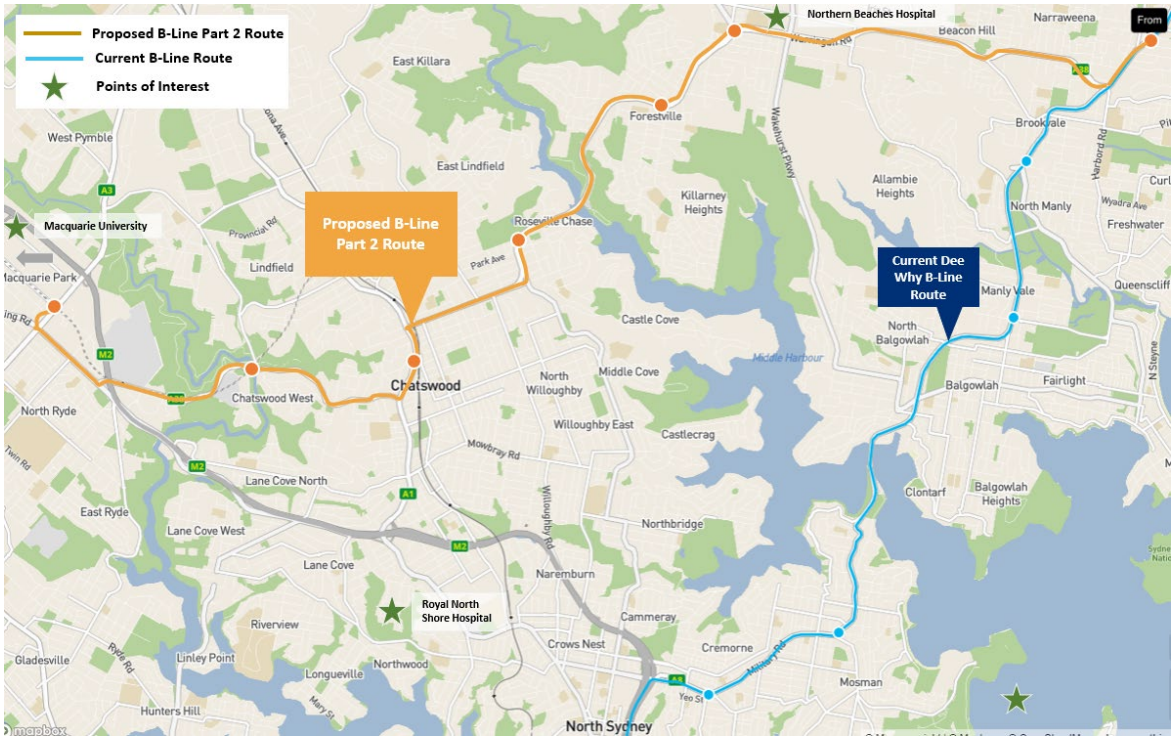


Figure 6.4 Proposed B-Line Busses Part 2 Route (Image Source: Transport of NSW – Trip Planner)

Frequency

The current B1 B-Line Bus between Mona Vale and Wynyard runs at the frequency listed in **Table 6.2**. The B-line busses Part 2 would begin at 50% of the frequency, relative to the current B-Line buses due to lower population density through the proposed corridor. This would progressively increase over time as community usage increases.

Table 6.2 B-Line Bus Frequency[27]

Current B-Line	Peak Hour	Off Peak Hour
Monday to Friday	Every 2 – 7 minutes	Every 12-15 minutes
Saturday	Every 8 -12 minutes	Every 12-15 minutes
Sunday / Public Holidays	Every 8 -12 minutes	Every 12-15 minutes
Proposed B-Line	**Peak Hour**	**Off Peak Hour**
Monday to Friday	Every 5 – 12 minutes	Every 25-30 minutes
Saturday	Every 15-20 minutes	Every 25-30 minutes

[27] Transport for NSW Timetables

Current B-Line	Peak Hour	Off Peak Hour
Sunday / Public Holidays	Every 15-20 minutes	Every 25-30 minutes

6.1.3 Light Rail

The proposed light rail corridor for the Northern Beaches is shown in **Figure 6.5.** The line is proposed to begin at Dee Why and end at Chatswood, connecting to the Sydney Metro Northwest line, which is currently under construction. The Metro Northwest will have trains running every 4 minutes. Pending population growth and demand increases, the frequency of this service would be comparable. This would allow commuters from Northern Beaches to conveniently travel to the Eastern Economic Corridor including Macquarie Park or to the City CBD.

