PARK & RIDE POLICIES & CRITERIA

Transfund New Zealand Research Report No. 136

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AN IMPORTANT NOTE FOR THE READER

The research detailed in this report was commissioned by Transfund New Zealand.

Transfund New Zealand is a Crown entity established under the Transit New Zealand Act 1989. Its principal objective is to allocate resources to achieve a safe and efficient roading system. Each year, Transfund New Zealand invests a portion of its funds on research that contributes to this objective.

The material contained in this report is the output of research and should not be construed in any way as policy adopted by Transfund New Zealand but may form the basis of future policy.

ACRONYMS & ABBREVIATIONS

AITPM	Australian Institute of Traffic Planning & Management
APTRANS	Adelaide Public Transport System
ARC	Auckland Regional Council
ATR	Alternative To Roading
BAH	Booz•Allen & Hamilton Ltd
CBD	Central Business District
CCTV	Closed circuit television
DoI Vic	Department of Infrastructure, Victoria, Australia
DoT NSW	Department of Transport, New South Wales, Australia
HOV	High Occupancy Vehicle
ITE	Institute of Transportation Engineers
K+R	Kiss and Ride, i.e. commuter is passenger
LOS	Level of Service
NSE	Network South East, London
NSR	Northern Suburbs Railway, Perth, Western Australia
NZ	New Zealand
pa	per annum
P+R	Park and Ride, i.e. commuter is driver
PT	Public Transport
PTRC	Planning & Transport Research & Computational International Association
RLTS	Regional Land Transport Strategies
SRA	State Rail Authority
TRL	Transport Research Laboratory, Crowthorne, UK (after Jan.1992)
TRRL	Transport & Road Research Laboratory, Crowthorne, UK (before Dec.1991)
TSG	Transport Supplementary Grant
UK	United Kingdom
UK DOT	UK Department of Transport
US/ USA	United States of America
WA	Western Australia
WCC	Wellington City Council
WRC	Wellington Regional Council

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EXECUTIVE SUMMARY

1. Background

In urban areas with relatively low population densities and high car ownership (as in New Zealand), "Park and Ride" (P+R) is a potentially powerful urban transport policy tool. It is being adopted in cities worldwide (especially UK, Europe and Australia) as a major component of urban transport policies to restrain road traffic and to encourage public transport use. Recognising the potential advantages of P+R, the planning authorities in both Auckland and Wellington have been developing and expanding their P+R facilities, particularly those associated with rail-based services.

2. Objective

The report describes a project, carried out in 1998, to develop guidelines and criteria to assist in the planning and demand estimation for P+R policies and facilities in New Zealand's major urban centres. It will have direct applications in urban transport policy development and planning studies, including modelling and evaluation aspects.

The main tasks undertaken for this project were:

- A review of international policies, practices and experience relating to both rail-based and bus-based P+R.
- A review of policies and guidelines on P+R developed by New Zealand local authorities.
- Discussions with key practitioners in New Zealand (primarily regional and city councils) regarding P+R issues, and aspects on which practitioners need improved advice and information.
- Development of guidelines and criteria for the development of P+R in New Zealand.

3. Definition of P+R

P+R involves the provision of:

- Car parking facilities well outside the central area of the city; and
- Public transport (PT) services linking these car parks with the central city area.

P+R attempts to combine the benefits of both car use and PT use into an efficient and effective system.

4. Role of P+R in Urban Transport Policy

The main role of P+R policies and measures is to transfer parking demand from the central business district (CBD) to suburban/urban fringe locations, to achieve the following benefits:

- Reduce traffic levels and congestion levels on urban radial routes and in the CBD itself.
- Reduce the need and pressure for increased road capacity, and reduce emission levels, energy use and other environmental impacts.
- Reduce the amount of parking required in the CBD (where land is scarce and expensive, and large car parks may be out-of-scale with the CBD townscape), by providing parking in other locations (where land is cheaper and more readily available).

P+R may also help to increase the level of service and cost-effectiveness of PT provision, by concentrating PT demand on the major line haul routes (between the P+R site and the CBD), and reducing the need for PT services in low density suburban areas which are difficult to serve cost-effectively.

5. Review of International Experience of P+R

International experience with P+R projects and programmes relates mainly to the UK and USA. The international literature is reviewed, and attempts are made to identify the necessary and desirable characteristics, and the conditions, for such projects to be effective.

Characteristics reviewed are: transport policy and their geographic context, target markets, P+R facility planning, levels of P+R provision, site selection and location, site design, area required, and costs, related PT services, pricing and ticketing, marketing and information, and funding aspects.

The literature suggests that the most essential and almost universally applicable criterion for the success of P+R schemes is a shortage of reasonably-priced central area parking. If this criterion does not apply, then P+R is only likely to succeed if an exceptionally high level and high quality PT service links the parking site with the CBD. Also access to the CBD via P+R needs to be competitive with the use of the car for the whole trip, in terms of perceived generalised costs (quality, reliability, comfort, travel time, out-of-pocket costs, etc.).

Other key features required for the success of P+R schemes are:

- Appropriate car park sites, in terms of location, facilities and design;
- High level and quality of the PT service between the car park and the CBD;
- Appropriate information and marketing of the scheme.

6. International Evidence on Demand and Effectiveness of P+R

Information from the literature review on how effective the more successful P+R schemes have been in attracting users, influencing travel mode choice, and reducing the extent of car travel and CBD parking demand, is summarised. Factors for success, reasons for use or non-use, usage rates, alternative travel options, effects on traffic levels, environmental and energy impacts, are discussed. If P+R measures are to be effective, they need to be considered as one component of a CBD parking policy.

The techniques used for estimating likely demand from new P+R sites range from simple observation approaches to more complex modelling approaches. The technique used, and the time and resources required to conduct the analyses, should be matched to the scale, scope and complexity of the P+R project. However, much depends on the type and level of service being offered, the potential time and cost savings over alternative modes, and other aspects unique to the local situation.

The main demand estimation approaches used are Demand observation, Market area population, Modal split, and Modelling.

7. New Zealand Policies & Experience

P+R is operational in a formal way in two New Zealand cities, Auckland and Wellington. Both of the regional councils in these two centres have developed P+R policies, which are contained in their respective Regional Land Transport Strategies (RLTS). These are outlined.

8. Policy and Planning Criteria and Guidelines

Planning guidelines and development criteria for P+R facilities for use in the main urban centres in New Zealand are set out in tabular form, to allow easy transfer into a policy and planning manual, or for use now by practitioners.

9. Role of P+R in Urban Transport Policy

Issue	P+R Mechanism	Desired Effect
Lack of parking in CBD: land scarcity (carparks expensive), out-of-scale with CBD townscape	Provide parking in other locations where land is more readily available and cheaper.	CBD visitors park in other locations, thereby reducing demand for CBD parking.
Congested radial routes: and in CBD	Provide parking before congested corridor/area, allied with priority public transport service.	Diversion of peak time travellers to public transport, thereby reducing congestion.
Low Public Transport Usage	Make public transport more attractive for a market segment.	Attract new users on to public transport from motor vehicles.
Environmental Issues: high vehicle emission levels & other negative impacts	Make public transport more attractive for motor vehicle drivers.	Reduce total vehicle kilometres by car drivers taking public transport for longest portion of their journey.

10. Stages in Developing P+R Facilities

The stages for planning, developing and operating a P+R Programme are shown in the following table. For each of the nine stages (A-I), separate tables in the report provide further criteria and guidelines for each separate activity. Some iteration will occur between stages (especially stages B and C), and the programme will not necessarily be a straight staged process.

Stage	Description	Key Activity
A	Examine Need for P+R Facilities	• Determine specific need for P+R within urban transport area
B	Identify & Select P+R Sites	• Identify possible P+R locations • Select potential P+R sites
C	Estimate Demand for Potential P+R Facility	• Gather available data • Apply appropriate demand estimation approach
D	Design the P+R Facility	• Design P+R facility (site and amenities)
E	Design PT Service	• Design accompanying PT service
F	Cost the Proposed P+R Facility & PT Service	• Estimate size and cost of proposed P+R facility
G	Market the P+R Facility	• Pricing, marketing and promoting the P+R facility
H	Maintain the P+R Facility	• Ongoing maintenance of P+R facility
I	Monitor the P+R Facility	• Monitoring of P+R operation

ABSTRACT

In urban areas with relatively low population densities and high car ownership, as in New Zealand, "Park and Ride" (P+R) is a potentially powerful urban transport policy tool. It is being adopted in cities worldwide (including UK, Europe and Australia) as a major component of urban transport policies to restrain road traffic and to encourage public transport use.

This report describes a project, carried out in 1998, to develop guidelines and criteria to assist in the planning and demand estimation for P+R policies and facilities in New Zealand's major urban centres. It will have direct applications in urban transport policy development and planning studies, including modelling and evaluation aspects.

P+R attempts to combine the benefits of both car use and PT use into an efficient and effective system and to transfer parking demand from the central business district (CBD) to suburban/urban fringe locations.

International experience with P+R is reviewed. Attempts are made to identify the necessary and desirable characteristics, and the conditions, for such projects to be effective. P+R is presently operational in Auckland and Wellington, and these programmes are reviewed.

Planning criteria and guidelines for P+R facilities for use in the main urban centres in New Zealand are set out, in tabular form to allow easy transfer into a policy and planning manual, and for use now by practitioners. The stages for developing and operating a P+R Programme are shown for each of nine stages, with separate tables providing further criteria and guidelines for each separate activity.

1. INTRODUCTION

1.1 Background

In urban areas with relatively low population densities and high car ownership (as in New Zealand), "Park and Ride" (P+R) is a potentially powerful urban transport policy tool. It is increasingly being adopted in cities worldwide (especially UK, Europe and Australia) as a major component of urban transport policies to restrain road traffic and to encourage public transport use. Recognising the potential advantages of P+R, the authorities in both Auckland and Wellington (in particular) in the 1990s have been developing and expanding their P+R facilities, particularly those associated with rail-based services. However, little information was readily available to assist in the planning of P+R facilities. To help overcome this deficiency, this project was initiated.

1.2 Objective

The overall objective of this project, carried out in 1998, was to develop guidelines and criteria to assist in the planning and demand estimation for P+R policies and facilities in New Zealand's major urban centres.

The project outputs will have direct applications in urban transport policy development and planning studies, including modelling and evaluation aspects. The outputs will also be relevant to the evaluation of Alternatives to Roading (ATR) projects (involving P+R) and the evaluation of existing public transport (PT) services.

