

As a Cohousing development, the project falls into a parking grey area. We're currently providing 52 spaces (including a bike rack), and believe this will be sufficient to meet the needs of the homeowners and any visitors without placing undue burden on the surrounding area. As is common for many cohousing developments, the community developing the project has placed an emphasis on shared resources and plans to share cars, in addition to their designed communal spaces. Heartwood Commons will also meet HUD's requirements under the Fair Housing Act: Housing for Older Persons

and will be a 55+ community; the ownership requirements for the program will ensure that the residents remain in the 55+ age range, which should bolster our parking request. The next page highlights other residential parking requirements in the Tulsa Zoning Code and requests the requirement be taken down to 43 spaces (from 71). Page three highlights the site relative to public transportation. Finally, included is a study from Victoria's Transit Policy Institute; page 25 indicates parking reductions for transit access, carsharing, bikeability, and demographics (under 30 and over 65 years of age).

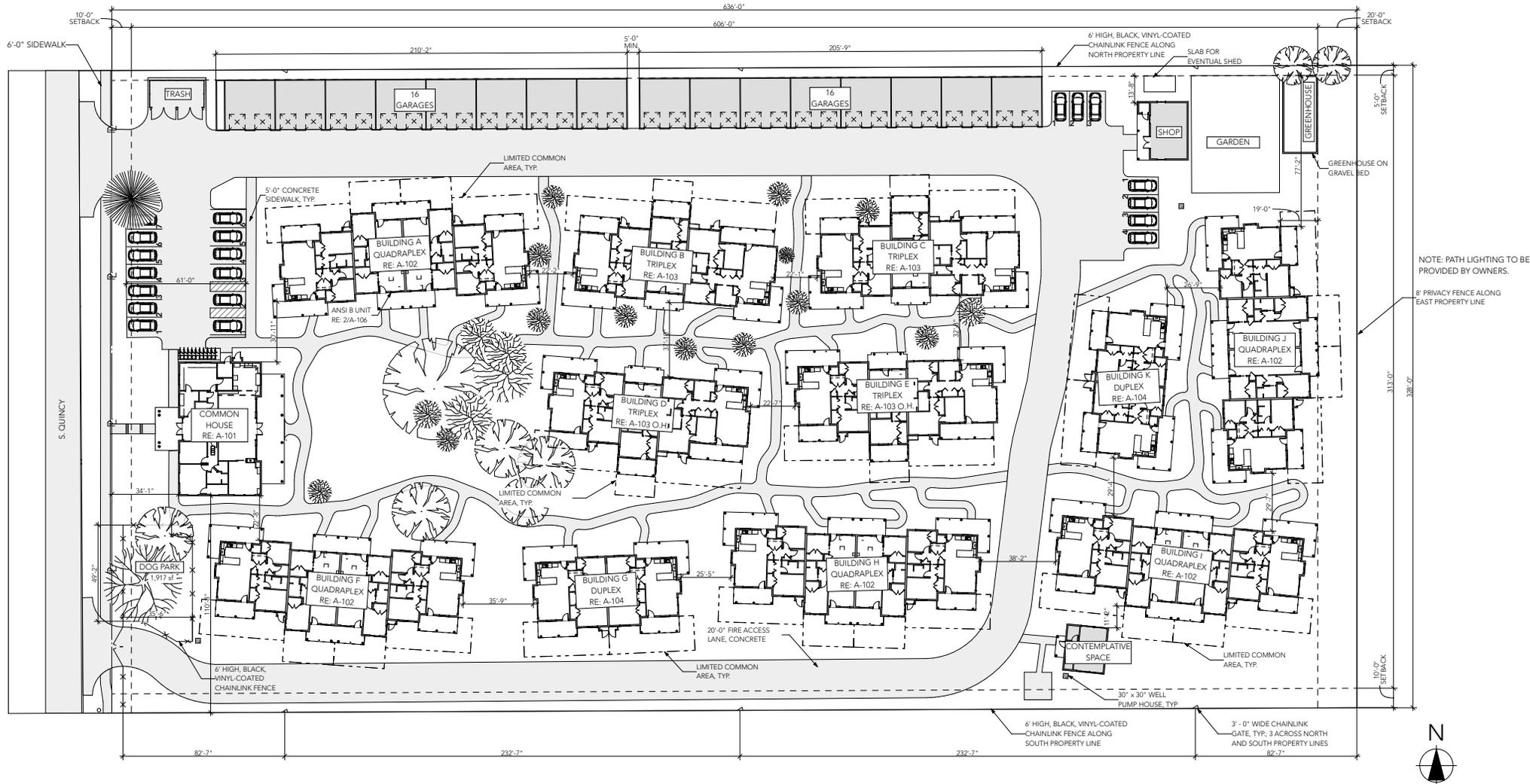
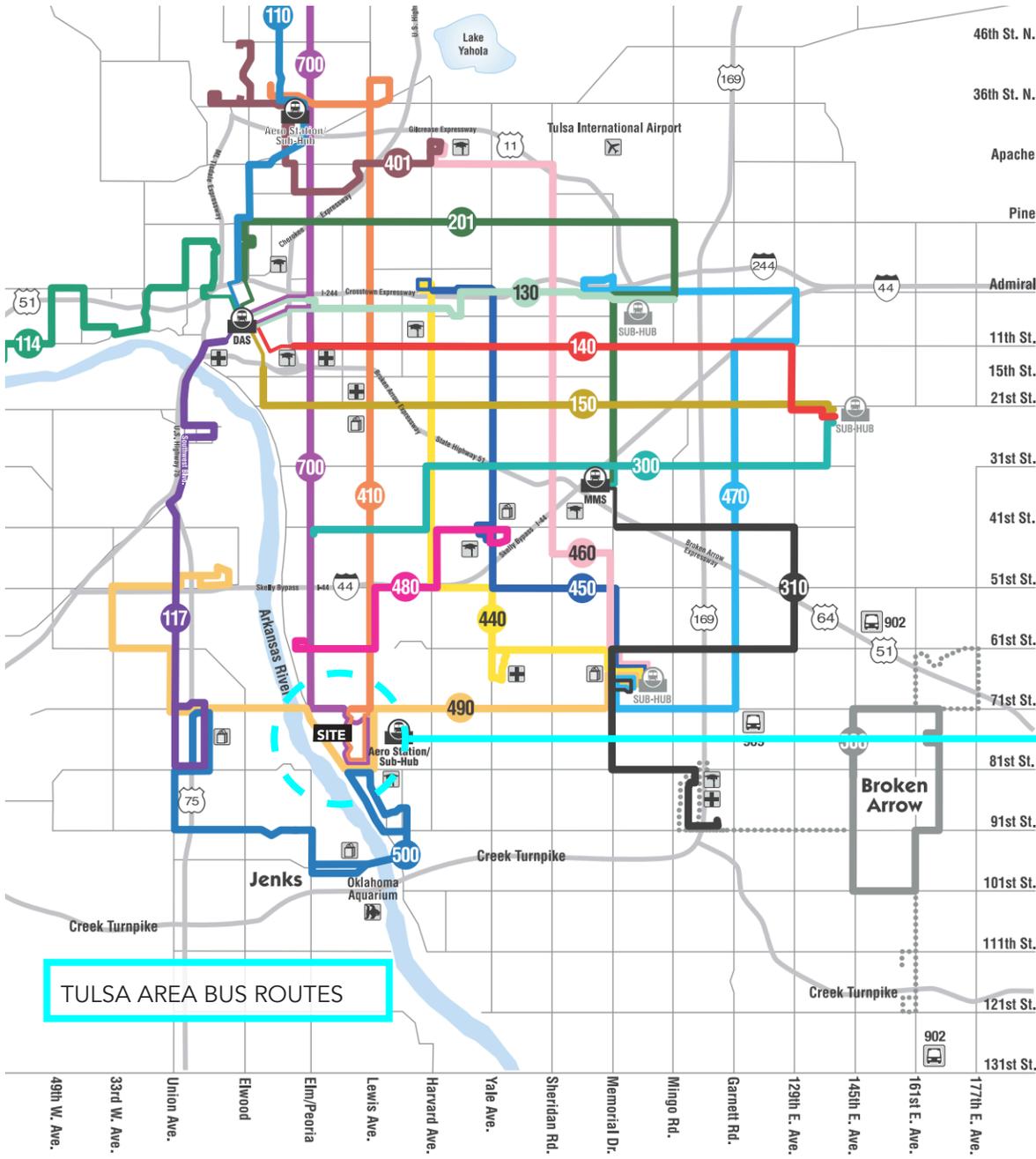


Table 55-1: Minimum Motor Vehicle Parking Ratios

USE CATEGORY	Measurement (spaces per)	CBD District	CH District and MX District	All Other Districts and PI Overlay [1]	Additional requirements/notes
Subcategory					
Specific use					
[1] See <a href="#">Section 20.040</a> for information on PI Overlay					
<b>RESIDENTIAL</b>					
<b>Household Living</b>					
Detached house	dwelling unit	0.00	1.00	2.00	
Townhouse	dwelling unit	0.00	1.00	2.00	
Duplex	dwelling unit	0.00	1.00	2.00	
Manufactured housing unit	dwelling unit	0.00	1.00	2.00	
Mobile home	dwelling unit	0.00	1.00	2.00	
Multi-unit house	0-1 bedroom dwelling unit	0.00	1.10	1.25	
Multi-unit house	2+ bedroom dwelling unit	0.00	1.50	2.00	
Apartment/condo	0-1 bedroom dwelling unit	0.00	1.10	1.25	69 SPACES REQUIRED
Apartment/condo	2+ bedroom dwelling unit	0.00	1.75	2.00	
<b>Group Living</b>					
Assisted living facility	dwelling unit	0.00	0.33	0.45	
Community group home	1,000 sq. ft.	0.00	0.65	0.85	38 SPACES REQUIRED
Convent/monastery/novitiate	1,000 sq. ft.	0.00	0.65	0.85	
Elderly/retirement center	dwelling unit	0.00	0.50	0.65	24 SPACES REQUIRED
Fraternity/Sorority	bed	0.00	0.33	0.45	
Homeless Center	established as part of special exception				
Life care retirement center	dwelling unit	0.00	0.50*	0.65*	*plus 0.20 per nursing center bed
Re-entry facility	1,000 sq. ft.	0.00	0.65	0.85	
Residential treatment center	1,000 sq. ft.	0.00	0.65	0.85	
Rooming/boarding house	bed	0.00	0.33	0.45	
Shelter, emergency and protective	1,000 sq. ft.	0.00	0.65	0.85	
Transitional living center	1,000 sq. ft.	0.00	0.65	0.85	

52 SPACES CURRENTLY PROVIDED (including 1 bike rack)

An average of the above housing types would require 43 spaces, which we would exceed. This approach would more accurately reflect the program of the cohousing community, as it isn't a retirement center, but will house exclusively 55+ individuals who plan to share many resources, including cars. If 43 became the minimum requirement, we would still provide the 52 spaces currently planned, which would cover one car per unit, in addition to 16 visitors. It's also likely the members would agree to zoning provision 55.050-F.2, allowing a 4-space reduction for car-sharing use.



Site has easy access to the 700, 490, 410, and Rapid Transit bus lines, as well as the Riverside bike trail on two sides, which residents plan to use.

**Table 12 Parking Requirement Adjustment Factors**

Factor	Typical Adjustments
<b>Geographic Location.</b> Vehicle ownership and use rates in an area.	Adjust requirements to reflect actual vehicle ownership and trip generation rates. 40-60% reductions are often justified in Smart Growth neighborhoods.
<b>Residential Density.</b> Number of residents or housing units per acre/hectare.	Reduce requirements 1% for each resident per acre (e.g. 15% where at 15 residents per acre and 30% at 30 res. per acre).
<b>Employment Density.</b> Number of employees per acre/hectare.	Reduce requirements 10-15% in areas with 50 or more employees per gross acre.
<b>Land Use Mix.</b> Land use mix located within convenient walking distance.	Reduce requirements 5-15% in mixed-use developments. Additional reductions with shared parking.
<b>Transit Accessibility.</b> Nearby transit service frequency and quality.	Reduce requirements 10% within ¼ mile of frequent bus service, and 20-50% within ¼ mile of a rail transit station.
<b>Carsharing.</b> Whether carsharing services are located within or nearby a building.	Reduce residential requirements 10-20% if carshare vehicles are located onsite, or 5-10% if located nearby.
<b>Walkability and bikeability.</b> Walking environment quality.	Reduce requirements 5-15% in very walkable and bikeable areas, and substitute bike parking for up to 10% of car parking.
<b>Demographics.</b> Age and physical ability of residents or commuters.	Reduce requirements 20-40% for housing for young (under 30), elderly (over 65) or disabled people.
<b>Income.</b> Average income of residents or commuters.	Reduce requirements 10-20% for the 20% lowest income households, and 20-40% for the lowest 10%.
<b>Housing Tenure.</b> Whether housing is owned or rented.	Reduce requirements 20-40% for rental versus owner-occupied housing.
<b>Pricing.</b> Parking that is priced, unbundled or cashed out.	Reduce requirements 10-30% for cost-recovery prices, and 10-20% for unbundling (parking rented separate from building space).
<b>Sharing/overflow.</b> Ability to share parking	Depends on the differences in peak demands with other land use. Shared parking is often possible.
<b>Contingency-Based Planning.</b> Use lower-bound requirements, and implement additional strategies if needed.	Reduce requirements 10-40% at worksites with effective parking management programs. Reduce requirements 10-20% if a 10 <sup>th</sup> annual design hour is replaced by a peak hour. Requires overflow plan. Reduce requirements 10-30%, and more if a plan exists indicating the responses that will be deployed if the number of parking spaces initially built is insufficient in the future.

TABLE FROM VICTORIA TRANSIT POLICY INSTITUTE PARKING MANAGEMENT STUDY, ATTACHED.

*This table summarizes various factors that affect parking demand and optimal parking supply.*

# Parking Management

## *Comprehensive Implementation Guide*

5 June 2020

by  
Todd Litman  
*Victoria Transport Policy Institute*



### **Abstract**

*Parking management* refers to various policies and programs that result in more efficient use of parking resources. This guide describes and evaluates more than two-dozen such strategies. It investigates problems with current parking planning practices, discusses the costs of parking facilities and the savings that can result from improved management, describes specific parking management strategies and how they can be implemented, discusses parking management planning and evaluation, and describes how to develop the optimal parking management program in a particular situation. Cost-effective parking management programs can usually reduce parking requirements by 20-40% compared with conventional planning requirements, providing many economic, social and environmental benefits.

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## Introduction

A typical automobile is parked 23 hours each day, and uses several parking spaces each week. Parking facilities are an essential component of a transportation system. They are also costly; for every dollar motorists spend on their vehicles, somebody (they, their employers, local government, businesses, etc.) spend more than a dollar to park it. Parking conflicts are among the most common problems facing designers, operators, planners and other officials. Such problems can be often defined either in terms of *supply* (too few spaces are available, somebody must build more) or in terms of *management* (available facilities are used inefficiently and should be better managed). Management solutions tend to be better than expanding supply because they support more strategic planning objectives:

- Reduced development costs and increased affordability.
- More compact, multi-modal community planning (smart growth).
- Encourage use of alternative modes and reduce motor vehicle use (thereby reducing traffic congestion, accidents and pollution).
- Improved user options and quality of service, particularly for non-drivers.
- Improved design flexibility, creating more functional and attractive communities.
- Ability to accommodate new uses and respond to new demands.
- Reduced impervious surface and related environmental and aesthetic benefits.

*Parking management* refers to various policies and programs that result in more efficient use of parking resources (Barter 2014). Parking management includes several specific strategies; nearly two dozen are described in this guide. When appropriately applied parking management can significantly reduce the number of parking spaces required in a particular situation, providing a variety of economic, social and environmental benefits. When all impacts are considered, improved management is often the best solution to parking problems.

### Parking Management Principles

These ten general principles can help guide planning decision to support parking management.

1. *Consumer choice.* People should have viable parking and travel options.
2. *User information.* Motorists should have information on their parking and travel options.
3. *Sharing.* Parking facilities should serve multiple users and destinations.
4. *Efficient utilization.* Parking facilities should be sized and managed so spaces are frequently occupied.
5. *Flexibility.* Parking plans should accommodate uncertainty and change.
6. *Prioritization.* The most desirable spaces should be managed to favor higher-priority uses.
7. *Pricing.* As much as possible, users should pay directly for the parking facilities they use.
8. *Peak management.* Special efforts should be made to deal with peak-demand.
9. *Quality.* Parking facility quality (aesthetics, convenience, safety, etc.) is as important as quantity.
10. *Comprehensive analysis.* All significant costs and benefits should be considered in parking planning.

Parking management generally improves *travel options* (walking, cycling, ridesharing, public transit, carsharing), *parking options* (allowing motorists to choose between more convenient but higher priced spaces, and less convenient but cheaper spaces), and *pricing options* (hourly, daily or monthly fees, mobile phone payments, etc.). Parking management is becoming increasingly feasible, due to new technologies and services, and increasingly important, due to new planning goals.

#### **Parking Management Benefits**

- *Facility cost savings.* Reduces costs to governments, businesses, developers and consumers.
- *Improved service quality.* Many strategies improve service quality by increasing consumer options, reducing congestion, improving user information, and creating more attractive facilities.
- *More flexible facility location and design.* Parking management gives architects, designers and planners more ways to address parking requirements.
- *Reduced congestion.* In large commercial districts, a major portion of peak-period vehicle traffic consists of vehicles cruising for parking (about 15% according to Hampshire and Shoup 2018). Efficient parking management eliminates this traffic.
- *Revenue generation.* Some management strategies generate revenues that can fund parking facilities, transportation improvements, or other important projects.
- *Reduces land consumption.* Parking management can reduce land requirements and so helps preserve greenspace and other valuable ecological, historic and cultural resources.
- *Supports mobility management.* Parking management is an important component of efforts to encourage more efficient transportation, which helps reduce problems such as traffic congestion, roadway costs, pollution emissions, energy consumption and traffic accidents.
- *Supports Smart Growth.* Parking management helps create more accessible and efficient land use patterns, and support other land use planning objectives.
- *Improved walkability.* By allowing more clustered development and buildings located closer to sidewalks and streets, parking management helps create more walkable communities.
- *Supports transit.* Parking management supports transit oriented development and transit use.
- *Reduced stormwater management costs, water pollution and heat island effects.* Parking management can reduce total pavement area and incorporate better design features.
- *Supports equity objectives.* Management strategies can reduce the need for subsidies, improve travel options for non-drivers, and increase affordability for lower-income households.
- *More livable communities.* Parking management can help create more attractive and efficient communities by reducing paved areas, increasing walkability and allowing more flexible design.

This guide describes various parking management strategies, how to evaluate these strategies and develop an integrated parking plan, plus examples and resources for more information. It describes *contingency-based planning*, which deals with uncertainty by identifying possible responses to future conditions, such as the set of strategies that will be implemented if the current parking supply turns out to be inadequate sometime in the future.

## *Examples*

Below are three examples of parking management programs. More examples and case studies are described in a later section of this guide.

### **Reducing Building Development Costs**

A mixed-use building is being constructed in an urban or suburban area that will contain 100 housing units and 10,000 square feet of commercial space. By conventional standards this requires 200 parking spaces (1.6 spaces per housing unit plus 4 spaces per 1,000 square feet of commercial space), costing from \$2 million for surface parking (about 9% of the total development costs), up to \$6 million for underground parking (about 25% of total development costs). However, because the building is in a relatively accessible location (on a street that has sidewalks, with retail business and public transit services located nearby) and on-street parking is available nearby to accommodate occasional overflows, the building owners argue that a lower standard should be applied, such as 1.2 parking spaces per housing unit and 3 spaces per 1,000 square feet of commercial space, reducing total requirements to 150 spaces. To further reduce parking requirements the developer proposes the following:

- Unbundle parking, so parking spaces are rented separately from building space. For example, rather than paying \$1,000 per month for an apartment with two parking spaces renters pay \$800 per month for the apartment and \$100 per month for each parking space. This typically reduces parking requirements by 20%.
- Encourage businesses to implement commute trip reduction programs for their employees, including cashing out free parking (employees are offered \$50 per month if they don't use a parking space). This typically reduces automobile commuting by 20%.
- Regulate the most convenient parking spaces to favor higher-priority uses, including delivery vehicles and short errands, and handicapped users.
- Include four carshare vehicles in the building. Each typically substitutes for 5 personal vehicles, reducing 4 parking spaces.
- Incorporate excellent walking facilities, including sidewalk upgrades if needed to allow convenient access to nearby destinations, overflow parking facilities and transit stops.
- Incorporate bicycle parking and changing facilities into the building.
- Provide information to resident, employees and visitors about transit, rideshare and taxi services, bicycling facilities, and overflow parking options.
- Develop a contingency-based overflow parking plan that indicates where is available nearby if on-site facilities are full, and how and spillover impacts will be addressed. For example, identify where additional parking spaces can be rented if needed.

This management program allows total parking requirements to be reduced to 100 spaces, providing \$100,000 to \$500,000 in annualized parking facility capital and operating cost savings (compared with \$20,000-\$50,000 in additional expenses for implementing these strategies), as well as providing improved options to users and reduced vehicle traffic.

### **Increasing Office Building Profits and Benefits**

An office building has 100 employees and 120 surface parking spaces, providing one space per employee plus 20 visitor spaces. The building earns \$1,000,000 annually in rent, of which \$900,000 is spent on debt servicing and operating expenses, leaving \$100,000 annual net profit.

Parking management begins when a nearby restaurant arranges to use 20 spaces for staff parking during evenings and weekends for \$50 per month per space, providing \$12,000 in additional annual revenue. After subtracting \$2,000 for walkway improvements between the sites, and additional operating costs, this increases profits 10%. Later a nearby church arranges to use 50 parking spaces Sunday mornings for \$500 per month, providing \$6,000 in annual revenue. After subtracting \$1,000 for additional operating costs, this increases profits by another 5%. Next, a commercial parking operator arranges to rent the building's unused parking to general public during evenings and weekends. This provides \$10,000 in net annual revenue, an additional 10% profit.

