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Technical Note 3

Subject: Where should GWRC invest in Park and Ride to maximise benefits?	
Project: Park and Ride Strategy	
Our file: NZ 2263	**Prepared by:** Peter Nunns, Anthony Leung, Elizabeth Whitaker
Status: Final	**Date:** 6 August 2018

1. Introduction

Greater Wellington Regional Council (GWRC) commissioned MRCagney to provide inputs into a Park and Ride Strategy (PaRS) for the Wellington Region, which will guide how GWRC invests in and manages Park and Ride in the Wellington Region over the next 30 years. In three separate technical notes, we:

- Discuss ***why*** GWRC invests in Park and Ride (Technical Note 1);
- Evaluate ***when*** Park and Ride is an appropriate intervention (Technical Note 2); and
- Consider ***how*** Park and Ride should be managed and designed to maximise benefits (Technical Note 4).

In this, the third technical note, we now examine ***where*** GWRC should invest in Park and Ride to maximise benefits.

The primary output of Technical Note 3 is a ranking of opportunities for Park and Ride investment in the Wellington Region, and a proposed format for reporting strategic recommendations for individual stations.

In order to rank opportunities, Technical Note 3 develops and applies an Investment Prioritisation Framework (IPF) that compares the relative costs and benefits of Park and Ride investment in different locations. This is a relative ranking that should not be taken as a measure of the *absolute* value of investing in different locations. Further information on local context, as well as a more in-depth quantification of costs and benefits, is needed to make decisions about whether to provide Park and Ride facilities in specific locations.

This technical note is structured as follows:

- Section 2 presents a proposed format for summarising and reporting the results of the assessment at a station level;
- Section 3 assesses future Park and Ride investment in Wellington, based on existing station sites by applying the IPF;
- Section 4 summarises assessment results and identifies a prioritised list of candidate locations for Park and Ride provision;

- Section 5 considers the economic effectiveness of Park and Ride; and
- Section 6 concludes.

2. Proposed format for reporting results

Based on discussions with GWRC and the results we achieved from implementing the IPF, we have identified a proposed format for reporting the results of analysis and communicating the strategic approach for each individual site.

This table is intended to provide an 'at a glance' view of GWRC's existing Park and Ride facilities and stations where there may be an opportunity to expand provision or change enforcement and management, subject to investments achieving value for money and meeting community expectations. It includes the following key pieces of information for each rail station, or other location where Park and Ride is being considered:

- Number of existing spaces at this location (zero if there is no Park and Ride)
- Occupancy at the end of the peak period, if available – see Technical Note 4 for some suggestions on occupancy targets for Park and Ride facilities
- Arrival time at Wellington Station once an 85% occupancy level is reach at each station
- Average weekday boardings
- Ranking on the IPF – we suggest reporting this in five 'bands' reflecting the relative feasibility of implementing Park and Ride at each location
- Local context for the site, including any comments on opportunities or constraints that were not measured in the IPF
- A defined short-term strategy for each site which generally focuses on enforcement activities
- An indicative medium-term strategy for each site which expands enforcement and management policies including the use of pricing to manage demand
- An indicative long-term strategy for this site, encompassing the above options.

Table 2-1 on the following page presents a proposed format for reporting outputs. The information required to populate the first six columns is available through information collected by GWRC and data generated as a result of this study. The final four columns will need to be populated by GWRC officers based on the technical advice we have offered, plus their own judgment and experience with the local context. Table 2-1 should be considered as a minimum level of data needed to inform the decision-making process. Therefore, GWRC may wish to adapt this table to report other items they deem important.

Table 2-1: Proposed format for reporting results

Station	Number of Park and Ride spaces	Occupancy at end of AM peak	Arrival time at Wgtn Station	Average weekday boardings	IPF results	Local context	Short term strategy	Medium term strategy	Long term strategy
[Station name]	[Number]	[%]	[Time]	[Number]	[5 bands related to feasibility]	[Written comments]	[Enforcement and management]	[Enforcement and pricing]	[Pricing, retain, expand, repurpose]

3. Assessment framework for Park and Ride locations

Technical Note 2 proposed an IPF to rank alternative opportunities for Park and Ride investment based on the Strategic Location principle and sub-principles. As noted above, this should not be interpreted as a measure of the *absolute* value of providing Park and Ride facilities in different locations. Instead, it highlights which locations are likely to deliver relatively higher value for money. Additionally, because the framework assesses existing locations, it may reflect locations where good investment decisions have already been made.

This Technical Note applies the framework to existing and proposed Park and Ride sites, based on the data that was available at the time that this analysis was conducted. Table 3-1 details the modified measurable indicators for the IPF. While the specifics have changed, the overall intent of the assessment criteria remains the same.

This framework can be applied to both proposed and existing Park and Ride facilities:

- First, it can be used to rank alternative options to expand Park and Ride facilities, either on existing sites or on new sites.
- Second, it can be used to undertake an indicative comparison of the relative costs and benefits of different existing Park and Ride facilities. This could be used to assist in identifying where there may be opportunities to repurpose low-ranked facilities, eg for transit-oriented development or multi-modal mobility hubs.

We report both potential and existing sites together in order to provide a consistent benchmark. It should be noted that data for Wellington Station has been excluded from this assessment as this location is not a candidate for Park and Ride provision.

Table 3-1: Investment Prioritisation Framework - Strategic Location Principle

Strategic Location Sub-Principles	Measurable Indicator	Principle Weighting	Indicator Weighting	Interpretation
1a) Expand access to the rapid public transport network	Population within 1 km of station	40%	10%	**Lower** values indicate fewer people are likely to have walking, cycling, or bus options to access the station
	Population within 1-3 km of station		10%	
	Population within 3-5 km of station		0%	Because there is some ambiguity regarding the preferred station access mode within this distance range, we have opted to apply a weight of zero.
	Population beyond 5 km of station		50%	**Higher** values indicate more people that could use PnR facility but who are outside walk, cycle, and feeder bus catchments. This is the primary market for Park and Ride users.
	Number of inbound services arriving at Wellington Station during the AM peak (7am-9am)		30%	**Higher** values indicate station is more desirable for users
1b) Intercept car commuters as early as possible in advance of congested bottlenecks	Road network distance from station to the CBD	30%	40%	**Higher** values indicate the distance people would have to travel to reach the CBD. This represents an opportunity to increase PT-passenger kms, reduce emissions, etc.
	Percent increase in travel time due to congestion from station to CBD		20%	**Higher** values indicate people would experience greater levels of congestion as they travel from the station to the CBD on the road network. Park and Ride could intercept trips before reaching congested areas of the network.
	Qualitative indicator of the accessibility and visibility of this station via car (via GWRC)		40%	**Higher** values indicate that the station is more visible / accessible
1c) Represent an efficient transport	Estimated cost per park and ride space provided ($)	20%	60%	**Lower** values indicate more cost-effective locations

Strategic Location Sub-Principles	Measurable Indicator	Principle Weighting	Indicator Weighting	Interpretation
investment	Amount of land zoned for medium to high density residential or commercial use within 500m of station		40%	**Lower** values represent locations where land may not have a higher or better use.
1d) Respond to community needs	Qualitative assessment based on requests from the local councils, public submissions, media and social media (via GWRC)	10%	100%	**Higher** values indicate more community interest in the site

We have suggested weightings for each of the Strategic Location sub-principles and the measurable indicators. The sub-principles are weighted and sum to 100%. Each measurable indicator nested under the sub-principles is also weighted to sum to 100%.

For the qualitative measures we have relied on inputs from GWRC officers. For the quantitative indicators, we have developed scores based on GIS analysis, Census data, transport network analysis, and analysis of land costs. The detailed methodology for developing these indicators is described at the end of this Technical Note.

3.1 Measuring people within station catchments

The version of the IPF we report in this technical note uses ‘theoretical’ catchments around stations. These have been calculated using GIS analysis using the following approach:

- For each point in the city, identify the closest rail station, based on straight-line distance. The total theoretical catchment for each station consists of all the points that are closer to this station than they are to any other station on the network.
- Divide the theoretical catchment up into distance bands, identifying the number of people within a one kilometre, three kilometre, five kilometre, or greater distance of the station.

We describe these as ‘theoretical’ catchments because we know, from work in other cities, there is frequently a great deal of overlap between Park and Ride facility catchments. Park and Ride users from the same suburb (or even the same street) will frequently choose to travel to different stations. This may reflect specific factors that make one Park and Ride facility more attractive than another for some users, such as presence inside a fare zone boundary or greater visibility from main roads, or it may reflect individual needs, such as the need to drop a child off at a nearby school.

For instance, vehicle number plate data on Park and Ride users in Brisbane / South East Queensland suggests that vehicles from each suburb disperse to a range of destinations. In most suburbs, there tended to be a ‘dominant’ station, but on average, only 44% of vehicles from that suburb used that station. There were relatively few suburbs where more than four out of five vehicles travelled to a single station.

As a result, in this Technical Note we also calculate 'actual' walk, cycle, and feeder bus catchments around each of Wellington's rail stations. Examples of these are mapped in Section 4.1. Where stations are close together, their catchments frequently overlap. However, we find that the number of people within these 'actual' catchments correlate well with population numbers within the 'theoretical' catchments described above.

Figure 3-1 shows that there is a strong positive correlation between the number of people within a 10-minute walk (via the existing street network) and the number of people in 'theoretical' catchments who are within a 1km straight-line distance of stations. This suggests that these measures provide a similar view on populations within walking catchments.

Figure 3-1: Correlation between 'actual' and 'theoretical' walking catchments

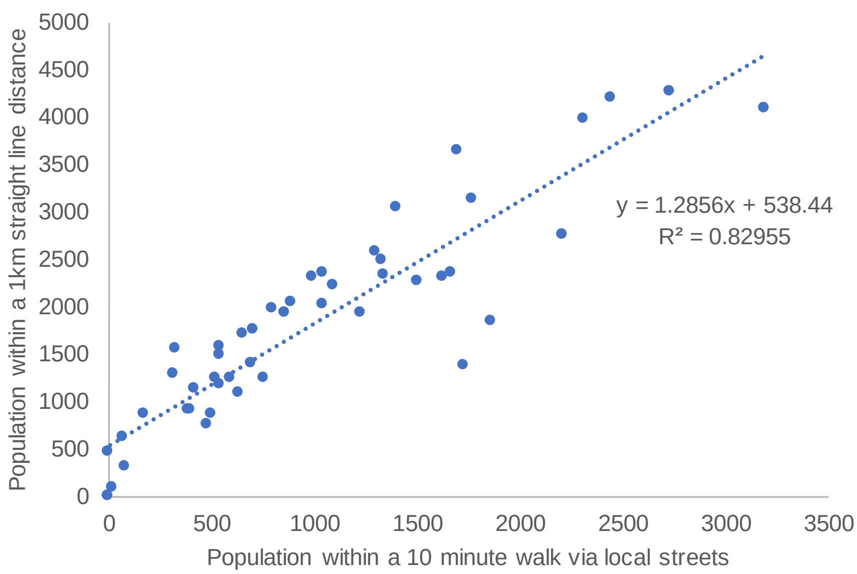


Figure 3-2 and Figure 3-3 show that there is also a positive, albeit weaker, correlation between the number of people within a 10 minute cycle or 15 minute bus journey and the number of people in 'theoretical' catchments who are within a 3km straight-line distance of stations. The R^2 values on these scatterplots indicate that the number of people living within a 3km distance of stations can 'explain' about 30% of the variation in the number of people within the 'actual' catchments.

Remaining differences between these measures are likely to reflect (a) the role of street networks and feeder bus networks in determining who can *actually* access stations via these access modes and (b) the fact that cycling and feeder bus catchments are likely to overlap. However, in many cases both measures tell the same underlying story, and as a result choosing a different catchment measure does not materially affect the assessment.

In sensitivity testing, we find that there is an almost perfect correlation (R^2= 97%) between the results obtained by using the 'actual' versus 'theoretical' catchments.