1.3 Approach

The main tasks undertaken in this project were:

- A comprehensive review (updating previous Booz•Allen & Hamilton (BAH) work) of international policies, practices and experience relating to both rail-based and bus-based P+R. This included evidence on P+R demand levels (especially from Australian experience).
- A review of policies and guidelines on P+R developed by New Zealand local authorities.
- Discussions with key practitioners in New Zealand (primarily regional and city councils) regarding P+R issues and aspects on which practitioners needed improved advice and information.
- Development of draft guidelines and criteria for the development of P+R in New Zealand.

1.4 Report Structure

The remainder of the report is structured as follows:

Chapter 2	-	provides a description of P+R, and discusses the role of P+R in urban transport policy
Chapter 3	-	sets out the results of the review of international experience with P+R
Chapter 4	-	outlines international evidence on demand & effectiveness of P+R
Chapter 5	-	outlines current New Zealand policies and experience in regard to P+R
Chapter 6	-	sets out proposed P+R policy and planning criteria and guidelines, and guidelines for demand assessment

2. ROLE OF PARK & RIDE

2.1 Description

P+R essentially involves the provision of:

- Car parking facilities well outside the central area of the city; and
- Public transport (PT) services linking these car parks with the central city area.

Essentially, P+R may be regarded as an extension of providing central area parking, but putting the parking facility outside the central area rather than within it, and linking it to the central area with a good PT service.

P+R attempts to combine the benefits of both car use and PT use into an efficient and effective system:

> *The essence of P+R lies in overcoming the idea that the private car and the public transport system are in competition, and seeks to create an interface between the two* (Moran 1990).

Rail station car parks are the "classic" type of P+R, and have been used for many years, both in Auckland and Wellington, and in many other cities internationally. More recently, there has been a surge of interest in and development of bus-based P+R schemes, particularly in the UK.

2.2 Role in Urban Transport Policy

The main role of P+R policies and measures is to transfer parking demand from the central business district (CBD) to suburban/urban fringe locations, to achieve the following benefits:

- Reduce traffic levels and congestion levels on urban radial routes and in the CBD itself.

- Correspondingly reduce the need and pressure for increased road capacity, and reduce emission levels, energy use and other environmental impacts.

- Reduce the amount of parking required in the CBD (where land is scarce and expensive, and large car parks may be out-of-scale with the CBD townscape), by providing parking in other locations (where land is cheaper and more readily available).

P+R may also help to increase the level of service and cost-effectiveness of PT provision, by concentrating PT demand on the major line haul routes (between the P+R site and the CBD), and reducing the need for PT services in low density suburban areas which are difficult to serve cost-effectively.

P+R schemes are almost always designed to serve trips to areas of concentrated demand, because:

- parking is likely to be scarce or expensive in such areas;
- concentrated passenger flows are necessary to provide effective and economic PT services.

Most schemes are oriented to serve town centres. However some schemes are designed to serve other locations, such as airports, sports stadia, amusement parks, etc.

Schemes oriented to serve town centre movements may be targeted at different market segments. Internationally, most schemes are probably targeted principally at commuters, e.g. station car parks are a common type of such schemes. However other schemes are targeted principally at off-peak CBD travellers, particularly shoppers. For example, many of the UK bus-based schemes were initially designed (and in some cases continue) to serve shoppers in the pre-Christmas period, when CBD parking was insufficient to meet the seasonal demand.

There are good arguments in favour of targeting each of these two markets, with no single "right" answer for all situations:

> *What is not yet clear is whether an authority should try to encourage P+R use by commuters to free up central parking for shoppers - who might make more productive use of the space - or if shoppers who represent a greater number of journeys per parking space should be the principal market for P+R in order to reduce overall traffic levels* (Huntley 1993).

3. REVIEW OF INTERNATIONAL EXPERIENCE OF P+R

3.1 Overview

This chapter summarises the international experience with P+R projects and programmes, and attempts to identify the necessary and desirable characteristics, and the conditions, for such projects to be effective.

The international literature reviewed relates mainly to the UK and then to USA.

- In the UK, rail-based P+R is very well established and plays a major role for movements to inner London (principally on the British Rail services); bus-based P+R has been developed over the last 20 years in a number of cities; and there has been a resurgence of interest in such policies over the last few years.
- In the USA, P+R plays a major role in association with a number of rail and bus-based line haul routes (e.g. bus services using High Occupancy Vehicle (HOV) lanes on expressways).

P+R does play a significant role in urban transport in a number of other countries, in Europe and elsewhere, but this experience appears to be less well documented (certainly in the English language sources). A list of references is set out in the Bibliography to this report.

International experience to date has not resulted in any simple set of universal rules about the situations in which P+R will be successful and effective, or when it will not:

> *The wide variety of situations in which P+R has proved to be successful however argues against the existence of any such criteria of universal applicability* (Armstone 1992).
>
> *There don't appear to be any ... simple rules which would show whether or not P+R would be successful* (Buchanan 1992).

The remainder of this chapter gives what guidance can be given on the situations which generally favour P+R and the desirable characteristics of P+R schemes.

3.2 Transport Policy and Geographic Context

As noted earlier, P+R is most usefully regarded as a component of CBD traffic and parking restraint policies. It is most appropriate in situations where there is:

- A shortage of CBD parking spaces, whether as a result of geographic limitations or for transport policy reasons.
- Limited traffic capacity on radial routes into the CBD.

In the UK, rail-based P+R is most prominent in London, which has both parking and road capacity constraints. Bus-based P+R has been most developed and had the

greatest success in historic cities such as Bath, Cambridge, Chester, Chichester, Exeter, Oxford, York. These cities are all characterised by:

- very compact central areas, with high land values and a shortage of space for parking,
- traffic problems because of the limited road space within the CBD and on radial routes,
- heavy emphasis on maintaining the fabric and integrity of the historic central areas.

There seems to be general agreement that CBD parking shortages are essential to the success of P+R:

> *The one rule which the (UK) Department of Transport seem prepared to concede is that ... there needs to be a shortage of central area parking* (Buchanan 1992).

> *Central area parking capacity is therefore a crucial factor in where P+R is likely to be seen most favourably ..... English historic towns, ... where additional town centre parking is either difficult to provide or seen as environmentally unwelcome typify the circumstances in which P+R prospers* (Huntley 1993).

Thus the "stick" of traffic restraint appears essential to the success of P+R schemes. The evidence is also that this needs to be accompanied by the "carrot" of a good quality PT service linking the P+R sites with the CBD:

> *The experience of P+R schemes is very mixed and in general car drivers seem to be willing to transfer to transit in mid-journey only if there is a considerable advantage in doing so: P+R in connection with the successful freeway bus lanes in North America or with the faster rail mode in to large cities, or for shopping at peak times (e.g. Christmas) when city centre parking is difficult, seem to offer the most successful examples* (TRRL 1980).

Also, as noted earlier, P+R can have a particular role in low density high car ownership suburban areas, where it is not cost-effective to provide attractive levels of PT service through these areas. Instead travellers may be attracted to a good quality PT line haul service if they can get convenient access to this. This is the case in many US situations and in the outer parts of the London conurbation.

3.3 Target Markets

As noted earlier, most successful P+R schemes internationally have been targeted principally at commuters. This emphasis is consistent with parking restraint policies in most cities, which discourage long-stay (commuter) parking but attempt to provide a good supply of off-peak parking. However the exceptions to this include:

- In the largest cities (e.g. London), both peak and off-peak parking are heavily constrained, and rail-based P+R (in particular) is used by both commuters and shoppers.
- In a number of UK cities, P+R was introduced principally to target shoppers over the pre-Christmas peak shopping period. For many UK bus-based P+R schemes, shopping is the predominant journey purpose.

The important point to recognise is that P+R schemes need to be market-oriented. Generally their potential users will have the option of making their complete trip by car. Hence for a scheme to be successful it must offer a level of service comparable with that for making the full trip by car, as explained in Miller (1991):

> *P+R passengers ... are a different type of passenger to our normal bus user. They are car oriented and expect a standard of service that is normally higher. They want reliability, cleanliness and a good driver attitude.*

3.4 P+R Facility Planning

A US study of P+R practice (Turnbull 1995) identified the following factors as important in planning for P+R schemes:

- Locate P+R facilities in congested travel corridors.
- Locate P+R facilities in advance of areas experiencing major traffic congestion.
- Locate P+R lots in areas with high levels of travel demand to the major activity centre or centres served by the facility.
- Include preferential public transport services, either rail or HOV lanes, to enhance P+R facility ridership levels.
- Locate P+R facilities so that commuters do not have to backtrack to reach a lot.
- Orient P+R facilities to ensure good accessibility and visibility, and address safety and security concerns for passengers and vehicles.
- Locate P+R facilities with appropriate intervening distances to ensure PT services and facilities are not duplicated.
- Encourage co-operation among agencies in developing and operating P+R facilities.

This US study identified six general steps in planning and designing a P+R facility:

Step 1 Examine General Need for Facility
Step 2 Define Study or Market Area
Step 3 Estimate Demand for Facility
Step 4 Determine Needed Size of Facility
Step 5 Site Evaluation and Selection
Step 6 Design Facility

3.5 Levels of P+R Provision

No general guidelines or recommendations exist as to what level of P+R provision might be appropriate in different urban situations.

The level of provision in any situation should be based on the expected demand (refer detailed discussion in Chapter 4 of this report).

For UK cities with permanent (i.e. not seasonal) bus-based P+R schemes, the level of provision involved ranges between 1.9 spaces per 1000 population and 28.1 spaces per 1000 population (in Oxford). Most of these cities have levels of provision in the range of 5-14 spaces/1000 catchment area population.

3.6 Site Selection and Location

P+R sites should satisfy two main criteria:

- They should be located before the main congestion points on the radial route.
- They should have a clear rationale in terms of the overall transport strategy for the area, e.g. peripheral sites will only capture trips from outside the urban area, whereas closer-in sites can also capture trips from the suburban areas.

In addition, sites should be located:

- On or close to a major radial route (preferably readily visible from such a route).
- Close to a ring road or bypass, where possible: access from major roads will help reduce developmental costs and increase ease of use; multiple access points (or at least access from two streets) are preferred.
- In close proximity to existing PT routes and stops: sites selected should maximise operating efficiencies to ensure operating savings and encourage patronage.
- If possible, in reasonable proximity to amenities in the area: this will encourage use, and may help deter vandalism (although sites in developed areas are likely to be more expensive than those in undeveloped areas).