Inspired, the building manager develops a comprehensive management plan to take full advantage of the parking facility's value. Rather than giving each employee a reserved space, spaces are shared, so 80 spaces can easily serve the 100 employees. A commute trip reduction program is implemented with a \$40 per month cash-out option, which reduces parking requirements by another 20 spaces. As a result, employees only need 60 parking spaces. The extra 40 parking spaces are leased to nearby businesses for \$80 per month, providing \$32,000 in annual revenue, \$9,600 of which is used to fund cash-out payments and \$2,400 to cover additional costs, leaving \$20,000 net profits.

Because business is growing, the tenant wants additional building space for 30 more employees. Purchasing land for another building would cost approximately \$1 million, and result in two separate work locations, an undesirable arrangement. Instead, the building manager stops leasing daytime parking and raises the cash-out rate to \$50 per month, which causes an additional 10 percentage point reduction in automobile commuting. With these management strategies, 87 parking spaces are adequate to serve 130 employees plus visitors, leaving the land currently used by 33 parking spaces available for a building site. To address concerns that this parking supply may be insufficient sometime in the future, a contingency plan is developed which identifies what will be done if more parking is needed, which might involve an overflow parking plan, providing additional commuter incentives during peak periods, leasing nearby parking, or building structured parking if necessary.

This parking management plan saves \$1 million in land costs, a \$50,000 annualized value. Parking spaces can still be rented on weekends and evenings, bringing in an additional \$25,000. These parking management strategies increased total building profits about 75%, allow a business to locate entirely at one location, and provide parking to additional users during off-peak periods. Other benefits include increased income and travel options for employees, reduced traffic congestion and air pollution, and reduced stormwater runoff.

### **Downtown – Addressing Parking Problems**

A growing downtown is experiencing parking problems. Most downtown parking is unpriced, with 2-hour limits for on-street parking. During peak periods 90% of core-area parking spaces are occupied, although there is virtually always parking available a few blocks away, and many of the core spaces are used by commuters or long-term visitors, who moved their vehicles every two hours to avoid citations. During peak periods, a major portion of downtown traffic consists of vehicles cruising for parking (Hampshire and Shoup 2018).

Local businesses asked the city to build a \$5 million parking structure, which would either require about \$500,000 in annual subsidies or would require user charges. Experience in similar downtowns indicates that if most public parking is unpriced, few motorists will pay for parking so the structure would be underutilized and do little to alleviate parking problems. Local officials decide to first implement a management program, to defer or avoid the need for a parking structure. Parking surveys are performed regularly to track utilization and turnover rates, in order to identify problems. The program's objectives are to encourage efficient use of parking facilities, insure that parking is convenient for priority uses (deliveries, customers and short errands), and maintain parking utilization at about 85%. It includes the following strategies:

- Increase enforcement of regulations, particularly during busy periods, but insure that enforcement is friendly and fair.
- Reduce on-street time limits (e.g., 2-hours to 90 minutes) where needed to increase turnover.
- Expand core area boundaries to increase the number of spaces managed for short-term use.
- Encourage businesses to share parking, so for example, a restaurant allows its parking spaces to be used by an office building during the weekdays in exchange for using the office parking during evenings and weekends.
- Encourage use of alternative modes. The city may partner with the downtown business organization to support commute trip reduction programs and downtown shuttle service.
- Develop special regulations as needed, such as for disabled access, delivery and loading areas, or to accommodate other particular land uses.
- Implement a residential parking permit program if needed to address spillover problems in nearby residential areas, but accommodate non-residential users as much as possible.
- Provide signs and maps showing motorists where they may park.
- Have an overflow parking plan for occasionally special events that attract large crowds.
- Establish high standards for parking facility design, including aesthetic and safety features, to enhance the downtown environment.
- Price parking, using convenient pricing methods. Apply the following principles:
  - Adjust rates as needed to maintain optional utilization (i.e., 85% peak occupancy).
  - Structure rates to favor short-term uses in core areas and encourage longer-term parkers to shift to other locations.
  - Provide special rates to serve appropriate uses, such as for evening and weekend events.
  - Use revenues to improve enforcement, security, facility maintenance, marketing, and mobility management programs that encourage use of alternative modes.

*Types of Parking*

Table 1 describes various types of parking facilities and the role they play in an efficient parking system. These categories overlap: surface parking lot can be unpriced, priced but serve just one destination, or commercial. Parking facilities that are regulated and priced to favor higher value trips (such as deliveries and customers over commuters and residents), and serve multiple destinations tend to be used most efficiently.

**Table 1**      **Types of Parking Facilities**

Type	Images	Costs and Density	Role
<p><b>On-Street (or Curb)</b>                      Designated parking spaces located within a road right-of-way, usually in the curb lane.</p>		Moderate construction costs and high density (relatively little land used per space) because they require no driveway.	Convenient to use, and can serve multiple destinations. On-street parking should be managed for maximum efficiency.
<p><b>Surface Parking</b>                      A parking lot directly on the ground (either paved or unpaved).</p>		Low to moderate construction costs. Low density (they require lots of land per space, including driveways and circulation lanes).	Inefficient if they serve a single destination. Should be minimized and managed for efficiency.
<p><b>Structured or Underground</b>                      Any multi-story parking structure (often called a <i>parking garage, parkade</i> or <i>ramp</i>), including parking facilities within or under a building.</p>		High construction costs but relatively low land costs and high densities.	Supports compact development but must be efficiently managed to justify their high construction costs.
<p><b>Priced (or Metered)</b>                      Any parking facility where motorists are charged directly for use, including on-street metered parking, and off-street lots where motorists pay by the hour, day, week, month or year.</p>		Varies. Can be applied to any type of parking structure.	Pricing, particularly congestion pricing (fees are higher at times and places with high demand) tends to encourage efficient use of parking facilities.
<p><b>Commercial Parking</b>                      A for-profit parking lot available to any motorist and serves multiple destinations.</p>		Varies. Can be applied to any type of parking structure.	Tends to be efficient because it is priced and usually serves multiple destinations.

*Parking facilities that are priced and serve multiple destinations tend to be most efficiently used.*

***Paradigm Shifts and Innovations***

Parking planning is undergoing a *paradigm shift*, a fundamental change in how problems are perceived and solutions evaluated (Belmore 2019; Economist 2017). The old paradigm assumed that “transportation” means driving, so parking facilities should be as abundant and cheap as possible, with costs borne indirectly by governments and businesses. The new paradigm strives to provide *optimal* parking supply and price. It assumes that transportation includes multiple modes, and not everybody drives. It considers too much supply as harmful as too little, and too low prices as harmful as excessive prices. The new paradigm strives to use parking facilities efficiently. It considers full lots to be acceptable, provided that additional parking is available nearby and any spillover problems are addressed. It favors charging parking facility costs directly to users, and providing financial rewards to people who reduce their parking demand.

The old paradigm places a heavy burden of proof on innovation. The new paradigm recognizes that transport and land use conditions evolve, so parking planning practices need frequent adjustment. It shifts the burden of proof, allowing new approaches to be tried to test their effectiveness, or lack thereof. Table 2 compares old and new parking paradigms.

**Table 2 Old and New Parking Paradigms Compared**

Old Paradigm	New Paradigm
<i>Parking problem</i> means inadequate parking supply.	There can be many types of parking problems, including inadequate or excessive supply, too low or high prices, inadequate user information, and inefficient management.
<i>Transportation</i> means driving.	Travelers may use various modes. Not everybody drives.
Abundant parking supply is always desirable.	Too much supply is as harmful as too little.
All parking demand should be satisfied on-site. Motorists should not be forced to walk to their cars.	Parking can often be provided off-site, allowing sharing of parking facilities among various destinations.
Parking should generally be provided free, funded indirectly, through rents and taxes.	As much as possible, users should pay directly for parking facilities.
Parking should be available on a first-come basis.	Parking should be regulated to favor higher priority uses and encourage efficiency.
Parking requirements should be applied rigidly, without exception or variation.	Parking requirements should reflect each particular situation, and should be applied flexibly.
Innovation faces a high burden of proof and should only be applied if proven and widely accepted.	Innovations should be encouraged, since even unsuccessful experiments can provide useful information.
Parking management is a last resort, to be applied only if increasing supply is infeasible.	Parking management programs should be widely applied to prevent parking problems.
Land use dispersion (sprawl) is acceptable or even desirable.	Dispersed, automobile-dependent development can be harmful.

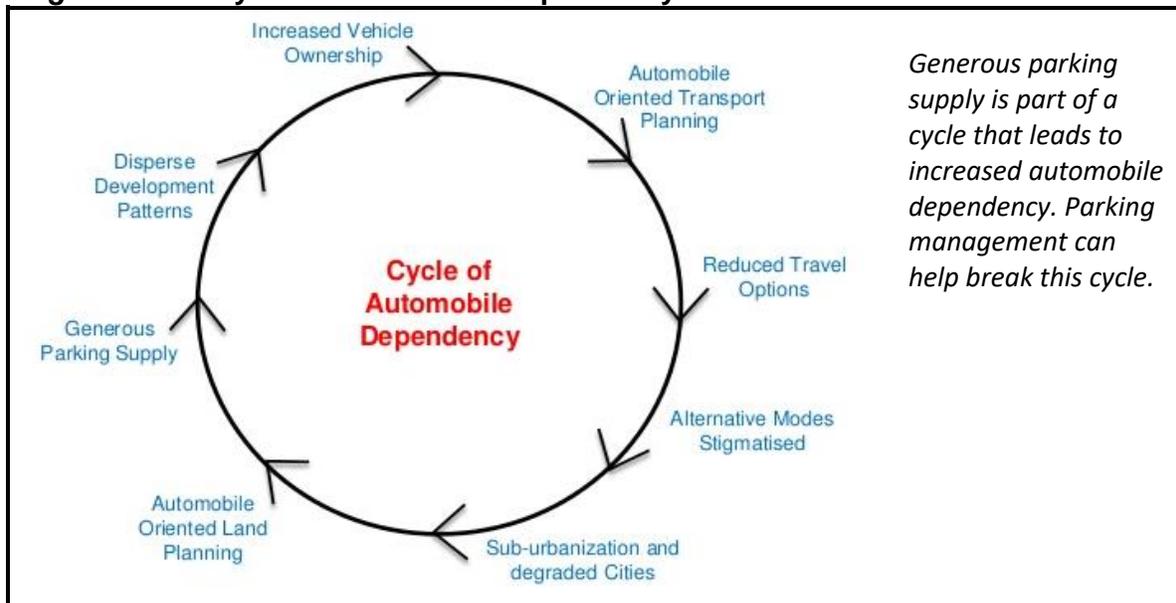
*Parking management changes the way parking problems are defined and solutions evaluated.*

Emerging technologies and planning goals increase the feasibility and benefits of parking management (Rosenblum, Hudson and Ben-Joseph 2020). For example, new payment technologies reduce the inconvenience of parking pricing, and new planning goals such as

housing affordability, public health, compact development and environmental protection, justify policies that minimize parking supply and increase parking fees, at least to cost recovery levels.

The old paradigm results in *predict and provide* planning, in which past trends are extrapolated to predict future demand, which planners try to satisfy. This often creates a self-fulfilling prophecy, since abundant parking supply increases vehicle use and sprawl, creating a cycle of increased automobile dependency, as illustrated in Figure 1.

**Figure 1** Cycle of Automobile Dependency



Parking, land use and transportation planning decisions are intertwined. Abundant parking requirements create more dispersed, automobile-oriented land use development patterns, and encourage increased automobile ownership and use (McCahill, et al. 2016). Parking management must therefore be implemented as part of an integrated effort to reduce parking costs, encourage more compact development, and encourage use of resource-efficient transport options to reduce congestion, accidents and pollution emissions. These require coordinated parking, land use and transport policy reforms, which lead to changes in physical design and operations, and therefore changes in travel behaviour.

It is important to carefully define parking problems. For example, if people complain about a parking problem, it is important to determine the exact problem type, location and time. The table on the next page lists various parking problems and compares the impacts of increasing parking supply with management solutions. Increasing supply helps reduce parking congestion and spillover problems but increases most other problems. Management solutions tend to reduce most problems, providing a greater range of benefits and so are supported by more comprehensive planning.

**Table 3 Comparing Increased Supply and Management Solutions**

Problem	Increased Supply	Management Solutions
<i>Parking congestion.</i> Too many vehicles trying to use available parking facilities.	<i>Positive.</i> Increases number of available parking spaces.	<i>Positive.</i> More efficient use of available parking spaces.
<i>Spillover.</i> Problems from motorists parking where they are not wanted.	<i>Positive.</i> Reduces incentive for motorists to use off-site spaces.	<i>Mixed.</i> Some management strategies increase spillover problems, others reduce them.
<i>Facility costs.</i> Increased development and operating costs for parking facilities.	<i>Negative.</i> Increases facility costs.	<i>Positive.</i> Reduces parking facility costs.
<i>Traffic congestion.</i> Too many vehicles for existing road capacity.	<i>Negative.</i> Generous, free parking increases vehicle use.	<i>Positive.</i> Many management strategies reduce vehicle use.
<i>Inequity.</i> Distribution of costs, including cost burdens on people who do not use parking facilities, and the quality of accessibility options for `disadvantaged people.	<i>Negative.</i> Forces non-drivers to pay for parking they do not use, and reduces access` options for non-drivers.	<i>Positive.</i> Reduces costs borne by non-drivers and improves accessibility options.
<i>Tax costs.</i> Tax burden required to subsidize parking facilities.	<i>Negative.</i> Often involves public subsidy of parking.	<i>Positive.</i> Reduces the need to subsidize parking facilities.
<i>Environmental impacts.</i> Loss of greenspace, stormwater management costs, air pollution, unattractive landscapes.	<i>Negative.</i> Increases total paved land, and increases total vehicle ownership and use.	<i>Positive.</i> Reduces total parking requirements and vehicle use.
<i>Sprawl.</i> Encouraging dispersed, urban fringe development, and discouraging multi-modal, urban infill development.	<i>Negative.</i> Discourages infill and encourages dispersed, urban fringe, auto-oriented development.	<i>Positive.</i> Encourages smart growth development patterns.

*This table compares the effects of increasing parking supply with parking management solutions. The more impacts that are considered, the more management solutions are justified.*

Parking demands can be categorized in various ways that affect parking management opportunities and requirements:

- *Short-term parking* (less than one hours) consists of delivery, and most errand trips.
- *Medium-term parking* (one- to four hours) consists of some diners, shoppers, some service trips (plumbers and electricians), and some commuters and visitors.
- *Long-term parking* consists of commuting, residents and some service trips.

In addition, some trips involve heavy loads or people with disabilities that limit the distance that passengers can reasonably walk to destinations, and some motorists are more price sensitive than others. Parking management must respond to these differences. In general, short-term parking requires more convenience and shorter walking distances to destinations, while longer-term parking requirements lower unit prices (\$2/hour may be a reasonable price for convenient downtown parking used for errands, but few commuters can afford to pay \$16 per day to park).

### *Impacts of New Mobility Services and Technologies*

New mobility services and technologies can affect parking management in various ways.

New telecommunications systems, such as integrated navigation and parking apps, electronic cards and RFID payment systems tend to increase the convenience and efficiency of parking and transportation demand management. These can help reduce the number of parking spaces needed to serve a destination, particularly if implemented with other demand management strategies, such as improved walkability and transit service quality.

Dynamic ridesharing and ridehailing services, such as Uber and Lyft, already affect travel and parking demands, including reducing urban vehicle ownership (Clewlow and Mishra 2017), commercial center parking demand, and airport vehicle rentals (Bergal 2017; Hickman 2016), and increasing total vehicle traffic and congestion in some city centres (Schaller 2017).

Autonomous vehicle technologies may affect future parking demands in several ways (DeLuca 2018). Some studies predict that autonomous taxis will replace most personal vehicle travel (Keeney 2017; Kok, et al. 2017), and by allowing vehicles to park closer together, autonomous vehicles could increase parking lot capacity up to 62% (Nourinejad, Bahrami and Roorda 2018). However, these technologies are unlikely to eliminate urban parking demand in the foreseeable future since many years will probably be required before they are sufficiently reliable and affordable that most vehicles can operate autonomously, and even when common many travellers may choose to continue owning personal vehicles, for convenience and status sake, and so will want to park near destinations so they are available with minimal delay (Litman 2017; Mauchan, Long and Holmes 2017). As a result, during the 2020s and 2030s, growth in overall vehicle travel is likely to offset reductions due to these technologies. Parking demand may eventually decline in many areas, but it is unlikely to disappear. These innovations are likely to make parking and travel more price sensitive, so parking fees and transportation subsidies will reduce parking demands more than would otherwise occur. As a result, their impacts will be affected by public policies that affect travel options and prices.

This has several implications for parking planning and management. Overall parking demand growth is likely to decline as new apps, mobility services and technologies develop, although these changes will probably be gradual and variable, and sensitive to public policies. Their impacts are likely to be largest in denser urban areas where these innovations significantly improve travel and parking options, traffic and parking problems are most severe, and parking and transportation management programs are commonly implemented.

These innovations increase the justification for management strategies that encourage efficient travel and parking. If implemented without strategic planning, transport apps are likely to be uncoordinated, new mobility services will increase traffic congestion, and there may be few savings to consumers, businesses and governments. New services and technologies can be deployed in ways that favor space-efficient travel and parking options, such as high-occupant vehicle lanes and curb access, efficient road and parking pricing, integrated parking and navigation apps, and improvements to non-auto modes. In addition, parking facilities should be designed for flexibility, so they can accommodate other uses, including carsharing and ridehailing vehicle parking, storage, or developed into other building types (Fane 2018).

## How Much Is Optimal?

There is no single way to determine optimal parking supply, there are many possible ways to calculate this that result in very different conclusions as to how much parking should be supplied at a particular location. A variety of basic assumptions, or *principles*, affect these determinations, as summarized in Table 4.

**Table 4** Parking Requirement Principles

Factor	Favors Higher Supply	Favors Lower Supply
How frequently adjacent parking may fill.	Parking facilities should almost never fill (at most, a few times annually).	Adjacent parking facilities may frequently fill, provided overflow parking is available nearby.
Whether all parking demand must be accommodated on site.	All parking demands should be accommodated on-site.	Off-site parking may be used, provided motorist have information about their options and good walking connections
If offsite parking is allowed, the acceptable distance.	300 feet maximum.	Up to 1,000 feet for longer-term uses, provided good walking conditions.
Whether on-street parking can be counted toward parking supply.	All parking demand should be off-street.	Nearby on-street parking may count as a portion of parking supply.
Whether parking facilities should be priced, and if so, what price level is considered acceptable.	Parking should only be priced in a few situations, such as downtowns and airports.	Parking should be priced as frequently as possible.
Whether parking supply should be reduced to reflect geographic, demographic and management factors that affect parking supply.	Parking standards should be applied consistently, with a high burden of proof required for any adjustments.	Adjust parking standards when justified to reflect demands, provided a contingency plan indicates how problems will be addressed if supply is inadequate.
Whether parking supply should be reduced where facilities are more costly to build.	Parking standards should be applied consistently, regardless of cost.	Parking standards should be reduced where parking is more costly to supply.
Whether parking supply must be oversized to accommodate possible future demand growth, such as new building uses.	Parking supply should anticipate possible future increases in demands.	Parking supply should be minimized, provided that a contingency plan indicates how problems will be addressed if supply is inadequate.
Whether parking supply may be constrained to help achieve strategic planning objectives.	Parking standards should be applied consistently, regardless of other objectives.	Parking standards should be consistent with strategic planning objectives, such as mobility management and smart growth.
Whether transportation management programs can be implemented to reduce parking demand and achieve other planning objectives.	Parking management is only applied as a last resort, where increasing supply is infeasible.	Parking management should be implemented whenever it is cost effective, considering all benefits.

*This table compares different principles that can be applied when determining optimal parking supply.*

Optimal parking supply can vary significantly depending on which principles are applied. In general, the principles currently applied in conventional parking planning favor higher levels of supply and inefficient parking management, that is, they insure that parking supply is so generous that there is no need to apply management strategies that result in more efficient use of parking resources. Only by adjusting these principles to favor reduced supply and improved management can parking facilities be used efficiently.

Conventional planning determines the amount of parking to provide at a particular site based on published minimum standards, such as those in Table 5. These generally reflect assumptions that favor maximum parking supply and inefficient management.