Figure 3-2: Correlation between 'actual' and 'theoretical' cycling catchments

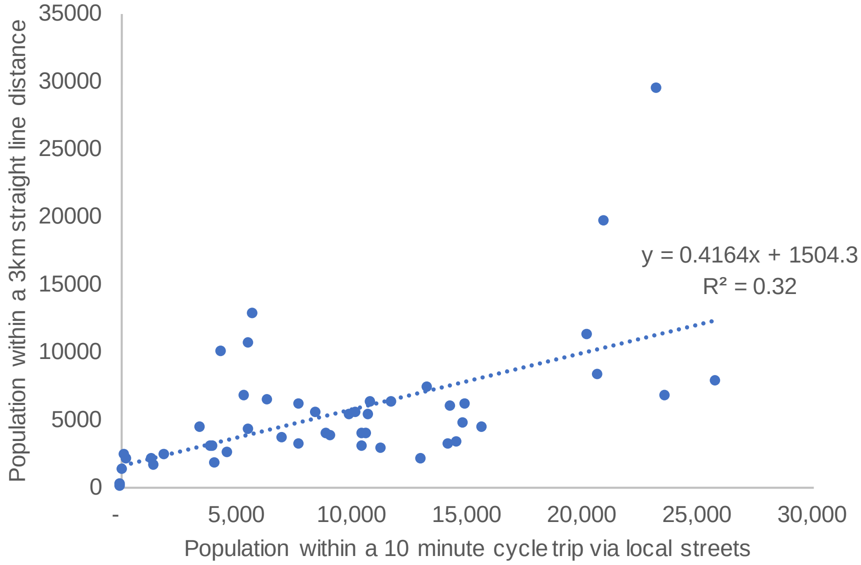
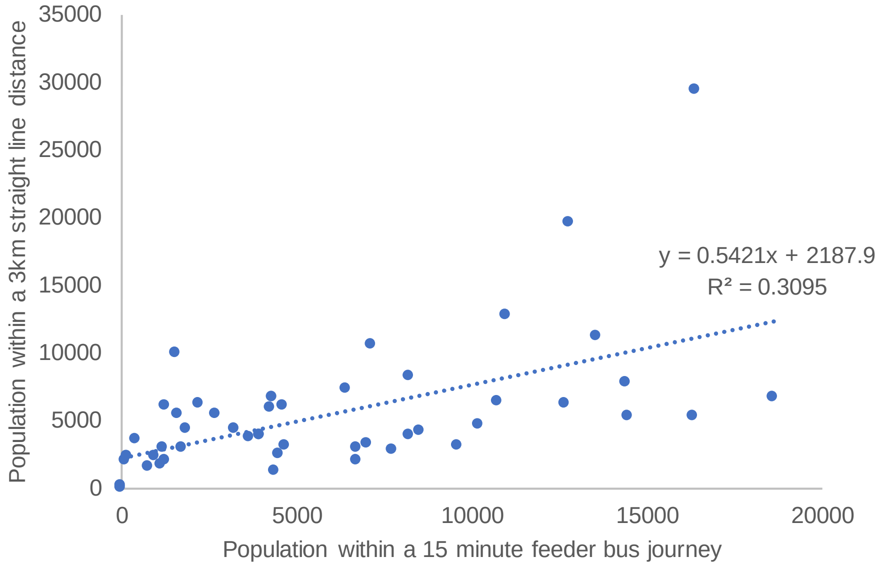


Figure 3-3: Correlation between 'actual' and 'theoretical' feeder bus catchments



4. Assessment Results

Table 4-1 summarises the key results of this assessment for 48 Wellington rail stations, 33 of which have existing Park and Ride facilities and 15 of which do not. We have grouped stations into five bands of feasibility based on their scoring on the IPF. Stations in band 1 were ranked highest or are the most feasible for Park and Ride, while stations in band 5 were ranked lowest or the least feasible for Park and Ride. We note that the stations are not prioritised within the bands, but rather arranged alphabetically by rail line then by distance from Wellington Station.

These rankings are indicative, not definitive. There are likely to be some difficult-to-measure factors that mean that some locations are more or less attractive than they seem on paper, such as access arrangements around the station or difficulty acquiring nearby sites for Park and Ride.

With that caveat in mind, higher-ranked sites are likely to be more appropriate for investment in new or expanded Park and Ride facilities, while lower-ranked sites are likely to be lower priorities for investment. In some cases, it may be desirable to investigate opportunities for repurposing sites to enable transit-oriented development or mobility hubs, acknowledging that these are not necessarily appropriate solutions in all locations.

Detailed information for each station can be found in Section 8.

Table 4-1: IPF Results

IPF Band	Station	Rail Line	Area Type	# of spaces
1 – Most feasible locations for Park and Ride	Featherston	Wairarapa	Rural	147
	Woburn	Hutt	Suburban	159
	Solway	Wairarapa	Rural	87
	Petone	Hutt	Urban	448
	Silverstream	Hutt	Suburban	95
	Melling	Hutt	Urban	187
	Waikanae	Kapiti	Suburban	377
	Matarawa	Wairarapa	Rural	0
	Paremata	Kapiti	Suburban	222
	Manor Park	Hutt	Suburban	55
	Masterton	Wairarapa	Rural	87
	Carterton	Wairarapa	Rural	98
2	Porirua	Kapiti	Urban	811
	Renall St	Wairarapa	Rural	0
	Woodside	Wairarapa	Rural	98
	Takapu Road	Kapiti	Rural	175
	Maymorn	Wairarapa	Rural	0
	Plimmerton	Kapiti	Rural	107
	Waterloo	Hutt	Urban	628
	Paraparaumu	Kapiti	Urban	527
	Crofton Downs	Johnsonville	Suburban	54
	Redwood	Kapiti	Suburban	147
	Johnsonville	Johnsonville	Urban	35
	Paekakariki	Kapiti	Rural	79
3	Simla Crescent	Johnsonville	Suburban	0
	Ngauranga	Hutt	Urban	0
	Taita	Hutt	Suburban	120
	Tawa	Kapiti	Suburban	214
	Mana	Kapiti	Suburban	48
	Upper Hutt	Hutt	Urban	349
	Awarua Street	Johnsonville	Suburban	0
	Linden	Kapiti	Suburban	0
	Kenepuru	Kapiti	Suburban	0
	Pomare	Hutt	Suburban	77
	Trentham	Hutt	Suburban	127
4	Ngaio	Johnsonville	Suburban	49
	Epuni	Hutt	Suburban	0
	Raroa	Johnsonville	Suburban	45
	Wingate	Hutt	Suburban	0
	Box Hill	Johnsonville	Suburban	0
	Pukerua Bay	Kapiti	Rural	30
	Khandallah	Johnsonville	Suburban	14
	Naenae	Hutt	Suburban	24
	Heretaunga	Hutt	Suburban	0
	Western Hutt	Hutt	Suburban	0
	Ava	Hutt	Suburban	0
	Wallaceville	Hutt	Suburban	126
5 – Least feasible location for Park and Ride	Wellington	All	Urban	0

To provide additional context, Figure 4-1 shows the times at which Wellington's Park and Rides reach 85% occupancy. Outer stations are more likely to reach high occupancy levels before the peak period. However, as Figure 4-2 demonstrates, this is partly a function of the fact that rail journey times from these locations to Wellington Station are long, meaning that people must leave earlier to arrive at work on time. Once travel time to Wellington Station is factored in (via Figure 4-2), it appears that some of the closer-in facilities are less available for Park and Ride.

Figure 4-1: Time at which Park and Ride is 85% occupied

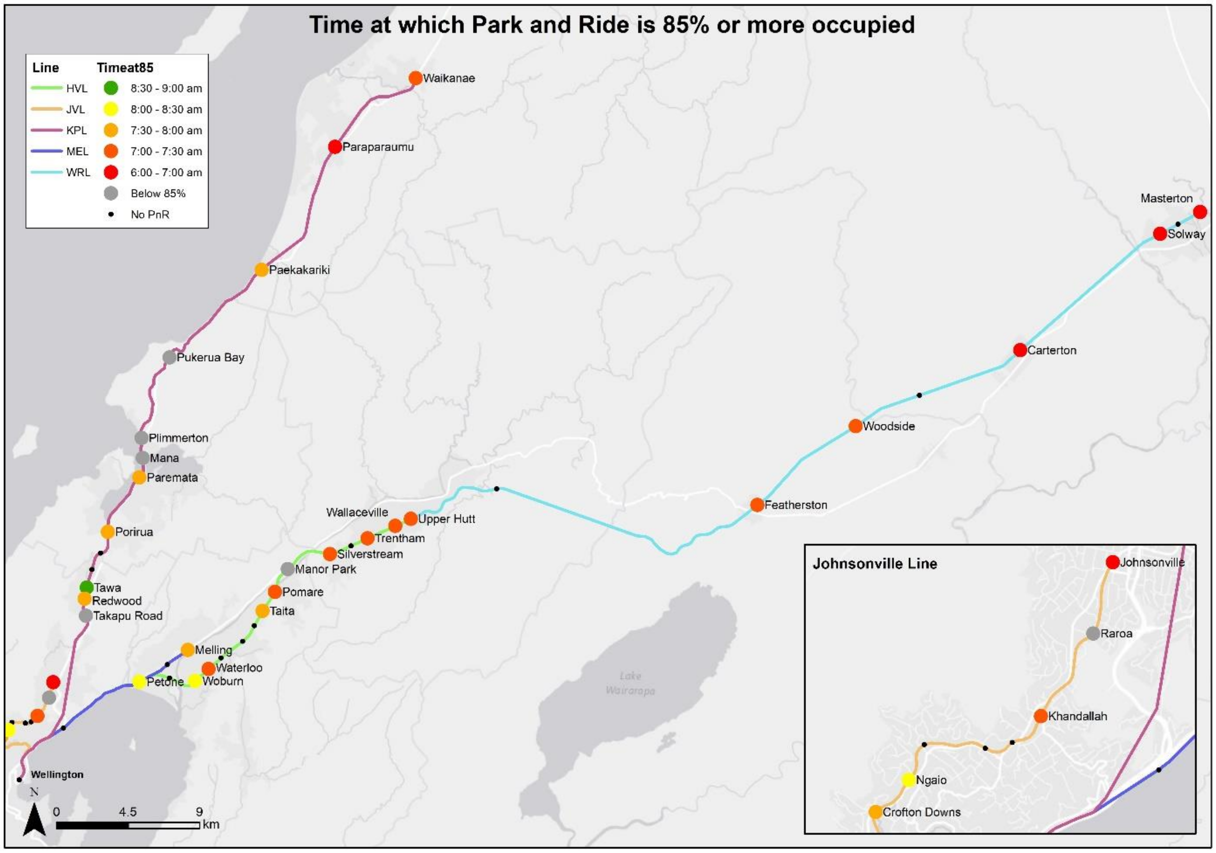
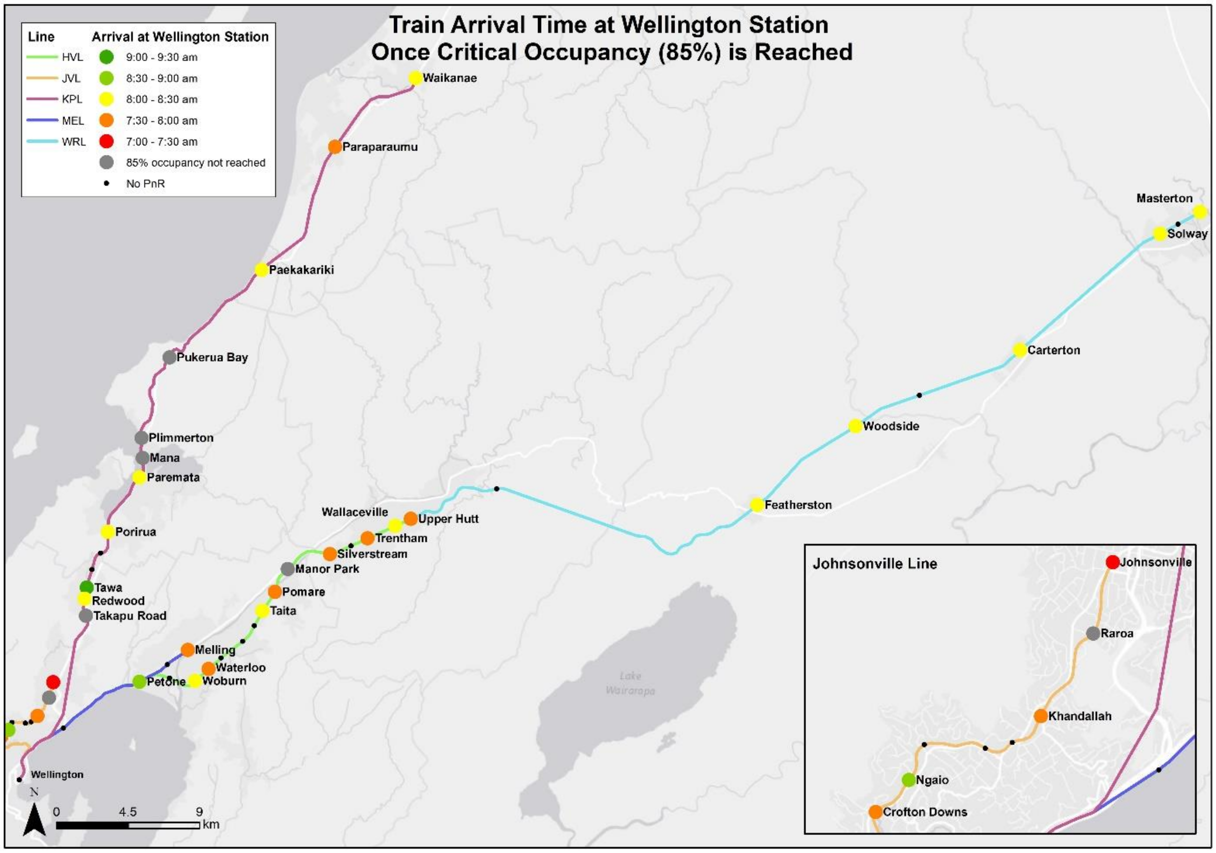


Figure 4-2: Arrival Time at Wellington Station Once Critical Occupancy is Reached



In addition, the assessment reveals locations that are likely to be lower priorities for investment and where there may be more attractive options for land near stations. Likewise, a number of rail stations without existing Park and Ride facilities fell towards the bottom of the rankings, indicating that GWRC has historically avoided investing in sites that are likely to offer lower value for money.