P+R sites should be located so that they intercept commuters early in their overall trip, otherwise commuters will be reluctant to change mode if the public transport leg of the trip is short relative to the car leg. One US report recommends that P+R lots should generally *"be at least 16 km from the job locations where parking charges are substantial"* (Stevens & Homburger 1985). However such a distance may be excessive in New Zealand conditions.

A further criterion for a potential P+R site is that it is able to accommodate the projected P+R demand. Consideration should be given to both immediate and long-term demand, with space reserved for future expansion. Sites can be constructed where capacity will not be adequate to meet demand. However, this may result in parking flowing over into neighbouring streets. Another important factor is the cost

of developing a P+R facility. Sites that are level, have good access, and are free of environmental problems, should be sought.

A P+R programme is likely to be most effective when sites are provided close to all major radial routes, because that is where the economics of the policy are favourable.

The literature gives no specific recommendations about the size of individual P+R sites. The site needs to be large enough to cater for the anticipated demand: the larger the level of demand, then the more attractive and economic the project is likely to be, as a higher level of PT service will be affordable. However, very large sites (e.g. 1,000+ spaces) are likely to involve long walking distances between some of the spaces and the public transport service. In UK practice, individual sites range in size from around 200-300 spaces to around 900 spaces.

3.7 Site Design

The following features are generally regarded as highly desirable for P+R sites:

Site Layout
- Open, level site
- Site design to allow good access/egress, but to restrict car speeds within the site (by layout, speed tables/humps, etc.)
- Bus pick-up/set-down area central to the parking area
- Landscaping treatment, to be environmentally acceptable, with light, low-level foliage to subdivide the parking area
- Parking area to be tarmac, well drained (though in some areas unsealed P+R sites are acceptable)

Site Facilities
- Shelter

The following will increase the attractiveness of the site, but are not essential:
- Basic retail facility (newspapers, sweets, etc.)
- Telephone
- Toilets

User Information
- Appropriate signing within the car park
  - well marked parking bays
  - labelling/colour coding of individual areas in large car parks
- Information display about parking facilities and PT services

Security Aspects
Adequate security measures for users and vehicles through:
- Periodic patrols
- Lighting
- Fencing

The following will increase users' perception of security, and may be necessary in some situations:

- CCTV (closed circuit Television) surveillance
- On-site staffing
- Layout and landscaping design
- Co-ordinating with adjacent activities

3.8 Site Areas and Costs

Site Areas

For a single-level site, a common rule of thumb adopted is for an area of $25m^2$ per parking space (Richards & Rickard 1996; advice from DoT NSW (Department of Transport, New South Wales).

Clearly the requirement will depend on the shape and size of the site, with larger sites generally making more economic in use of land. DoI Vic (Department of Infrastructure, Victoria) advises that figures in the range of $25\text{-}40m^2$ per parking space are appropriate. In New Zealand, WRC (Wellington Regional Council) advises that tight parking layouts can be used at P+R sites because of the limited number of vehicle movements per day and smaller average vehicle size.

Construction Costs

For a single-level site, construction costs will be dependent on the starting condition of the site and the level of facilities provided. Advice on unit construction costs is as follows:

- DoI Vic: c$1,500/space, starting with a reasonably flat site, and involving paving, drainage, marking, good quality lighting, etc.
- DoT NSW: c$3,000/space as typical "rule of thumb" (c.$10,000/space for multi-level car parks).
- Western Australia (WA): estimate of $3,100/space, which is said to be conservative, to include high quality lighting, landscaping, toilet facilities, waiting area and fencing, plus contingencies (Arup 1998).
- WRC, NZ: typical figures are around $1,500/space (reasonably flat site, paving, drainage, marking, minimal facilities).

Operational and Maintenance Costs

Maintenance costs for a paved site are low: DoI Vic advises typical figures of $20-30 pa/space, to cover cleaning, occasional re-marking, etc.

If the site is to have more elaborate facilities and to be staffed, additional costs need to be estimated on a case-specific basis.

3.9 Associated Public Transport Services

In planning public transport services to operate in conjunction with P+R facilities, the market being served, and the need for these services to be competitive with the car must be borne in mind. It is desirable, therefore, that the bus service component of any bus-based P+R scheme provides a better image and quality of service than "normal" bus services. Either a dedicated bus service is desirable or, if a standard bus service is used, it should be re-designed to meet the requirements set out below.

The following are desirable features for bus-based services (most also apply to rail-based P+R).

Route and Stops

- Simple route, preferably non-stop between the parking site and the CBD.
- Stop at P+R site to be located to minimise walking distances and to have high standard of facilities (shelter, information, etc.).
- CBD stops located to minimise walking distances.
- CBD departure points to be well signposted and highly visible.
- Bus shelters desirable at all main stops.

Level of Service, Frequency, Reliability and Fares

- Journey time must be competitive with car travel time: express or limited stop services may be required.
- Operating hours to be sufficient to serve the target markets, including late-night shopping, late commuters, etc.
- Maximum headway of 10 minutes is desirable.
- Timings to be suited to office/shop start and finish times.
- Service reliability is important.
- Desirable to always have a bus waiting at the parking site.
- Fares should be set so that total out-of-pocket costs are comparable with that for car travel.

Bus Priorities

- Desirable to have bus priorities (bus lanes, bus-activated lights, etc.) where necessary and feasible.

Vehicle and Drivers

- Attractive, modern vehicle image.
- Distinctive livery (different from standard services).
- Adequate seating capacity.
- Adequate luggage space and leg room.
- Good standard of comfort.
- Clean buses.
- Friendly, helpful drivers.

Disabled Access

- Design to suit needs of people with mobility impairments (consistent with wider policies).

3.10 Pricing and Ticketing

For bus-based schemes with dedicated P+R buses, no general guidelines are available as to how charges should be levied:

> *The issue of whether to charge for parking (and provide free bus travel) or charge for the bus travel (and provide free parking) still exercises the minds of scheme operators* (Huntley 1993).

> *On-bus ticketing is probably more widespread and is logical in so far as the bus journey usually represents the bulk of the cost* (Buchanan 1992).

Fare levels should be set to take account of:
- Existing bus fares.
- CBD parking charges.
- Costs for the total facility (parking site and bus service).

On UK bus-based schemes, return fare levels for P+R system users range from a low of £0.50 per adult (Bath) and £0.70 per car (Canterbury), to a high of £0.90 per adult (York) and £1.50 per car (Norwich) (Huntley 1993). Most schemes involve payments for the bus travel on a per person basis.

On UK rail-based schemes (principally Network South East (NSE)), station car park users are generally charged separately for their car park usage. The pricing is generally based on the local car parking alternatives.

Ticketing is commonly by the "pay and display" method. For bus-based schemes, two-part tickets are sometimes used: one part is left on the car windscreen, one part is presented to the bus driver. Some schemes make use of pre-payment cards (maybe Smartcards), at discount rates.

In the US, the majority of P+R facilities do not charge a parking fee. In general, parking fees are only charged in P+R facilities associated with rail systems in major metropolitan areas, many of which are at or close to capacity. In the Washington DC area, for example, parking fees range from $0.50 to a high of $3.00 a day.

In Australia as in New Zealand, the norm is for both rail-based and bus-based P+R to be provided at no charge (additional to the normal public transport ticket). No bus-based P+R sites in either country appear to have a separate charge levied.

3.11 Marketing and Information

The following types of traveller information are necessary:
- Road signs to highlight access to the parking site from nearby main routes.
- Guidance signing for motorists on the site (entry, exit, parking areas, bus stops).
- Parking site information display, giving PT service details, prices, etc.
- CBD bus stop signs to distinguish P+R stops/services from those of other buses.

Advertising/promotional campaigns are appropriate on opening a new P+R scheme and periodically thereafter. These may include:

- Leaflets delivered house-to-house, on vehicles, at car parks, etc.
- Media publicity.

(The literature gives details of promotional campaigns in some specific cities.)

3.12 Funding Aspects

The cost of implementing and operating a P+R scheme can be substantial (see Section 3.8 of this report). Means used in the UK to fund the shortfall between any revenue collected (and held by the P+R owner), and costs incurred, have included (Pickett & Gray 1994) :

- Obtaining a special grant (e.g. a Transport Supplementary Grant, TSG) from the Highway Authority.
- Commuter payments scheme on commercial development.
- Levy on town centre parking fees.
- Developer contributions.
- Other local authority funds.

A survey of 10 UK P+R schemes (Pickett & Gray 1994) showed that, of the schemes for which financial data were available, income did not cover expenditure. Responsibility for funding the deficit lies with the highway authority or local authority, and in most cases this responsibility was shared. There are examples where the income from P+R users is collected and retained by one party (e.g. bus operator) while the operating costs (e.g. maintenance of site) fall to another.

3.14 Summary

The literature suggests that the most essential, and almost universally applicable, criterion for the success of P+R schemes is a shortage of reasonably-priced central area parking. If this criterion does not apply, then P+R is only likely to succeed if an exceptionally high level and high quality PT service links the parking site with the CBD.

Other key features required for the success of P+R schemes are:

- Appropriate car park sites, in terms of location and facilities and design.
- High level and quality of the PT service between the car park and the CBD.
- Appropriate information and marketing of the scheme.

In essence, the basic requirement for success is that the access to the CBD via P+R needs to be competitive with the use of the car for the whole trip. This is in terms of perceived generalised costs (quality, reliability, comfort, travel time, out-of-pocket costs, etc.).

Few other "hard and fast" rules exist for the success of P+R schemes, although much can be learnt from international experience at the more detailed design level.

4. INTERNATIONAL EVIDENCE ON DEMAND & EFFECTIVENESS OF P+R

4.1 Overview

This chapter summarises the evidence, obtained from the literature review, on how effective the more successful P+R schemes have been in attracting users, influencing travel mode choice, and reducing the extent of car travel and CBD parking demand.

Desirably, any appraisal of the effectiveness of P+R schemes would involve a comprehensive assessment in relation to the stated objectives of the scheme. However, in practice little systematic assessment of P+R projects and programmes has been made, and thus most of the assessment data are limited and fragmented. One commentator notes:

> *With so little analysis available on the achievement of strategic objectives, there must still be doubt as to what is being delivered and what is the long term potential* (Huntley 1993).