**Table 5 Typical Parking Standards** (Stover and Koepke, 2002)

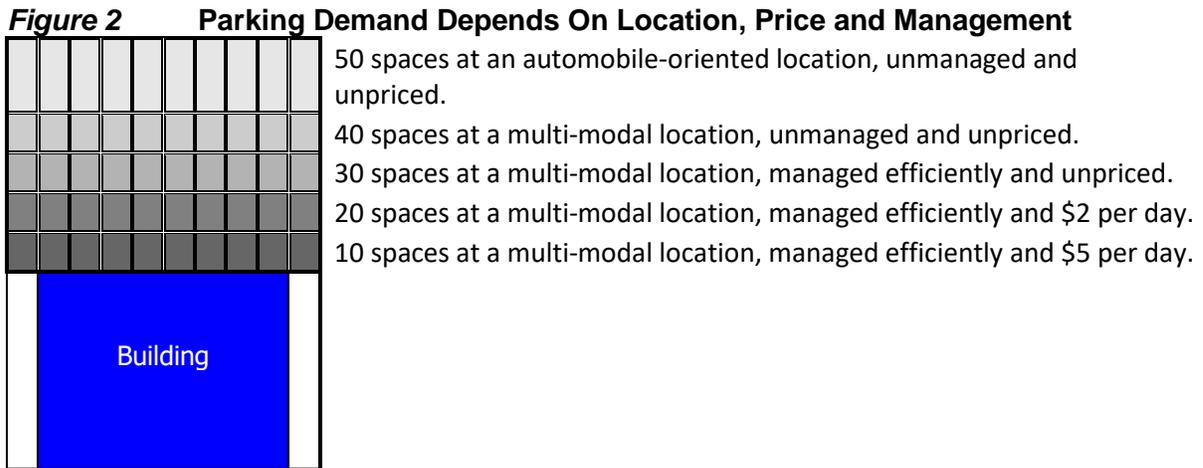
Land Use Category	Unit	Index (85 <sup>th</sup> Percentile)	Peak Parking Period
Single Family Housing	Dwelling Unit	2.0	Evening
Multi-Family Housing	Dwelling Unit	1.5	Evening
Elderly Housing	Dwelling Unit	0.5	Weekday
Hotel	Guest Room	1.0	Weekday-evening
Hospital	100 sq. m./Bed	5/2.6	Weekday-day
Retail – Shopping Center	100 sq. m. GLA	5.0	Saturday-day
Office Building	100 sq. m. GFA/Employee	3.3/0.9	Weekday-day
Light Industry	100 sq. m. GFA/Employee	2.2/1.0	Weekday-day
Heavy Industry	100 sq. m. GFA/Employee	1.7/0.6	Weekday-day
Fast-Food Restaurant	Seat	0.85	Weekday
Church/Synagogue/Mosque	Seat	0.2	Sunday/Saturday/Friday
Movie Theater	Seat	0.25	Saturday-Evening

GLA = Gross Leasable Area      GFA = Gross Floor Area

*This table illustrates typical minimal parking standards. The index is used to calculate the number of parking spaces that should be supplied at a particular location. These “unadjusted” values should often be reduced based on various factors and management strategies described in this guide.*

These are *unconstrained* and *unadjusted* values, which generally reflect the maximum parking supply possibly needed. These standards can usually be adjusted downward (Cuddy 2007). To appreciate why it is helpful to understand how they are developed. These standards are based on parking demand studies, the results of which are collected and published in technical reports such as ITE’s *Parking Generation*. The data are often limited and the results are biased upward. Fewer than a dozen demand surveys are used to set standards for many land use categories. The analysis seldom accounts for geographic, demographic and economic factors that can affect parking demand, such as whether a site is urban or suburban, and whether parking is free or priced (Knepper 2007; Cervero, Adkins and Sullivan 2010; Daisa and Parker 2010). Most demand studies were performed in automobile-dependent locations. They generally reflect an 85<sup>th</sup> percentile demand curve (which means that 85 out of 100 sites will have unoccupied parking spaces even during peak periods), an 85<sup>th</sup> occupancy rate (a parking facility is considered full if 85% of spaces are occupied) and a 10<sup>th</sup> design hour (parking facilities are sized to fill only ten hours per year). These standards often results in far more parking supply than is usually needed at most destinations, particularly where land use is mixed, there are good travel options, or parking is managed efficiently.

This process is said to measure parking demand, but *demand* is actually a function: the quantity consumers would purchase at a given price. Parking is free at most parking survey sites so their results are equivalent to determining the amount of food stores can give away. To truly measure demand the analysis must determine how much parking would be used under various conditions and prices. For example, rather than saying, “A 12,500sf commercial building requires 50 spaces,” a planner should say, “A 12,500sf commercial building requires 50 spaces at an automobile-dependent location with unmanaged and unpriced parking; 40 spaces at a multi-modal location; 30 spaces at a multi-modal location with efficiently managed parking; 20 spaces at a multi-modal location with parking efficiently managed and \$2 per day prices; and 10 spaces at a multi-modal location, with efficiently managed parking and \$5 per day prices” as illustrated in Figure 2.



*The number of parking spaces needed to serve a building can vary significantly depending on factors such as the quality of travel options available, and how parking facilities are managed.*

The optimal parking supply should vary depending on geographic conditions.

- In rural areas, land costs are low so parking is generally unregulated and unpriced.
- In suburban areas, land costs are moderate so parking is generally regulated but unpriced.
- In urban areas, land costs are high so parking is regulated and priced.
- In central business districts (CBDs), land costs are very high, so parking is generally priced.

Various planning and market distortions can result in economically excessive parking standards, supply and demand, as summarized in Table 6 (Litman 2005; Cuddy 2007). Correcting these distortions can significantly reduce parking requirements.

**Table 6 Parking Planning and Market Distortions and Corrections**

Distortions	Corrections
Most parking demand studies are performed at single-use, suburban sites where parking is unpriced, resulting in standards that are excessive in other conditions.	Perform more research to determine how geographic, demographic and management factors affect parking demand.
Parking standards are often not adjusted to reflect geographic, demographic and economic factors that affect demand.	Apply more accurate parking standards that reflect specific conditions.
Standards are based on 85% percentile demand, the 10 <sup>th</sup> annual design hour, and 85-90% occupancy.	Apply more accurate parking standards that reflect specific conditions.
Parking standards are often designed to accommodate the highest level of demand the site may ever encounter, although this is excessive most of its operating life.	Apply more accurate parking standards, with contingency-based solutions available to address future changes in demand.
Generous minimum parking standards result in abundant parking supply, which discourages owners from charging for parking, creating a self-fulfilling prophecy.	Apply more accurate parking standards and parking management solutions before expanding parking supply.
Governments often provide subsidized parking, which discourages businesses from charging for parking at their sites.	Price public parking efficiently.
Parking facility funding often cannot be used for management programs, even if such programs are more cost effective and provide greater total benefits.	Apply <i>least cost planning</i> , so management strategies receive equal support as capacity expansion.
Tax policies encourage employers to provide subsidized parking.	Make tax policy more neutral.
A heavy burden of proof is often placed on reductions from conventional standards.	Shift the burden of proof to allow management solutions unless they are proven undesirable.
When demand can be calculated in various ways, zoning codes require use of the highest value.	Allow the most appropriate indicator to be used when calculating parking requirements.
Generous parking requirements are often imposed on new developments to remedy deficiencies at existing sites.	Apply management solutions to address existing parking problems.
Officials who set parking standards often favor abundant supply and avoid other solutions since they do not bear the costs.	Encourage officials to support efficient parking management.
Evaluation often overlooks some costs of devoting land to parking, such as opportunity costs (if the land is owned), stormwater management and environmental impacts.	Use comprehensive evaluation which takes into account all economic, social and environmental impacts.
Generous standards were created when land costs were lower and there was less concern about traffic impacts and sprawl.	Adjust parking planning practices to reflect changes in land values and planning objectives.
Older pricing methods (meters and passes) tend to be inconvenient, creating opposition to pricing.	Apply better pricing methods.
Current laws and planning practices often discourage shared parking, forcing each site to supply its own parking facilities.	Correct planning practices to support sharing and other management strategies.
Parking facilities are ignored when calculating <i>Floor Area Ratios</i> (FAR), which favors parking over other building amenities.	Include parking facilities when calculating FARs.
Current transportation policies and planning practices tend to be automobile-oriented, which increases parking demand.	Encourage more multi-modal planning.

*This table summarizes various planning and market distortions that result in economically-excessive parking requirements, supply and demand, and how they can be corrected.*

Although individually these distortions may seem modest and reasonable, their impacts are cumulative and synergistic (total impacts are greater than the sum of their individual impacts). For example, a public official or developer may specify generous supply thinking that a few extra parking spaces impose modest costs. But the total economic, social and environmental costs of this excessive supply are large, considering the indirect costs resulting from the additional automobile travel and land use dispersion stimulated by such generous parking requirements.

Most people involved in planning have little understanding of the biases and errors contained in conventional parking standards and the problems created by excessive parking supply. The application of generous and inflexible parking standards is often defended as being *conservative*, implying that this approach is cautious and responsible. Use of the word *conservative* in this context is confusing because it results in the opposite of what is implied. Excessive parking requirements waste resources, both directly, by increasing the money and land devoted to parking facilities, in indirectly, by increasing automobile use and sprawl. Better parking management actually tends to be more *conservative* overall.

#### **Parking Demand in Compact, Multi-modal Areas**

Several recent studies indicate that households in compact, multi-modal areas (often called *Smart Growth* or *Transit-Oriented Developments*) own about half as many vehicles and generate about half as many trips as conventional models predict. For information see:

G.B. Arrington, et al. (2008), *Effects of TOD on Housing, Parking, and Travel*, Report 128, Transit Cooperative Research Program ([www.trb.org/CRP/TCRP](http://www.trb.org/CRP/TCRP)); at <http://bit.ly/2pgkSYp>; summarized in "New Transit Cooperative Research Program Research Confirms Transit-Oriented Developments Produce Fewer Auto Trips," *ITE Journal* ([www.ite.org](http://www.ite.org)), Vol. 79, No. 6, June 2010, pp. 26-29; at <http://tinyurl.com/q2usu3r>.

Reid Ewing, et al. (2017), *Trip and Parking Generation Study of Orenco Station TOD, Portland Region*, NITC-RR-767, Transportation Research and Education Center (TREC); at <https://doi.org/10.15760/trec.157>.

Metro Vancouver (2012), *Metro Vancouver Apartment Parking Study; Revised Technical Report*, Metropolitan Planning, Environment, and Parks ([www.metrovancouver.org](http://www.metrovancouver.org)); included in 7 Sept. 2012 Regional Planning Committee Agenda at <http://bit.ly/2ovC89m>.

Adam Millard-Ball (2015), "Phantom Trips: Overestimating the Traffic Impacts of New Development," *Journal of Transportation and Land Use* ([www.jtlu.org](http://www.jtlu.org)); at <http://tinyurl.com/m6ay4ut>; summarized in, *ACCESS 45*, pp. 3-8; at [www.accessmagazine.org/articles/fall-2014/phantom-trips](http://www.accessmagazine.org/articles/fall-2014/phantom-trips).

Daniel Rowe, et al. (2013), "Do Land Use, Transit and Walk Access Affect Residential Parking Demand?" *ITE Journal*, Vol. 83. No. 2, February, pp. 24-28; at <http://metro.kingcounty.gov/up/projects/right-size-parking/pdf/ite-journal-feb-2013-drowe.pdf>. This article summarizes the results of King County's *Right Size Parking Project* ([www.rightsizeparking.org/index.php](http://www.rightsizeparking.org/index.php)).

Robert J. Schneider, Susan L. Handy and Kevan Shafizadeh (2014), "Trip Generation for Smart Growth Projects," *ACCESS 45*, pp. 10-15; at <http://tinyurl.com/oye8aqj>. Also see the *Smart Growth Trip-Generation Adjustment Tool*, (<http://ultrans.its.ucdavis.edu/projects/smart-growth-trip-generation>).

Rachel Weinberger and Joshua Karlin-Resnick (2015), "Parking In Mixed-Use U.S. Districts: Oversupplied No Matter How You Slice The Pie," *Transportation Research Record*, 2537, pp. 177-184 (DOI: 10.3141/2537-19); at <https://bit.ly/2HBy6oL>.

### *Alternative Ways to Determine How Much Parking to Supply*

Conventional parking requirements often result in more supply than is efficient; surveys find that many parking facilities are never fully occupied even during peak periods (Quednau 2018). There are better ways to determine how much parking to supply at a particular site. *Efficiency-based standards* size facilities for optimal utilization. This means that most parking lots are allowed to fill, provided that management strategies can insure user convenience and address any problems. For example, parking facilities at a store can be sized to fill daily or weekly, provided that overflow parking is available nearby, motorists have information about available parking options, and regulations are adequately enforced to address spillover problems.

Efficiency-based standards take into account geographic, demographic and economic factors that affect parking demand (Cuddy 2007). They also reflect the relative costs and benefits of different options, so less parking is supplied where parking supply is relatively costly to provide or where management programs easy to implement. Efficiency-based standards should also reflect strategic planning objectives such as a desire for more compact development, or to reduce traffic. Current geographic and economic trends, including more compact development, more multimodal transport planning, and emerging mobility services and technologies, are reducing the number of parking spaces demanded per vehicle or capita (DeLuca 2018). In addition, reducing parking supply is one of the most effective ways to achieve vehicle travel reduction targets (Christiansen, et al. 2017).

Because it is not possible to predict exact parking demand and management program effectiveness, efficiency-based standards rely on *contingency-based planning*, which means that planners identify solutions that can be deployed if needed in the future. For example, if a new building is predicted to need 60 to 100 parking spaces, the conventional approach is to supply either the middle (80 spaces), or maximum values (100 spaces). With contingency-based planning, the lower-bound value (60 spaces) is initially supplied, conditions are monitored, and various strategies identified for implementation if needed. This may include banking land for additional parking supply and various management strategies. This allows planners to use lower parking standards with the confidence that any resulting problems can be easily solved.

#### **Vehicle Ownership Data**

Various data sources can be used to determine how demographic and geographic factors affect vehicle ownership and use, and therefore parking demands. For example, the U.S. *Consumer Expenditure Survey* ([www.bls.gov/cex](http://www.bls.gov/cex)) provides vehicle ownership by income group (quintile and decile), geographic region and household size. It indicates that:

- The lowest income quintile households own on average 0.9 vehicles, compared with 2.7 for the highest income households.
- Renter households own on average 1.2 vehicles, compared with 2.3 for homeowners.
- Central City households own on average 1.5 vehicles, compared with 2.4 in rural areas.

The American Community Survey ([www.census.gov/programs-surveys/acs](http://www.census.gov/programs-surveys/acs)) and other Census ([www.census.gov](http://www.census.gov)) data sets, local travel surveys, and special parking occupancy surveys can help identify factors that affect vehicle ownership and use.

## Parking Facility Costs

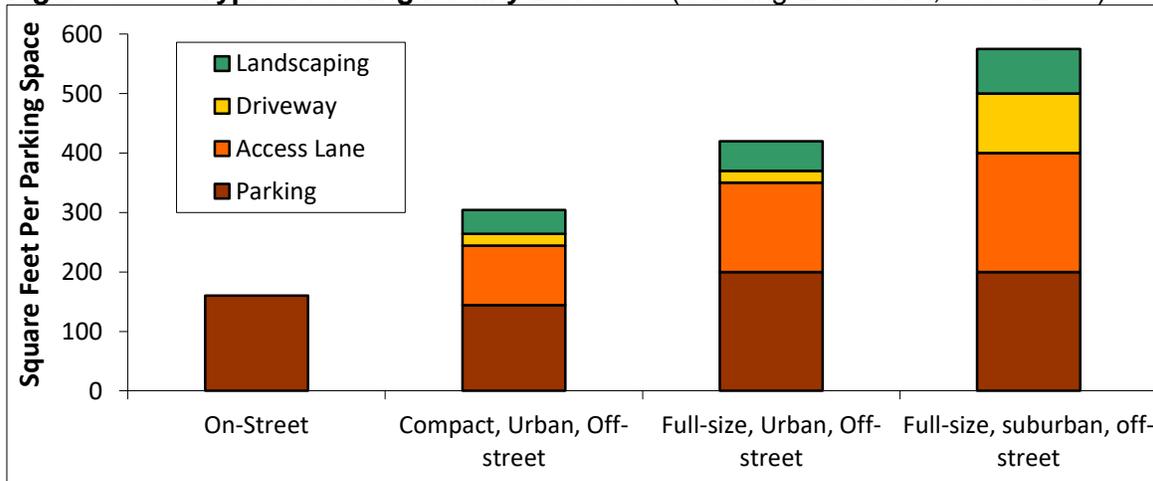
A major benefit of parking management is its ability to reduce facility costs. Parking facility costs are usually borne indirectly through rents, taxes and as a component of retail goods, so most people have little idea how much they really pay for parking facilities, and their potential savings from more efficient management.

Various types of parking costs are described below (“Parking Costs,” Litman 2009).

### Land

A typical parking space is 8-10 feet (2.4-3.0 meters) wide and 18-20 feet (5.5-6.0 meter) deep, totaling 144-200 square feet (13-19 sq. meters). Off-street parking requires driveways (connecting the parking lot to a road) and access lanes (for circulation within a parking lot), and so typically requires 300-400 square feet (28-37 square meters) per space, allowing 100-150 spaces per acre (250-370 per hectare). On-street parking is usually 7-8 feet wide (2.1-2.4 meter) and requires 20-22 feet (6.1-6.7 meters) of curb.

**Figure 3** Typical Parking Facility Land Use (“Parking Evaluation,” VTPI 2005)



*Land requirements per parking space vary depending on type and size. Off-street spaces require driveways and access lanes. Landscaping typically adds 10-15% to parking lot area.*

Because parking must be located near destinations, parking facilities often occupy prime real estate with high land costs. The portion of total land devoted to parking varies depending on conditions. In typical urban or suburban areas, streets (partly used for parking) and off-street parking each cover 5-10% of land area, but in commercial and industrial areas, such as a downtown or retail mall, streets often cover 10-30% of land, while driveways and off-street parking cover 30-50% of land. Various studies have estimated the amount of land devoted to parking facilities (Chester, et al. 2015; Davis, et al. 2010; Marshall and Garrick 2006; McCahill and Garrick 2012; Pijanowski 2007)

**Curb Space**

On-street parking uses less land per space than off-street parking, because it requires no driveway, but the land it uses often has a high opportunity costs. Road space to parking displaces traffic lanes, bicycle lanes, sidewalks and greenspace. An on-street parking space typically requires 20-24 feet (6-8 meters) of curb, while a residential or light commercial driveway typically requires 12-20 feet (4-6 meters) of curb, so each driveway displaces about one on-street parking space. As a result, a residential driveway with two parking spaces typically provides a net gain of just one space due to lost curb parking.

**Construction Costs**

Table 7 indicates typical construction costs for above-ground parking facilities under optimal conditions. Underground parking (such as in a building basement) typically costs about twice as much per space as above ground structured parking. Costs increase if soils are poor, lots are steep or irregularly shaped, if significant landscaping is required, or if washrooms and elevators are included. Actual costs are often far higher. In addition to these “hard” costs, there are “soft” costs for project planning, design, permits and financing, which typically increase costs by 30-40% for a stand-alone project.

**Table 7 Typical Parking Construction Costs Per Space (PT 2000)**

	<b>Small Site (30,000 sf)</b>	<b>Medium Site (60,000 sf)</b>	<b>Large Site (90,000 sf)</b>
<i>Area Per Space</i>	<i>350 sf</i>	<i>325 sf</i>	<i>315 sf</i>
Surface Parking	\$1,838	\$1,706	\$1,654
Ground + 1 level	\$7,258	\$6,143	\$5,705
Ground + 2 level	\$8,085	\$6,767	\$6,284
Ground + 3 level	\$8,407	\$6,996	\$6,491
Ground + 4 level	\$8,747	\$7,269	\$6,747
Ground + 5 level	\$8,973	\$7,451	\$6,918
Ground + 6 level	\$9,135	\$7,581	\$7,040
Ground + 7 level	\$9,256	\$7,678	\$7,132
Ground + 8 level	\$9,351	\$7,754	\$7,203

2000 U.S. dollars. Assumes rectangular site, good soil conditions, quality finish and no extra costs.  
 “sf” = Square Feet.

**Operation and Maintenance**

Operation and maintenance costs include cleaning, lighting, maintenance, repairs, security services, landscaping, snow removal, access control (e.g., entrance gates), fee collection (for priced parking), enforcement, insurance, labor and administration. Parking facilities need periodic resurfacing and repaving. Parking structures typically have an operating life of 20-40 years, after which they require major reconstruction or replacement. Structured parking may require additional costs for fire control equipment and elevators, and underground parking may require mechanical ventilation. Private parking facilities must pay taxes and provide profits. Typical annual operating costs range from about \$200 per space for basic maintenance of a surface lot, up to \$800 per space for a facility with tollbooth attendants (Dorsett 1998).

**Transaction Costs**

*Transaction costs* are any ongoing incremental costs required for regulations and pricing, including costs for equipment (signs, parking meters, ticket printers, access gates), attendants, space (such as sidewalk area used by parking meters), administration and enforcement. The incremental cost of pricing parking ranges from less than \$50 annually per vehicle for a simple pass system with minimal enforcement, to more than \$500 per space for facilities with attendants or automated control systems. Pricing also imposes transaction costs on motorists for the time and inconvenience of paying fees.

**Total Parking Cost**

Various studies have calculated the number of parking spaces provided in a typical community. Scharnhorst (2018) The table below illustrates examples of the direct, annualized costs of providing parking (not including indirect costs such as stormwater management, environmental impacts, aesthetic degradation, etc.). This varies from about \$250 per space if otherwise unused land is available, and construction and operating costs are minimal, to more than \$2,250 for structured parking with attendants. On-street parking spaces require less land per space than off-street parking, since they do not require access lanes, but their opportunity costs can be high if they use road space needed for traffic lanes or sidewalks. The *Parking Cost, Pricing and Revenue Calculator* ([www.vtpi.org/parking.xls](http://www.vtpi.org/parking.xls)) can be used to calculate these costs for a particular situation.