4.1 Walking, cycling, and feeder bus catchments

To that end, Figure 4-3 through Figure 4-10 show walking, cycling and feeder bus catchments for several stations in the Wellington region. These catchments provide an example of the access opportunities around each station. The amount of area and people within a short walking, biking, or bus transfer distance varies considerably between locations, reflecting:

- The density of land uses around stations – stations located within reasonably dense urban or suburban areas are likely to have more people in catchments;
- The structure of local street networks – this affects how easy it is to walk directly to stations, or how easy it is to provide direct bus services;
- Local topography, which affects how easy it is to cycle to stations; and

- The structure and frequency of local bus networks – areas with higher-frequency services or routes that serve more of the surrounding suburbs are likely to have larger feeder bus catchments.

As a general principle, Park and Ride investments will have larger benefits where other access options are more limited by the above factors. In these places, most people may not be *able* to access stations without Park and Ride options. However, where there is an abundance of options for accessing stations, then adding Park and Ride spaces may simply divert some people from alternative access modes.

An important point is that, where Park and Ride is freely available, people may drive quite short distances to access it, rather than employing alternatives. There is no guarantee that new spaces will be used for people travelling from outside of existing walking, cycling, or feeder bus catchments.

Figure 4-3: Petone Station Catchments

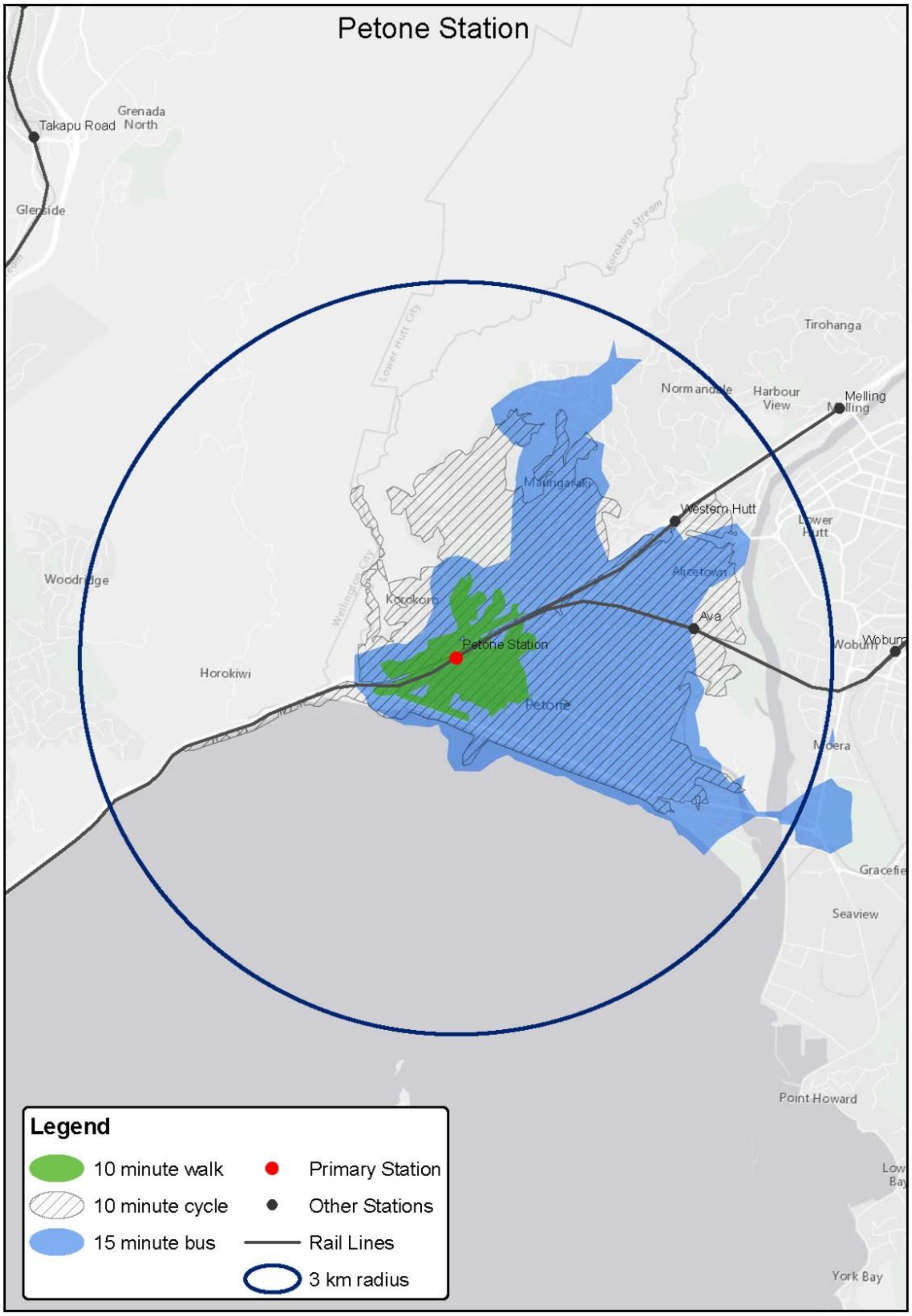


Figure 4-4: Melling Station Catchments

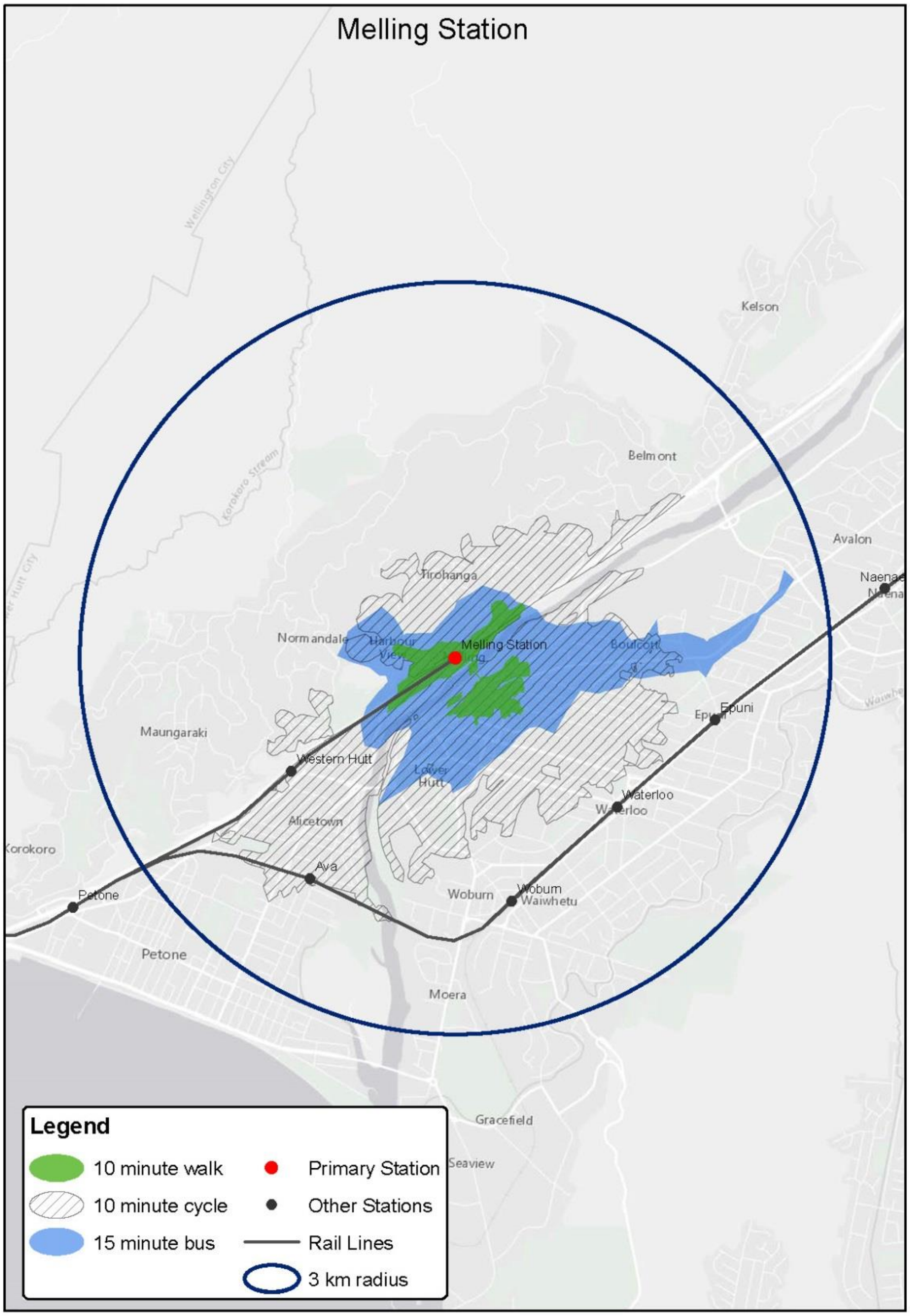


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Figure 4-5: Waterloo Station Catchments