One of the practical difficulties is that P+R schemes are often implemented in a piecemeal fashion, rather than simultaneous with complementary policy measures:

> *Rarely however has a "stick" of reduced parking provision or substantial charge measures for town centre parking been simultaneously applied* (Huntley 1993).

Thus any assessment of P+R schemes as part of a co-ordinated transport policy package is likely to be difficult, if not impossible, from the experience available.

In the light of these caveats, the rest of this chapter summarises the evidence available on traveller response to P+R measures, and their effectiveness in influencing mode choice and as a component of wider transport policy objectives.

4.2 P+R Success Factors

US research has investigated the sensitivity of P+R usage to various features and trip characteristics. It states that:

> *The successful bus service/P+R facilities are in cities with downtown parking charges over $2/day, are served with buses running at least every 15 minutes, and are less than a 30 minute bus ride from the CBD.*
>
> *If extra time by P+R is less than 10 minutes, daily out-of-pocket savings of at least $0.30 are sufficient to attract P+R usage. If extra time is more than 10 minutes, P+R usage drops substantially, and is minimal if extra time is over 25 minutes.*

It is further noted that successful schemes require PT headways that are no greater than every 10-15 minutes, and that for greater headways, usage falls rapidly (US DoT 1981).

The same report comments that rail P+R schemes are generally better patronised than bus P+R schemes:

- Rail travel times are more competitive with the car.
- More intensive developments around rail stations restrict parking availability.
- Rail travel is more highly visible.

However, where bus P+R schemes are linked to HOV lanes and other priority measures, the performance of P+R is much closer to that of rail-based schemes (see Section 4.4 below).

4.3 Reasons for Use or Non-Use

4.3.1 UK Market Research

A 1993 survey of weekday users of bus-based P+R in Oxford and York found that the reasons given in both cities for use of P+R were, in descending order of importance:

- Cheaper than parking in CBD (42% Oxford, 31% York).
- Because of CBD parking shortage/difficulty (22%, 27%).
- Easier access to ultimate destination (13%,19%).
- Reduces stress on person and vehicle (10%, 13%).

Thus it is evident that the "stick" of parking restraint is the dominant factor influencing use of P+R (Parkhurst 1994).

A UK report into the effectiveness of Bus P+R (Pickett & Gray 1994) reported an early 1978 survey of Oxford P+R users, which found that the reasons given for using the scheme were:

- Quicker
- No parking problems
- No congestion
- No parking costs
- Direct to centre

This TRL report also cited a 1987 survey of reasons given by motorists for choosing **not** to use P+R:

- Inconvenient in time terms
- Expensive

- Driver was "car loving"
- Awkward when carrying a load
- Need to have car available for work
- Not aware of service
- Had access to free or private parking
- Location of town centre bus stop was inconvenient
- Problems of children on bus

4.3.2 North American Market Research

Several North American studies investigated the reasons for use of P+R facilities. One US survey (US DoT 1981) found the following reasons for use, in descending order of importance:

- Traffic congestion
- Parking costs at destination
- Trip costs
- Parking shortage at destination
- Trip length
- Companionship

A Vancouver survey of P+R users found the following reasons were given for changing to P+R by **former car drivers**, in descending order of importance:

- Parking costs
- Driving strain
- Traffic congestion
- Trip time
- More frequent buses
- Less walking

A survey of car commuters in a corridor not served by P+R indicated that, to shift to P+R, would require frequent bus services and minor travel time savings (US DoT 1981).

Table 4.1 Public transport access mode shares for Australasian major city corridors.
% of total inbound public transport users by access mode.

Mode/Corridor	Source	AM Peak %					Off Peak %					Total %				
		P+R	K+R	Walk	PT	Other	P+R	K+R	Walk	PT	Other	P+R	K+R	Walk	PT	Other
Adelaide																
Rail - Northern	(1)	14.2	21.1	36.9	25.9	1.8	5.0	7.5	63.5	21.7	2.4					
Rail - Southern	(1)	17.0	11.1	56.0	14.6	1.3	5.1	4.2	80.4	9.1	1.2					
Busway (O-Bahn)	(2)	12.6	11.5	69.2	6.1	0.5	7.6	5.2	76.9	9.9	0.3					
Bus - Northern	(1)	0.7	5.6	82.9	10.1	0.7	0.7	1.2	86.0	10.9	0.6					
Bus - South Eastern	(1)	2.4	7.3	67.2	22.6	0.4	2.4	2.4	83.6	11.2	0.5					
Brisbane																
Bus Total - Northern	(3)	3.4[5]	5.6[5]	81.5	9.1	0.5	2.5[5]	3.1[5]	71.7	22.0	0.6					
Bus Express - Northern	(3)	4.9[5]	8.8 [5]	78.8	7.5	-	2.2[5]	5.4[5]	76.2	15.4	0.7					
Bus Stopping - Northern	(3)	2.9[5]	4.6[5]	82.3	9.6	0.6	2.6[5]	2.5[5]	70.6	23.6	0.6					
Perth																
Rail - Total	(12)	43														
Rail - Northern Suburbs	(4)											28.2[5]	14.1[5]	16.3	38.6	2.9
Bus - Total	(12)	5.0														
Bus - Northern Suburbs	(6)											4.6	6.3			
Sydney																
Bus Express -Warringah ave	(7)											13.8		82.5	3.3	0.4
Bus Express -Warringah max	(7)											32.0				
Rail - Liverpool Station	(8)											15.5	15.7			
Melbourne																
Rail - Overall	(9)											20.4[5	7.6[5]	47.0	14.0	11.0
Wellington																
Rail - Hutt Valley	(10)	19.7														
- Paraparaumu	(10)	18.9														
- Johnsonville	(10)	12.0														
- Wairarapa	(10)	61.8														
Bus - WN City overall	(11)	7.0														
Auckland																
Rail - Overall	(10)	8.5														

Notes/Sources

(1) Adelaide Public Transport Survey Report, Travers Morgan, March 1992.

(2) North East (Busway) Market Analysis Report, State Transport Authority, February 1994.

(3) Brisbane Northern Corridor Line Haul Study, Travers Morgan, 1993.

(4) Northern Suburbs Railway (NSR) Questionnaire Survey (August 1993), as analysed by Webster Research (1993) and Transperth (1993).

(5) P+R figure is "Car Driver"; K+R figure is "Car Passenger".

(6) Pre-NSR survey.

(7) Manly-Warringah Corridor Bus Study, Travers Morgan, 1990.
Maximum figure relates to longest distance trips (from Narrabeen and further north).

(8) State Rail Authority (SRA) Study.

(9) Advice from DoI Victoria.

(10) Refer Table 5.3 for details.

(11) Estimated from household survey - refer Section 5.4 of this report. Most of this is "informal" P+R.

(12) BAH estimates - relate to CBD-bound trips only.

4.4 Usage Rates

4.4.1 Usage as Proportion of Public Transport Trips

Table 4.1 presents a summary of information on access mode shares for public transport travel, in major radial corridors in Australasian cities. Note that:

- All figures relate to **inbound** travel only.
- Figures relate to morning (AM) peak (typically 0700-0900 h) and interpeak (weekdays) separately where available, otherwise to weekday totals.
- P+R has been distinguished from K+R (kiss and ride) where possible. In some cases, the only separation available was the car commuter is the driver (i.e. drives to park, and rides, and represents P+R) or the car commuter is a passenger (i.e. is driven to the park, and rides, and represents K+R).

The following general conclusions may be drawn:

- P+R and K+R proportions are greater at peak than off-peak periods.
- For **rail** services, the P+R peak proportion is typically around 15% of users, with a further 15% by K+R (Adelaide, Sydney, Melbourne).
- In the case of the Perth Northern Suburbs Railway (NSR), which runs through a relatively low density area with limited walk-in catchment, the P+R proportion is significantly higher (28% peak/off-peak combined). The walk proportion is very much lower than for other rail systems.
- For typical **on-street (all stops) bus services**, proportions are much lower than for rail. Typical peak figures (for Adelaide, Brisbane and Perth) are 1%-5%, for the P+R proportion, with K+R accounting for a further c.5%.
- For **express/busway bus services**, proportions are more comparable with those for rail-based services. The Adelaide O-Bahn (peak) has about 12.5% P+R plus 11.5% K+R. In Sydney, the Warringah Peninsula express bus services to the CBD (which use an extensive length of transit lane) achieve about 14% car access (P+R/K+R together); while for the longer distance passengers, the car access proportion increases to 32% (all periods).

These results are consistent with the earlier comments relating to "P+R Success Factors" (Section 4.2 in this report).

Various US studies into access modes of express bus users, which often used reserved freeway lanes, found that:

- For routes with the highest level of P+R facilities, between 60% and 95% of bus users gained access by car: the car driver share was between 45% and 69%.
- For routes with a "moderate" level of P+R facilities, between 30% and 60% of bus users gained access by car.
- For routes with a "limited" level of P+R facilities, between 4% and 40% of bus users gained access by car (US DoT 1981).

4.4.2 Usage Rates per Person

P+R usage data, for the UK cities with bus-based P+R schemes, indicate typical usage data in the range of 5-30 return trips per day per 1,000 population (or 10-60 one-way trips per day). With typical total trip rates of 3 one-way trips per person per day, this indicates that P+R accounted for up to 2% of all trips.

P+R would of course account for a considerably higher proportion of CBD trips, typically up to 10%. Taking a typical P+R proportion of 15%, and a PT mode share for CBD travel of say 30%, indicates that P+R accounts for 4.5% of all CBD trips, with K+R perhaps accounting for a similar proportion.

4.5 Alternative Means of Travel

A UK survey of bus-based P+R users in the historic towns of Oxford and York found that:

- Before introduction of P+R, 60% of York weekday users said they would have travelled to the city as car drivers, 6% as car passengers, 26% by public transport (all the way), and 7% would have travelled by other means.
- When asked about their alternative travel behaviour if P+R was unavailable, 55% of the York weekday respondents said they would travel to the city by car, 24% by bus public transport, 11% would travel elsewhere or not that day, while 4% gave other responses. The Oxford responses were very similar.
- However, alternative travel behaviour differed dramatically according to trip purpose. People travelling on work/education trips were much more likely to travel by public transport or cycle, while those on shopping trips were very likely to travel elsewhere or not make the trip (Parkhurst 1994).

A UK (TRL) survey of bus-based P+R in four towns indicated that between 59% and 78% of P+R users would have driven into town if the facility had not been available. Of those who would not have driven (19%-40% of the total), the largest proportion (11%-25%) would have made the same trip by bus; the second largest would have not travelled at all (4%-9% of the total); while 2%-8% would have visited another location (Pickett & Gray 1994).