**Table 8 Typical Parking Facility Financial Costs** (“Parking Evaluation,” VTPI, 2005)

Type of Facility	Land Costs	Land Costs	Construction Costs	O & M Costs	Total Cost	Daily Cost
	Per Acre	Per Space	Per Space	Annual, Per Space	Annual, Per Space	Per Space
Suburban, On-Street	\$50,000	\$200	\$2,000	\$200	\$408	\$1.36
Suburban, Surface, Free Land	\$0	\$0	\$2,000	\$200	\$389	\$1.62
Suburban, Surface	\$50,000	\$455	\$2,000	\$200	\$432	\$1.80
Suburban, 2-Level Structure	\$50,000	\$227	\$10,000	\$300	\$1,265	\$5.27
Urban, On-Street	\$250,000	\$1,000	\$3,000	\$200	\$578	\$1.93
Urban, Surface	\$250,000	\$2,083	\$3,000	\$300	\$780	\$3.25
Urban, 3-Level Structure	\$250,000	\$694	\$12,000	\$400	\$1,598	\$6.66
Urban, Underground	\$250,000	\$0	\$20,000	\$400	\$2,288	\$9.53
CBD, On-Street	\$2,000,000	\$8,000	\$3,000	\$300	\$1,338	\$4.46
CBD, Surface	\$2,000,000	\$15,385	\$3,000	\$300	\$2,035	\$6.78
CBD, 4-Level Structure	\$2,000,000	\$3,846	\$15,000	\$400	\$2,179	\$7.26
CBD, Underground	\$2,000,000	\$0	\$25,000	\$500	\$2,645	\$8.82

*This table illustrates the direct financial parking facility costs under various conditions. (CBD = Central Business District; Assumes 7% annual interest rate, amortized over 20 years.)*

In addition to these direct costs generous parking supply imposes indirect costs including increased sprawl and impervious surface, higher stormwater management costs, reduced design flexibility, reduced efficiency of alternative modes (walking, ridesharing and public transit use), and increased traffic problems (Chester, Horvath and Madanat 2010). Put more positively, parking management can help solve numerous economic, social and environmental problems, increase economic productivity, and benefit consumers overall.

## Parking Management Strategies

*This section describes a variety of specific parking management strategies. For more information see Litman (2006a), Willson (2015) and related chapters in VTPI (2005).*

### *Shared Parking*

*Shared Parking* means that a parking facility serves multiple users or destinations (“Shared Parking,” VTPI 2005). This is most successful if users and destinations have different peak periods. This can be done in several ways, depending on circumstances.

- *Curb parking.* Curb parking is often the most suitable for sharing. It is generally the most visible and convenient type of parking, and can serve multiple users and destinations, for example, delivery vehicles in the morning, shoppers during the day, restaurant patrons in the evening, and residents overnight. These are the parking spaces that tend to generate the most conflicts, so efficient sharing depends on regulations, pricing and user information that favors higher value users (deliveries, passenger drop-off and pickup, short-term errands, etc.) over lower-value users (commuters, long-term errands and residents) for these prime spaces.

Efficient management of curb spaces becomes more important as travellers shift from driving personal vehicles, which rely on off-street parking, to ridehailing and taxi services (including self-driving taxis) that drop-off and pick up passengers.

- *Sharing Within a Parking Facility.* Motorists share parking spaces rather than being assigned reserved spaces. For example, 100 employees can usually share 60-80 spaces since at any time some are on leave or in the field, commuting by alternative modes or working off-peak shifts. Hotels, apartments and dormitories can share parking spaces since the number of vehicles per housing unit varies over time. Sharing can be optional, so for example, motorists could choose between \$60 per month for a shared space or \$100 for a reserved space.
- *Share Parking Among Destinations.* Parking can be shared among multiple destinations. For example, an office building can share parking with a restaurant or theater, since peak demand for offices occurs during weekdays, and on weekend evenings for restaurants and theaters, as indicated in Table 9. Sharing can involve mixing land uses on single site, such as a mall or campus, or by creating a sharing arrangement between sites located suitably close together.

**Table 9 Typical Peak Parking Periods For Various Land Uses**

Weekday	Evening	Weekend
Banks and public services	Auditoriums	
Offices and other worksites	Bars and dance halls	
Park & Ride facilities	Meeting halls	
Schools, daycare centers and colleges	Restaurants	Religious institutions
Factories and distribution centers	Theaters	Parks
Medical clinics	Hotels	Shops and malls
Professional services		

*This table indicates peak parking demand for different land use types. Parking can be shared efficiently by land uses with different peaks.*

- *Public rather than private parking.* Public parking, with parking facilities owned by governments or commercial operators, is more suited to sharing than private, on-site parking. “In lieu fees” mean that developers help fund public parking facilities instead of private facilities serving a single destination. Businesses in an area can be assessed a special assessment or tax to fund parking facilities in their area, as an alternative to each business supplying its own facilities. This can be implemented through a local organization, such as a business organization or transportation management association, that provides parking brokerage services.

Table 10 summarizes the requirements for implementing more sharing of parking facilities.

**Table 10 Shared Parking Requirements**

Shared Parking Type	Description	Implementation Requirements
Curb parking	Efficient curb parking management	Regulate and price on-street parking to favor higher-value uses (e.g. deliveries and urgent errands).
Within a parking facility	Multiple users share several spaces rather than assigned spaces.	Reduce parking requirements. Allow multiple users to share spaces, with a plan for addressing overflows.
Between destinations	Parking facilities serve multiple destinations.	Reduce requirements in compact, mixed-use areas. Establish sharing agreements between destinations with varied peaks. Improve walkability between parking and destinations. Create parking brokerage services.
Public rather than private parking	Rely on government or commercial parking, rather than private on-site parking.	Reduce parking requirements in compact, mixed-use areas. Build government or encourage commercial parking operators. Improve walkability and wayfinding.

*There are many ways to share parking with various implementation requirements.*

***Parking Regulation***

*Parking regulations* control who, when and how long vehicles may park at a particular location, in order to prioritize parking facility use. There are three general steps to developing parking regulations.

**First**, rank parking facility use priorities. Here is a typical example:

1. Deliveries and service vehicles.
2. Vehicles used by people with disabilities.
3. Rideshare and transit vehicles.
4. Customers, tourists and visitors.
5. Employees and residents.
6. Long-term vehicle storage.

**Second**, choose appropriate regulations to favor the higher-priority activities. The table below describes common regulations and the type of parking activity they favor.

**Table 12 Common Parking Regulations**

Name	Description	Favored Activity
User or vehicle type	Spaces dedicated to loading, service, taxis, customers, rideshare vehicles, disabled users, buses and trucks.	As specified
Duration	Limit parking duration (5-minute loading zones, 30-minutes adjacent to shop entrances, 1- or 2-hour limits).	Short-term users, such as deliveries, customers and errands
Time period restrictions	Restrictions at certain times, such as before 10 a.m. to discourage commuters or 10 p.m. to 5 a.m. to discourage residents.	Depends on restrictions
Employee restrictions	Require or encourage employees to use less convenient parking spaces.	Customers, deliveries and errands
Special events	Have special parking regulations during special events.	Depends on restrictions
Special use parking	Provide special bulk parking passes or reserved spaces for delivery, service and construction vehicles.	Vehicles used for specified purposes
Residential parking permits	Use Residential Parking Permits (RPPs) to give area residents priority use of parking near their homes.	Residents.
Restrict overnight parking	Prohibit overnight parking to discourage use by residents and campers.	Shorter-term parkers
Street cleaning restrictions	Regulations that prohibit parking on a particular street one day of the week to allow street sweeping.	Street cleaning. Insures motorists move their vehicles occasionally.
Large vehicle restrictions	Limit on-street parking of large vehicles, such as freight trucks and trailers.	Normal-size vehicles
Arterial lanes	Prohibit on-street parking on arterials during peak periods, to increase traffic lanes.	Vehicle traffic over parking
Abandoned vehicles	Have a system to identify and remove abandoned vehicles from public parking facilities.	Operating vehicles

*Various regulations can manage parking for efficiency and prevent problems.*

**Third**, determine how regulations will be indicated and enforced. Use signs, curb paint, maps and brochures to denote which parking facilities are intended for which user type, and how violations will be punished.

In a commercial area, the most convenient 10-30% of parking spaces should typically be regulated for short-term use. Such spaces usually have 30-120 minute time limits, so each space serves 6-10 vehicles per day. Shorter time limits increase turnover but constrain the types of activities that can be accommodated, and may frustrate customers who are unable to complete a transaction due to limited parking time.

#### **How Much Time?**

One of the most common ways to manage parking is to limit parking duration. Shorter time periods increase turnover but constrain the activities that can be performed. Below are some general guidelines.

- Very short time periods (3-10 minutes) accommodate passenger drop-off and deliveries. This is appropriate in busy loading areas, such as in front of transportation terminals, schools, theaters, hotels and hospitals. Some parking meters have a free 10-minute option to accommodate such stops.
- Short time periods (15-30 minutes) accommodate quick errands. This is appropriate for the most convenient parking spaces at post offices, convenience stores and other destinations that often involve quick errands.
- Medium time periods (1/2 – 4 hours) accommodate longer errands and activities such as shopping and dining. Customers often find that one hour is inadequate for a shopping trip, meal or errand, so 90-minute or 2-hour limits are common.
- Three- or four-hour limits are commonly used to prevent commuters from using parking spaces either in business districts or on nearby residential streets, although some commuters will simply move their vehicles once or twice each day to avoid citations.
- Long time periods (8-hours or more) accommodate commute trips and residential parking.
- Special time restrictions, such as parking prohibited before 10 am, to discourage use by employees, or between 10 pm and 5 am to discourage use by residents

In denser urban areas, such as downtowns and entertainment districts, curb space management is increasingly important to accommodate delivery vehicles and passenger drop-off/pick-up activities for taxi, ride-hailing (such as Uber and Lyft) and ridesharing trips (ITF 2018). This generally requires regulations that designates areas for these uses or limits parking to a few minutes, with policies to achieve 85% maximum occupancy in those areas, so parking spaces are virtually always available for high-value, short-term uses.

*Reduced and More Accurate and Flexible Minimums*

*More accurate and flexible standards* means that minimum parking requirements are adjusted to reflect the needs of each location (Cervero, Adkins and Sullivan 2010; Cuddy 2007; Daisa and Parker 2010; Engel-Yan and Passmore 2010; King Co. 2011; Nelson/Nygaard 2009; Smith 2006; Metro Vancouver 2012) or eliminated altogether (Lewyn 2010; Strong Towns 2020). Gabbe, Gregory and Clowers (2020), found that developers built about 40% fewer parking spaces when parking minimums were eliminated in some central Seattle neighborhoods. Table 12 summarizes various factors that should be used to adjust parking requirements.

**Table 12 Parking Requirement Adjustment Factors**

Factor	Typical Adjustments
<b>Geographic Location.</b> Vehicle ownership and use rates in an area.	Adjust requirements to reflect actual vehicle ownership and trip generation rates. 40-60% reductions are often justified in Smart Growth neighborhoods.
<b>Residential Density.</b> Number of residents or housing units per acre/hectare.	Reduce requirements 1% for each resident per acre (e.g. 15% where at 15 residents per acre and 30% at 30 res. per acre).
<b>Employment Density.</b> Number of employees per acre/hectare.	Reduce requirements 10-15% in areas with 50 or more employees per gross acre.
<b>Land Use Mix.</b> Land use mix located within convenient walking distance.	Reduce requirements 5-15% in mixed-use developments. Additional reductions with shared parking.
<b>Transit Accessibility.</b> Nearby transit service frequency and quality.	Reduce requirements 10% within ¼ mile of frequent bus service, and 20-50% within ¼ mile of a rail transit station.
<b>Carsharing.</b> Whether carsharing services are located within or nearby a building.	Reduce residential requirements 10-20% if carshare vehicles are located onsite, or 5-10% if located nearby.
<b>Walkability and bikeability.</b> Walking environment quality.	Reduce requirements 5-15% in very walkable and bikeable areas, and substitute bike parking for up to 10% of car parking.
<b>Demographics.</b> Age and physical ability of residents or commuters.	Reduce requirements 20-40% for housing for young (under 30), elderly (over 65) or disabled people.
<b>Income.</b> Average income of residents or commuters.	Reduce requirements 10-20% for the 20% lowest income households, and 20-40% for the lowest 10%.
<b>Housing Tenure.</b> Whether housing is owned or rented.	Reduce requirements 20-40% for rental versus owner-occupied housing.
<b>Pricing.</b> Parking that is priced, unbundled or cashed out.	Reduce requirements 10-30% for cost-recovery prices, and 10-20% for unbundling (parking rented separate from building space).
<b>Sharing/overflow.</b> Ability to share parking facilities with other nearby land uses.	Depends on the differences in peak demands with other land use. 20-40% reductions are often possible.
<b>Management programs.</b> Parking and mobility management programs implemented at a site.	Reduce requirements 10-40% at worksites with effective parking and mobility management programs.
<b>Design Hour.</b> Number of allowable annual hours a parking facility may fill.	Reduce requirements 10-20% if a 10 <sup>th</sup> annual design hour is replaced by a 30 <sup>th</sup> annual peak hour. Requires overflow plan.
<b>Contingency-Based Planning.</b> Use lower-bound requirements, and implement additional strategies if needed.	Reduce requirements 10-30%, and more if a plan exists indicating the responses that will be deployed if the number of parking spaces initially built is insufficient in the future.

*This table summarizes various factors that affect parking demand and optimal parking supply.*

### *Reduce Residential Street Width Requirements*

Most jurisdictions require wide streets in order to provide on-street parking. This practice is not justified for safety or by consumer demands, since many households would not choose to pay for parking if it were unbundled, and so represents a hidden subsidy of automobile ownership and use (Guo, et al. 2012). Reducing minimum residential street widths in municipal zoning codes and development policies allows developers to build *new urbanist* communities with narrower streets and less parking, and rely more on efficient parking management.

### *Parking Maximums*

*Parking Maximums* limit parking supply, either at individual sites or in an area in order to encourage more efficient parking management. Area-wide limits are called *Parking Caps*. These can be in addition to or instead of parking minimums (Manville and Shoup 2005). Excessive parking supply can also be discouraged by reducing public parking supply, imposing parking taxes, and enforcing regulations on temporary parking facilities. Maximums often apply only to certain types of parking, such as long-term, single-use, free, or surface parking, depending on objectives. These strategies are usually implemented in large commercial centers as part of programs to reduce excessive parking supply, encourage use of alternative modes, create more compact development patterns, create more attractive streetscapes, and preserve historic buildings.

Maximums are often unnecessary. As discussed earlier, parking regulations could simply be eliminated, allowing property owners to determine how much parking to supply at their sites. However, parking minimums have been applied for decades, resulting in well-established transport and land use market distortions, so markets may be slow to reach an optimal level, so parking maximums may be necessary to achieve quicker benefits.

Since businesses may consider abundant, free, on-site parking to convey a competitive advantage, individual firms often find it difficult to reduce supply. Parking maximums that apply equally to all businesses may be an acceptable and effective way to reduce supply in an area. A study comparing various cities found that (Martens 2006):

- Many European cities restrict commercial building parking supply.
- Public parking management complements reductions in private parking supply.
- Restrictive parking policies and public transport improvements support each other, but major transit service improvements need not precede adoption of parking restrictions.
- Restrictive city center parking policies have been introduced without strict regulations preventing unwanted suburbanization of economic activities.
- Case studies suggest that parking restrictions will not have negative economic impacts if implemented in cities with a strong and vibrant economic structure.

The City of Seattle requires that major institutions which propose to provide more than 135% of minimum required parking supply develop a transportation management plan to help reduce trip generation and parking demand (SMC 23.54.016). San Francisco places a two year limit on the use of vacant downtown parcels for parking lots, to encourage redevelopment (Manville and Shoup 2005).

### *Remote Parking and Shuttle Service*

*Remote Parking* (also called *Satellite Parking*) refers to the use of off-site parking facilities. This often involves shared facilities, such as office workers parking at a restaurant parking lot during the day, in exchange for restaurant employees using the office parking lot evenings and weekends. It can involve use of public facilities, such as commercial parking lots. Remote parking can also involve use of parking facilities located at the periphery of a business district or other activity center, and use of overflow parking during a special event that attracts large crowds. Special shuttle buses or free transit service may be provided to connect destinations with remote parking facilities, allowing them to be farther apart than would otherwise be acceptable. Another type of remote parking is use of *Park & Ride* facilities, often located at the urban fringe where parking is free or significantly less expensive than in urban centers.

**Figure 4**      **Overflow Parking Sign**



Remote parking requires providing adequate use information and incentives to encourage motorists to use more distant facilities. For example, signs and maps should indicate the location of peripheral parking facilities, and they should be significantly cheaper to use than in the core. Without such incentives, peripheral parking facilities are often underused while core parking is congested.

### *Smart Growth*

*Smart growth* is a general term for development policies that result in more efficient transportation and land use patterns, by creating more compact, development with multi-modal transportation systems (“Smart Growth,” VTPI 2005; Tachieva 2010). Smart growth includes several overlapping strategies, as summarized below.

#### *New Urbanism*

*New urbanism* refers to a set of community design principles that help create mixed-use, walkable neighborhoods (sometimes called “urban villages”) by clustering suitable activities together and improving pedestrian conditions. It is the local scale of smart growth. It includes design features to reduce the total amount of land devoted to parking, locating parking facilities behind or below buildings, and parking facility design improvements.

#### *Location Efficient Development*

*Location efficient development* consists of residential and commercial development located close to important services such as transit, schools and stores in order to reduce the need to own and use automobiles. It involves reducing parking requirements, unbundled parking and other parking management strategies to provide savings in such locations.

#### *Transit Oriented Development*

*Transit oriented development* (TOD) refers to residential and commercial areas designed to support transit and walking. It creates “transit villages” around transit stations, where a significant portion of local errands (travel to school, shops and other errands) can be performed by walking. It usually involves parking management to allow higher densities around transit stations and encourage use of alternative modes.

Smart growth supports and is supported by parking management. Parking management reduces the amount of land required for parking facilities, reduces automobile use and increases infill affordability. This, in turn, tends to reduce vehicle ownership and use, and so reduce parking demand (Lee, Rees and Watten 2010). It allows more sharing of parking facilities, shifts to alternative modes, and various types of parking pricing. Smart growth usually incorporates specific parking management strategies, as indicated in Table 13. Effective parking management is a key component of smart growth.

**Table 13 Conventional and Smart Growth Parking Policies**

Conventional Parking Policies	Smart Growth Parking Policies
Managed only for motorist convenience	Managed for transport system efficiency
Maximum parking supply	Optimal parking supply (not too little, not too much)
Prefers free parking	Prefers priced parking (user pays directly)
Dedicated parking facilities	Shared parking facilities
Favors lower-density, dispersed development	Favors compact development.

### *Ridesharing, Ride-Hailing and Public Transit Improvements*

Ridesharing (car- and van-pooling), dynamic ridesharing (ridesharing organized for individual trips), ride-hailing services (for-profit personal mobility services such as Uber and Lyft), and public transit service improvements can reduce automobile ownership and use, and therefore parking demands.

Ridesharing is often implemented as part of Commute Trip Reduction programs, and is supported by High Occupancy Vehicle (HOV) priority lanes and Transportation Demand Management Associations. Some public transit agencies support ridesharing, particularly vanpooling. Dynamic ridesharing and ride-hailing services require regulatory approval, and can be encouraged with curb management policies that improve passenger drop-off and pick-up opportunities. Public transit services improvements can include new technologies, payment systems, increased service, faster and more reliable service, dedicated bus lanes and bus priority signal controls, nicer vehicles, nicer stations and waiting areas, and amenities such as on-board wifi access.

These services can significantly reduce parking demand and vehicle traffic. They tend to be most convenient and cost effective in urban areas where demand is concentrated and traffic problems are most severe, and so are particularly important in urban centers, but can also be effective in suburban and rural areas, particularly if supported with compact development and commute trip reduction programs. Residents of transit-oriented areas tend to own about half as many vehicles and generate half as many trips as in automobile-dependent areas (Arrington, et al. 2008), and in many commercial centers, and major portion of workers commute by ridesharing, ride-hailing and public transit, and their mode shares are likely to increase in the future with improved technologies and more transportation demand management. De Gruyter, Truong and Taylor (2020) calculate that each 10% improvement in public transport service is associated with a 0.9–1.2% reduction in car parking demand. As previously discussed, dynamic ridesharing and ridehailing services already affect travel and parking demands, including reducing urban vehicle ownership (Clewlow and Mishra 2017), commercial center parking demand, and airport vehicle rentals (Bergal 2017; Hickman 2016).

### *Walking and Bicycling Improvements*

*Walking and bicycling* (together called *Non-motorized, Active or Human Powered* transport) improvements support parking management strategies in several ways (“Walking and Cycling Improvements,” VTPI, 2005):

- Improving walkability (the quality of walking conditions) expands the range of parking facilities that serve a destination. It increases the feasibility of using shared and remote parking facilities.
- Improving walkability increases “park once” trips, that is, parking in one location and walking rather than driving to other destinations, which reduces vehicle trips and the amount of parking required at each destination.
- Active travel improvements allow these modes to substitute for some automobile trips.
- Walking and cycling improvements encourage transit use, since most transit trips have walking and bicycling links.

Walkability is affected by pedestrian facility quality (sidewalks, paths, crosswalks), and the distance between parking and destinations (“Evaluating Nonmotorized Transport,” VTPI, 2003). Acceptable walking distances vary depending on the type of trip, the type of user and conditions. Table 14 indicates acceptable walking distances for various conditions (also see Childs, 1999, Table 6.1). For typical urban conditions, LOS A is less than one block, LOS B is 1-4 blocks, LOS C is 4-8 blocks, and LOS D is more than 8 blocks between a destination and its parking facilities.

**Table 14** Level of Service By Walking Distance (in Feet) (PT, 2000)

Walking Environment	LOS A	LOS B	LOS C	LOS D
Climate Controlled	1,000	2,400	3,800	5,200
Outdoor/Covered	500	1,000	1,500	2,000
Outdoor/Uncovered	400	800	1,200	1,600
Through Surface Lot	350	700	1,050	1,400
Inside Parking Facility	300	600	900	1,200

*This table indicates parking access Level of Service (LOS) rating under various conditions.*

Parking facility design factors can affect walkability. Parking facilities (especially large lots) should have marked walkways that protect pedestrians from traffic and conveniently connect to sidewalks. Urban parking lots can serve as mid-block walkways, allowing pedestrians a short-cut from one street to another, which improves nonmotorized accessibility in an area, and expands the number of destinations that a parking lot can serve.