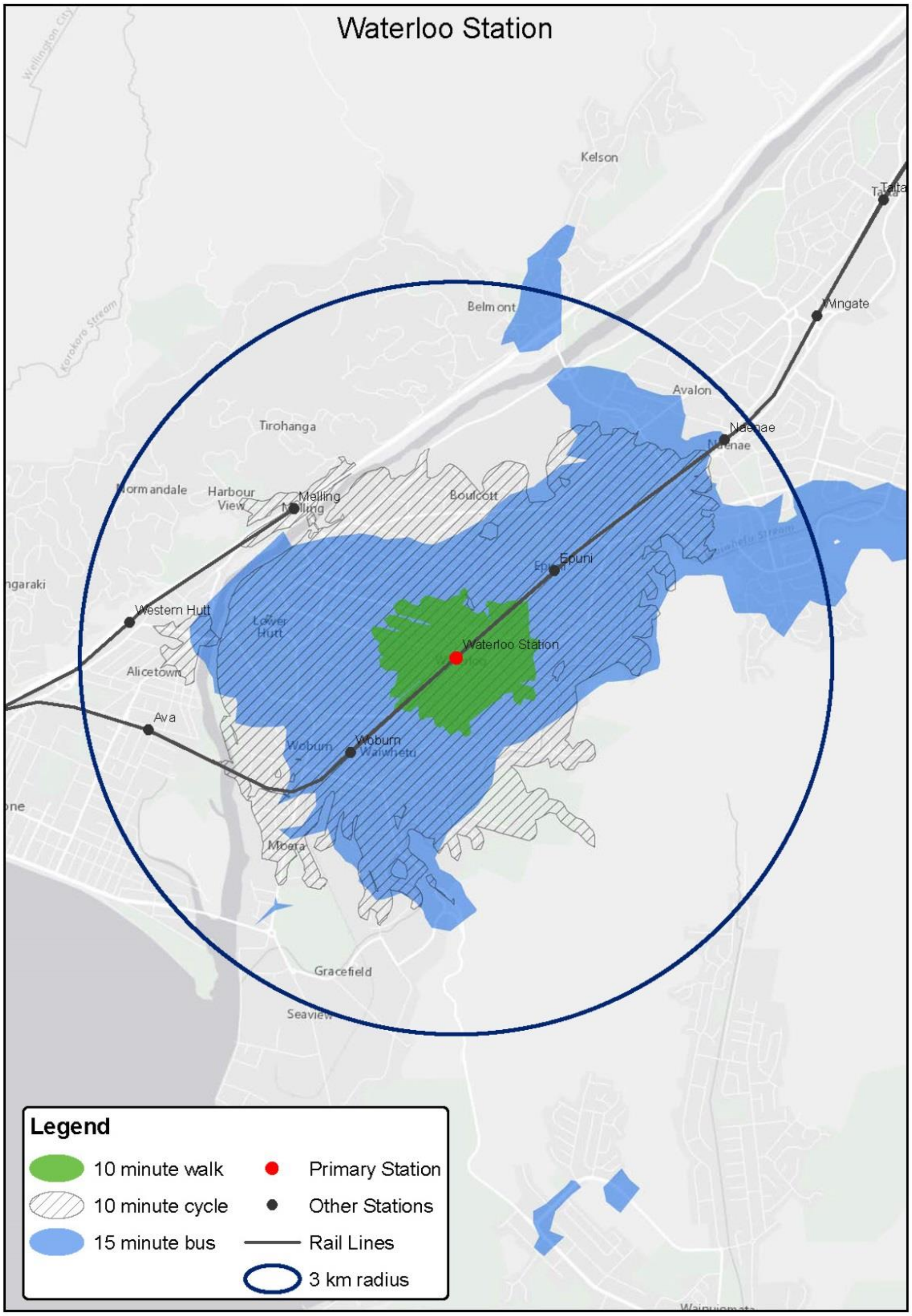


Figure 4-6: Silverstream Station Catchments

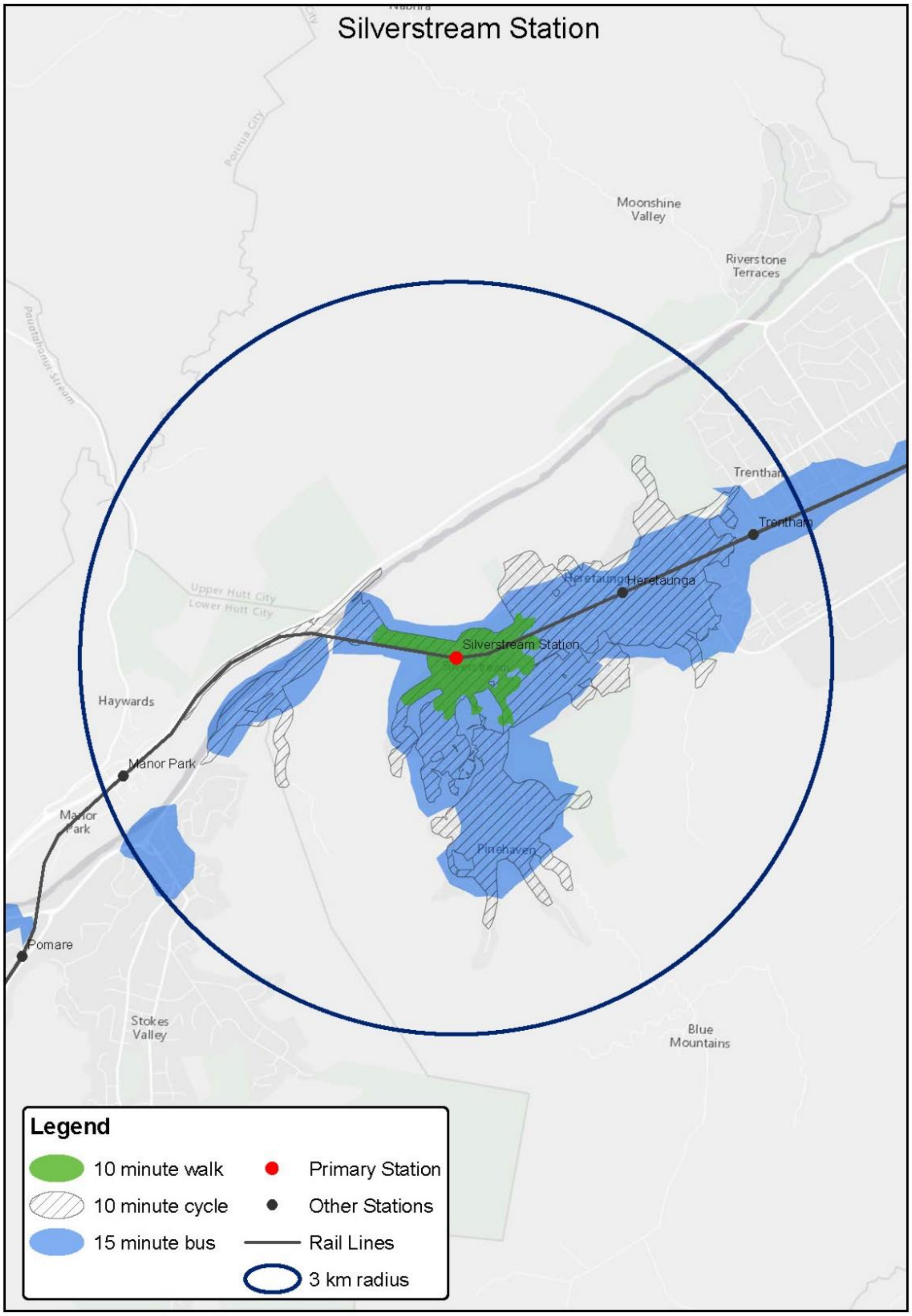


Figure 4-7: Porirua Station Catchments

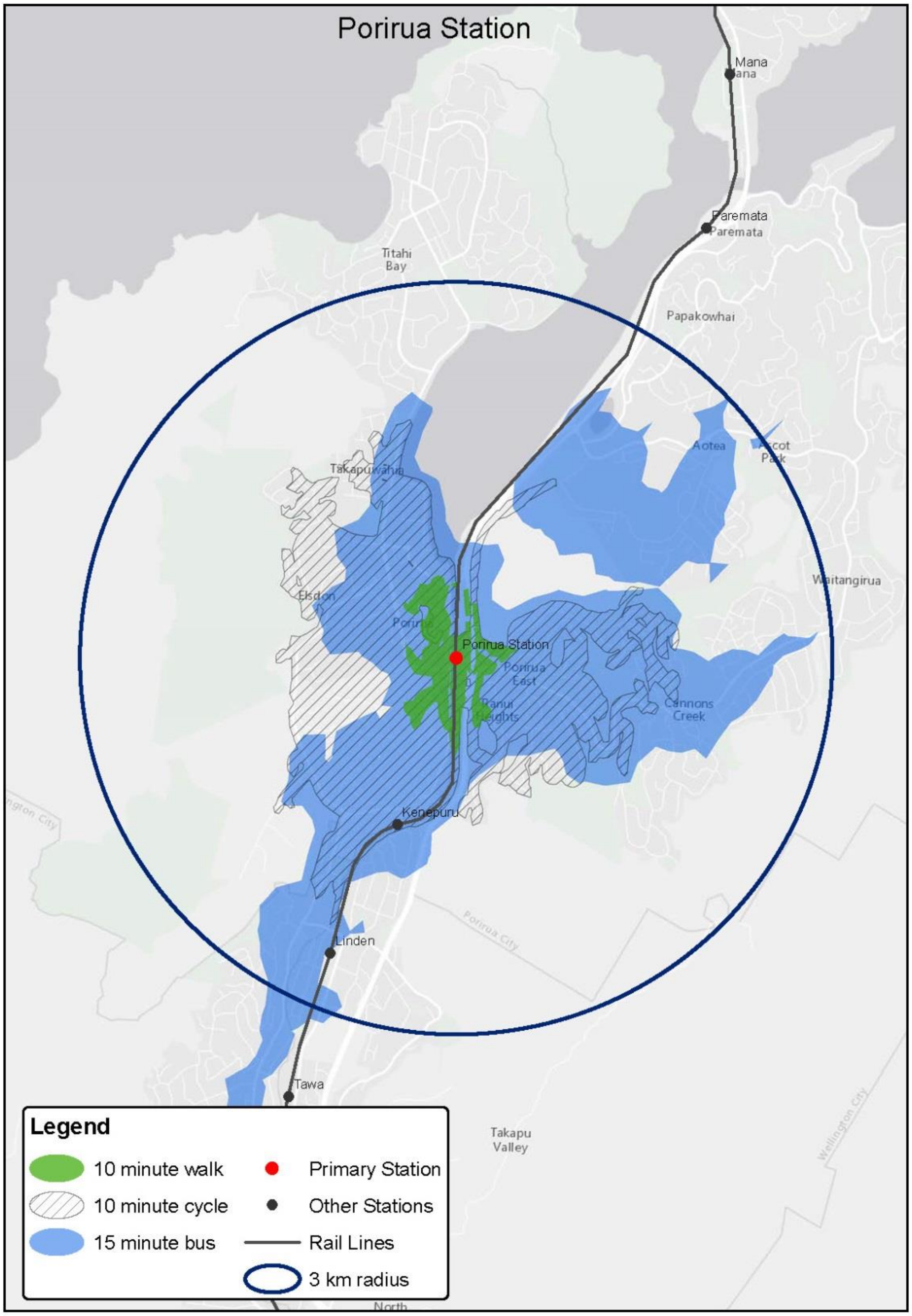


Figure 4-8: Paremata Station Catchments

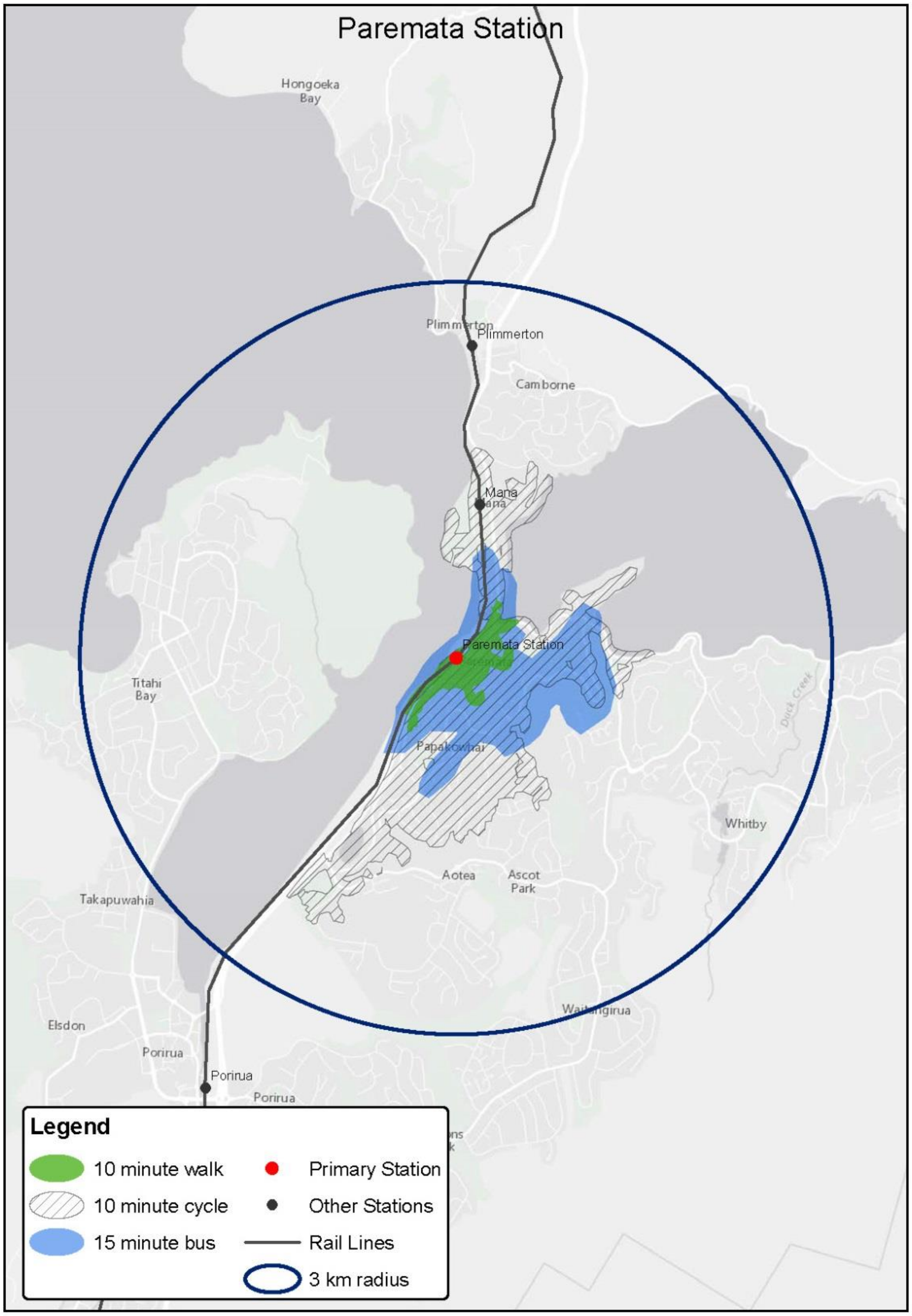


Figure 4-9: Paraparaumu Station Catchments

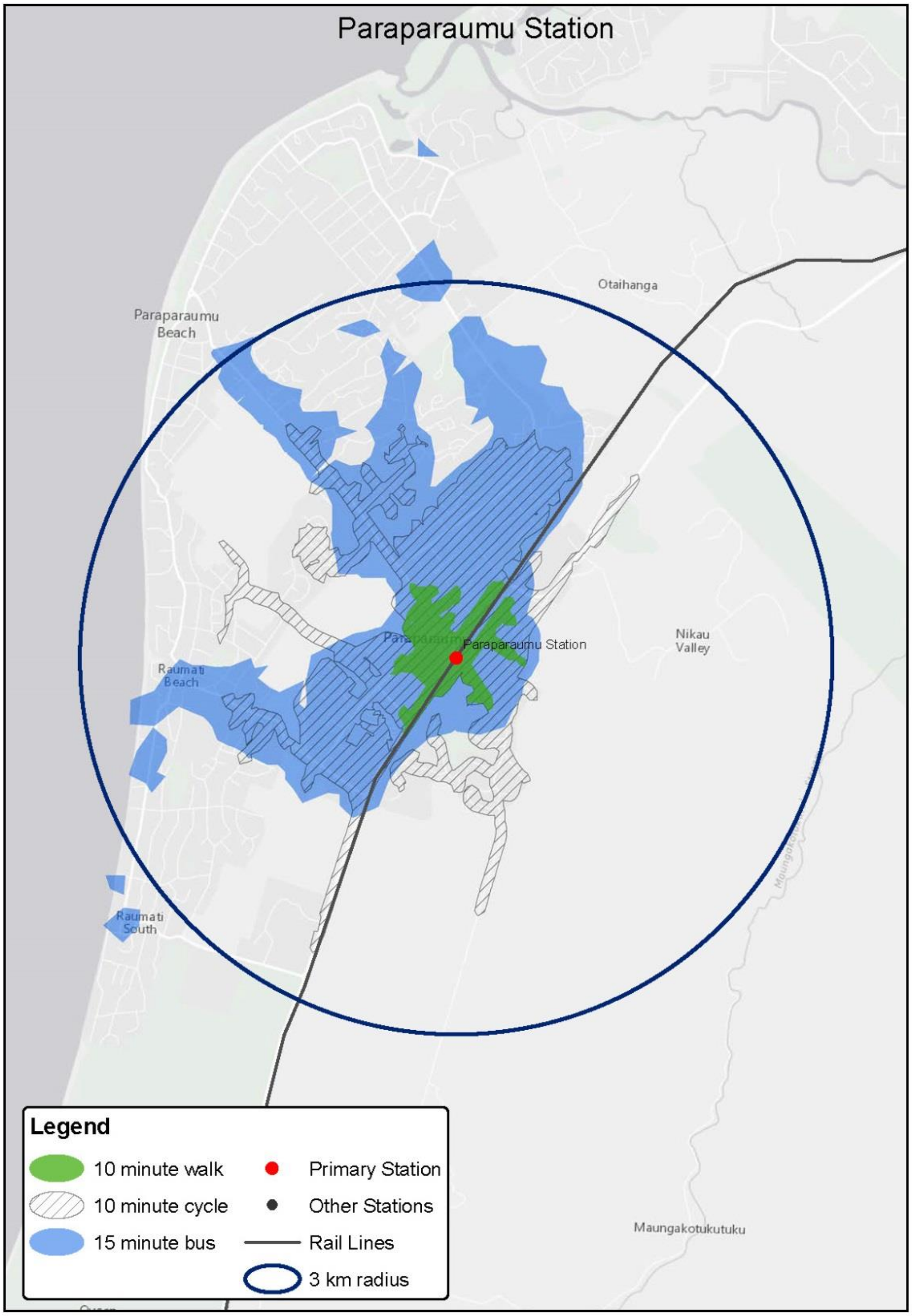
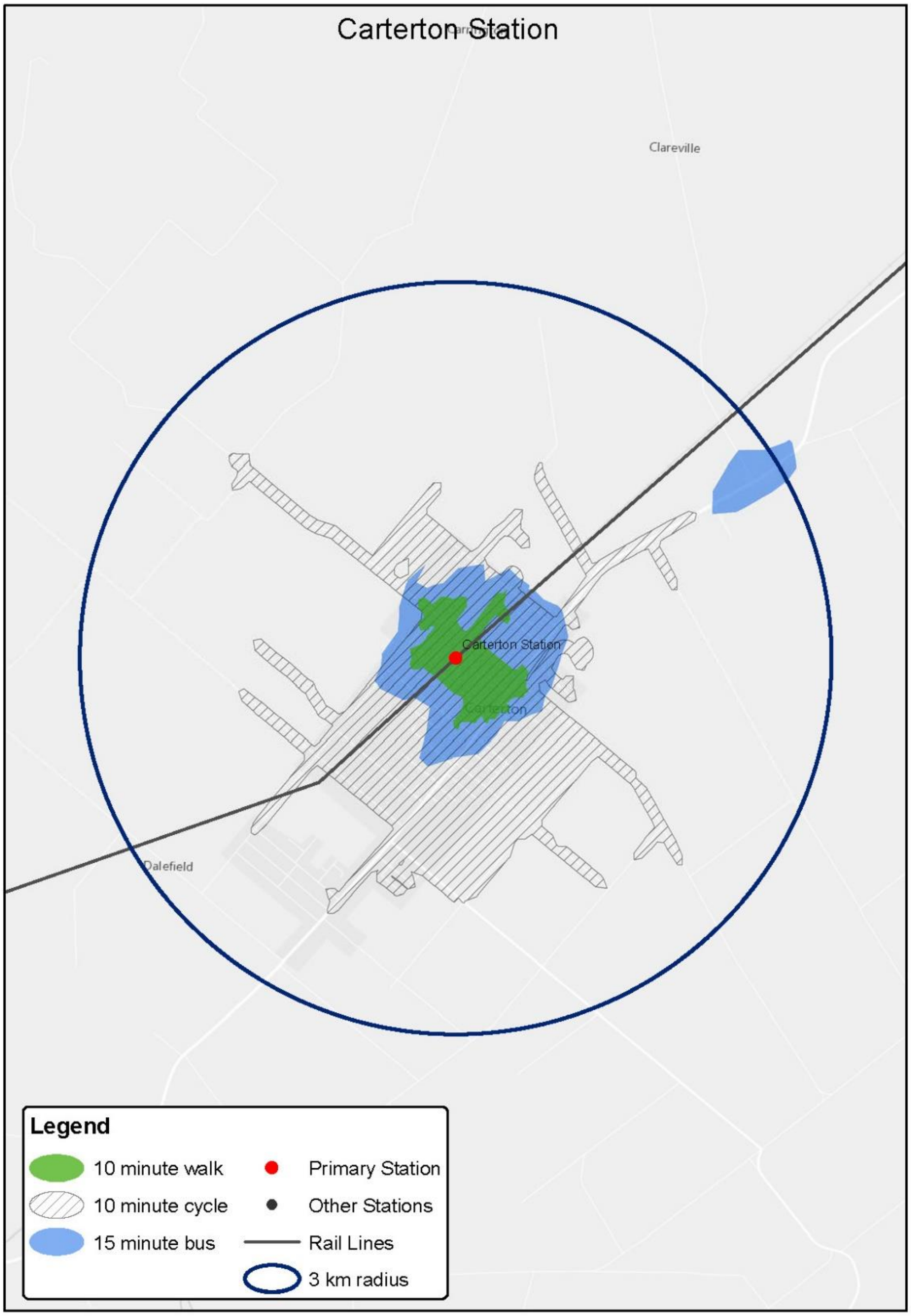


Figure 4-10: Carterton Station Catchments



4.2 The cost of Park and Ride provision

The assessment included an indicative estimate of the cost to build new Park and Ride spaces in different locations. Using estimated land values around the station and construction cost estimates, we calculated costs to provide surface parking and multi-storey parking at each location. We then identified whether surface or structured parking could be delivered for a lower cost.

Interestingly, for 17 stations, a multi-storey facility would be the lowest cost option for the provision of addition parking capacity. This reflects relatively high land values in these areas. In other areas, surface parking is likely to be cheaper to provide.

Table 4-2: Lowest cost parking option

Surface Parking		Multi-Storey Parking
Awarua Street	Plimmerton	Ava
Box Hill	Pukerua Bay	Epuni
Carterton	Raroa	Johnsonville
Crofton Downs	Redwood	Mana
Featherston	Renall St	Manor Park
Heretaunga	Silverstream	Naenae
Kenepuru	Simla Crescent	Paremata
Khandallah	Solway	Petone
Linden	Takapu Road	Pomare
Masterton	Tawa	Porirua
Matarawa	Trentham	Taita
Maymorn	Waikanae	Upper Hutt
Melling	Wallaceville	Waterloo
Ngaio	Woodside	Wellington
Ngauranga		Western Hutt
Paekakariki		Wingate
Paraparaumu		Woburn

5. Factors affecting value for money from Park and Ride facilities

To help guide investment decisions, it is useful to consider factors that affect value for money from proposed or existing Park and Ride facilities. Our previous work suggests that Park and Ride is best-viewed as a complement to the public transport system. In this section we:

- Explore the costs and benefits of Park and Ride, which drive value for money;
- Examine land use opportunities at new or existing Park and Ride locations; and
- Provide an example of the costs associated with providing Park and Ride versus feeder bus services.

5.1 Costs and benefits of Park and Ride

To understand whether proposed or existing Park and Ride facilities are likely to provide value for money, it is useful to consider the factors that drive costs and benefits. As previously noted, the key economic benefits of Park and Ride relate to its role in increasing access to public transport and diverting car trips away from congested roads, while the economic costs relate to the cost of land for parking spaces, including the 'opportunity cost' of foregone alternative uses of that land.

Table 5-1 summarises the key factors related to value for money from Park and Ride. We split these into benefits and costs, provide some economic intuition as to their origins, and highlight the key variables that tend to differ between sites.

Park and Ride will benefit users where it offers a more attractive way for them to complete their journey. The size of this benefit reflects the 'consumer surplus' associated with using Park and Ride compared to their next best alternative, which will vary by site and by person.[1] Therefore, the size of these user benefits is defined by the total number of users, as well as the degree to which users are diverted from other modes and the relative costs of these modes compared to Park and Ride.