A major US review study of P+R sites served by express bus services found that (though bearing in mind that feeder bus services are of a low level in many US cases):

- 40-60% of P+R/transit users previously commuted as car drivers;
- a further 8%-15% were previously car passengers;
- 25-45% were former transit trips, of whom 15%-20% would have walked directly to the transit service in the absence of the P+R facility (US DoT 1981).

A Californian study found that 27% of P+R users previously drove their vehicle alone to their destination (California Department of Transportation 1988).

The Vancouver survey (quoted in Section 4.3.2) found that 38% of P+R users were former car drivers, while 21% were former bus travellers (all the way) (US DoT 1981).

In **Adelaide**, the provision of P+R spaces associated with the O-Bahn is said to be a major contributing factor in encouraging former car drivers to use the O-Bahn for the major part of their journeys to the CBD (Wayte 1991). However, detailed statistics appear to indicate that the P+R mode share by "new" users is similar to that by "existing" bus users.

London data (for Network South East (NSE) rail services) indicates that approximately 21% of NSE passengers to Central London use station car parks (P+R); and that, for each person using the P+R facilities, there are 0.16 new return rail trips. Most of the P+R users would have used a train in the absence of the P+R facility.

4.6 Effects on Road Traffic Levels

4.6.1 Intercept Rates

One measure of the effect of P+R schemes on road traffic is the "intercept rate", which is the proportion of all car travellers on the relevant radial route or corridor passing the P+R site that transfer to P+R. Typical intercept rates in UK cities which are oriented to bus P+R are in the range of 10-20%:

- *P+R could attract up to 20% of traffic past the site which is travelling into a town centre* (Davidson 1992).
- *(In Oxford) 17% of car-based journeys from outside the urban area now transfer to P+R, but this contribution is helping to absorb growth, rather than displacing existing demand* (Huntley 1993).
- In York, the P+R scheme intercepts 12% of car trips on the adjacent radial route.

Oxford has probably the most used bus-based P+R scheme in the UK, but the car park sites are near the outer edge of the city area. Thus the proportion of overall CBD-oriented traffic affected by P+R is very much less than the 17% figure. It should also be noted that, in the absence of P+R, not all the intercepted trips would necessarily have gone by car all the way to the CBD, although a substantial proportion of them would.

4.6.2 P+R Use by Former Car Drivers

The US and Canadian data quoted above indicate that broadly half (38%-60%) of P+R users were former car drivers.

European data tend to indicate smaller proportions of users transferring from car driver. The London (NSE) assessment is as follows:

- Approximately 21% of NSE passengers to Central London used P+R;

- For each person using the P+R facilities, there are 0.16 new return rail trips;
- Assuming NSE accounts for 70% of travel to Central London in the relevant corridors and each new return rail trip results in 0.7 fewer car trips, then 2.2% of the total travel market would stop using the train and become car drivers if the P+R facilities were closed.

This extreme scenario would have perceptible effects on the total travel market to and from Central London, but its effect on overall road traffic levels in the area concerned would be barely perceptible.

4.6.3 Road Traffic Generated by P+R

There is a danger that P+R schemes may in fact generate additional car travel:

- Some motorists may travel a greater distance to reach a P+R site rather than drive directly into the town centre (although this does not necessarily mean extra congestion and pollution, given that a short journey in a congested network may have a greater adverse impact).
- P+R may encourage motorists to make additional journeys.
- Cars left at a P+R site that were previously driven into the town centre may be replaced by other vehicles in the town centre.
- Some people who previously travelled all the way by bus now switch to driving to the P+R site, then continuing by bus.

A UK survey of P+R users in four towns found that 75% of users travel from or through the sector of town in which the P+R site is located; and most likely do not travel further than if they drove into the town centre (Pickett & Gray 1994). The remainder would probably travel further "but part of the extra mileage covered would be along less congested roads". In addition, as noted earlier, a significant proportion of P+R users indicated they visited the town more often since the introduction of the P+R schemes, or would not have made the journey at all if the P+R scheme had not been available (Parkhurst 1994).

4.6.4 Overall Effects on Traffic Levels and Congestion

Pickett & Gray (1994) reviewed the relevant literature on bus P+R and found that *"none of the papers/articles reviewed demonstrated conclusively that Park & Ride reduced urban traffic congestion"*. This does not necessarily mean that P+R has not had significant effects on traffic volumes and congestion, but that any effects may be relatively small and difficult to measure.

As noted in Section 4.6.1, P+R appears to have had some success in "intercepting" road traffic (e.g. Oxford) and in attracting some former car users to public transport. Analyses in Oxford and Canterbury have failed to detect any absolute reduction in traffic levels as a result of P+R, most likely because any road space that has been freed-up is filled by previously suppressed demand. In Oxford, there has been very little traffic increase over the last 20 years, which has been a period of considerable national traffic growth. It appears that the combination of P+R, other traffic measures

(e.g. parking fees, increased enforcement), and lack of road capacity has contributed to this result. Pankhurst suggests that, in both Oxford and York, P+R has not directly reduced congestion, but that "congested equilibrium" has been maintained.

These conclusions on the effects of P+R on road traffic levels are consistent with the finding of other commentators:

- *With only a few exceptions, (existing P+R services) have not been shown to have a significant effect on volumes of traffic in the wider urban area* (Armstone 1992, referring to UK experience).
- *In Milwaukee, 6 shopping centre P+R lots removed 400 peak cars from radial routes, but these represented under 1% of car trips to the CBD* (US DoT 1981).

4.7 Environmental and Energy Impacts

The effects of P+R policies on the environment (noise, emissions, etc.) and on energy use are very dependent on their effects on total car travel (discussed in Section 4.6).

However, any benefits in terms of energy use and emissions are likely to be proportionally smaller than the reductions in car traffic levels. One effect of P+R will be to change longer car trips (to the destination) to shorter trips (to the P+R site). However the emission reductions will be much less than in proportion to the distance saved, as emissions are much greater in the warming-up stage. Similarly, any switch from PT travel all the way, to travel by car to P+R site followed by use of PT, will cause significant extra emissions.

Another potential "environmental issue" is the impact of the P+R site facility on the local ground level environment. In Cambridge the new P+R scheme was seen by some as environmentally unacceptable as it was proposed to locate sites in areas of Green Belt. Consideration of this issue deflected debate away from the overall benefits of the P+R scheme.

4.8 Summary of P+R Effectiveness

If P+R measures are to be effective, they need to be considered as one component of a CBD parking restraint/pricing policy. In the context of such a policy, P+R will only be successful if it is to offer an attractive PT service, in that the generalised cost, convenience and service quality of P+R travel combined are comparable with the alternative choices, particularly the use of the car for the full journey.

Generally, experience elsewhere is that the required PT service quality and convenience has been more readily achieved in cities with rail-based services than with bus-based services. However, high quality bus-based services (as exemplified by the Adelaide O-Bahn and US HOV lanes) may be as attractive for P+R as rail-based services.

The international experience is that, while P+R schemes have resulted in significant shifts from car to public transport for CBD-oriented movements in selected corridors, the overall impacts on total traffic in an urban area have generally been very small, and often imperceptible. This result arises in part because additional road traffic is often generated that fills road space vacated by those motorists switching to P+R.

In general, any environmental and emission benefits resulting from P+R schemes will tend to be even smaller proportionately than the reductions in car travel (because of the relative increase in short-distance car trips).

This certainly does not mean that P+R measures have no useful role to play as a component of urban transport policies. However, if they are to be pursued in New Zealand in the context of CBD parking/traffic restraint and public transport promotional policies, they need to offer a competitive alternative to the private car. They will have to be competitive in terms of car park location and facilities, PT service characteristics (vehicle type, frequency, reliability, stop location and facilities, etc.) and overall price.

4.9 Demand Estimation Methods

A number of techniques are used for estimating likely demand from new P+R sites. These techniques range from simple observation approaches to more complex modelling approaches. The technique used, and the time and resources required to conduct the analyses, should be matched to the scale, scope and complexity of the P+R project.

In using any of these approaches, however, much depends on the type and level of service being offered, the potential time and cost savings over alternative modes, and other aspects unique to the local situation. Estimation of demand for new P+R facilities is thus more an art than a science, and all demand estimates should be treated with some degree of caution. The main demand estimation approaches, summarised in this Section 4.9, are Demand observation, Market area population, Modal split, and Modelling.

4.9.1 Demand Observation

This is the simplest technique available, and is the most commonly used demand estimation approach in the US, particularly among small-to medium-sized PT systems. It involves using data from actual field observations and surveys to identify the potential demand.

Information may be obtained from:

- *Field observation*: obtain data on current traffic conditions, major congestion points, informal P+R arrangements, unsafe or illegal parking, major access points, and potential sites. Field observation will be needed for all demand estimation techniques.

- *PT Routes & Patronage*: examine current PT services to identify possible candidate corridors and areas (e.g. high frequency and high patronage).

- *Aerial Photographs*: can show size of area, road network, accessibility from different areas, and identify vacant land.

- *Census Data*: indicate information on income levels, car ownership and travel characteristics of people residing in an area.

- *Land Use Maps*: provide an indication of existing and future land use patterns and densities.

- *Traffic Counts* and other traffic data: identify congested corridors and specific bottleneck problems.

- *Special Surveys*: obtain data about, for example, PT riders, commuters in the corridor, employees and shoppers at a major activity centre, and residents in the neighbourhood.

4.9.2 Market Area Population

This technique uses the population in the proposed P+R facility service area to obtain an estimate of the facility's potential use. Under this approach, the ratio of users to catchment area population from existing P+R facilities would be estimated, and this percentage then applied to estimate the demand for a new facility in the same corridor or in another area.

This approach has been adopted recently in Perth (Arup Transportation Planning 1998). An empirical model was first derived for rail-based P+R demand:

$$P = 273 + 0.0127C - 173A$$

where:
P = P+R demand (spaces);
C = catchment area population;
A = index reflecting the attractiveness of the facility, with value between 0 and 2.

Catchment area population was said to be "estimated using a theoretical catchment area of parabolic, rectangular or circular shape".