### *Increase Capacity of Existing Parking Facilities*

*Increase capacity of existing parking facilities* means that parking supply increases without using more land or major construction. There are various ways to do this:

- Use currently wasted areas (corners, edges, undeveloped land, etc.). This can be particularly appropriate for small car spaces, motorcycle and bicycle parking.
- Where there is adequate street width, change from parallel to angled on-street parking.
- Maximize the number of on-street parking spaces, for example, by using a curb lane for parking rather than traffic during off-peak periods, and designating undersized spaces for small cars or motorcycles.
- Provide special, small parking spaces for motorcycles. Allow and encourage motorcycles to share parking spaces when possible.
- Reduce parking space size. Shorter-term parking requires larger spaces, but employee and residential parking spaces can be somewhat smaller. A portion of spaces can be sized for compact vehicles, which require about 20% less space than full-size stalls.
- Use car stackers and mechanical garages. These can significantly increase the number of vehicles parked in an area. However, they are only suitable for certain applications. They generally require an attendant to move lower-level vehicles when needed to access upper-level vehicles, and stackers may be unable to accommodate larger vehicles such as SUV, vans and trucks.
- Use valet parking, particularly during busy periods. This can increase parking capacity by 20-40% compared with users parking their vehicles. Commercial lots often have attendants park vehicles during busy periods, but not off-peak.
- Remove or consolidate non-operating vehicles, equipment, material and junk stored in parking facilities, particularly in prime locations.

**Figure 5** Carstackers



Carstackers allow more vehicles to be stored in a given area.

***Mobility Management***

*Mobility Management* (also called *Transportation Demand Management* or *TDM*) is a general term for strategies that increase transportation system efficiency by changing travel behavior (VTPI, 2005). It may affect travel frequency, mode, destination or timing (for example, shifting from peak to off-peak). There are many different mobility management strategies, as summarized in the table below.

**Table 15 Mobility Management Strategies** (VTPI, 2003)

Improved Transport Options	Incentives to Shift Mode	Land Use Management	Policies and Programs
Alternative Work Schedules	Bicycle and Pedestrian Encouragement	Car-Free Districts Compact Land Use Location Efficient Development New Urbanism Smart Growth Transit Oriented Development (TOD) Street Reclaiming	Access Management
Bicycle Improvements			Campus Transport Management
Bike/Transit Integration	Congestion Pricing		Data Collection and Surveys
Carsharing	Distance-Based Pricing		Commute Trip Reduction
Guaranteed Ride Home	Commuter Financial Incentives		Freight Transport Management
Security Improvements	Fuel Tax Increases		Marketing Programs
Park & Ride	High Occupant Vehicle (HOV) Priority		School Trip Management
Pedestrian Improvements	Pay-As-You-Drive Insurance		Special Event Management
Ridesharing	Parking Pricing		Tourist Transport Management
Shuttle Services	Road Pricing		Transport Market Reforms
Improved Taxi Service	Vehicle Use Restrictions		
Telework			
Traffic Calming			
Transit Improvements			

*Mobility management includes numerous strategies that affect vehicle travel behavior. Many affect parking demand.*

Mobility management both supports and is supported by parking management. Mobility management programs often reduce parking demand, and many parking management strategies help reduce vehicle traffic create more accessible land use patterns or support other mobility management objectives.

### *Parking Pricing*

*Parking Pricing* means that motorists pay directly for using parking facilities to efficiently manage demand or recover facility costs (CARB 2014; Shoup, 2006 and 2013). This may be implemented as a parking management strategy (to reduce parking problems), a mobility management strategy (to reduce traffic problems), to recover parking facility costs (so parking facilities are financed by users rather than being subsidized), or to raise revenue for any purpose (such as funding local transport programs or downtown improvements). It is often intended to achieve a combination of objectives.

Currently, most parking is inefficiently priced; it is provided free, significantly subsidized, or bundled (automatically included) with building purchases and rents, forcing consumers to pay for parking facilities regardless of whether or not they want it. When motorists do pay directly for parking, it is often a flat annual or monthly fee, providing little incentive to use an alternative mode occasionally. Charging users directly rather than indirectly for parking typically reduces automobile ownership and use by about 30% (Ostermeijer, Koster and Ommeren 2019; Spears, Boarnet and Handy 2014). Khordagui (2019) found that a 10% commuter parking price increase causes a 1–2 percentage point average decline in the probability of driving to work. Charging by the day rather than monthly significantly reduces driving (Gutman 2017). Rates should be set to optimize parking facility use, called *performance-based pricing*, which means that about 15% of parking spaces are unoccupied at any time, so drivers can usually see a parking space near their destination (Shoup, 2006 and 2008). Short-term parking can have higher unit fees than longer-term parking used by commuters. For example, \$2/hour may be a reasonable price for convenient downtown on-street parking used for errands, but few commuters can afford to pay \$16 per day to park.

Parking pricing implementation can be technically and politically difficult, so it is often best to establish long-term policies and plans that incrementally expand when and where parking is priced (for example, a city may set a goal of pricing four additional blocks of on-street parking each year, slowly expanding from the downtown core outward into nearby streets), raise rates to efficient levels. It is important to start with support policies, such as user information and efficient enforcement (described later).

Below are specific strategies for efficient parking pricing implementation:

- As much as possible, charge motorists directly for using parking facilities to efficiently manage parking demand, encourage use of alternative modes, and generate revenue. Cost recovery parking prices typically reduce parking demand by 10-30%.
- Set prices to maintain optimal demand, such as 80-90% maximum occupancy during peak periods. Vary rates as needed to achieve these targets (SFpark 2014). For example, charge \$1 per hour for parking downtown during weekdays, \$0.75 per hour for parking downtown during evenings and weekends, and \$0.50 per hour for parking in other locations.
- *Unbundle parking*, so parking is rented separately from building space. For example, rather than paying \$2,000 per month for an apartment with two “free” parking spaces, occupants pay \$1,600 per month for the apartment plus \$200 per month for each space they want.
- *Cash-out free parking*, so commuters who use non-auto modes receive a financial benefit equivalent in value to parking subsidies provided to motorists.

- Charge higher rates and use shorter pricing periods at more convenient parking spaces, to favor higher-priority uses and increase turnover. Prime space prices should be at least twice those at less-convenient locations. For example, at convenient locations charge 25¢ per 15-minute period with a two-hour limit, while at less convenient locations charge \$4 per day. Adjust these ratios as needed to optimize use.
- Minimize early-bird and long-term parking price discounts. For example, set daily rates at least 6 times the hourly rates, and monthly rates at least 20 times daily rates. Even better, eliminate long-term passes and charge for each hour or day, so commuters save money whenever they reduce driving.
- Allow motorists to rent or lease on-street parking. For example, a city can sell up to five nonresident permits on blocks that have more than 50% overnight vacancy rates; nonresidents pay market prices, such as \$50 a month, for an overnight permits. Each permit is valid only on that specific block.
- Use improved pricing methods to make priced parking more cost effective, convenient and fair. For example, use pricing systems that charge for just the amount of time a vehicle is parked, rather than fixed time blocks.
- Use short pricing periods. For example, for short-term parking change by the minute rather than by the hour, and for long-term parking charge by the hour rather than by the day or month.
- Create Parking Benefit Districts, with revenues used to benefit local communities.
- Set parking prices to equal or exceed transit fares. For example, set daily rates to equal or exceed two single fares, and monthly rates to equal or exceed a monthly pass price.

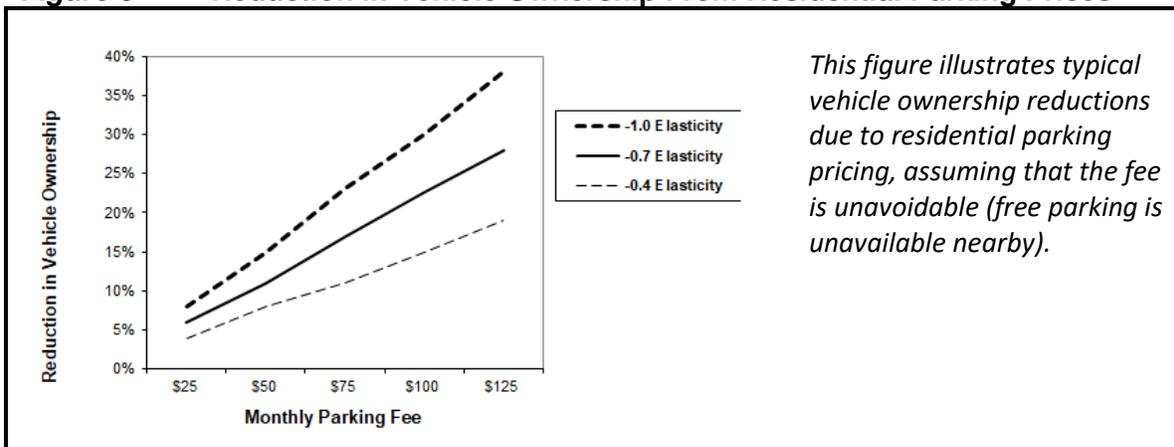
### Unbundle Parking

Unbundling means that parking is rented or sold separately, rather than automatically included with building space. For example, rather than renting an apartment with two parking spaces for \$1,000 per month, the apartment would rent for \$800 per month, plus \$100 per month for each parking space. This is more equitable and efficient, since occupants only pay for parking they need (Nelson/Nygaard 2009; Schmitt 2018). Parking can be unbundled in several ways:

- Facility managers can unbundle parking when renting building space.
- Developers can make some or all parking optional when selling buildings.
- In some cases it may be easier to offer a discount to renters who use fewer than average parking spaces, rather than charging an additional fee. For example, an office or apartment might rent for \$1,000 per month with two “free” parking spaces, but renters who only use one space receive a \$75 monthly discount.
- Parking costs can be itemized in lease agreements to help renters understand the parking costs they bear, and to help them negotiate reductions.
- Informal unbundling can be encouraged by helping to create a secondary market for available spaces. For example, office, apartment and condominium managers can maintain a list of residents who have excess parking spaces that are available for rent.

Unbundling is equivalent to pricing. Figure 6 indicates the reduction in vehicle ownership resulting from various residential parking fees. For example, a \$50 per month parking fee is likely to reduce automobile ownership 8-15%, and a \$100 per month fee a 15-30% reduction, assuming average consumers and adequate enforcement of offsite parking regulations.

**Figure 6** Reduction in Vehicle Ownership From Residential Parking Prices

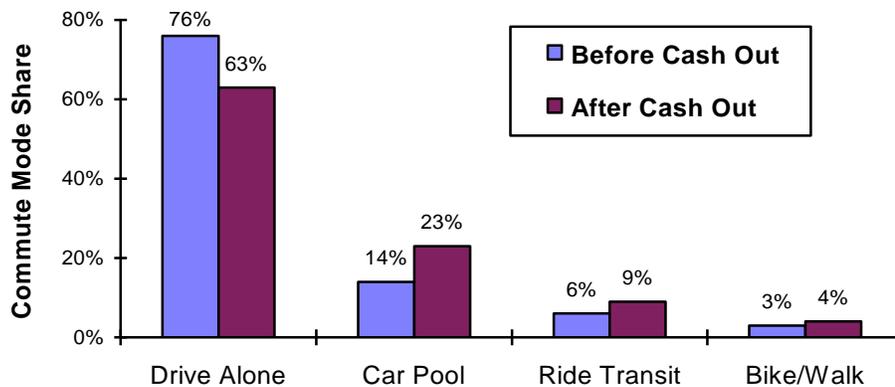


### Financial Incentives

*Financial Incentives* means that travelers (particularly commuters) are offered financial benefits for reducing their automobile trips (“Commuter Financial Incentives,” VTPI, 2005). These benefits represent the cost savings that result from reduced parking demand. There are various types of incentives. *Parking cash-out* means that commuters who are offered subsidized parking can choose cash instead. *Transit benefits* means that employees receive a subsidized transit pass. *Universal transit passes* means that a group purchases discounted, bulk transit passes for all members. Another incentive is to provide *discounted or preferential parking* for rideshare (carpool and vanpool) vehicles. Consumers value these options because they provide positive rewards for those who reduce vehicle trips and parking demand.

Financial incentives typically reduce automobile travel 10-30%, depending on the value of the incentive, and various factors. Figure 7 illustrates the effects of parking cash-out in one study, indicating a 17% average reduction in car trips. The more flexible the incentive the greater the impact. For example, parking cash-out tends to cause the greatest automobile trip reduction because it rewards any alternative mode. Transit benefits have less impact because they only encourage shifts to transit, but not shifts to walking, cycling or telework.

**Figure 7** Cashing Out Impacts on Commute Mode (Shoup, 1997)



*In this study, parking cash-out reduced automobile commute trips an average of 17%.*

### *Improve Pricing Methods*

Much of the resistance to parking pricing results from inconvenient pricing methods (“Pricing Methods,” VTPI, 2005; FHWA, 2007):

- Many require payment in specific denominations (coins or bills).
- Many require motorists to predict how long they will be parked, with no refund available if motorists leave earlier than predicted.
- Some payment systems cannot easily handle multiple price structures or discounts.
- Some are confusing or slow to use.
- Some have high equipment or enforcement costs.
- Enforcement often seems arbitrary or excessive.

Better payment methods are available, as summarized in the table below. Newer electronic systems are more convenient, accurate, flexible, and increasingly cost effective. They can accommodate various payment methods (coins, bills, credit and debit cards, plus mobile telephone and Internet transactions), charge only for the amount of time parked, incorporate multiple rates and discounts, automatically vary rates by day and time, and are convenient to use. Some can be integrated with payment systems for other public services such as transit, roads tolls, and telephone use. Some employ contactless technology which automatically deducts payment. Newer systems also produce printed receipts and record data for auditing, which prevents fraud and increases convenience for customers, operators and local governments. They can also automatically record data on utilization and turnover, which improves planning and administration.

Alternatively, parking pricing can be more convenient and secure if parking lots have attendants. Some parking facilities use attendants during peak periods, and rely on mechanical or electronic payment during off-peak periods. Better equipment maintenance and more courteous enforcement can also improve pricing.

**Figure 8**      **Better Payment Methods**



*New payment methods are more convenient and flexible, reducing objections to efficient pricing.*

**Table 16 Summary of Parking Pricing Options** (“Pricing Methods,” VTPI, 2005)

Type	Description	Capital Costs	Operating Costs	User Convenience	Price Adjustability	Enforceability
Pass	Parkers purchase and display a pass.	Low	Low	Medium	Poor to medium.	Good
Time-Coded Tickets	Parkers purchase a ticket for a certain amount of time (such as 2-hours). Punch out tabs indicating start time.	Low	Medium	Medium	Medium	Good
Single-Space Meters	Parkers prepay a mechanical or electronic meter located at each space.	High	High	Mechanical meters: low; electronic meters: medium.	Mechanical meters: poor; electronic meters: good.	Mechanical meters: poor; electronic meters: good.
Smart Meters	Parkers prepay electronic meters located at each space. Detectors determine when vehicles leave and reset meters.	High	High	Medium.	Good	Good
Pay Box	Parkers prepay into a box with a slot for each space.	Low	Medium	Low	Poor to medium.	Poor
Pay-And-Display Meters	Parkers prepay a meter, which prints a ticket that is displayed in their vehicle.	Medium	Medium	Medium	Mechanical meters: poor; electronic meters: good.	Good
Electronic Pay-Per-Space	Parkers prepay an electronic meter.	Medium	Medium	Medium	Very good.	Good
Debit Card	Prepay meters with debit cards. Some rebate unused time.	Medium	Medium	Medium	Very good.	Good
In-Vehicle Meter	Parkers display a small electronic meter with prepaid credits inside their vehicle when it is parked.	Medium	Low	High	Moderate	Good
Attendant	Parkers pay an attendant when entering or leaving parking lot.	High	High	High	Good	Good
Valet	Parkers pay an attendant who parks their car.	Low	High	High	Good	Good
Automated Controlled Access System	Parkers pay a machine when entering or leaving parking lot.	High	Moderate	Medium	Good	Poor
Automatic Vehicle Identification	System automatically records vehicles entering and leaving a parking area.	High	Medium	High	Good	Good
Global location technology	Satellite-based systems track vehicle location and automatically calculate fees.	High but declining	High but declining	High	Very high	Good

*Various systems can be used to price parking. Newer systems tend to provide various advantages.*

## *Parking Tax Reform*

*Parking tax reform* includes various tax policies that support parking management:

- *Commercial parking taxes.* This is a special tax on user-paid parking transactions. This is common and relatively easy to implement, but tends to discourage parking pricing (since it makes free parking relatively more valuable to motorists), and is geographically inequitable and encourages sprawl (since it is imposed primarily in urban areas).
- *Per-space levies.* This is a special tax imposed on parking facilities, such as a \$30 annual tax on each non-residential parking space. If applied specifically to employee parking it is called a *workplace parking levy*. This is more difficult to implement than a commercial parking tax, since it requires identifying individual parking spaces, but it tends to be more efficient and fair, because it applies to all parking.
- *Free parking levies.* This is a special tax imposed on unpriced parking, for example, a \$50 annual tax per space provided free to employees. This is a variation on per-space levies designed to discourage unpriced parking.
- *Stormwater management fees.* This is a utility fee based on impervious surface area to fund stormwater management services, such as a \$15 annual fee per 1,000 square feet of pavement, or a \$5 annual fee per parking space.
- *Car-free tax discounts.* This is a property tax discount provided to households that do not own an automobile, reflecting their lower roadway and traffic service costs they impose. For example, if municipal roadway maintenance and traffic service costs average \$200 annually per vehicle owned in the community, a tax discount up to this amount could be provided to households that do not own a car.
- *Income tax policy reforms.* This means that employee parking subsidies are treated as a taxable benefit, employee parking tax exemptions are limited (for example, only \$100 per month is income tax exempt), or tax exemptions are provided to subsidies of other modes, such as employer-provided transit passes. Current tax policies make parking subsidies an attractive employee benefit: A typical employee must earn \$1,500 or more in pre-tax income to pay for a parking space that costs their employer only \$1,000 to provide. Transit benefits are income tax exempt in the U.S., but other countries have yet to implement such reforms, and many employers have yet to offer them to employees.
- *Smart Growth Tax and Price Reforms.* Several tax and pricing reforms can encourage compact development and discourage sprawl (“Smart Growth Market Reforms,” VTPI, 2003). For example, development fees, utility rates and tax rates can reflect the higher costs of providing public services to more dispersed locations.

These tax reforms may be justified on several grounds: They can help correct current distortions that undertax parking facilities compared with other land uses. Special parking taxes, and car-free discounts, can be a surrogate for road user fees. They support efforts to reduce total parking supply and paved area. Parking tax revenues can be used to fund parking facilities and transportation programs, to fund stormwater management programs, or as a source of general revenues. If governments must tax something, parking facilities and activities can be particularly appropriate because it helps achieve parking and transport management objectives in addition to raising revenue, providing what economists call a “double dividend.”

***Bicycle Parking and Changing Facilities***

*Bicycle parking and changing facilities* increase the convenience and security of bicycle transportation (CARB 2014; VTPI 2005). In some situations, bicycle parking facilities can substitute for a portion of automobile parking, particularly if implemented as part of a comprehensive bicycle improvement and encouragement program.

Optimal bicycle parking supply depends on the level of cycling that occurs in that community and the type of destination. Some destinations, such as schools, campuses and recreation centers have 10-20% of visitors arrive by bicycle, at least during fair weather. Below are examples of recommended bicycle parking, but these should be adjusted to meet specific conditions. To determine whether additional bicycle parking may be needed, observe entrance areas to see if bicycles are frequently locked to posts and trees, an indication that bicycle parking facilities are inadequate, either because there are too few bicycle racks, or because existing bike racks are not well designed or located. Survey cyclists and potential cyclists to determine what facilities they would prefer.

**Table 17 Bicycle Parking Requirements (VTPI 2003)**

Type of Establishment	Minimum Number of Bicycle Parking Spaces
Primary or secondary school	10% of the number of students, plus 3% of the number of employees.
College or university classrooms	6% of the number of students, plus 3% of the number of employees.
Dorms, fraternities and sororities	One space per 3 residents.
Commercial – retail or office	One space per 3,000 sq. ft. of commercial space or 5-10% of the number of automobile spaces.
Sport and recreation center	10-20% of the number of automobile spaces.
Movie theater or restaurant	5-10% of the number of automobile spaces.
Industrial	2-5% of the number of automobile spaces.
Multi-unit housing	1 space per 1-2 apartments.
Public transit stations	Varies, depending on usage.

*This table indicates typical minimal bicycle parking requirements. These should be adjusted to reflect the needs of specific locations.*

It is important to provide quality bicycle facilities. There are two general categories of bicycle parking requirements:

1. *Short-term* (Class II) parking is needed where bicycles will be left for short stops. It requires a high degree of convenience (as close to destinations as possible). At least some short-term bicycle parking should be protected from the weather (a portion can be unprotected, since demand tends to increase during dry weather).
2. *Long-term* (Class I) parking is needed where bicycles will be left for hours at a time. It requires a high degree of security and weather protection, with well-designed racks in covered areas, lockers, storage rooms, or fenced areas with restricted access.

### *Improve User Information and Marketing*

*User information* refers to information for travelers about parking availability, regulations and price, and about travel options, such as walking, ridesharing and transit. Many parking problems result in part from inadequate user information. User information can be provided by signs, maps, brochures, websites, and electronic guidance systems (Poon 2018). Advanced parking management systems that provide real-time information on parking availability and price can increase motorist satisfaction, increase parking space utilization and encourage shifts to alternative modes (Kimblar 2010).

Local governments can produce brochures and websites that identify the location of parking facilities, indicate parking prices, describe parking planning and management activities, explain parking regulations, describe opportunities for citizen involvement, and answer other common questions about parking issues. An *access guide* is a document that provides concise, customized information on how to reach a particular destination, including information on parking options. Parking information can be incorporated into other visitor materials, such as event announcements, yellow pages and newspaper advertisements. All materials should have parking program contact information, such as a telephone number or website.