1 Formally, consumer surplus is defined as the gap between what someone is willing to pay to do something, and what they actually have to pay. For instance, if someone would be willing to travel up to an hour to reach their job, but they can actually get there in 30 minutes, then they would derive a corresponding consumer surplus. Where a policy or project reduces the cost that people face to travel, it can increase consumer surplus. In the above example, reducing commuting time to 25 minutes would increase the person's consumer surplus by the equivalent of five minutes of travel.

Table 5-1: Benefits and costs of Park and Ride – Types, origins, and key variables.

Type	Type and origins	Key variables
Benefits	*Park and Ride user benefits* – these benefits accrue to the people who use Park and Ride and reflect the consumer surplus they derive from using Park and Ride compared to their next best alternative.	Total number of Park and Ride users Diversion rates from other modes Costs of other modes
	Decongestion benefits – where Park and Ride users would have otherwise driven further in congested conditions, then the provision of Park and Ride will generate decongestion benefits for other road users.	Diversion rates from car Road congestion levels
	Public transport benefits – where Park and Ride users contribute to increased patronage and/or fare revenue, then this may lead to benefits in the form of lower operating subsidies and economies of scale/density in PT services.	Diversion rates to public transport Fare revenue per journey PT operating costs with/without Park and Ride
Costs	*Land purchase costs* – these costs relate to the value of land on which the Park and Ride is provided.	Cost of land
	Construction costs – these costs relate to the costs of constructing Park and Ride, which are primarily a function of individual site characteristics, such as geography/topography.	Costs of developing Park and Ride
	Maintenance costs – these costs arise from the need to maintain Park and Ride facilities, which are likely to incur both a fixed and a variable component (related to size).	Costs of maintaining Park and Ride
	Congestion costs – these costs may arise where Park and Ride leads to increased demand for vehicle travel on local street networks.	Diversion rates to car Road congestion levels
	Public transport costs – these costs may arise when Park and Ride diverts people from using connecting PT services.	Diversion rates from public transport Fare revenue per journey PT operating costs with/without Park and Ride.
	Health disbenefits – these costs may arise where Park and Ride diverts people from walking and cycling.	Diversion rates from walking and cycling Length of trips

This table provides a basis for understanding how the benefits and costs of Park and Ride vary between locations. For example, consider the relative merits of inner compared to outer suburban locations for providing Park and Ride. It seems reasonable to suggest that outer suburban locations will experience less demand, due to the smaller size and lower density of the catchment, which may reduce user benefits. On the other hand, outer suburban locations are also likely to have several factors that increase the relative benefits of Park and Ride, such as:

- Fewer alternative options (increasing user benefits)
- Higher diversion rates from car compared to non-car modes (increasing the net public transport benefits and reducing health disbenefits)
- Higher decongestion benefits, due to the longer length of diverted journeys
- Lower land costs, which will improve value for money by making it cheaper to supply new facilities.