Implementation Period

The time in which this is expected to be implemented is dependent on the level of demand for further transport options. However, this is expected to be constructed and ready for use by 2056 for the Metropolis of Three Cities. The proposed corridor pictured in **Figure 6.5** is subject to change based on detailed feasibility studies.

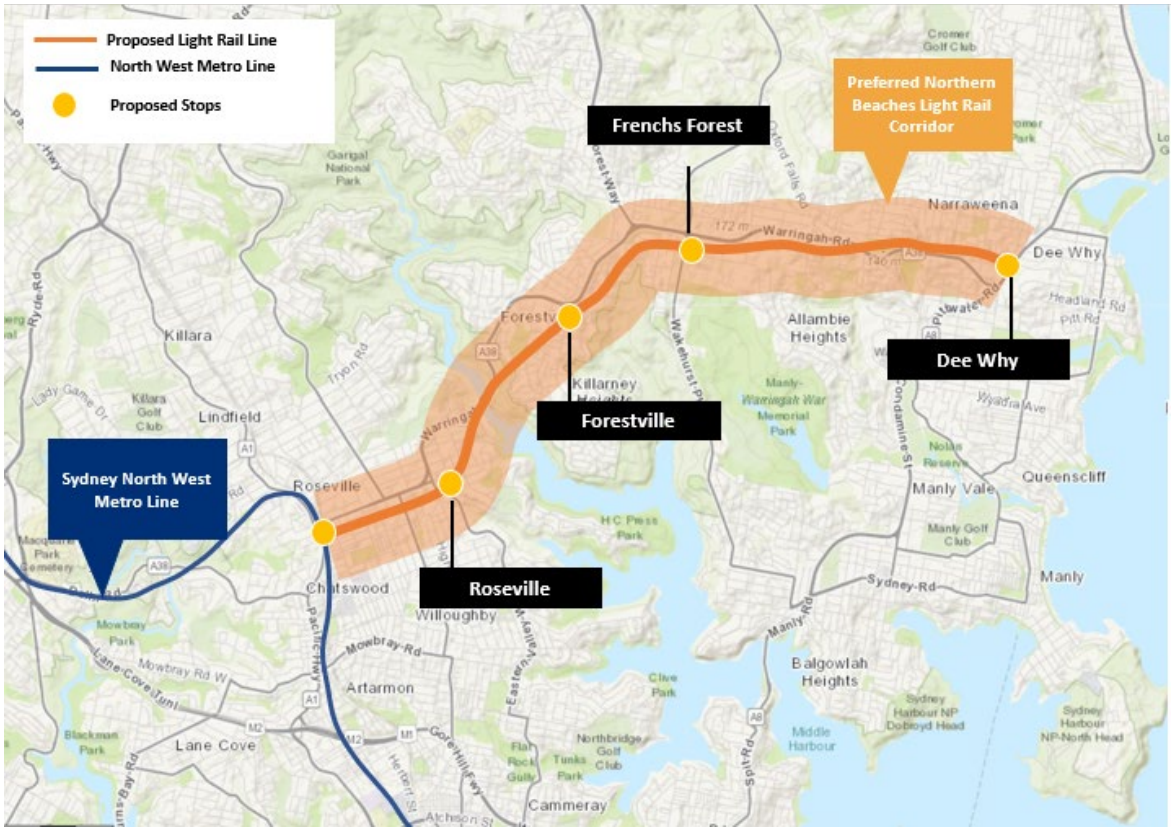


Figure 6.5 Proposed Northern Beaches Light Rail Corridor (Image Source: Sydney Metro – Interactive Map)

The expected outcomes of the alignment of light rail stations and B-line stops is the creation of transport interchanges, similar to Chatswood, at Dee Why, Frenchs Forest and Forestville. This is expected to activate the Northern Beaches Region into an active and liveable region. With the ease of

commute, residential infrastructure development and job opportunities is expected is drastically increase.