This formula was subsequently modified for bus-based P+R to:

$$P = 0.007C$$

This formula was derived from data for the Murdoch P+R facility, the only substantial bus-based P+R site in Perth. It was based on surveys of current users, and an estimated catchment population of about 70,000 people (in an area extending about 9 km S and 2 km N of the site). The formula implies a usage rate of 0.7% of the catchment population, which is in the order of half the usage rate for rail-based sites.

4.9.3 Modal Split

This approach takes the market area analysis one step further by examining the portion of the market area population that works in the activity centre or centres to be served by the facility. This approach attempts to account for the fact that different parts of the potential service area have different attraction rates to the various activity centres.

4.9.4 Modelling

The modelling of P+R mode choice is not well developed and difficult to do successfully. Full discussion of the issues and approaches would warrant a paper in its own right. The following examples merely summarise selected examples of models that have been developed for estimating the demand for P+R facilities. Two examples that are available are a linear model developed by the US Institute of Transportation Engineers (ITE), and a logit model used by Oscar Faber in evaluating possible P+R sites for the London Underground:

- *Linear model ITE:* this model is based on the assumption that P+R demand is a direct function of peak period traffic on adjacent travel facilities. As well, it is assumed that commuters will not divert to reach a P+R site, so that potential users will only be commuters who were already passing the location on their normal travel routes.

  The formula used for the ITE model is:

  $$Demand = a(Peak) + b(Prime)$$

  where
  Peak = total peak traffic on adjacent facilities (including the prime facility);
  Prime = peak-period traffic on the prime facility; and
  a, b = diversion rates for total traffic and prime traffic, respectively.

  Diversion rates of 1% for total area traffic and an additional 3% for traffic on the prime facility have been recommended for use with this model. The main limitations of this model is that no attempt is made to distinguish between commuting and non-commuting trips, or between trips to different destinations.

- *Logit model, Oscar Faber:* London Transport commissioned Oscar Faber (OF) to assess the potential for the development of a number of P+R sites as enhanced "Gateway" stations. To estimate the demand at the potential Gateway P+R sites, OF developed a simple logit model in which a diversion curve was used to estimate the proportion of trips switching from one mode to another. The diversion curve was determined on the basis of the difference in generalised costs. Total demand for individual sites incorporating existing and potential demand was estimated.

- *Other models:* Other models are available for estimating the demand for P+R facilities. One example is the P+R mixed mode logit model which has been developed for use in conjunction with the EMME/2 transportation planning package, and is available in the form of a macro entitled PARKRIDE.

5. NEW ZEALAND POLICIES & EXPERIENCE

5.1 Policies

P+R is presently operational (in a formal way) in two New Zealand cities, Auckland and Wellington. Both of the regional councils in these two centres have developed P+R policies, which are contained in their respective Regional Land Transport Strategies (RLTS).

5.1.1 Auckland

The 1998 Draft Auckland RLTS has both Region-wide policies and Corridor policies, and a series of Methods to carry out these policies.

The Region-wide policies contains a range of policy areas including Accessibility policies. Policy 2.11 of the Accessibility policies is to *"encourage the use of more sustainable modes of transport"*, including to *"introduce and promote park and ride facilities"*.

Under the Corridor policies, Policy C6.1 is to *"Increase the people moving capacity of the Southern corridor by increasing and improving passenger rail services"*. As part of this, the Auckland Regional Council (ARC) will *"Provide and promote additional park and ride facilities"*.

Under the Methods section to implement Region-wide Policy 2.11, Method 2.11.3 lists several criteria for locations to introduce P+R :

- where there is a catchment of potential users; and
- where the park and ride is served by attractive passenger transport services (such as rail, ferry or bus with priority measures).

Several requirements for a P+R facility are listed:

- security for both passengers and their vehicles;
- weather protection for waiting passengers;
- adequate car parking;
- convenient vehicle access.

5.1.2 Wellington

The Wellington RLTS (1996-2001) has six key strategy areas, one of which is Strategy A - to *"Enhance and expand urban public passenger transport facilities and services"*. Policy 8 under this strategy is to *"provide enhanced 'Park and Ride' facilities on all rail lines and key bus routes"*. This policy mentions several key requirements for P+R facilities:

- provide security;
- be well lit;
- be generally attractive to users.

The RLTS also sets out a number of Performance Measures as *"targets for the RLTS to achieve"*. A performance measure set under Strategy A is (h) *"A programme of enhancing rail and bus P+R continue to be implemented over a three year period"*.

5.2 Facilities and Usage

5.2.1 Auckland

Existing Facilities and Usage

P+R facilities are provided in Auckland for rail, ferry and bus services (and listed in Table 5.1) as follows:

- 4 bus P+R sites on the North Shore, 4 in West Auckland, and 1 in East Auckland (Pakuranga).
- 2 rail P+R sites in West Auckland, and 3 in South Auckland.
- 4 ferry P+R sites on the North Shore, and 1 on Waiheke Island.

Table 5.1 Auckland P+R sites & usage (August 1997).

Facility	No. of Carparks	Usage	Utilisation (%)
Bus			
Mays Road Trial	400	21	5
Silverdale	19	18	95
Dairyflat	10	8	80
Northcross	20	17	85
Waimauku	35	4	11
Kumeu	22	14	64
SH 16&18	14	12	86
Whenuapai	8	6	75
Pakuranga	30	–	–
Total Bus(1)	158	79	62
Rail			
Homai(2)	100 +	35	35
Papatoetoe	60	17	28
Papakura(2)	200 +	151	76
Waitakere	15	8	53
Swanson	25	10	40
Total Rail	400	221	55
Ferry			
Bayswater	50	–	–
Birkenhead	70	54	77
Devonport	150 +	150 +	100
Northcote Point	30	7	23
Total Ferry	300	211	84
Auckland Total	**858**	**511**	**60**

Note (1) Mays Road Trial excluded.
(2) both rail and bus.

Mays Road Trial
A trial bus P+R service from the Stagecoach Depot in Mays Road, Mt Roskill, has been instituted. This involves a dedicated bus every 15 minutes to the Auckland CBD at peak times, and every 30 minutes in offpeak times. A limited stops service is provided (4 stops instead of 20 on normal service). The bus is able to make use of bus lanes on Dominion Road. After 3-4 months, use of the service is around 21 cars a day.

Proposed Facilities
A bus-based P+R facility is proposed in conjunction with the scheduled North Shore busway.

Special Events
P+R has been also successfully used in Auckland in conjunction with bus services to special events.

5.2.2 Wellington

Existing Facilities and Usage
P+R facilities are currently provided predominantly for rail services, with one ferry P+R site, and only a single bus P+R site.

Table 5.2 lists the existing Wellington P+R sites with their capacity and utilisation. Nearly all the Wellington sites have high utilisation rates. Demand has continually exceeded supply at Waterloo, with new parking spaces being filled almost immediately upon construction.

P+R Development Programme
The Wellington Regional Council (WRC) has a P+R Development programme which it is implementing as funding is available. This primarily involves extensions and enhancements to existing P+R facilities. Several new rail stations are presently being evaluated and, if proceeded with, these stations would have P+R carparks.

5.3 Market Share and Demand Factors

5.3.1 Market Share

Market share for P+R can be considered in two ways:

Proportion of Public Transport (PT) passengers using P+R
This can be measured as either the proportion of passengers boarding at each stop who have arrived by P+R; or P+R as a proportion of all PT mode passengers on the service or corridor. Few data are generally kept in regard to PT boardings by individual stop, and this can be a misleading indicator given that P+R users can often access several stops with similar cost and time. The most useful indicator is thus P+R as a proportion of all PT mode users. The data presently available for Auckland and Wellington are summarised in Table 5.3.

Table 5.2 Wellington P+R sites & usage (1998).

Facility	No. of Carparks	Usage	Utilisation (%)
Rail			
Hutt Valley Line:			
Petone	170	134	79
Woburn	100	77	77
Waterloo	400	420	105
Taita	134	86	64
Siverstream	60	45	75
Trentham	60	51	85
Wallaceville	40	29	73
Upper Hutt	120	117	98
Melling	120	100	83
Hutt Valley Total	1,204	1,059	88
Johnsonville Line:			
Crofton Downs	44	26	59
Ngaio	26	22	85
Simla Crescent	6	6	100
Khandallah	7	6	86
Raroa	8	5	63
Johnsonville	43	43	100
Johnsonville Total	134	108	81
Western Line:			
Takapu Road	63	57	90
Redwood	92	77	84
Tawa	34	5	15
Porirua	145	146	101
Paremata	162	141	87
Mana	20	15	75
Plimmerton	35	15	43
Pukerua Bay	25	–	–
Paekakariki	50	24	48
Paraparaumu	205	204	100
Waikanae	50	24	48
Western Line Total	881	708	83
Wairarapa Line:			
Featherston	60	54	90
Woodside	45	36	80
Carterton	36	33	92
Solway	10	12	120
Masterton	50	39	78
Wairarapa Total	201	174	87
Rail Total	**2,420**	**2,049**	**85**
Karori Bus P+R	15	40	267
Days Bay Ferry	–	–	–
Wellington Total	**2,435**	**2,089**	**86**

Table 5.3 P+R usage as proportion of AM Peak passengers.

PT Service	AM Peak Pass	P+R Users[2]	% P+R
Wellington Rail[1]:			
Hutt Valley Line	5,900	1,160	19.7
Paraparaumu Line	4,600	870	18.9
Johnsonville Line	1,080	130	12.0
Wairarapa	340	210	61.8
Total	**11,920**	**2,370**	**19.9**
Auckland[3]:			
Bus	35,000	250	0.007
Rail	3,200	160	5.000
Ferry	2,500	270	10.800

(1) Wellington rail patronage based on 1996 Census Day count by WRC (total boardings between 0630-0900hours).
(2) P+R users based on 1.2 persons per parked vehicle for Wellington and 1.3 persons per vehicle for Auckland: derived from analysis of several WRC & ARC surveys.
(3) Auckland rail passengers derived from ARC 1997 rail survey matrices; Auckland bus and ferry passengers are an indicative estimate provided by ARC.

P+R Usage as a Proportion of Commuter Trips

P+R facilities are almost exclusively used in Auckland and Wellington by commuters travelling to the Central Business District (CBD). A relevant indicator is, therefore, P+R usage as a proportion of commuter trips to the CBD. The data presently available for Auckland and Wellington are summarised in Table 5.4.

These results indicate the substantial role of P+R in terms of CBD commuter travel. In Wellington, P+R is used by 35% of all rail commuters to the CBD, which represents 9% of all CBD commuters from zones in the rail catchment area. In Auckland P+R is a substantial portion of the rail and ferry CBD commuter market, but is much less important for bus CBD commuter trips. (It has been assumed that all P+R passengers are CBD commuters, and surveys of P+R users in Wellington have found this to be the case.)