User information is one component of marketing. *Marketing* is concerned with determining consumer needs and preferences, and providing suitable information and encouragement to help achieve an objective. It involves studies to help understand consumer needs, preferences and attitudes, plus barriers and opportunities for changing parking and travel behavior. It can also involve outreach campaigns to involve stakeholders in parking planning activities. Marketing can help planners anticipate and address possible objections to parking management. It is often useful to educate the public about the full costs of expanding parking supply, and the benefits of parking management programs, to help build community support for innovations.

*Intelligent Transportation Systems (ITS)* includes various communications technologies use to improve transportation services, including many that involve parking information, such as changeable signs and in-vehicle guidance systems that provide price and directional information on parking in a particular area. The 511 area code number is reserved for transportation information, including parking services, traffic reports and transit information. Some parking facilities have sensors that indicate which spaces are occupied, allowing motorists to quickly determine where parking is available.

### *Improve Enforcement and Control*

*Improve Enforcement and Control* means that parking regulations and pricing enforcement be more rational, effective and considerate. Evading parking regulations is a popular folk crime: Many upstanding citizens who otherwise never steal will proudly ignore parking regulations and evade payments, reducing their effectiveness. Regulations often include unjustified exemptions (Manville and Jonathan Williams 2011). As parking management activities expand, so too should enforcement activities.

To be effective and politically acceptable, the enforcement process – from identification of the offence to follow up, appeals against penalties and debt collection – must be perceived as efficient, considerate and fair. The need for citations should be minimized by providing adequate user information and options. For example, motorists sometimes violate parking regulations simply out of ignorance, because they lack the denomination required by a parking meter, or because a meeting took longer than expected. Better user information and newer pricing methods can help address these problems, reducing violations. It may be appropriate to have exemptions to parking regulations and fines, such as “First Time Free,” so the first time a motorist violates parking rules they are given information about parking regulations instead of a citation. Survey motorists who receive parking citations to determine how their parking needs can be better met.

Parking enforcement should be prioritized to focus on areas where parking violations create the greatest problems, such as arterials and downtown streets. New, hand-held data systems allow enforcement officers to track individual vehicles, identifying those that overstay (for example, commuters who feed meters), and habitual violators (motorists who ignore numerous parking regulations). It is important to have a system to collect outstanding parking fines. This may include use of a “boot” (a clamp that immobilizes a vehicle) or towing of vehicles with numerous unpaid fines, restrictions on renewing vehicle registrations or drivers licenses if parking fines are outstanding, or use of collection agencies.

Parking enforcement officers must be given adequate training and clear guidelines concerning how to enforce parking rules. They should be friendly, considerate and helpful. Parking enforcement officials should strive to be perceived as helpful community ambassadors. They should provide maps and brochures about local parking options, as well as general directions and tourist information.

Parking passes sold or allocated to employees, officials or visitors should have clear limitations regarding where, when and by whom they may be used. They should be audited regularly.

It is also important to enforce parking management agreements with developers and facility managers. For example, cities may require bonds or have special penalties for non-compliance if a developer fails to implement a trip reduction program, or a facility manager fails to support a parking sharing agreement as promised.

### *Transportation Management Associations and Parking Brokerage*

*Transportation Management Associations* (TMAs) are private, non-profit, member-controlled organizations that provide transportation and parking management services in a particular area, such as a commercial district, mall or medical center (“Transportation Management Associations,” VTPI 2005). TMAs can be an effective way to implement parking management programs. TMAs are typically funded through dues paid by member businesses, and local government grants.

A TMA may provide these services:

- Coordinate parking planning.
- Maintain an inventory of parking facilities.
- Perform regular parking utilization surveys.
- Provide parking brokerage services (described below).
- Coordinate shared parking. For example, help establish and enforce sharing agreements.
- Produce user information.
- Administrate commuter financial incentives, such as parking cash-out.
- Coordinate shuttle services.
- Manage overflow parking programs.
- Provide bicycle parking.
- Deal with spillover problems.
- Provide other mobility management services.
- Advise on parking facility design and management.
- Advise on regulations and enforcement policies.
- Coordinate enforcement services.
- Monitor parking problems.

TMAs can provide *parking brokerage services* (sometimes called a *parking exchange* or *parking bank*), helping businesses share, trade, lease, rent and sell parking facilities. For example, it matches businesses that have extra parking supply with nearby businesses that need parking at a particular time. This helps businesses deal with changing parking demands, and lets businesses benefit when their parking management programs free up existing parking spaces. TMAs can also be responsible for monitoring activities to identify potential problems and evaluate program effectiveness. A *Parking Authority* or *Parking Management Association* can provide many of the same services, but has a narrower scope that often excludes activities such as commute trip reduction programs.

### *Overflow Parking Plans*

*Overflow parking plans* describe the management strategies that will be applied when parking facilities fill, for example, during special events, peak shopping periods, or temporary reductions in parking supply. Below are some possible components of an overflow parking plan:

- Provide signs with directions to alternative parking facilities nearby.
- Establish shared and remote parking arrangements, with walkability improvements and shuttle services if necessary.
- Provide information on parking and travel options for special event participants, highlighting those that can be used to avoid parking problems. For example, include a brochure showing the location of parking facilities and describing how to arrive by transit with tickets to a major sport or cultural event.
- Encourage travelers to shift mode or use remote parking during peak periods. For example, retail employees can be required to use remote parking facilities or alternative commute modes during the holiday shopping season.
- Apply special parking regulations to favor priority vehicles (emergency, service, HOV, disabled, etc.) during busy periods.
- Provide special parking and transport services during peak periods, such as shuttle buses to remote parking, and valet parking to increase parking facility capacity.
- Design plazas, basketball courts and lawns so they can be used occasionally for vehicle parking.
- Provide adequate traffic and parking management staff during peak periods. Additional staff may be hired for special events.

Because most parking facilities are sized to accommodate peak demands that seldom or never occur, having an overflow parking plan can significantly reduce the amount of parking needed, and provide reassurance that reduced supply will not create problems. This is an important component of contingency-based planning.

### *Address Spillover Problems*

*Spillover parking problems* refers to the undesirable use of offsite parking facilities, such as when business customers and employees park on nearby residential streets or use another businesses' parking lot. Concerns about spillover impacts are used to justify excessive parking requirements and opposition to management solutions. Addressing spillover problems can increase parking management program acceptability and effectiveness.

There are several ways to address spillover parking problems:

- Provide information indicating where motorists may and may not park.
- Use regulations to control spillover impacts, such as time limits and permit programs on residential streets near activity centers.
- Use pricing to control spillover impacts, such as charging non-residents for parking on residential streets near activity centers, and businesses charging non-customers for using in their parking facilities.
- Create *Parking Benefit Districts* in areas that experience parking spillover problems, so on-street parking is priced (residents can be exempt).
- Compensate people who bear spillover parking impacts. For example, a high school can send complementary sport event tickets to residents of nearby streets who experience spillover parking problems.
- Establish a monitoring program to identify where parking spillover is a problem. This may include surveys to identify who is parking where, and ways for residents and businesses to report spillover problems.

### *Improve Parking Facility Design and Operation*

*Parking facility design and operation* refers to physical layout and day-to-day management. Improved design and operation can better integrate parking facilities into communities, improve service quality, support parking management, and help address various problems (Bojack 2020; Mukhija and Shoup 2006; Toronto 2007; Benfield 2010). Below are factors to consider:

- **Access Management** – This refers to coordination between roadway design and land use development, such as limiting the number of driveways and clustering land use activities.
- **Accessibility** (also called Universal Design) – This refers to accommodating people with disabilities and other special needs.
- **Aesthetics** – Attention to landscaping, materials, public art and other design features can improve parking facility appearance and the overall aesthetics of a site, street or city.
- **Asset Management** – This refers to programs that preserve the long-term value of facilities.
- **Circulation** - Parking lots can be designed to facilitate traffic circulation. Dead ends should be avoided, and multiple entrances should be provided if possible.
- **Flexibility** – Facilities can be designed to accommodate changing needs and temporary uses such as storage, recreation and community activities.
- **Heat Island Effect** – This refers to solar heat gain on dark surfaces. This can be reduced by limiting pavement area, shading, and use of light-colors materials.
- **Lighting** – Adequate lighting is important for user comfort, safety and security.
- **Orientation** – Many planners recommend locating buildings close to the sidewalk to improve pedestrian access, with parking located behind or at the side of a building.
- **Preservation and Enrichment** – Parking facilities can be designed to protect and enhance historic, cultural and natural resources.
- **Security** – Parking facilities can be designed to maximize security through natural surveillance, lighting, patrols, emergency alarms and closed circuit video observation.
- **Size and Scale** – Parking lot size can be minimized, and larger lots divided into smaller units.
- **Stormwater Management** - Newer stormwater management and pollution controls, can reduce environmental impacts and infrastructure costs.
- **Traffic Calming** – This includes design features to reduce vehicle traffic speeds and volumes on a particular road or driveway, some of which incorporate on-street parking.
- **Traffic Safety** – Parking lots can have features to control traffic speeds, improve visibility and protect pedestrians.
- **User Amenities** – Parking facilities can be designed with walkways, sheltered waiting areas, benches, drinking fountains, telephones, vending machines and washrooms.
- **User Information** – Wayfinding information should be provided in parking facilities.
- **Weather Protection** – Parking lots can be shaded with trees and awnings to increase user comfort and reduce vehicle pollution emissions.

### *Contingency-based planning*

*Contingency-base planning* identifies possible responses that can be implemented if the current parking supply turns out to be inadequate sometime in the future. Contingency-base planning requires a shift in the burden of proof for parking supply reductions: current practices place a high burden of proof, contingency-base planning allows any reasonable reduction provided that it includes a plan which indicates how parking shortages will be managed. City officials may be allow or encourage this when negotiating developments, and it may require additional administration to review and enforce parking management plans.

Where parking is oversupplied due to concerns about possible demand growth, contingency-based planning can reduce supply, often by 10-30%. If the plan includes trip reduction strategies, such as ridesharing, Commute Trip Reduction programs, and parking price increases, it can also reduce total vehicle travel.

## Summary

The table below summarizes the parking management strategies in this guide.

**Table 18 Parking Management Strategies**

Strategy	Description
<b>Strategies That Increase Parking Facility Efficiency</b>	
Shared parking	Parking spaces serve multiple users or destinations, including sharing rather than assigning reserved spaces to users, and sharing facilities among multiple destinations.
Parking regulations	Regulations that favor higher-value uses, increase turnover and address spillover problems.
More accurate and flexible standards	Parking standards are adjusted to more accurately reflect demand in a particular situation taking into account various geographic, demographic and management factors.
Parking maximums	Establish maximum parking standards.
Remote parking	Provide off-site or urban fringe parking facilities, and encourage their use.
Smart growth	Encourage more compact, mixed, multi-modal development.
Walking and bicycling improvements	Improve walking and cycling conditions to expand the range of destinations serviced by a parking facility and reduce automobile trips.
Increase capacity of existing facilities	Increase parking supply by using otherwise wasted space, smaller stalls, car stackers and valet parking.
<b>Strategies That Reduce Parking Demand</b>	
Mobility management	Encourage more efficient travel including changes in mode, timing and destination.
Ridesharing, ride-hailing and transit	Improve ridesharing (car- and vanpooling), ride-hailing (such as Uber and Lyft) and public transit services, particularly in denser urban areas.
Efficient parking pricing	Charge motorists directly for using parking facilities, with efficient prices that include lower rates during off-peak periods and higher rates during peak times and locations.
Unbundle parking	Rent or sell parking facilities separately from building space.
Financial incentives	Provide financial incentives to shift mode, such as parking cash-out and transit benefits.
Improve pricing methods	Use better charging techniques to make pricing more convenient and cost effective.
Parking tax reform	Various tax policy changes that support parking management objectives.
Bicycle facilities	Provide bicycle storage and changing facilities.
<b>Support Strategies</b>	
Improve user information	Provide convenient and accurate information on parking availability and price, using maps, signs, brochures and electronic communication.
Improve enforcement	Insure that parking regulation enforcement is efficient, considerate and fair.
Transport management associations	Establish member-controlled organizations that provide transport and parking management services in a particular area.
Overflow parking plans	Establish plans to deal with periods of peak parking demand.
Address spillover problems	Use management, enforcement and pricing to address spillover problems.
Parking facility design and operation	Improved parking facility design and operations to help solve problems and achieve parking management objectives.
Contingency-based planning	Identify possible responses that can be implemented if the current parking supply turns out to be inadequate sometime in the future

*This table summarizes the parking management strategies described in this guide.*

The table below indicates whether a strategy directly reduces total vehicle traffic (and therefore provides benefits such as reduced traffic congestion and pollution emissions), and the typically parking requirement reduction it provides.

**Table 19 Typical Reductions in Vehicle Traffic And Parking Requirements**

Strategy	Reduced Parking Requirements			Traffic Reductions
	Low	Medium	High	
Shared parking	10%	20%	30%	
Parking regulations	10%	20%	30%	
More accurate standards	10%	20%	30%	
Parking maximums	10%	20%	30%	
Remote parking	10%	20%	30%	
Smart growth	10%	20%	30%	✓
Walking and cycling improvements	5%	10%	15%	✓
Increase capacity of existing facilities	5%	10%	15%	
Mobility management	10%	20%	30%	✓
Parking pricing	10%	20%	30%	✓
Unbundle parking	10%	20%	30%	✓
Financial incentives	10%	20%	30%	✓
Improve pricing methods	NA	NA	NA	✓
Parking tax reform	5%	10%	15%	✓
Bicycle facilities	5%	10%	15%	✓
Improve user information	5%	10%	15%	✓
Improve enforcement and control	NA	NA	NA	
Transportation management associations	NA	NA	NA	✓
Overflow parking plans	NA	NA	NA	
Address spillover problems	NA	NA	NA	
Parking facility design	NA	NA	NA	
Contingency-based planning	NA	NA	NA	

*This table indicates typical reductions in parking requirements compared with conventional practices, and whether a strategy reduces vehicle traffic, thereby providing additional benefits. NA = Not Appropriate, indicating strategies that do not directly affect parking requirements.*

Not every strategy is appropriate in every situation. Actual impacts vary depending on geographic and demographic factors, how a strategy is implemented and other factors. Below are some general guidelines.

- Impacts are higher where there are more parking and travel options. For example, parking pricing will have greater demand reduction impacts if implemented in conjunction with improvements in rideshare and public transit services.
- Financial incentives tend to have greater impacts on lower-income consumers.
- Some strategies are complementary. For example, shared parking becomes more effective if implemented with suitable regulations, pricing and walkability improvements.
- Impacts generally increase over time as programs mature. A Low value may be appropriate the first year, but increases to Medium after two or three years, and High in five or ten years.

The table below summarizes potential parking management strategies and their impacts.

**Table 20 Parking Management Strategies**

Strategy	Description	Typical Reduction	Traffic Reduction
Shared Parking	Parking spaces serve multiple users and destinations.	10-30%	
Parking Regulations	Regulations favor higher-value uses such as service vehicles, deliveries, customers, quick errands, and people with special needs.	10-30%	
More Accurate and Flexible Standards	Adjust parking standards to more accurately reflect demand in a particular situation.	10-30%	
Parking Maximums	Establish maximum parking standards.	10-30%	
Remote Parking	Provide off-site or urban fringe parking facilities.	10-30%	
Smart Growth	Encourage more compact, mixed, multi-modal development to allow more parking sharing and use of alternative modes.	10-30%	✓
Walking and Cycling Improvements	Improve walking and cycling conditions to expand the range of destinations serviced by a parking facility.	5-15%	✓
Increase Capacity of Existing Facilities	Increase parking supply by using otherwise wasted space, smaller stalls, car stackers and valet parking.	5-15%	
Mobility Management	Encourage more efficient travel patterns, including changes in mode, timing, destination and vehicle trip frequency.	10-30%	✓
Parking Pricing	Charge motorists directly and efficiently for using parking facilities.	10-30%	✓
Improve Pricing Methods	Use better charging techniques to make pricing more convenient and cost effective.	Varies	✓
Financial Incentives	Provide financial incentives to shift mode such as parking cash out.	10-30%	✓
Unbundle Parking	Rent or sell parking facilities separately from building space.	10-30%	✓
Parking Tax Reform	Change tax policies to support parking management objectives.	5-15%	✓
Bicycle Facilities	Provide bicycle storage and changing facilities.	5-15%	✓
Improve Information and Marketing	Provide convenient and accurate information on parking availability and price, using maps, signs, brochures and the Internet.	5-15%	✓
Improve Enforcement	Insure that regulation enforcement is efficient, considerate and fair.	Varies	
Transport Management Assoc.	Establish member-controlled organizations that provide transport and parking management services in a particular area.	Varies	✓
Overflow Parking Plans	Establish plans to manage occasional peak parking demands.	Varies	
Address Spillover Problems	Use management, enforcement and pricing to address spillover problems.	Varies	
Parking Facility Design and Operation	Improve parking facility design and operations to help solve problems and support parking management.	Varies	

*This table summarizes the parking management strategies described in this report. It indicates the typical reduction in the amount of parking required at a destination, and whether a strategy helps reduce vehicle traffic, and so also provides congestion, accident and pollution reduction benefits.*

Table 21 indicates the appropriateness of various strategies for different types of parking demands. Short-term parking management should insure that convenient parking is available for deliveries and errands (including shoppers, visitors and service vehicles). In general, this should maintain less than 85% occupancy rates so drivers can usually see an unoccupied parking space near their destination. Long-term parking management should accommodate commuters and residents with minimal costs, and so can usually have higher occupancy rates and require greater walking distances. The application of parking management strategies often differs between different parking demands. For example, visitors need different types of user information than commuters.

**Table 21 Short- and Long-term Parking**

Management Strategies	Shorter Term	Longer Term
	Deliveries and errands	Commuters and residents
Shared Parking	Use on-street parking.	Share off-street parking facilities
Parking Regulations	Encourage turnover of the most convenient spaces.	Encourage use of less-convenient spaces.
More Accurate Standards	As appropriate	As appropriate
Parking Maximums	As appropriate	As appropriate
Remote Parking	Only if very close by	Often appropriate
Smart Growth	Allows more sharing and “park once” trips	Allows more sharing and use of alternative modes.
Walking and Cycling Improvements	Where possible	Where possible
Increase Capacity of Existing Facilities	Where possible	Where possible
Mobility Management		Often very appropriate
Parking Pricing	Encourage turnover of the most convenient spaces.	Encourage use of less-convenient spaces.
Unbundle Parking		Often appropriate
Financial Incentives (parking cash out)		Often appropriate
Improve Pricing Methods	Improve meters	Improve passes
Parking Tax Reform		Often appropriate
Bicycle Facilities	Short-term bike racks in convenient locations	Long-term bicycle parking and changing facilities
Improve User Information	Helps guide visitors to additional parking options	
Improve Enforcement and Control	Increases turnover.	Insures that longer-term parker use less-convenient spaces
Transportation Management Associations	Supports other strategies	Supports other strategies
Overflow Parking Plans	Sometimes appropriate	Often appropriate
Address Spillover Problems	Often appropriate	Often appropriate
Parking Facility Design	Often appropriate	Often appropriate

*This table indicates the degree to which various parking management strategies apply to various types of parking demands.*

**Evaluating Multiple Strategies**

Special care is needed when predicting the impacts of a program that includes multiple parking management strategies. Be careful to take into account strategies with overlapping impacts. For example, Transportation Management Associations (TMAs) provide an institutional framework for implementing strategies that directly affect parking requirements. While it would be true to say that a TMA can reduce parking requirements by 10-30% compared with not having such an organization, it would be incorrect to add the demand reductions of the TMA to the impacts of the individual strategies it helps implement.

Here is an illustration. Without a TMA, parking sharing, pricing and mobility management may each reduce parking requirements by 10%, but with a TMA they become more effective, providing 15% reductions. Table 22 illustrates the incremental gain that can be attributed to the TMA, due to the increase in the effectiveness of other strategies. In this example, the TMA causes an additional 12% reduction in parking requirements by enhancing the effects of other management strategies.

**Table 22 TMA Parking Requirement Reductions**

	Without TMA	With TMA	Reduction
Shared Parking	10%	15%	5%
Parking Pricing	10%	15%	5%
Mobility Management	10%	15%	5%
<i>Total Impacts</i>	$100\% - (90\% \times 90\% \times 90) = 27\%$	$100\% - (85\% \times 85\% \times 85\%) = 39\%$	12%

*This table shows how a transportation management association can reduce parking requirements by helping to implement specific management strategies.*

Total impacts are multiplicative not additive. For example, shared parking reduces the parking requirements by 10%, to 90% of the original level. The 10% reduction of Parking Pricing reduces this further to 81% of the original level, and another 10% reduction from Mobility Management results in 73% of the original level, a 27% reduction, somewhat less than the 30% reduction that would be calculated by adding three 10% reductions.

Some combinations of strategies have synergistic effects (total impacts are greater than the sum of their individual impacts), and so become more effective if implemented together. For example, sharing parking and walkability improvements may each reduce parking requirements just 10% if implemented alone, but 25% if implemented together because they are complementary.

## Developing an Integrated Parking Plan

Below are recommendations for integrated parking planning. Of course, this may be adjusted to reflect the needs of a particular situation.

### Define the Scope

Define the geographic scope of analysis. Parking planning can be performed at the site, street, district/neighborhood and regional scale. It is desirable to plan for a walkable area, such as a business district or neighborhood, since this is the functional scale of parking activities. For example, when planning for parking at a building, it best to survey parking supply and demand within about six blocks to help identify opportunities for sharing off-site parking facilities, and the severity of potential spillover parking problems.

### Define Problems

Carefully define parking problems. For example, if people complain of inadequate parking it is important to determine where, when and to whom this occurs, and for what types of trips (deliveries, commuting, shoppers, tourists, etc.). Consider other types of parking problems, such as high costs of providing parking facilities, inadequate user information, inconvenient pricing methods, inconsiderate enforcement, difficulties walking between parking facilities and destinations, inadequate security, and unattractive parking facilities.