7 Conclusion and Recommendations

With the future of Sydney envisioned to change drastically over the next two decades, this report proposes that the Northern Beaches are in an exceptionally unique position to harness both economic and social advantages from Sydney's growth. This report presented two strategic objectives to position the Northern Beaches for Sydney's future:

1. Improvement of the interconnectedness and efficiency of travel within the Northern Beaches Region

2. Connection of the Northern Beaches Region to the Eastern Economic Corridor, Macquarie Park, Chatswood and St Leonards

Several options for both responses were identified and explored before being assessed in a selection matrix detailing economic, environmental, social and goal-oriented criteria. This culminated in a final connected transportation proposal both within the suburbs of the Northern Beaches, as well as it's connection to the growth of future economic hubs in Macquarie Park and Chatswood.

An On-demand transport service was the preferred option for interconnectedness within the Northern Beaches region and offers the potential for more convenient and efficient transportation that is also better for the environment. Different zones, and the advantages of previous trials were detailed in the text.

In conjunction with this last mile transportation service, the preferential options for connecting the Northern Beaches region to growth areas in the Eastern Economic Corridor were a B-Line Part 2, implemented within the next 5 years, and a light-rail line, designed to build on the B-Line service and the hubs activated as a result.

It is envisaged that this integrated solution would provide benefits in the economic, social and environmental space while aligning with the future growth patterns of Sydney. Economically, a connection to the area would provide access to work outside of the region. This transport would also increase populations within the region supporting local business prospects. Socially, the implementation of on-demand transport would allow for the movement of those without a private vehicle. Greater transport infrastructure in the region would also improve access to hospitals and universities. Environmentally, the focus on public transport solutions would reduce the emissions associated with private vehicle transport.

8 Next Steps

To take advantage of growth opportunities, social infrastructure and increasing technological capabilities, the Northern Beaches will almost certainly have to improve their transport systems both within the Northern Beaches and connecting to surrounding economic hubs. The research conducted in this thought piece indicated that the local bus systems are arguably ineffective, and significant improvements to both the community's way of life and economic value would occur from the implementation of a Demand Rapid Transport service. Similarly, the mass rapid transport of people out of (or back into) the Northern Beaches via extended B-Line services and/or a light rail system is inevitable due to the increasing congestion occurring at the region's major choke points.

To facilitate this, action should be taken now to begin a technical feasibility study. This study would incorporate gathering detailed commuter information, B-line and light rail route planning and would generate quantitative data for time saved by commuters and the corresponding reduction in economic loss as a result of this time saved. From this data a business case, with a detailed options analysis could be conducted and presented for funding and to the community. Community engagement should also occur concurrently to facilitate communication, interaction, involvement and the exchange of ideas to further improve the transport systems in the Northern Beaches to meet the needs of Sydney's future.

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Appendix A : Northern Beaches Active Transport Tracks