This illustrates why the IPF tends to prioritise Park and Ride locations that are further from the urban centre over closer-in locations.

Although qualitative assessments are useful, one can go further. New Zealand Transport Agency Research Report 562[2] considers the economic benefits and costs of Park and Ride in Auckland and Wellington. Among other things, it provides data on 'diversion rates' between other travel options, as shown in Table 5-2.

Table 5-2: Park and Ride Diversion Rates in Auckland and Wellington

Previous/next best mode	Wellington*	Auckland
Car drivers	12	34
Direct bus service	3	16
Feeder bus service	9	6
On-street parkers	41	33
Parked at another station	16	6
Other	19	5
Total	100	100

* Average of Petone and Waterloo

In the Wellington context, Park and Ride users' next best alternative is characterised as follows:

- 41% of people would continue to drive to the PT station and park on-street
- 19% of people would choose an option that is not listed (i.e. Kiss and Ride, walking/cycling, and rideshare)
- 16% of people would drive to another PT station with Park and Ride
- 12% of people would drive the whole way to their destination
- 9% of people would access the PT station using a connecting bus service
- 3% of people would access their destination using a direct bus service

We note two aspects of this survey. First, if Park and Ride were not available, then 41% of respondents would expect to park on-street. Therefore, lack of Park and Ride in these locations

2 https://www.nzta.govt.nz/assets/resources/research/reports/562/docs/562.pdf

may contribute to significant spill-over parking issues. Second, a relatively low proportion of respondents (12%) would choose to drive the whole way to their destination[3].

The latter finding implies the provision of Park and Ride at these two locations in Wellington may result in limited decongestion benefits, which the research notes is the primary source of economic benefits from Park and Ride. Nonetheless, the report found that three case studies of Park and Ride in Wellington generated benefit cost ratios ranging from 2.0 to 3.1, indicating that total benefits were two to three times larger than costs.

5.2 Opportunities to repurpose land around stations

Park and Ride can be thought of as a form of strategic 'land banking' to ensure that transport agencies retain the ability to enable or deliver transit oriented development or multi-modal mobility hubs near rapid transit stations. In order to achieve benefits from this strategy, it is necessary to hold land until there is demand for more intensive development around stations, and then choose to repurpose it for alternative uses.

Where it is commercially feasible to develop, medium to high density development can deliver more passengers to rail stations than Park and Ride spaces. Parking is space-intensive, and as a result apartments or office buildings can deliver more *people* to stations.

To illustrate, Figure 5-1 shows the newly opened Daisy Apartments, which are located on a busy bus corridor and near the Western Rail Line in Auckland. There are 33 apartments in this building, which occupies a site of less than $400m^2$. Moreover, the building has zero parking spaces, meaning that most residents will travel by public transport, walking, or cycling for most trips.

Assuming an average of $28m^2$ per parking space, including access and manoeuvring, this site could accommodate only 14 surface parking spaces, compared to 33 apartments. Moreover, because this site is located in a relatively congested inner suburban area, a Park and Ride facility here would not only deliver fewer public transport users but would probably contribute to localised congestion around the station.

However, medium-density apartments like Daisy are not feasible to build in most places. They are most likely to be viable in places where land values are high, indicating pent-up demand for more intensive development. In areas with low land values, a lower-density built form is likely to be achieved, which may (a) not deliver as many people to the station and (b) may lock out more intensive development options in the future.

Historically, there has been relatively little demand for medium-density development outside of the central areas of Wellington City, but there is currently evidence of rising prices and rising housing demands in other city councils throughout the region. If this trend continues, there may

[3] Given the size and scale of Wellington's Park and Ride network this figure, in absolute terms, could represent a relatively large number of vehicles.

be more opportunities for transit oriented development in the future, which GWRC would be well placed to capitalise on, given the current land holdings at key locations.

Figure 5-1: Daisy Apartments, Akepiro St, Auckland

Multi-modal mobility hubs are another complementary opportunity for re-use of land around stations. Technical Note 2 provided a discussion on the concept of mobility hubs, including their characteristics, benefits to public transport patronage growth, ability to support residential and employment growth and to improve the urban public realm.

Toronto stands out as a city with a clearly defined mobility hub strategy, which identifies 51 sites as suitable for transformation into mobility hubs. In the New Zealand context, some private parties are developing aspects of mobility hubs, e.g. through the provision of extra services such as 'Click and Collect' at selected Auckland train stations to offer convenience to shoppers. Wellington's central train station also has several retail offerings, including a popular supermarket.

In light of these local and international trends, it would be useful to identify other stations in the Wellington Region that have potential to transform into mobility hubs. While a comprehensive mobility hub site identification process is beyond the scope of this Technical Note, we have drafted some indicative criteria to assist GWRC identifying potential opportunities for a comprehensive mobility hub strategy like that of Toronto.

Table 5-3 proposes a set of criteria for mobility hub that relate to the Effective Design sub-principles of the PaRS.

Table 5-3: Initial mobility hub identification criteria

Effective Design Sub-principle	Desired Outcome	Rationale	Indicator for assessment
Integrate with local transport networks	Existing or planned use of station as a public transport interchange (e.g. bus-train; train-train; bus-bus, etc)	Sites that serve as a transfer point between different public transport services are natural centres of human activity, rendering them potentially suitable for the provision of extra services and the development of mobility hubs.	Measured via formal classification as an interchange, as well as identification of informal interchanges through boarding/alighting/transfers data from ticketing
	Sites of considerable pedestrian and/or cycling activity	Sites with streets that contain high levels of footfall and/or cycling activity are potentially suitable as mobility hubs as the integration of transport services with consumer-oriented services would be able to leverage off the nearby pedestrian and cycling activity.	Measured through pedestrian and cycling counts
Support future land use development (both on site and in the wider vicinity)	Existing or planned medium to high residential and employment densities in the station's vicinity	Existing or planned medium to high residential and/or employment densities increase the number of people near stations. Development of mobility hubs at these sites would leverage off these populations, to benefit both public transport customers and local residents.	Identified through zoning, strategic planning documents, information on future developments, and Census data on population and employment
	Presence of public amenities and key destinations nearby (e.g. community centres, libraries, schools, retail, commercial services, places of interest)	Sites near these amenities / destinations may attract people travelling from different locations. Integrating the destination site with travel options in the form of a mobility hub increases public transport accessibility to and from these sites, leading to patronage benefits and added convenience for customers of these destinations.	Identified through GIS mapping or qualitative assessment of attractors / destinations

5.3 Feeder Services Comparison

When investigating whether to invest in Park and Ride facilities, it is necessary to consider alternative station access options, such as feeder bus services. The cost-effectiveness of Park and Ride and alternative access options can be compared to guide decision-making. In this example we consider the cost of providing Park and Ride versus the costs associated with expanding feeder services.

This assessment addresses an Auckland example and is intended to simply provide an order of magnitude of the relative costs. This exercise could be replicated with Wellington specific sites if the necessary inputs were provided.

We identified two locations in West Auckland for comparison:

1. A low density rural/fringe catchment focussed on a proposed busway station near Westgate
2. A higher density suburban catchment on the existing rail station at Glen Eden

In this exercise, feeder networks were expanded at each site to provide sufficient coverage, capacity and service levels to support approximately 500 additional peak period commuters. The costs associated with these services were then compared to the relative cost of providing 500 Park and Ride spaces at each location.

A 30-year analysis period was used with a 6% discount rate which yielded the results outlined in Table 5-4.

Table 5-4: Comparison of whole of life cost to provide of Park and Ride versus feeder bus services

Rapid Transit Station	Feeder bus network for approximately 500 peak passengers ($2018)	Park and Ride facility with 500 bays ($2018)	Residential catchment of feeder bus network
Rural-fringe station (Brigham Creek Road)	Present value over 30 years: $59.7m Annualised cost: $4.3m	Present value over 30 years: $15.1m Annualised cost: $1.1m	7,700 residents served
Suburban station (Glen Eden)	Present value over 30 years: $23.7m Annualised cost: $1.7m	Present value over 30 years: $32.5m Annualised cost: $2.4m	71,900 residents served

The table shows that for the rural/fringe area, the cost of providing a bus feeder network of sufficient coverage and service quality to attract a significant number of peak commuters is almost four times the cost of serving an equivalent number of commuters via Park and Ride. This reflects the high and ongoing operating costs to provide a new feeder bus network with adequate service levels to a large and widely dispersed catchment, compared to the relatively low cost of providing Park and Ride in the rural/fringe location (primarily due to relatively low land costs).

Conversely, within the suburban area the cost of providing Park and Ride was estimated to be approximately 50% higher than meeting the equivalent demand using feeder buses. This reflects the relatively high cost of Park and Ride expansion (due to high land costs and limited site availability in established areas), compared to the relatively low costs of enhancing the existing feeder bus network with additional coverage and capacity in a relatively dense and compact catchment.

6. Summary

This Technical Note applies the Investment Prioritisation Framework outlined earlier to rank alternative sites for Park and Ride provision. This ranking is not intended to provide an *absolute* measure of the value of Park and Ride provision – instead, it provides a *relative* indication of which areas are likely to deliver higher value for money.

Higher-ranked sites tend to:

- Be located in places with few opportunities for walking, cycling, or PT access, yet with high numbers of potential customers;
- Be further away from the City Centre; and
- Have less potential for more intensive land use, as reflected in low land values and low-density zoning.

However, outcomes at any individual locations may vary. A number of other policy considerations need to be taken into account before investing in expanding Park and Ride provision or adapting / reconfiguring existing Park and Ride facilities. For example, deploying management techniques outlined in Technical Note 4 may shift demand for Park and Ride. Likewise, implementation of new bus services, integrated ticketing, increased urban development around stations, or desired community outcomes may shift the conversation around Park and Ride.

7. Appendix: Assessment Methodology

7.1 1a Indicators

Population estimates provided by GWRC. For each of the population measures the population figures were normalised based on each indicator's desired trend.

Rail timetables were tabulated to quantify the number of inbound services arriving at Wellington Station from each station during the morning peak period, defined as 7:00 am to 9:00 am. Values were normalised based on the indicator's desired trend.

7.2 1b Indicators

The distance to the CBD was calculated using the OpenStreetMaps street network. Wellington Station was selected as the location within the CBD that distances would be measured to. Park and Ride provision at stations located further away from the CBD are assumed to have better outcomes as they can reduce the number of private vehicle kilometres travelled and increase PT passenger kilometres. The distances to the CBD were normalised, based on desired trend.

For the percent increase in travel time due to congestion, typical travel times from each station to Wellington Station via the roadway network, were recorded using Google Maps data. The analysis assumed that the user would reach Wellington Station by 8:00 am on a typical weekday (Wednesday specifically). The upper and lower bounds of the typical travel times were averaged. This was compared to the typical free flow travel time. This resulted in a measure that accounts for an increase in travel time due to congestion. The results were normalised, based on desired trend.

GWRC provided data for the qualitative indicator of the accessibility and visibility of each station via private vehicle. Stations evaluated as low were given a score of 0, stations evaluated as medium were given a score of 3, and stations evaluated as high were given a score of 10. Values were normalised based on the indicator's desired trend.

7.3 1c Indicators

The cost per space measure averaged land values within a 300 m of each station to generate an average cost per square meter. Using the typical area required per carpark and QV Cost Builder[4] typical costs for surface and multi-storey parking structures for Wellington, an average cost per space was estimated. This cost estimate is reflective of capital cost only. The results were normalised, based on desired trend.

To assess development capacity on land within 500 m of a station, based on District Plan zoning and overlays, we utilised GIS-based zoning data from the constituent territorial authorities that we already possessed, except for those in the Wairarapa. We generated 500 m buffers from each station in ArcGIS and intersected them with the underlying zoning data. The output of this process allowed the calculation of the zoning composition within each station's

4 https://qvcostbuilder.co.nz/

500 m radius. Stations with predominantly residential or commercial zoning are deemed to have higher development capacity than zones with predominantly rural, industrial or recreational zoning. The results were normalised, based on desired.

7.4 1d Indicator

GWRC provided data for the qualitative indicator related to community needs. Stations evaluated as low were given a score of 0, stations evaluated as medium were given a score of 3, and stations evaluated as high were given a score of 10. Values were normalised based on the indicator's desired trend.