### Strategic Planning Context

Parking planning should be coordinated with a community's overall strategic vision. This helps insure that individual decisions reflect broader community objectives. There may be several possible solutions to a parking problem, some of which support strategic objectives, while others contradict them. For example, both increasing parking supply and improved management of existing supply can address parking congestion problems, but one approach may support other community planning objectives, such as encouraging use of alternative travel modes, and reducing urban sprawl.

### Establish Evaluation Framework

Develop a comprehensive *evaluation framework*. This provides the basic structure for analyzing options, insuring that critical impacts are not overlooked and different situations are evaluated consistently. A framework identifies:

- Perspective and scope, the geographic range and time-scale of impacts to consider.
- Goals (desired outcomes to be achieved) and objectives (ways to achieve goals).
- Evaluation criteria, including costs, benefits and equity impacts to be considered, such as those listed in Table 23.
- Evaluation method, how impacts are to be evaluated, such as benefit/cost analysis.

Performance indicators, practical ways to measure progress toward objectives, such as increased availability of parking to customers, or reduced complaints of spillover parking.

Base Case definition, that is, what would happen without the policy or program.

How results are presented, so results of different evaluations can be compared. For example, results can be presented as annualized cost per parking space, or net present value.

**Table 23 Impacts to Consider**

Name	Description
Land costs	Value of land devoted to parking facilities.
Construction costs	Project construction expenses.
Operation and maintenance costs	On-going operation and maintenance expenses.
Implementation	Ease of implementation.
User convenience	The relative ease of use.
Consumer choice	Impacts on the range of parking, transport and housing options available.
User financial impacts	Additional consumer payments, savings or benefits.
Revenues	Additional revenue to facility owners.
Spillover impacts	May cause undesired use of off-site parking spaces.
Economic development impacts	Changes in employment and business activity.
Travel impacts	Shifts in parking location, mode, destination, time, etc. Some are considered desirable, and others undesirable, depending on conditions and perspective.
Traffic impacts	Changes in vehicle traffic volumes, including reductions in car trips and increased driving to search for a parking space.
Accessibility impacts	Changes in the location and dispersion of activities.
Greenspace preservation	Changes in the amount of land devoted to landscaping, farms, habitat and other forms of landscaping.
Stormwater management and heat island effects	Changes in the amount of impervious surface, stormwater management costs, and solar heat gain.
Fairness and equity	Changes in unjustified subsidies (user pays principle), and impact on people who are physically, economically or socially disadvantaged.

*This table lists impacts (costs and benefits) to consider when evaluating parking management programs.*

**Survey Conditions**

Survey parking supply (the number of parking spaces available in an area) and demand (the number of parking spaces occupied during peak periods) in the study area. Collect the following data on all parking facilities in an area:

1. Location and ownership of parking facility.
2. Type of facility (on-street, off-street surface, off-street structured, underground).
3. Number of spaces.
4. Intended users (customers, employees, residents, etc.).
5. Regulation (i.e., “One Hour Maximum,” “Delivery Vehicles Only”).
6. Prices (hourly, daily, weekly, monthly fees).
7. *Utilization* (how many spaces are occupied), *turnover* (the number of different vehicles using a space during a time period) and *duration* (length of time vehicles are parked).
8. Types of problems identified (parking congestion, spillover conflicts, poorly maintained facilities, inadequate enforcement, inadequate security, etc.)

**Identify Options**

Develop a list of potential solutions using ideas from this guide and stakeholder ideas. This list may include a combination of capacity expansion and management solutions. Management solutions can consist of individual strategies or integrated programs that include a coordinated set of strategies.

**Evaluate Options**

Evaluate each option with respect to evaluation criteria. Some impacts, such as equity and land use effects, are unsuited for *monetization* (measuring in monetary units). They can be evaluated using a rating system. For example, a community may have established equity objectives to improve mobility for non-drivers and provide affordable mobility for non-drivers, and land use objectives to reduce total impervious surface and discourage sprawl. A committee of experts or stakeholders rates each option according to these objectives. The results are presented in a matrix, as illustrated below.

**Table 24 Evaluation Matrix Example (Litman, 2001)**

	Cost Effectiveness	Mobility for Nondrivers	Affordability	Impervious Surface	Discourages Sprawl	Total Points
Option 1	-2	4	4	3	4	14
Option 2	-1	4	-1	4	4	10
Option 3	-4	5	3	4	1	9
Option 4	-1	3	-4	5	3	6
Option 5	-3	2	4	-3	5	5

*Each option is rated from -5 (negative) to 5 (positive) based on how well it helps achieve each objective.*

**Prioritize Options**

Potential solutions should be prioritized, as illustrated in the examples below.

*Single Building Example*

Conventional standards require 100 parking spaces (90 employee and 10 visitor) for a 100-employee office. Each space has an annualized cost of \$600. Various management strategies are considered and ranked by cost effectiveness (annualized dollars per space).

- Sharing rather than assign spaces reduces needed parking supply by 20 spaces, with an estimated annualized cost of \$10 per space to deal with occasional problems.
- Arranging to use parking at a nearby church in exchange for their use of office parking Sunday mornings reduces the need for 10 spaces at \$50 annualized cost per space.
- Allowing more employees to telecommute and installing bicycle storage and changing facilities reduces parking requirements by 5 spaces, at \$200 annually per space.
- A \$15 per month cash-out payment to 20 employees (10 who currently use alternative modes and 10 more who would shift if offered this incentive) would reduce parking requirements by 10 spaces at \$360 per space (20 employees x \$15/month x 12 months = \$3,600 ÷ 10).
- A \$25 per month cash-out benefit is predicted to reduce parking requirements by 15 spaces at a cost of \$500 per space (25 employees x \$25/month x 12 months = \$7,500 ÷ 15).
- Additional spaces could be rented at \$65 per month.

Table 25 summarizes the results, ranked from lowest to higher unit costs.

**Table 25 Office Parking Management Evaluation Example**

Strategy	Unit Cost	Spaces Provided	Cumulative Increase	Cumulative Cost
	\$/space/year		Total spaces	\$/year
Shared Parking	\$10	20	20	\$200
Remote Parking & Improved Walkability	\$50	10	30	\$700
Bicycle Parking and Allow Telecommuting	\$200	5	35	\$1,700
Cash-out A, \$15/month to 20 employees	\$360	10	45	\$5,300
Cash-out B, \$25/month to 25 employees	\$500	15	50	\$9,200
<i>Build Additional Parking Capacity</i>	<i>\$600</i>	<i>No Limit</i>		
Additional Remote Parking, Leased at \$65/month	\$780	20	75	\$31,700

*This table ranks strategies by cost effectiveness. Management strategies should be implemented if they are cheaper than capacity expansion. Note, only one of the three Cash-out options can be selected.*

The developer should therefore implement all parking management strategies up to the \$25 per month parking cash-out benefit and provide 50 rather than 100 parking spaces to minimize direct financial cost. Additional management strategies may be implemented to help achieve other objectives, such as reduces traffic congestion and pollution emissions.

*Commercial District Example*

A growing commercial district is experiencing parking congestion problems. The area has 10,000 parking spaces: 1,000 free on-street; 3,000 public, priced off-street; and 6,000 private, off-street spaces currently unavailable to the general public. Most on-street spaces are occupied, but many off-street spaces are vacant during peak periods. Planners identify various parking management and capacity expansion options and rank them by increasing unit costs. Here is what they find.

- 200 on-street parking spaces are unregulated and used all day by commuters. These can have 2-hour limits to encourage turnover. The cost is estimated to total \$1,000 per year for additional signs and enforcement.
- Signs and maps can be provided to help motorists find parking. This is predicted to increase peak-period customer parking supply by an equivalent of 300 spaces, the number of spaces that are unused because customers don't know about them. This project is estimated to cost \$6,000 per year for materials. This increases user convenience with no evident indirect costs.
- A program can encourage employees to use remote parking. This is estimated to increase customer parking supply by 100 spaces. Costs are estimated to total \$5,000 per year for program materials and administration. The main indirect cost is inconvenience to employees.
- Free shuttle bus service could be provided during peak days (summer weekends and holiday shopping periods) between the commercial district, remote parking facilities, and a transit terminal. This is predicted to provide the equivalent of 500 additional parking spaces within

the commercial district. Costs are estimated to total \$35,000 per year. This would increase user convenience and reduce some traffic congestion.

- A transportation management association could provide trip reduction services, help establish parking sharing arrangements, provide parking information and enforcement services, and support other parking management strategies. Three options are considered:
  - A minimal program, costing \$50,000 annually, which is predicted to increase peak-period parking supply available to the public by 500 spaces.
  - A moderate program, costing \$150,000 annually, which is predicted to increase peak-period parking supply available to the public by 1,000 spaces.
  - A maximum program, costing \$500,000 annually, which is predicted to increase peak-period parking supply available to the public by 2,000 spaces.
  
- 300 surface spaces could be added on otherwise unused city land for \$200 annualized cost per space, but any more spaces will require structured parking, with annualized costs of \$1,500 per space. Although the city could charge for use of this parking, existing parking structures are generally not filled, so net revenues from this additional capacity would be minimal.

Table 26 summarizes these options. The city can begin implementing the most cost effective options, and work down to more costly strategies if needed. Although it may initially be difficult to predict the effectiveness of some management strategies, this will become easier with experience. For example, the first year a parking management association is established it may only free up 250 parking spaces, but this should increase over time as its services develop and are better tailored to meet local needs.

**Table 26 Community Parking Management Evaluation Example**

Strategy	Unit Cost	Spaces Provided	Cumulative Increase	Cumulative Cost
	\$/space/year		total spaces	\$/year
Regulate currently unregulated parking	\$5	200	200	\$1,000
Provide user information	\$20	300	500	\$7,000
Encourage employees to use less-convenient spaces	\$50	100	600	\$17,000
Provide free shuttle bus service	\$70	500	1,100	\$52,000
A. Parking Management Association: Minimum	\$100	500	1,600	\$102,00
B. Parking Management Association: Moderate	\$150	1,000	2,100	\$202,000
<i>Add surface parking</i>	<i>\$200</i>	<i>300</i>	<i>2,400</i>	<i>\$262,000</i>
C. Parking Management Association: Maximum	\$250	2,000	3,100	\$552,000
Add structured parking	\$1,500	No Limit		

*This table ranks various strategies by increasing unit costs. Management strategies should be implemented if they are cheaper than building additional capacity. Note that only one of the three Parking Management Association options can be selected.*

**Developing an Implementation Plan**

Once the components of a parking management plan are selected, the next step is to develop an implementation plan. This may include various phases and contingency-based options. For example, some strategies will be implemented the first year, others within three years, and a third set will only be implemented if necessary, based on performance indicators such as excessive parking congestion or spillover problems. Table 27 illustrates an example of such a plan.

Once a general implementation plan is established, create a workplan that identifies specific tasks to be accomplished, when they should be completed, and who is responsible for them.

Innovative strategies can first be implemented with pilot projects. This helps overcome a frequent barrier to innovation: that the costs and effectiveness of a new strategy are difficult to predict. For example, a facility manager might first implement shared parking in a relatively small area, and expand the program after gaining experience.

**Table 27 Example of Contingency-Based Parking Management Plan**

Phase	Timing	Strategies
1	Implement within one year.	Improve parking information with signs and a parking facility map. Shift from dedicated parking spaces to “open” (shared) parking spaces in each lot. Impose 2-hour limitations on the most convenient parking spaces. Encourage employees to use less convenient parking spaces. Improve enforcement of parking regulations and fees. Establish an evaluation program, to identify impacts and possible problems.
2	Implement within two years.	Price the most convenient parking spaces. Impose 2-hour limit on a larger portion of parking spaces. Arrange shared parking agreements with neighbors that have excess parking supply. Install bicycle storage and changing facilities. Establish a commute trip reduction program.
3	Implement if peak-period occupancy exceeds 85%.	Gradually and predictably increase parking fees (e.g., 10% annual price increases). Improve area walkability and address security concerns. Provide real-time information on parking availability using changeable signs.
4	Implement as needed, based on peak-period occupancy rates.	Address spillover parking problems. Address barriers to walking between remote parking and destinations. Develop overflow parking plans for special events and peak periods.
5	Implement if problems continue.	Expand the portion of parking spaces that are priced and regulated. Increase support for commute trip reduction programs. Provide shuttle van services to bus stops and remote parking during peak periods.

*This table illustrates a parking management plan. Some strategies are implemented right away; others over a longer period, and some are only implemented if needed, based on specific indicators such as excessive parking congestion or spillover problems.*

## **Generic Outline for a Parking Management Plan**

### *Introduction*

Describe what this plan is intended to achieve. Describe, in a general way, the project and its context, and the benefits of more efficient parking management. Discuss the change now occurring in the way planners think about parking problems and solutions.

### *Context*

Describe the geographic area, such as the city, district and neighborhood. Highlight any strategic planning documents that support smart growth, transportation demand management, neighborhood redevelopment and parking management.

### *Project Description*

Describe the project. Highlight features that support parking management, such as:

- Site and neighborhood design that limits on-site parking supply.
- Geographic factors, such as compact, mixed use development, within the project or the neighborhood.
- Proximity to high quality public transit, good walkability and cycling facilities.
- Demographic factors that reduce parking demands, such as lower-income, young, or disabled occupants and visitors.
- Potential management strategies including sharing of parking facilities, development of an off-site overflow plan, efficient regulations and pricing, improved user information, incentives to use alternative modes (such as parking cash out or transit subsidies), bicycle parking and promotion, carsharing services, etc.
- Facility design features that support parking management, such as good pedestrian access to nearby offsite parking facilities.

### *Analysis*

Indicate how much parking would be required by conventional zoning or generic ITE parking generation analysis, and then identify how specific adjustment factors and management strategies can reduce these requirements. For example, estimate the parking demand reduced due to proximity to transit services and demographic factors, and additional reductions that can be achieved through management strategies. Provide evidence supporting each of these adjustment factors.

### *Parking Management Plan*

Identify specific actions that can be taken to more efficiently manage parking and address any problems that may occur. Indicate which of these will be implemented, with specific details of what, who and when these actions will be taken. Also indicate contingency actions that *can* be deployed in the future if needed. Indicate your monitoring plan which determine if problems develop and additional parking management strategies are needed.

### *References*

Provide documentation that supports your arguments.

## Examples and Case Studies

All strategies described in this guide have been successfully implemented. Examples are described in Kolozsvari and Shoup (2003); Kuzmyak, Weinberger, Pratt and Levinson (2003); Shoup (2005); USEPA (2006); Litman (2006a); MTC (2007), and Nelson/Nygaard (2009).

### Jurisdictions Reducing and Eliminating Parking Minimums

Many North American towns and cities are reducing or eliminating parking minimums, as documented in [Progress on Parking Minimum Removals Across the Country](#), a crowd-sourced map by [Strong Towns](#). Last year, officials in [Buffalo, New York](#) and [Hartford, Connecticut](#) eliminated parking minimums for commercial and residential developments. Many other municipalities have removed parking minimums for at least one part of the city or have lowered or removed minimums for certain uses.

### Communities Reducing Parking Minimums



### Parking Policies for Sustainable Urban Mobility Plans

The European Commission encourages towns and cities to develop [Sustainable Urban Mobility Plans](#) or SUMPs. The [Eltis Urban Mobility Observatory](#) provides numerous [guidance documents](#) and information resources including [Park4SUMP](#), which helps cities integrate innovative parking management for better mobility and quality of life. The report, [Parking and Sustainable Urban Mobility Planning: How to make parking policies more strategic, effective and sustainable](#) is a useful overview, and their [videos](#) provide examples and information resources in an easy-to-understand format.

### On-Street Parking Management (Barter 2016)

The report, *On-Street Parking Management: An International Tool-kit*, provides specific recommendations for managing on-street (curb) parking for efficiency and equity.

### **Commercial District Parking Management** (Gibbs 2012)

In his book *Principles of Urban Retail*, Gibbs (2013) describes various ways to create more attractive urban retail centers, including ways to manage parking for shopper convenience. It emphasizes the importance of convenience and secure parking that accommodates various types of customers. Regional shopping centers parking ratios have declined significantly in recent decades, from 10 down to 4.0 spaces per 1,000 square feet, and that this can be further reduced with more efficient management. Gibbs recommends pricing the most convenient parking spaces to insure that parking spaces are always available to shoppers in a hurry.

### **Downtown Pasadena Redevelopment** (Kolozsvari and Shoup 2003)

During the 1970s Old Pasadena's downtown had become run down, with many derelict and abandoned buildings and few customers, in part due to the limited parking available to customers. The city proposed pricing on-street parking as a way to increase turnover and make parking available to customers. Many local merchants originally opposed the idea. As a compromise, city officials agreed to dedicate all revenues to public improvements that make the downtown more attractive. A Parking Meter Zone (PMZ) was established within which parking was priced and revenues were invested.

Connecting parking revenues to new local services helped guarantee the program's success. Merchants began to see parking meters as a way to fund projects and services that directly benefit them and their customers. Investments included new street furniture and trees, police patrols, better street lighting, more street and sidewalk cleaning, pedestrian improvements, and marketing (including production of maps showing local attractions and parking facilities). To highlight these benefits to motorists, each parking meter has a small sticker which reads, "Your Meter Money Will Make A Difference: Signage, Lighting, Benches, Paving."

This created a *virtuous cycle* in which parking revenue funded community improvements that attracted more visitors, new businesses and residential development, which increased parking revenue, allowing more improvements. Parking is no longer a problem, customers can almost always find a convenient space. Local sales increased faster than in other shopping districts with cheaper parking. This shows that efficient parking pricing supports urban redevelopment.

### **Parking Management Mitigation** (<https://bit.ly/2TCxtBD>)

The report, *Modernizing Mitigation: A Demand-Centered Approach*, (Sundquist, et al. 2018) provides practical guidance and useful examples of ways that cities and regions can encourage or require developers and other stakeholders to support vehicle travel reductions in order to mitigate traffic and parking congestion problems and achieve other community goals.

### **Red Deer Parking Management Strategy** (<http://bit.ly/2GOPOFt>)

Red Deer, a medium-size Canadian city, established a Parking Management Plan based on the following principles:

1. *Customer Focus.* Provide and maintain an appropriate supply of affordable, secure, accessible, convenient and appealing public parking.
2. *Economic Development.* Provide and promote affordable short-term parking services, and fair and consistent enforcement services, that support local businesses, institutions and tourism.
3. *Multimodal Transportation.* Promote, establish and maintain programs and facilities that encourage the use of alternative modes including walking, bicycling, ridesharing and public transit.
4. *Financial Sustainability.* Ensure that parking program revenues can recover all program costs, finance future parking facilities, and help fund alternative mode improvements and encouragement.

### **Smart Growth and TOD Parking Demand**

Various studies (Arrington, et al. 2008; Ewing, et al. 2017; Metro Vancouver 2012; Rowe, et al. 2013; Schneider, Handy and Shafizadeh 2014; Weinberger and Karlin-Resnick 2015) indicate that more compact, mixed, multimodal developments (i.e., Smart Growth and Transit Oriented Development) generate only 35-70% of trip generation and 25-75% of the parking demand recommended by standard guidelines published by the Institute of Transportation Engineers.

### **Regional Parking Management** (Tyler, et al. 2012),

Researchers investigated the link between parking and urban centre success. They recommend various parking data collection improvements to help public officials identify parking problems and evaluate potential solutions. They found:

- More parking does not necessarily mean greater commercial success. Improved parking management can support businesses as much as an increase in parking supply.
- There is no such thing as 'free' parking, parking costs are either borne directly or indirectly.
- Shopkeepers consistently overestimate the share of their customers coming by car.
- Motorists spend more per trip, while walkers and bus users spend more per week or month.
- There is little evidence that parking supply affects the evening entertainment activity.
- More data on commercial activity is needed to better study this issue.

### **Parking Impacts on Downtown Economic Success** (<https://bit.ly/2rXBzXm>)

The study, "Is Parking Supply Related to Turnover of Shopping Areas?" (Mingardo and Meerkerk 2012) investigated the degree that parking pricing affects retail sales (measured as gross sales per square meter of retail floor area) in Dutch commercial districts. It found no significant relationship between parking supply and sales volumes in most shopping districts, but a positive relationship between parking supply and turnover in large regional shopping centers. It found a significant positive relationship between parking fees and turnover per sales floor area. They conclude that this indicates that in most shopping districts, customers value the convenience of priced parking (pricing favors *spenders* over *cheapskates*).

The study indicates that a 1% increase in regional shopping center parking supply typically increases gross revenue per square meter by 0.26%. For the average regional shopping center, a 1% parking supply increase would require 24 additional spaces, costing at least €35,400 annually in depreciation and operating costs, which would increase annual gross revenue €456,105. This indicates that additional parking costs at least 8% of the additional gross revenue. That is a typical profit margin, so the additional parking provides little net benefit. More efficient parking and transportation management be a more profitable solution in many situations.

### **Parking Demand Study ([Boulevard Consulting 2016](#))**

A study to update Victoria, Canada parking requirements used vehicle registration data to measure occupants' vehicle ownership at 126 multi-family sites with 6,475 total units. It found:

- Overall vehicle ownership averaged 0.63 vehicles per unit, with 0.74 vehicles per condominium unit and 0.49 vehicles per apartment unit.
- Vehicle ownership among "Affordable" sites was approximately 30% lower than the average among Condominium and Apartment sites.
- Vehicle ownership averaged 0.57 vehicles per unit in Downtown Area sites, approximately 25% to 30% lower than elsewhere in the City.
- Vehicle ownership ranged from 0.31 vehicles per unit in bachelor/studio units up to to 1.04 vehicles per unit among three-bedroom units.
- Visitor parking demand averaged 0.07 vehicles per unit among 16 multifamily sites.