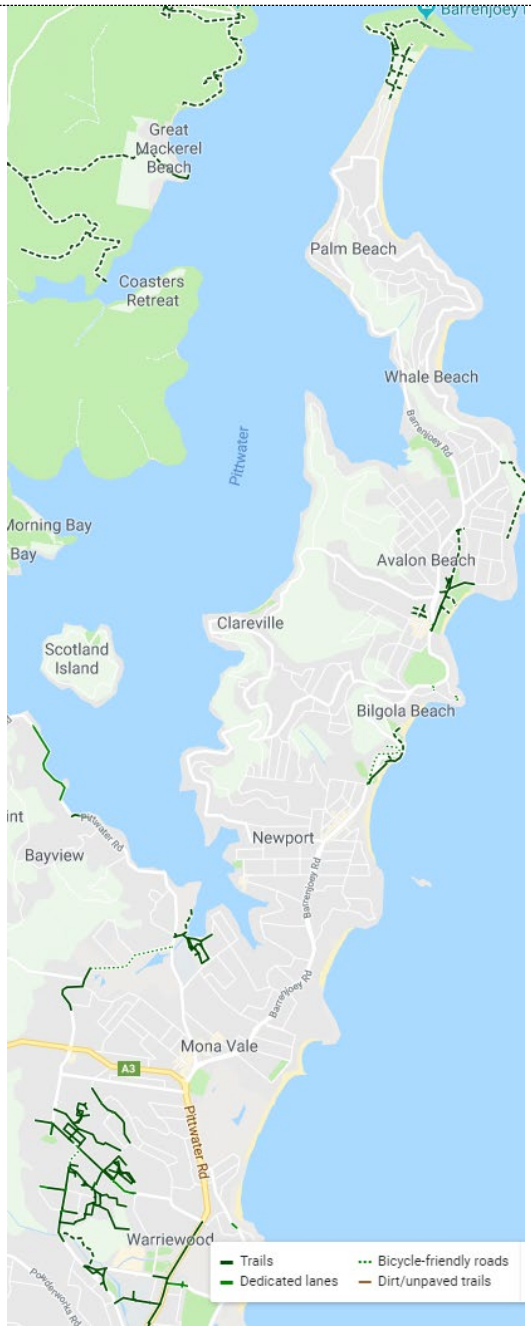

Figure A1 (a): Trails, dedicated lanes, bicycle-friendly roads and unpaved trails in the Northern Beaches from Palm Beach to North Narrabeen.

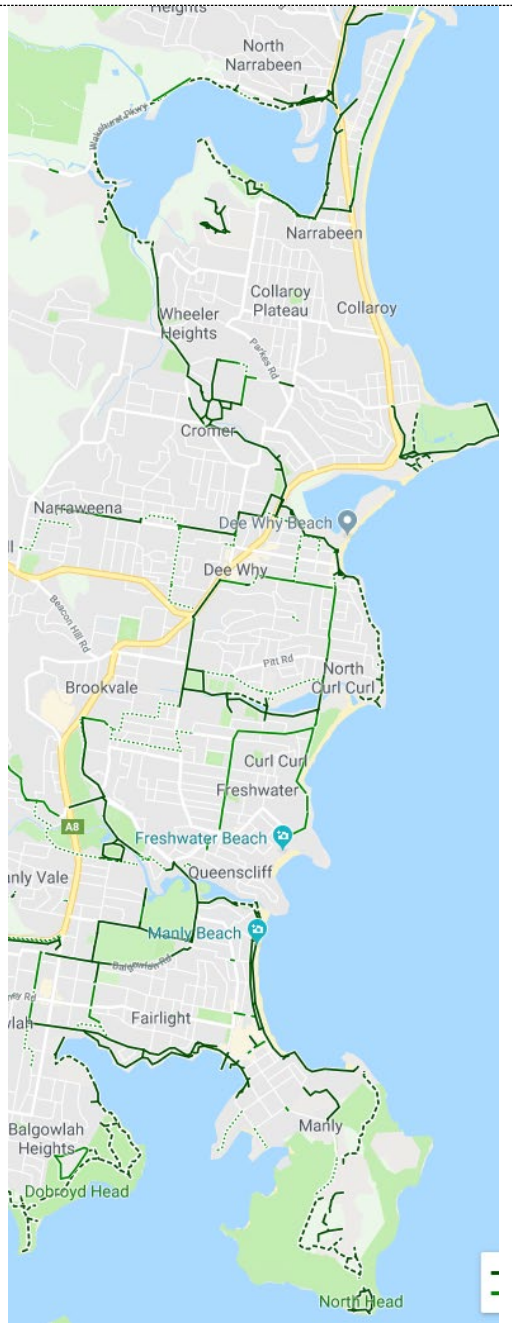

Figure A1 (b): Trails, dedicated lanes, bicycle-friendly roads and unpaved trails in the Northern Beaches from North Narrabeen to Manly.