Table 5.4 P+R usage as proportion of CBD commuter trips.

PT Service	% JTW to CBD
Wellington Rail:	
Hutt Valley Line	34.3
Paraparaumu Line	34.1
Johnsonville Line	19.7
Wairarapa	100.0
Total	**34.9**
Auckland:	
Bus	3.3
Rail	44.1
Ferry	32.7

JTW - Journeys to work

5.3.2 Demand Factors

In a 1994 study of P+R in the Hutt Valley for the WRC, Travers Morgan (1994b) identified a number of factors which impact on the demand for P+R facilities:

Availability and Price of CBD Car Parking

Demand for P+R facilities is related to the availability and price of car parking at the destination. Where parking at destination is limited and expensive, demand for P+R facilities will be higher. However, this will also depend on the availability and price of parking at the P+R facility.

In both Wellington and Auckland, P+R parking is free. In Wellington CBD the price of parking has been increasing over the last 5 years, particularly in regard to "fringe parking" (Wellington City Council (WCC) introduced a coupon parking scheme for these areas in 1993). P+R use has increased in Wellington region over this period.

Level of Service of Public Transport Mode

To attract those people making car-based trips to use P+R facilities, the level of service (LOS) on the PT mode must be competitive with the car in terms of critical LOS features. One important LOS feature is trip frequency.

The effect of trip frequency on P+R use has been demonstrated in Wellington region with the re-focussing of Lower Hutt bus and train services on the Waterloo interchange in 1989. Before this all the Wainuiomata bus services had met the train at Woburn, and all trains stopped there. With the advent of the Waterloo interchange the Wainuiomata bus services were re-routed to Waterloo, and train services from Upper Hutt were introduced that were express from Waterloo (i.e. did not stop at Woburn). The service frequency at Waterloo therefore became nearly double that of Woburn, and most of the Woburn P+R users moved to Waterloo.

Price of P+R/Public Transport Package

The relative cost of the P+R/PT package against the cost of car travel and parking at the destination, affects the attractiveness of P+R to people making car-based trips. In both Auckland and Wellington, P+R users do not have to pay for parking and are charged only the normal train fare. This should give P+R some cost advantage over private car travel to the CBD. However, many workers have free or subsidised parking at or near their workplace.

Rail fare stages will also influence the relative use of different P+R sites on a rail line. This has been evident with the change in rail fares on the Hutt Valley line at different times.

Traffic Congestion

The level of road congestion, and its effect on journey time, has an effect on the attractiveness of the P+R package. This has been evident at Paraparaumu where P+R use has been increasing significantly over the last few years, as road congestion between Paraparaumu and Wellington has gradually worsened. Roading developments are planned to alleviate it. As more P+R spaces are provided they are filled immediately, indicating a latent demand that has not yet been satisfied.

P+R Carpark Security

Although not highlighted by Travers Morgan, evidence in Wellington over the last few years points to the importance of carpark security for potential users. For example, P+R use at the Porirua facility had been running at around 100 vehicles for several years. Security was not particularly good, but following several car break-ins, the Police mounted a surveillance program and apprehended the people responsible. Since then public perception of security at Porirua has improved, and use has increased significantly.

5.4 Market Research

Very little research into the characteristics and attitudes of P+R users in New Zealand has been undertaken (up to 1998). However, Travers Morgan carried out (for WRC) two surveys of Hutt Valley rail P+R, and a survey of Wellington City commuters in 1994 (Travers Morgan 1994b-d). The main findings of these surveys relevant to this project are summarised below.

5.4.1 Waterloo P+R User Survey

All users of the Waterloo P+R facility were surveyed on the one day. Key characteristics of users were:

- 97% of users were commuters, with nearly all the remaining 3% travelling to education.
- Nearly all users were getting off the train at Wellington rail station, with most people finishing their trip within walking distance of the station.
- The most common reason given for using the P+R facility was convenience, followed by "environmentally friendly", quicker and cheaper.
- 80% of users park at Waterloo at least 3 times a week, with only 4% using it less than once a week.
- Most users were female (59%), and close to half were aged between 25 and 39 (46%).
- P+R users were also asked to indicate what they would do under four different options. These options, and the expected responses, are outlined below:
  - $2/day parking charge at Waterloo - this option was strongly opposed, with only 16% indicating they would continue to park at Waterloo. 31% indicated they would park at another station, 18% walk/cycle to the train, and 15% would travel by car to Wellington.
  - Extra 200m walk to station platform - 69% would continue at Waterloo, with most of the switchers parking at another station.
  - Improved bus service - 14% would switch to the bus as their access mode to the train.
  - Express trains also stop at neighbouring stations - a large number of Waterloo users would switch to one of the (closer) neighbouring stations.

These results highlight the impacts of P+R parking charges and of public transport level of service on P+R use levels.

5.4.2 Waterloo Telephone Survey

A random telephone survey of people travelling from the "wider Waterloo area" to the Wellington central city area was carried out. Respondents were asked to indicate what they would have done for their trip to Wellington under a number of different scenarios. As the Waterloo carpark was operating at or over capacity, the likely response to providing more carparks was one aspect being investigated.

The main conclusions were:

- Providing more carparks at Waterloo would attract new P+R users. However, primarily these would be existing train users switching from other station carparks.
- Less than 1% of people who currently travel by motor vehicle to Wellington CBD would switch to using the train if extra carparks were available at Waterloo, or if improvements were made to all station carparks.

These results are consistent with the understanding that most motor vehicle users do not use the train for convenience-related reasons, and significant improvements to the total PT system are required to attract these people. Providing a P+R facility, even one of a high quality, will on its own attract few motor vehicle users out of their cars on to PT.

Another aspect of this survey involved asking existing train users to rank different carpark features in terms of importance. Good security and good lighting received the highest rankings, followed by having a short walk to the platform.

5.4.3 Wellington City Commuter Survey

A survey of people travelling from three selected areas to work in the Wellington CBD was carried out to determine the likely response to providing Bus P+R facilities. The main findings were:

Existing Bus Users

- Nearly all bus users walk to the bus stop, with around 7% taking their car to the stop and parking there.
- The majority (84%) who had a car available would be "not likely" to use a bus P+R facility if provided.

Non-Bus Users

- 55% of respondents who had made their most recent trip to work by motor vehicle indicated they did not use the bus at all for their travel to work. The main reason for non-bus use was convenience, and this related primarily to the need for the car during the day, greater flexibility, and relative ease of travel.
- The most attractive single bus service improvement for non-users was instituting express services. Simply providing a P+R facility on its own was the least attractive improvement.
- Only 2.7% of motor vehicle users indicated they would be "almost certain" to use a specific proposed new P+R facility. 66% stated they would not use it all.

6. POLICY & PLANNING CRITERIA & GUIDELINES

6.1 Introduction

This chapter sets out planning guidelines and development criteria for P+R facilities for the main urban centres in New Zealand. These are presented in tabular form to allow easy transfer later into a policy and planning manual. As such, they are suitable for use by practitioners.

6.2 Role of P+R in Urban Transport Policy

The guidelines in regard to the Role of P+R are set out in Table 6.1.

Table 6.1 Role of P+R in urban transport policy.

Issue	P+R Mechanism	Desired Effect
Lack of parking in CBD: land scarcity (carparks expensive), out-of-scale with CBD townscape	Provide parking in other locations where land is more readily available and cheaper.	CBD visitors park in other locations, thereby reducing demand for CBD parking.
Congested radial routes: and in CBD	Provide parking before congested corridor/area, allied with priority public transport service.	Diversion of peak time travellers to public transport, thereby reducing congestion.
Low Public Transport Usage	Make public transport more attractive for a market segment.	Attract new users on to public transport from motor vehicles.
Environmental Issues: high vehicle emission levels & other negative impacts	Make public transport more attractive for motor vehicle drivers.	Reduce total vehicle kilometres by car drivers taking public transport for longest portion of their journey.

Several other comments regarding the overall role of P+R can be given:

- Target Markets
  - Main target market will be commuters travelling at peak time.
  - P+R is not used extensively in New Zealand at off-peak times, and this is not likely to change significantly with the general availability of off-peak parking. In addition, public transport services generally operate at lower frequencies at off-peak times.
- CBD Focus
  - Given the general CBD focus of public transport and availability of parking at suburban locations, P+R will be most effective when focussed on the CBD.

6.3 P+R Planning Criteria and Guidelines

The stages for developing and operating a P+R Programme are shown in Table 6.2. For each of these nine stages (A-I), a separate table provides further criteria and guidelines for each separate activity. It should be noted that there will be some iteration between stages (especially stages B and C), and that the programme will not necessarily be a straight staged process.

Table 6.2 Stages in developing P+R facilities.

Stage	Description	Key Activity	Table
A	Examine Need for P+R Facilities	• Determine specific need for P+R within urban transport area	6.3
B	Identify & Select P+R Sites	• Identify possible P+R locations • Select potential P+R sites	6.4 6.5
C	Estimate Demand for Potential P+R Facility	• Gather available data • Apply appropriate demand estimation approach	6.6
D	Design the P+R Facility	• Design P+R facility (site and amenities)	6.7
E	Design PT Service	• Design accompanying PT service	6.8
F	Cost the Proposed P+R Facility & PT Service	• Estimate size and cost of proposed P+R facility	6.9
G	Market the P+R Facility	• Pricing, marketing, and promoting the P+R facility	6.10
H	Maintain the P+R Facility	• Ongoing maintenance of P+R facility	6.11
I	Monitor the P+R Facility	• Monitoring of P+R facility	6.12

Stage A - Examine need for P+R Facilities

Table 6.3 Guidelines for determining specific need for P+R within urban transport area.

Planning Guideline		Key Aspects
1	Identify issues	P+R can be considered to assist with any of the following: • Lack of parking in CBD or major business/retail area • Congested radial routes to those centres • Low public transport use • Environmental issues
2	Assess likely effectiveness of P+R – current conditions	P+R will be effective where: • Radial routes to the CBD or major business/retail centres have high levels of congestion • Parking in those centres is in short supply and/or relatively highly priced • Public transport services which are "competitive" with the car are available, or could be implemented, on those radial routes Note: if radial routes are not congested, small P+R sites may still be used by existing PT users with cars
3	Assess ability & cost of providing P+R support measures	Often all the conditions needed for P+R to succeed are not present. The ability and cost of the planning organisation to provide/influence these must be assessed. Questions to address include: • Who controls the key areas of roading, parking and public transport provision? • To what extent are we able to influence these organisations to provide P+R supportive measures? • What is the likely cost of providing these measures?
4	Assess likely "Success" of P+R, and need for a P+R development programme	Based on analysis above, determine need for developing a P+R programme

Stage B - Identify and Select P+R Sites

Table 6.4 Criteria for identifying possible locations for P+R facility.