8. Appendix: Station Evaluation Process

8.1 Evaluation process

Data was generated using the methods described in the previous section. On applicable measures, the results were then normalised based upon the desired trend noted in Table 3-1. The weightings were then applied to generate a score for each measure. The measures were summed for each site, and then classified into five bands related to the feasibility of implementing Park and Ride at each location. Stations in band 1 were identified as the most feasible locations, whereas stations in band 5 (just Wellington Station) were identified as the least feasible locations.

8.2 Data

The following table shows the data inputs for each site. Wellington Station data has been excluded from this assessment.

Strategic Location Sub-principle	1a) Expand access					1b) Intercept car commuters			1c) Efficient transport investment		1d) Community needs
Measurable Indicator	Population within 1 km of station	Population within 1 - 3 km of station	Population within 3-5 km of station	Population beyond 5 km of station	Number of inbound services arriving at Wgtn station during AM Peak	Road network distance from station to CBD	Percent increase in downstream travel time due to congestion	Qualitative indicator of accessibility and visibility of station via car	Estimated cost per Park and Ride space	Land zoned for medium to high density residential or commercial use within 500m	Qualitative assessment of formal requests, public submissions, etc.
Ngauranga	459	768	-	-	5	5.2	50%	M	$361	9%	L
Petone	903	2,973	828	6	14	11.7	64%	H	$1,834	48%	M
Western Hutt	2,034	3,768	234	-	5	12.6	121%	L	$1,363	14%	L
Melling	1,542	3,807	375	-	5	14.1	150%	H	$633	12%	L
Ava	2,754	3,270	-	-	6	13.2	96%	L	$2,414	8%	L
Woburn	4,188	3,924	2,454	19,878	6	15.0	94%	M	$2,849	27%	L
Waterloo	4,086	2,583	-	-	14	16.9	92%	M	$3,386	4%	M
Epuni	4,263	3,480	27	-	6	17.4	92%	M	$1,552	1%	L
Naenae	3,630	7,428	357	-	6	18.8	92%	M	$1,905	18%	L
Wingate	2,307	2,283	393	45	6	21.5	67%	M	$1,914	24%	L
Taita	2,334	2,928	1,191	288	11	20.6	77%	M	$2,156	21%	L
Pomare	1,923	4,374	426	3	5	22.5	77%	M	$1,784	2%	L
Manor Park	615	1,662	180	459	5	22.3	111%	H	$1,937	0%	L
Silverstream	1,392	2,784	687	63	5	25.5	89%	M	$168	43%	H
Heretaunga	2,217	807	99	72	5	27.4	63%	L	$479	57%	L
Trentham	2,307	2,982	129	384	5	28.8	70%	L	$174	44%	L
Wallaceville	3,129	4,119	1,023	-	5	31.4	70%	L	$384	77%	L

Upper Hutt	1,224	4,878	3,900	267	8	32.0	58%	M	$1,421	66%	M
Crofton Downs	1,740	4,464	294	1,701	8	6.0	30%	M	$729	3%	M
Ngaio	2,253	648	-	-	8	5.3	40%	L	$529	1%	L
Awarua Street	2,478	246	-	-	8	5.6	50%	L	$317	1%	L
Simla Crescent	1,377	546	-	-	8	6.4	42%	M	$650	0%	L
Box Hill	1,824	1,158	-	-	8	6.6	33%	L	$688	2%	L
Khandallah	2,346	834	-	-	8	6.5	42%	L	$806	1%	L
Raroa	2,565	1,644	-	-	8	8.7	100%	L	$686	21%	L
Johnsonville	3,966	15,609	4,419	162	8	8.5	110%	M	$1,550	44%	H
Takapu Road	861	1,983	207	-	8	13.6	96%	M	$139	15%	L
Redwood	2,013	1,701	-	-	8	15.1	94%	L	$215	7%	L
Tawa	2,346	1,491	15	-	8	15.8	100%	L	$416	10%	L
Linden	3,024	843	-	-	8	17.1	65%	L	$502	2%	L
Kenepuru	1,242	1,239	66	-	8	18.2	70%	L	$123	64%	L
Porirua	849	11,796	11,154	-	12	19.5	78%	H	$4,822	92%	H
Paremata	1,284	8,544	7,590	1,215	8	23.1	83%	H	$1,007	52%	M
Mana	1,134	492	-	234	8	24.2	77%	M	$1,007	40%	L
Plimmerton	1,071	1,878	120	288	8	25.5	82%	M	$103	46%	L
Pukerua Bay	1,227	669	24	120	4	31.1	73%	L	$103	86%	L
Paekakariki	741	753	201	120	4	39.4	44%	M	$313	37%	L
Paraparaumu	1,476	9,066	11,334	5,022	5	49.5	39%	M	$376	99%	M
Waikanae	1,959	4,695	1,575	12,156	5	59.0	40%	M	$431	84%	L
Maymorn	90	1,866	4,644	717	3	38.5	50%	L	$20	0%	M
Featherston	900	1,371	216	3,534	3	62.3	33%	M	$44	0%	M
Woodside	-	-	210	336	3	78.5	23%	L	$102	0%	L
Matarawa	-	126	789	2,100	3	83.6	19%	L	$9	0%	L
Carterton	1,701	2,511	1,212	1,611	3	83.5	19%	L	$92	0%	M
Solway	306	3,129	45	1,329	3	94.7	21%	M	$61	0%	L
Renall St	1,575	3,813	1,074	636	3	96.1	29%	L	$90	0%	L
Masterton	1,173	4,833	3,045	3,360	3	98.4	22%	L	$163	0%	L

8.3 Normalised Values

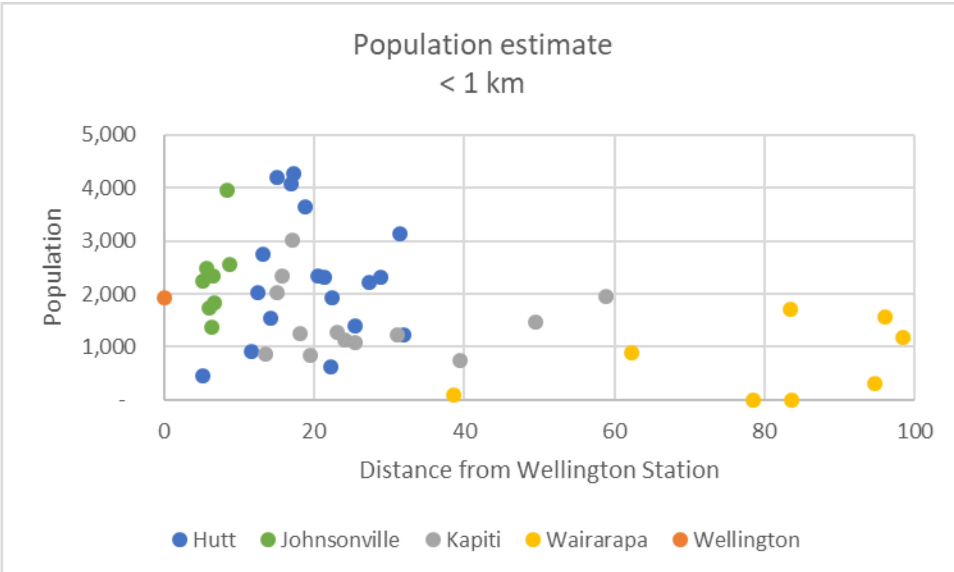
The following table shows the normalised values for each site. Wellington Station data has been excluded from this assessment.

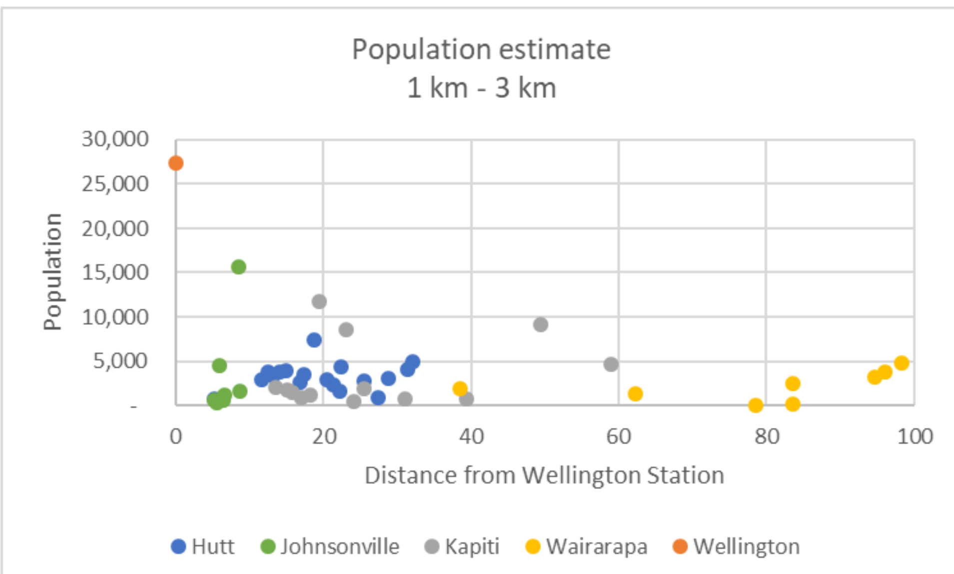
Strategic Location Sub-principle	1a) Expand access					1b) Intercept car commuters			1c) Efficient transport investment		1d) Community needs
Measurable Indicator	Population within 1 km of station	Population within 1 - 3 km of station	Population within 3-5 km of station	Population beyond 5 km of station	Number of inbound services arriving at Wgtn station during AM Peak	Road network distance from station to CBD	Percent increase in downstream travel time due to congestion	Qualitative indicator of accessibility and visibility of station via car	Estimated cost per Park and Ride space	Land zoned for medium to high density residential or commercial use within 500m	Qualitative assessment of formal requests, public submissions, etc.
Ngauranga	0.89	0.95	1.00	0.00	0.36	0.05	0.33	0.30	0.74	0.91	0.00
Petone	0.79	0.81	0.93	0.00	1.00	0.12	0.43	1.00	0.35	0.52	0.30
Western Hutt	0.52	0.76	0.98	0.00	0.36	0.13	0.81	0.00	0.40	0.85	0.00
Melling	0.64	0.76	0.97	0.00	0.36	0.14	1.00	1.00	0.58	0.88	0.00
Ava	0.35	0.79	1.00	0.00	0.43	0.13	0.64	0.00	0.28	0.92	0.00
Woburn	0.02	0.75	0.78	1.00	0.43	0.15	0.63	0.30	0.23	0.72	0.00
Waterloo	0.04	0.83	1.00	0.00	1.00	0.17	0.61	0.30	0.17	0.96	0.30
Epuni	0.00	0.78	1.00	0.00	0.43	0.18	0.61	0.30	0.38	0.99	0.00
Naenae	0.15	0.52	0.97	0.00	0.43	0.19	0.61	0.30	0.34	0.82	0.00
Wingate	0.46	0.85	0.97	0.00	0.43	0.22	0.44	0.30	0.34	0.76	0.00
Taita	0.45	0.81	0.89	0.01	0.79	0.21	0.52	0.30	0.31	0.79	0.00
Pomare	0.55	0.72	0.96	0.00	0.36	0.23	0.52	0.30	0.36	0.98	0.00
Manor Park	0.86	0.89	0.98	0.02	0.36	0.23	0.74	1.00	0.34	1.00	0.00
Silverstream	0.67	0.82	0.94	0.00	0.36	0.26	0.59	0.30	0.86	0.57	1.00
Heretaunga	0.48	0.95	0.99	0.00	0.36	0.28	0.42	0.00	0.68	0.43	0.00
Trentham	0.46	0.81	0.99	0.02	0.36	0.29	0.46	0.00	0.85	0.56	0.00
Wallaceville	0.27	0.74	0.91	0.00	0.36	0.32	0.46	0.00	0.73	0.22	0.00
Upper Hutt	0.71	0.69	0.66	0.01	0.57	0.33	0.39	0.30	0.40	0.34	0.30

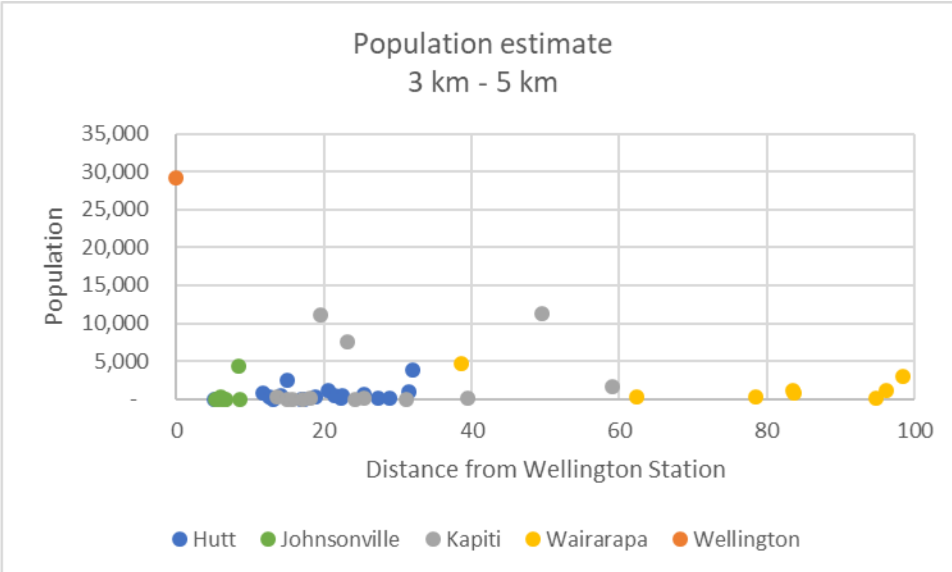
Crofton Downs	0.59	0.71	0.97	0.09	0.57	0.06	0.20	0.30	0.53	0.97	0.30
Ngaio	0.47	0.96	1.00	0.00	0.57	0.05	0.27	0.00	0.65	0.99	0.00
Awarua Street	0.42	0.98	1.00	0.00	0.57	0.06	0.33	0.00	0.77	0.99	0.00
Simla Crescent	0.68	0.97	1.00	0.00	0.57	0.07	0.28	0.30	0.57	1.00	0.00
Box Hill	0.57	0.93	1.00	0.00	0.57	0.07	0.22	0.00	0.55	0.98	0.00
Khandallah	0.45	0.95	1.00	0.00	0.57	0.07	0.28	0.00	0.48	0.99	0.00
Raroa	0.40	0.89	1.00	0.00	0.57	0.09	0.67	0.00	0.55	0.79	0.00
Johnsonville	0.07	0.00	0.61	0.01	0.57	0.09	0.73	0.30	0.38	0.56	1.00
Takapu Road	0.80	0.87	0.98	0.00	0.57	0.14	0.64	0.30	0.87	0.85	0.00
Redwood	0.53	0.89	1.00	0.00	0.57	0.15	0.63	0.00	0.83	0.93	0.00
Tawa	0.45	0.90	1.00	0.00	0.57	0.16	0.67	0.00	0.71	0.90	0.00
Linden	0.29	0.95	1.00	0.00	0.57	0.17	0.43	0.00	0.66	0.98	0.00
Kenepuru	0.71	0.92	0.99	0.00	0.57	0.18	0.47	0.00	0.88	0.36	0.00
Porirua	0.80	0.24	0.02	0.00	0.86	0.20	0.52	1.00	0.00	0.07	1.00
Paremata	0.70	0.45	0.33	0.06	0.57	0.24	0.55	1.00	0.45	0.48	0.30
Mana	0.73	0.97	1.00	0.01	0.57	0.25	0.52	0.30	0.45	0.59	0.00
Plimmerton	0.75	0.88	0.99	0.01	0.57	0.26	0.55	0.30	0.90	0.54	0.00
Pukerua Bay	0.71	0.96	1.00	0.01	0.29	0.32	0.49	0.00	0.90	0.13	0.00
Paekakariki	0.83	0.95	0.98	0.01	0.29	0.40	0.29	0.30	0.77	0.62	0.00
Paraparaumu	0.65	0.42	0.00	0.25	0.36	0.50	0.26	0.30	0.74	0.00	0.30
Waikanae	0.54	0.70	0.86	0.61	0.36	0.60	0.27	0.30	0.70	0.15	0.00
Maymorn	0.98	0.88	0.59	0.04	0.21	0.39	0.33	0.00	0.94	1.00	0.30
Featherston	0.79	0.91	0.98	0.18	0.21	0.63	0.22	0.30	0.93	1.00	0.30
Woodside	1.00	1.00	0.98	0.02	0.21	0.80	0.16	0.00	0.90	1.00	0.00
Matarawa	1.00	0.99	0.93	0.11	0.21	0.85	0.13	0.00	0.95	1.00	0.00
Carterton	0.60	0.84	0.89	0.08	0.21	0.85	0.13	0.00	0.90	1.00	0.30
Solway	0.93	0.80	1.00	0.07	0.21	0.96	0.14	0.30	0.92	1.00	0.00
Renall St	0.63	0.76	0.91	0.03	0.21	0.98	0.20	0.00	0.90	1.00	0.00
Masterton	0.72	0.69	0.73	0.17	0.21	1.00	0.15	0.00	0.86	1.00	0.00

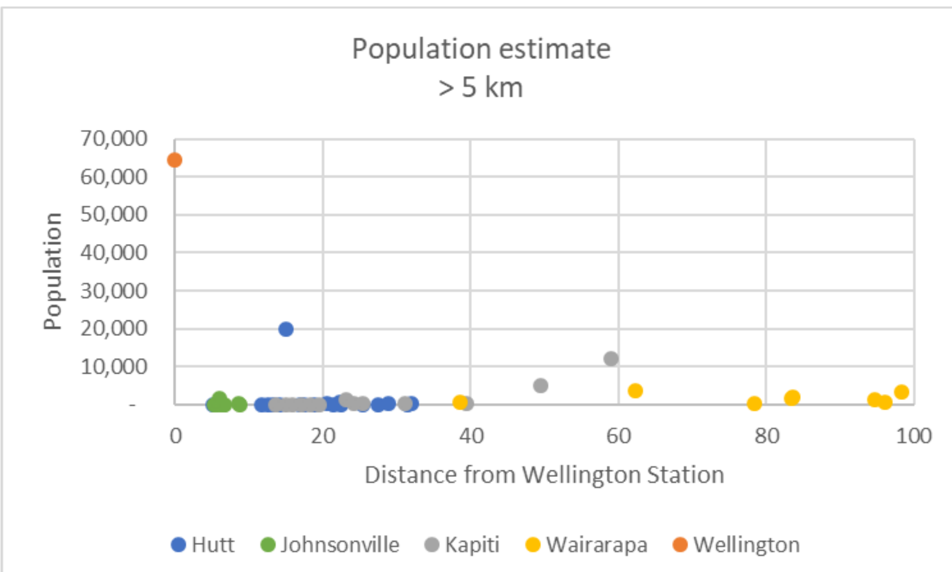
8.4 Charts

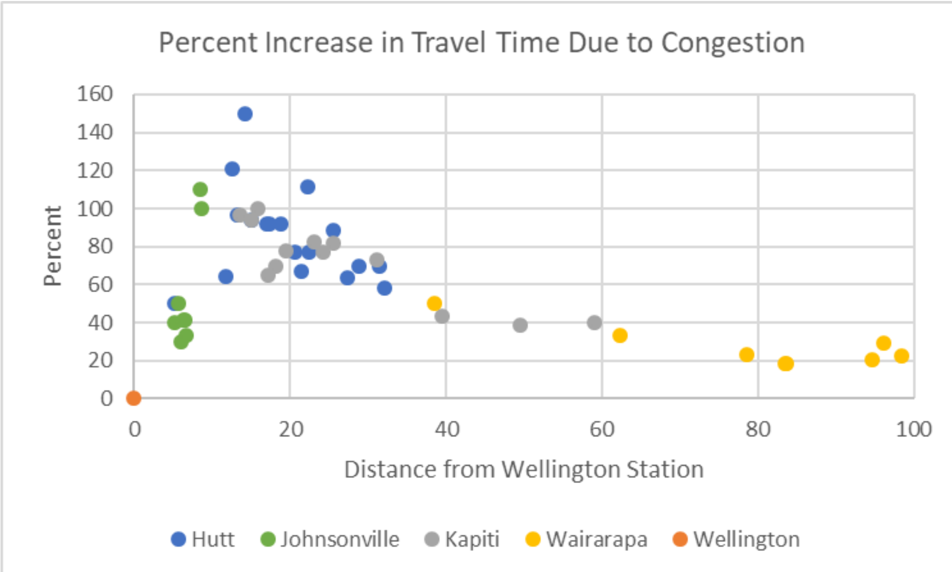
The following charts show the relationship between the measurable indicators and their distance from Wellington Station.

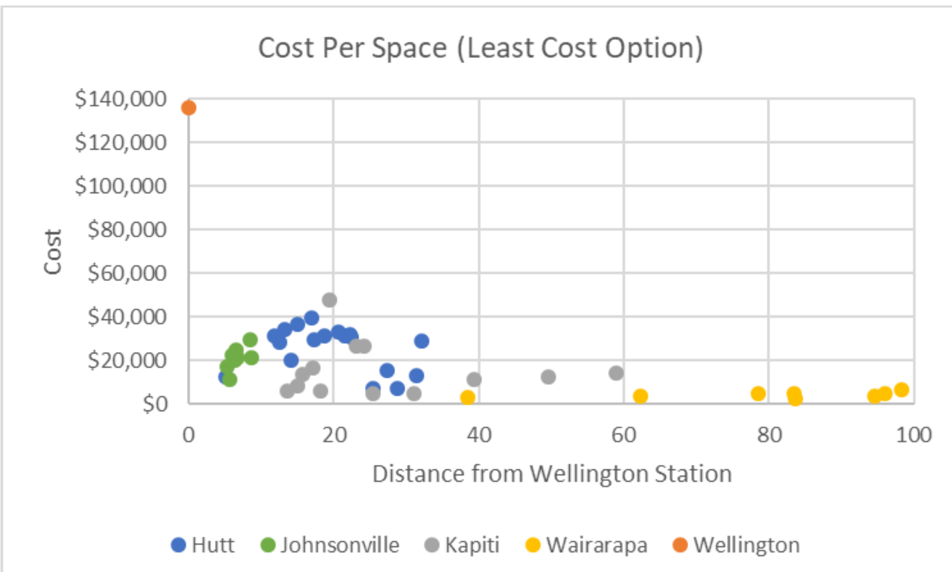


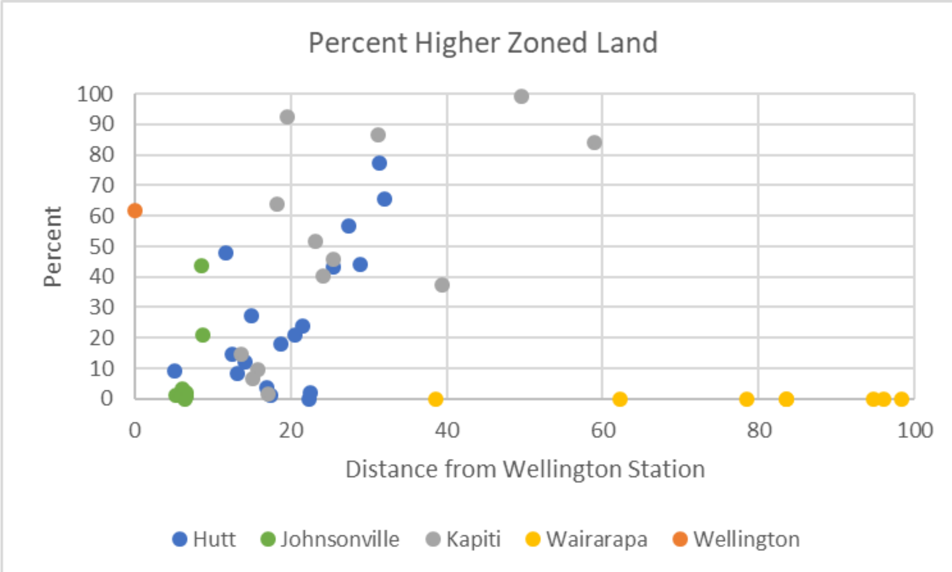



Population estimate
3 km - 5 km
35,000
30,000
25,000
20,000
15,000
10,000
5,000
-
Population
0
20
40
60
80
100
Distance from Wellington Station
Hutt
Johnsonville
Kapiti
Wairarapa
Wellington


Population estimate
> 5 km
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Population
0
20
40
60
80
100
Distance from Wellington Station
Hutt
Johnsonville
Kapiti
Wairarapa
Wellington


Percent Increase in Travel Time Due to Congestion
Percent
160
140
120
100
80
60
40
20
0
0
20
40
60
80
100
Distance from Wellington Station
Hutt
Johnsonville
Kapiti
Wairarapa
Wellington


Cost Per Space (Least Cost Option)
Cost
$140,000
$120,000
$100,000
$80,000
$60,000
$40,000
$20,000
$0
0
20
40
60
80
100
Distance from Wellington Station
Hutt
Johnsonville
Kapiti
Wairarapa
Wellington


Percent Higher Zoned Land
Percent
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
Distance from Wellington Station
Hutt
Johnsonville
Kapiti
Wairarapa
Wellington