Planning Criterion		Key Aspects
1	Locate P+R sites in congested corridor	• Reasonable portion of travel corridor must have significant congestion to attract car drivers on to public transport (PT)
2	Locate sites in advance of congestion	• Car drivers will switch to P+R to avoid congestion: thus P+R facility must be placed before significant congestion is experienced
3	Locate sites in conjunction with separate corridor/priority PT	• PT service should not be in congested traffic • Priority should be given to PT where separate corridor is not available (e.g. HOV lanes)
4	Locate sites with high travel demand to areas served by PT	• Low demand areas will not warrant an investment in a P+R facility
5	Locate sites so that users do not have to backtrack to reach site	• Car drivers will not generally deviate much from their normal travel direction to reach a P+R site • However, the longer the journey involved the less important this criterion is
6	Locate sites with appropriate distances between sites	This has two aspects: • Providing too many sites will duplicate PT services unnecessarily, increasing costs and imposing extra "stopping" costs on PT services • Providing too few sites will increase the car-driver portion of the journey, hinders the switch to PT

Table 6.5 Criteria for selecting potential sites for P+R facility.

Planning Criterion		Key Aspects
1	Identify potential sites in appropriate locations	• Apply site location criteria from Table 6.4
2	Close proximity to PT service	• Shorter walking distance from the PT service is more attractive for users • A maximum walking distance of 100m is recommended (preferably considerably less)
3	Good accessibility and visibility from adjacent road network	• Helpful if site readily visible from main routes • Multiple access points, or access from two streets can ease congestion; this however will reduce parking capacity and may increase security risk
4	Adequate space	• Ideally should be able to accommodate the projected demand; with room for expansion to meet long-term demand • Inadequately sized sites will result in P+R users overflowing on to surrounding street network
5	Low development costs	• In selecting between sites in the same area, relative development cost is an important selection criterion • Factors affecting this include: purchase/lease price, grading & levelling, environmental factors & construction costs • Potential for joint-development should be considered
6	Close proximity to user amenities	• Close proximity to user amenities will encourage use; however, this is not a critical factor • Amenities include: dairies, day-care facilities, petrol stations, retail area

Stage C - Estimate Demand for Potential P+R Facility

Table 6.6 Guidelines for estimating P+R facility demand.

	Guideline	Key Aspects
1	Determine market area for P+R facility	• Assess the geographic catchment for the proposed P+R site. This should take into account: proximity of other sites, distance from destination (a further distance has larger catchment), position in road network (sites on major roads will have larger catchments), and type of PT service (larger catchment for rail than bus)
2	Gather traffic & PT data for market area and travel corridor	Key data required include: • Population of area, particularly work-age population • Peak commuter and trips from market area to destination area • Peak PT trips from market area to destination area • Existing & projected peak car travel time to destination • Existing & projected peak PT travel time to destination • Existing & projected PT peak frequency
3	Obtain P+R data for travel corridor & similar corridors	Key data required include: • Proportion of commuters to destination using P+R • Proportion of peak period PT passengers using P+R as their access mode
4	Base Estimation	• To provide a base estimation of P+R use, rates from other sites in the corridor & other (comparable) corridors can be applied • Key rates will be the proportion of AM peak rail passengers using P+R: typical expectation in New Zealand/Australia is 15-20% for rail and reserved bus services, 5-10% for on-street bus services
5	Modify Base Estimation	The base estimation will need to be modified to take into account the local conditions and PT service provided. Factors which are important include: • Frequency of PT service provided • Proportion of express services from P+R site • Expected relative journey times by car & by PT • Availability & price of parking at destination • Amenities & level of security at proposed site Data from existing P+R sites should be analysed to determine the relative impact of these factors on P+R use
6	Modelling Approach	• If resources & time allow, one of the modelling approaches available can be used; for most individual P+R sites this will not be warranted; however, for larger scale facilities it would be beneficial • Where a transport model is available, develop a P+R component to that model as one cost-effective approach

Stage D - Design the P+R Facility

Table 6.7 Guidelines for designing P+R facility.

Guideline		Key Aspects
1	Site design to allow good access/egress	• Design must allow for safe access/egress and minimise impact on adjacent road network • Bus P+R sites may require special bus-only entrances/exits
2	Internal design to allow good, safe vehicle circulation	• Need to allow enough room for vehicle manoeuvring (balance against need for more carparks) • Vehicle speeds should be restricted in large sites, e.g. speed tables, etc. • Vehicle/pedestrian conflicts must be minimised
3	Internal design to allow easy access to PT	• PT pick-up/set-down should be central to site, with 100m maximum walk (preferably much less)
4	Carpark design	• Use AS2890.1:1993 as a good design standard for off-street carparks
5	Parking area sealed & marked	• Carparks should generally be sealed and marked • The area should be well drained
6	Good security	Security for both users and vehicles is paramount for a successful P+R facility. For more remote sites, more of these measures become basic requirements. Key security measures are: • Good lighting • Site visible from road and neighbouring services • Fencing to prevent general pedestrian "through-traffic" • Periodic patrols or on-site staffing-notices of security patrol operation should be posted • CCTV surveillance (not generally required)
7	User information	• P+R site should be well signed from road to notify new users of site and entrance • Information about security patrols, & contact number if required, should be provided • Information about PT services should be provided, if not a normal rail/bus stop
8	Amenities	Generally other amenities are not required for a P+R site to succeed, as most users will go directly to the PT vehicle. However, at high use sites, provision of other amenities will further enhance the site: • basic retail facility - newspapers, confectionery • telephone • toilets
9	Landscaping	Landscaping can enhance a P+R site & increase user satisfaction; however, it is not a critical feature, and must not interfere with sight distance or affect security perceptions
10	PT waiting area	High standard waiting area should have, as minimum, the PT stop, seats, shelter, timetable and route information on PT services (if possible)

Stage E - Design Public Transport Service

Table 6.8 Guidelines for designing accompanying PT service.

	Guideline	Key Aspects
	PT must be "competitive"	PT service must be "competitive" with private car in terms of travel time and cost
1	Priority PT service	• Either rail service or bus service with priority over congested portions of travel corridor
2	Direct service	• PT service should run direct to major destination (normally CBD), with no detours
3	Express service	• Most of the PT trips at peak times from the P+R site should be express trips
4	High frequency	• Ideally a maximum frequency of 10 min. (at peak times) will be provided; where this is not done, express services must be provided
5	Operating hours	• Operating hours need to be sufficient to serve the target markets (e.g. include evening commuters)
6	Reliability	• Service reliability is very important for P+R users

Stage F - Cost the Proposed P+R Facility & PT Service

Table 6.9 Guidelines for estimating size and cost of proposed P+R facility.

	Guideline	Key Aspects
1	Area requirement	• Generally allow 25m^2 per carpark • Rectangular sites are usually more efficient in use of space than odd-shaped sites (maybe greater area for small or irregular shaped sites)
2	Carpark construction	• Approx. $1,500 per space for at-grade carpark on level site that only requires grading, surfacing, etc. • Up to $3,000 per space if more difficult site, provide more amenities, security, etc. • $10,000+ per space for multi-level carpark (hence multi-level parks would not usually be contemplated)
3	Signage	• P+R carpark signs are approx. $500 per sign
4	Security	• Lighting: approx. $2,000 per carpark light • CCTV: $10,000 set up costs; $3,000 per fixed camera; $7,000 per Zoom Camera; maintenance - $60/camera/quarter • Remote monitoring - $1 a minute on line
5	Bus stop & shelter	• $2,000 per bus stop • $6,000-10,000 per bus shelter
6	Maintenance	• Approx. $20-30 pa per space

Stage G - Market the P+R Facility

Table 6.10 Guidelines for pricing, marketing, and promoting the P+R facility.

	Guideline	Key Aspects
1	Pricing	• P+R parking must be priced substantially below that of destination (normally CBD) parking • In most cases P+R parking will need to be free to attract new users from car driver mode • Where additional security measures are provided, a charge would most likely be acceptable to users
2	Ticketing	• If a fee is charged for P+R, only one ticket should be required, i.e. P+R ticket also covers PT trip
3	Promote new facilities	• Identify target market & use appropriate promotion tools, e.g. roadside signs, billboards, direct mail, leaflets at CBD carparks, etc.
4	Ongoing information	• Ongoing provision of P+R information is important, given the continual turnover of users, and need to inform potential new users • P+R information should be included in regular household direct mail programmes • This information should include that about PT services associated with P+R facility, e.g. a P+R map with details on PT services

Stage H - Maintain the P+R Facility

Table 6.11 Guidelines for ongoing maintenance of P+R facility.

	Guideline	Key Aspects
1	Maintenance programme	• P+R users generally have high expectations regarding site standards: a regular site maintenance programme is required
2	Periodic inspection	• All P+R sites should be inspected annually and features needing repair identified; critical features include: seal condition, space marking, lighting, signs, fencing, seats, and shelters
3	Regular maintenance	• A regular (e.g. monthly) maintenance programme including mowing, sweeping & cleaning, trash removal, graffiti removal, should be carried out

Stage I - Monitor the P+R Facility

Table 6.12 Guidelines for monitoring of P+R facility.

Guideline		Key Aspects
1	Monitoring Programme	• A monitoring programme is needed to identify: if P+R objectives are being met; any potential operational issues; any safety/security problems; and to provide for future P+R developments
2	Utilisation Surveys	• Periodic surveys/counts to assess number of people and vehicles using site: should identify peak v. off-peak use
3	User Surveys	• Periodic surveys to assess user satisfaction & issues to be addressed • Surveys could also explore user characteristics & travel patterns • Complaints procedure to ensure any complaints received are followed up
4	Observation Surveys	• Periodic observation surveys of P+R operation to examine: vehicle movements, interaction with local road network, accident factors
5	Special Surveys	• The above surveys/counts can be conducted to address particular issues as required; these could include before and after studies on the surrounding transport network

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