### **Right-Size Parking Study**

The *Right Size Parking Project* ([www.rightsizeparking.org](http://www.rightsizeparking.org)) has developed practical tools for more accurately calculating parking demand, taking into account geographic and economic factors. The study found that parking demand per unit declines with increased transit proximity, local population and employment density, and parking price (the amount that residents must pay extra, if any, for a parking space), and increases with rents, unit size and number of bedrooms. The resulting model can be used to determine the parking supply needed in a particular development.

### **UK Maximum Parking Standards (<http://bit.ly/2C5g8bM>)**

UK planning policy guides published by the *Department of the Environment, Transport and the Regions* has maximum as well as minimum parking requirements designed to help reduce the car dependency of development and promote sustainable transport choices. For example, the proposed maximum parking standard for office buildings is 1 parking space per 35 square metres of gross floor space, for buildings above 2,500 square metres gross floor space. These standards have been derived from analysis of existing levels of parking, consideration of the potential for changing travel patterns and consideration of potential effects on investment.

### **More Accurate Parking Requirements (Vancouver 2012)**

The City of Vancouver applies reduced and more flexible parking requirements for multi-family dwellings to support efficient transportation, smart growth and affordable housing planning objectives. These new standards are based on a parking demand study showing declining vehicle ownership rates. City staff proposed a Sustainable Transportation Credit Program that allows developers more flexibility based on specific location and circumstances, based on the LEED TM Green building rating system. Developers receive credits for reducing total parking supply, providing carshare vehicle parking and transit passes to building occupants.

***On-Street Parking Management and Pricing Study*** ([www.sfcta.org/content/view/303/149](http://www.sfcta.org/content/view/303/149))

In 2009 the San Francisco Countywide Transportation Authority undertook the *On-Street Parking Management and Pricing Study* to assess parking conditions and investigate new approaches for more efficient curbside parking management. It reached the following conclusions:

- *Effective parking management requires a neighborhood-level approach.* On-street parking management should be planned and coordinated at the neighborhood level, with attention to the tradeoffs associated with any strategy and the interactions between component parts of the parking supply (i.e., individual block faces and off-street supplies). Neighborhood-level parking management requires flexible approaches that can be tailored to an area's conditions, needs, and priorities, which must evolve over time to reflect changing land use and travel patterns.
- *Existing management strategies are ill-suited for confronting key parking challenges.* On-street parking regulations have developed incrementally over time, such that many neighborhoods are subject to an uncoordinated management regime that is misaligned with parking conditions and management needs. Existing strategies cannot address parking availability when there is an imbalance between supply and demand.
- *The most promising management approach for addressing imbalances between supply and demand is price-based regulation, which also has significant secondary benefits.* Pricing of on-street spaces that responds to parking demand helps ensure sufficient availability, improve utilization, and appropriately value on-street space. Addressing availability is the primary purpose and benefit of parking pricing. Secondary benefits include a reduction in "cruising" behavior and the opportunity to generate revenues.
- *Underpriced parking represents a significant source of untapped revenue that could be dedicated to transit-first uses; attempts to close this pricing gap must be planned and executed carefully, in a manner that the public will understand and support.* Given that on-street parking in many areas is currently minimally regulated, future revenue gains have the potential to be substantial. It is doubtful that the public will support widespread parking charge increases without a clear link to tangible transportation improvements in the city's neighborhoods. The "user fee" principle is also supported by providing a high-quality parking experience through improved payment options, real-time information, and flexible time limits. Reinvestment of a portion of future new revenues will encourage neighborhood-level support for parking pricing, thus increasing the overall pool of funds from which transit stands to benefit.
- *Current parking policies contradict other planning objectives and warrant significant reform.* Reforms to residential parking management are warranted to better value on-street space, create a more multimodal program, and provide more equitably distributed costs and benefits. Neighborhoods should have the ability to utilize pricing strategies to manage parking demand while returning benefits to the area in which revenues are collected.

The report made the following recommendations:

- *Re-balance the allocation of on-street spaces.* The goal of re-balancing is to better accommodate varying demands within the confines of scarce supply. Examples of rebalancing include periodic consideration of the demand for commercial loading zones and evaluation of the appropriateness of various time limitations. This assessment should be

done in cooperation with neighborhood residents and merchants, and other strategies and tools should be considered along with conventional regulatory strategies.

- *Regulate unregulated or under-regulated spaces.* Where warranted, currently metered areas could be expanded, or unregulated spaces could be regulated. A technical evaluation is required to identify the best regulatory design (e.g., meter vs. time limit vs. color curb). Typically, meters have been confined to the downtown area and neighborhood commercial corridors (and some adjoining blocks). Extending metering hours into the evening (until 10:00 p.m., for example) is appropriate in those areas with evening parking generators, such as restaurants or nightlife, where turnover is desirable, provided that adequate enforcement can be provided. Extension of metering into evening hours can provide a significant benefit to local commercial activity, by prioritizing metered spaces during high demand periods.
- *Reform residential parking permit management.* The existing RPP program provides benefits to a small group—eligible permit holders that store their car(s) on-street during weekday middays.
- *Establish a policy on the use of new incremental parking revenue.* SFMTA has not articulated a clear policy on the use of any revenue gains associated with implementation of demand-responsive pricing. It is important to affirm the policy of applying the revenues to parking improvements and transit-first uses. SFMTA should clarify this policy and allow for public review and input into this decision.
- *Share some portion of net new revenues with the areas in which the monies are collected.* By investing in the neighborhoods affected by parking pricing, tangible benefits will accrue to the areas that are priced and local impacts are mitigated. The public will be skeptical of any program that simply provides incremental revenue to an opaque budget that funds programs across the entire city.
- *Pursue data-driven pricing policy, in support of articulated performance objectives.* Ongoing system monitoring is crucial for demand-responsive parking pricing. This facilitates ongoing management and operation of the system guided by street-level outcomes.
- *Adjust parking rates systematically.* To be effective, demand-responsive pricing requires periodic adjustments to parking rates. These adjustments must be performed frequently enough to seek the desired availability target but not so frequently as to obscure the behavior response. Monthly adjustments are appropriate for the first several months of implementation in a given area to allow for program managers to find optimal prices to meet performance objectives. Following the initial period, less frequent adjustments (such as quarterly) are warranted.
- *Coordinate demand-responsive pricing implementations in metered areas with the regulations in place on unmetered blocks, including warranted expansions of metered areas.* The implementation of demand-responsive pricing is a unique opportunity to better manage parking on a neighborhood or area level. Current policies create an artificial distinction between blocks designated as commercial and residential. As demand-responsive pricing is implemented in neighborhoods, an assessment of parking conditions in metered and unmetered blocks is necessary. This assessment may reveal a need to expand the metered areas and/or metered time periods as new payment technologies and pricing strategies are implemented.

**Austin Parking Benefit District** ([www.ci.austin.tx.us/parkingdistrict/default.htm](http://www.ci.austin.tx.us/parkingdistrict/default.htm))

Many neighborhoods experience parking spillover problems, including difficulty finding parking for residents and visitors, concerns that public service vehicles cannot pass two lanes of parked vehicles on the street, or that on-street parking reduces neighborhood attractiveness. The city of Austin, Texas is addressing these problems by allowing neighborhoods to establish *Parking Benefit Districts* (PBDs). A PBD is created by metering on-street parking and dedicating the net revenue (less costs for maintenance and enforcement) to neighborhood improvements such as sidewalks, curb ramps, and bicycle lanes. The PMD is used in conjunction with a Residential Permit Parking program to ensure that parking is available for residents and their visitors.

**Using Parking Revenue to Support Transit** (USEPA 2006)

Faced with a shortage of customer parking, Boulder, Colorado encourages downtown employees to use alternative modes. The city uses parking meter revenue to subsidize bus passes for 7,500 downtown employees and support other commute trip reduction activities, and offers discounted bus passes to residents and non-downtown businesses. The program has improved customer parking and reduced parking costs, congestion, accidents and pollution emissions. Employee carpooling increased from 35% in 1993 to 47% in 1997 and downtown retail activity increased.

**Centralized Parking** (USEPA 2006)

To encourage downtown development the Chattanooga Area Regional Transit Authority built peripheral parking garages with free shuttle service. By constructing parking facilities at either end of the business district, the system intercepts commuters and visitors before they drive into the city center, reducing traffic problems. Garage parking revenues finance the shuttle buses which operate daily with five-minute frequencies and pass within walking distance of most downtown destinations. The electric-powered shuttles transport approximately one million riders each year, making shuttle-served property attractive to businesses.

**Seoul Parking Enforcement** (<http://english.seoul.go.kr>)

Employees at the city of Seoul, South Korea TOPIS (Transport OPERations and Information Service) traffic control center monitor major arterials using a closed circuit television network. If a vehicle stops or parks illegally, they record a time-stamped image of the vehicle and its license plate. After five minutes, if the vehicle has not moved, a second set of images are recorded, the license number automatically read using optical character recognition (OCR), and a parking ticket is sent to the motorist. After another ten minutes a tow truck is dispatched to remove the vehicle. This system has greatly reduced traffic delay and accident risk caused by illegally parked vehicles at relatively low cost and with few challenges (since motorists are sent photographic images of their illegally-parked vehicles).

**Campus Parking Management** (Isler, Hoel, Fontaine 2005)

A survey of university campuses indicate that many are converting parking lots to buildings, fewer are adding parking capacity, and many are implementing various parking and transportation management strategies in order to devote more campus land to academic facilities rather than parking lots. Typical parking management strategies include permits, meters, cash-out program, prohibitive policy for freshmen, and eligibility based on residential location. Annual permit fees varied by location of campus and location of a parking space within the campus. Various strategies are used to deal with spillover parking problems.

**Commercial Street Parking Management** ([www.communityconsulting.org](http://www.communityconsulting.org))

The character of Bay Ridge, NY is largely defined by its bustling retail streets. Easy access to this area is important to nearby residents both for shopping and for the frequent contact with friends and neighbors that builds a strong community. Planners identified a number of potential ways to improve access to these commercial streets by parking management and encouraging use of alternative modes by shoppers and employees. After careful analysis of the options they identified several specific strategies that provided the equivalent of approximately doubling the local parking supply:

- Use Pay-And-Display parking meters rather than individual parking meters, which allow more vehicles to be parked on a length of curb.
- Encourage Shared Parking, to increase the utilization of off-street lots.
- Support employee Commute Trip Reduction programs.
- Use angled rather than parallel parking.
- Use variable priced meters that are higher during peak periods, coupled with residential parking meters to avoid spillover parking problems.

**Redeveloping Transit-Station Area Parking Lots** (CNT 2006)

The study, *Paved Over: Surface Parking Lots or Opportunities for Tax-Generating, Sustainable Development?* ([www.cnt.org/repository/PavedOver-Final.pdf](http://www.cnt.org/repository/PavedOver-Final.pdf)), evaluates the potential economic and social benefits if surface parking lots around rail transit stations were developed into mixed-use, pedestrian friendly, transit-oriented developments. The analysis concludes that such development could help to meet the region's growing demand for affordable, workforce, senior, and market rate housing near transit, and provide a variety of benefits including increased tax revenues and reduced per capita vehicle travel. The parking lots in nine case studies are estimated to be able to generate 1,188 new residential units and at least 167,000 square feet of new commercial space, providing additional tax revenues, plus significant reductions in trip generation and transportation costs compared with more conventional development.

**Context-Specific Requirements and TDM** (USEPA 2006)

Arlington County, Virginia, near Washington, DC, adopted countywide development standards and guidelines to encourage more efficient transportation and land use development, including reduced and more flexible minimum parking requirements. Every development is required to have a transportation plan, which establishes parking requirements based on location and use factors, which can be reduced if projects include demand management features such as transit and rideshare subsidies and encouragement programs. Parking is encouraged to be below ground, or if at surface level, it must be in a structure that is wrapped with occupiable ground floor space to reduce visual impacts.

**Residential Garage Conversions** ([www.ci.santa-cruz.ca.us/pl/hcd/ADU/adu.html](http://www.ci.santa-cruz.ca.us/pl/hcd/ADU/adu.html))

Santa Cruz, CA has a special program to encourage development of *Accessory Dwelling Units* (ADUs, also known as *mother-in-law* or *granny* units) to increase housing affordability and urban infill. These often consist of converted garages. The city has ordinances, design guidelines and information for such conversions. The Vancouver, BC firm *Smallworks* (<http://smallworks.ca>) specializes in small lane-way (alley) housing, which are often converted garages.

**Bike Versus Parking Lanes** (Sztabinski 2009)

A survey of merchants along Toronto's busy Bloor Street found that a majority of customers arrive by walking or cycling (only 10% drive) and that those who arrive by nonmotorized modes tend to spend more. On street parking is seldom fully occupied and offstreet parking lots could accommodate additional demand. More merchants believe that a bike lane or widened sidewalk would increase business than merchants who believe such changes would reduce business.

**New York Parking Management** ([www.transalt.org](http://www.transalt.org))

New York City has limited parking supply and high parking prices in commercial lots, but on-street parking is poorly managed. Transportation Alternatives, a local advocacy organization, recommends the following reforms for more efficient management (Schaller Consulting, 2006).

- Increase the portion of priced on-street parking spaces. Most on-street spaces are currently regulated but not priced. This encourages more efficient use and provides revenues.
- Increase prices to equal or exceed off-street commercial rates in order to encourage turnover and shift longer-term parkers to off-street spaces.
- Better regulate parking permits. In New York there are an estimated 150,000 government-issued permits which are often abused for non-government activities.
- Establish an overall city parking plan.

**Unbundling and Carsharing** (Nelson/Nygaard 2009)

The city of San Francisco requires residential developments in downtown and transit-oriented areas to unbundle parking, and requires all new residential developments to provide one parking space for each 200 housing units.

**Parking Policy Reforms** ([www.transalt.org/files/newsroom/reports/suburbanizing\\_the\\_city.pdf](http://www.transalt.org/files/newsroom/reports/suburbanizing_the_city.pdf))

The report, *Suburbanizing the City: How New York City Parking Requirements Lead to More Driving* (Weinberger, Seaman and Johnson 2008) recommends the following reforms for more sustainable parking management in New York City:

1. Fully assess the amount of existing and planned off-street parking.
  - Inventory existing and planned off-street parking to provide a baseline.
  - Measure how much driving is created by new off-street parking.
  - Determine parking demand based on the assumption that off-street parking has a cost.
  - Measure the effect of increases in parking growth on local and citywide traffic congestion.
2. Consider measures to significantly reduce required parking.
  - Unbundle the price of parking from the cost of new residences.
  - Eliminate minimum parking requirements.
  - Reclassify minimum parking requirements as maximums.
  - Peg the maximum parking requirement to the proximity to transit.
  - Establish impact fees for new parking spaces.
  - Prohibit curb cuts on key pedestrian and transit streets.
  - Incentivize car-sharing spaces in new development.
  - An interim strategy is to simply convert existing minimums to maximums.

3. Revise environmental laws to fully account for parking impacts.
  - Revise CEQRA and the special permitting process so that the cumulative impact of new parking on neighborhoods is considered.
4. Stop directly subsidizing new parking and freeze special permits
  - Place a moratorium on issuing new special parking permits in Manhattan’s Clean Air Act Zone (the Manhattan Core) until an inventory of existing and planned parking is completed and a study conducted of cumulative environmental impact of new parking.
  - Freeze new city subsidies for building parking until a complete accounting of the extent and environmental impact of those subsidies is completed.
  - Eliminate minimum parking requirements for affordable housing developments.

#### **Transit-Oriented Development Reduces Parking Demand**

Cervero, Adkins and Sullivan (2010) investigated the degree to which residential developments near urban rail stations are “over-parked.” They found the mean parking supply of 1.57 spaces per unit was 31% higher than the 1.2 spaces recommended in ITE *Parking Generation*, and 37% higher than the weighted-average peak demand of 1.15 parked cars per unit at 31 residential projects near BART rail stations. The analysis indicates that increased parking supply tends to increase vehicle ownership: an increase of 0.5 spaces per unit is associated with a 0.11 additional cars parked per unit at the peak. Parking demand tends to decline with improved pedestrian access to stations and improved transit service frequency. Rail access reduces vehicle trips at a faster rate than vehicle ownership, indicating that transit commuters still want vehicles for other trips, and so recommends incorporating carshare services into transit-oriented development as a substitute for private vehicle ownership.

#### **Optimizing Transit Oriented Development Area Parking**

Willson and Menotti (2007) analyzed the ridership and fiscal outcomes that result from devoting land around rail transit stations to housing or parking. They find that only in low-density suburban areas with little development potential is it optimal to maximize the amount of land devoted to parking; in other conditions, developing the land for housing and commercial activity tends to provide greater economic benefits by providing land rents and creating housing and destinations that tend to generate high rates of transit ridership. This analysis indicates that it is generally not optimal for transit agencies to require that all parking spaces located near rail transit stations that are lost to development be replaced.

#### **Advanced Parking Management Systems (FHWA 2007)**

Advanced parking management systems (APMS) provides real-time information through the Internet and in-vehicle navigation systems to help motorists quickly find a parking space. These systems increase user convenience, reduce delays, driving and illegal parking, increase parking facility utilization, and encouraging shifts to alternative modes.

- At Baltimore-Washington International (BWI) Airport, nearly 13,000 parking spaces are served by an advanced parking management system. The system has increased customer satisfaction and improved traffic flow, and been widely praised by users.

- In San Francisco, the SFpark parking management pilot project applies new strategies and technologies using demand-responsive pricing to manage parking in ways that support overall transport system goals, including shifts from driving to alternative modes.
- In downtown St. Paul, an advanced parking management system improved user convenience and reduced congestion during special events. Estimated vehicle delay decreased 10% while traffic volume increased 15% at major intersections.

**Market Commons Unbundled Parking** (Wilbur Smith Associates, et al. 2006)

Residents in 300 apartment units at Market Common in Arlington Virginia have unbundled parking. Residents pay \$25 per month for one space and \$75 to \$100 for a second. Residents and retail patrons share about 1,100 parking structure spaces. Residents pay for swipe cards used at structure gates. Shoppers buy short term permits to access the garage (\$1-4/hr depending on length of stay, with merchant validation allowed). Because retail is at ground floor and resident units at upper floors (10 story building), residents generally park on the upper levels where spaces are generally available. Elevators in the parking structure leading to residential areas are opened only by tenant pass key to maintain security.

**Underground Parking Profitably Converted To Storage**

The *Broadway Store-All* ([www.weblocal.ca/broadway-store-all-vancouver-bc.html](http://www.weblocal.ca/broadway-store-all-vancouver-bc.html)) in Vancouver, British Columbia demonstrates that excess parking spaces have other profitable uses. This building was originally constructed with an extra 28 underground parking spaces to serve a nearby restaurant, but the restaurant soon found that these were not needed. In response, the building operator obtained municipal approval to convert parking spaces into commercial storage lockers. They constructed 28 wooden lockers, each with a sprinkler head, and installing heaters and fans for climate control. The lockers rent for about \$250 per month, more than twice the rate charged for parking spaces in that area. They are mostly used by nearby businesses to store archive files. Renters have access to the facility Tuesday through Saturday. The facility is fully occupied although virtually nothing is spent on advertising.

**Lloyd District, Portland** (Wilbur Smith Associates, et al. 2006)

The Lloyd District is a TOD in Portland, Oregon. Before it developed into a transit district the area's transit commute mode split was 10%, but this increased to 21% by 1997 and 41% at the end of 2005. To achieve this local planners worked with local government and the transit provider to develop an aggressive transit improvement and incentive program. This included:

- Elimination of free commuter parking.
- Development of aggressive maximum parking ratios.
- Agreement to purchase annual employee transit passes through the PASSport Program.
- Restrictions on surface parking lot development.
- Design guidelines and restrictions on parking near the MAX light rail system.
- New direct route transit.
- Revenue sharing of meters and transit pass sales.

For businesses, the result was over 1.3 million square feet of new public/private development, a decrease in commercial office occupancy rate from 12% (2001) to 3% (2005), a decrease in parking from 3.5 spaces per 1,000 square feet to 1.95, and the removal of 1,433 commute vehicles with an estimated savings of over \$35 million in parking development costs (estimated based upon a construction cost of \$25,000 per space in the Lloyd District).

**ParkSmart Increases Turnover ([www.nyc.gov/html/dot/html/motorist/parksmart.shtml](http://www.nyc.gov/html/dot/html/motorist/parksmart.shtml))**

The ParkSmart project in New York City found higher turnover and improved availability of on-street parking spaces after time-variable meter pricing was introduced, with higher rates during peak periods and lower rates off-peak (NYDOT 2009).

**GreenTRIP ([www.transformca.org/GreenTRIP](http://www.transformca.org/GreenTRIP))**

*GreenTRIP* is a Traffic Reduction + Innovative Parking certification program for new residential and mixed use developments. It rewards projects that reduce traffic and greenhouse gas emissions. GreenTRIP expands the definition of green building to include robust transportation standards for how people get to and from green buildings. Each certified project receives a *Project Evaluation Report* which describes the project location, details and inventories how the project meets GreenTRIP standards. The GreenTRIP program provides the following support:

- Tailored Traffic Reduction Strategies – Experts work with developers, designers and operators to identify the most appropriate transportation and parking management strategies in a particular situation.
- Public Hearing Testimony - GreenTRIP staff will explain the traffic and emission reduction benefits provided by GreenTRIP projects to decision-makers and the public.
- Market Differentiation - Use of the GreenTRIP name and logo in promotional materials, and a plaque to mount on the project when built.

As of March 2010 the following projects were certified:

- The Crossings ([www.transformca.org/files/SLCrossingsProjEvalRpt.pdf](http://www.transformca.org/files/SLCrossingsProjEvalRpt.pdf))
- Parker Place ([www.transformca.org/files/ParkerPlace\\_ProjEvalRpt.pdf](http://www.transformca.org/files/ParkerPlace_ProjEvalRpt.pdf))
- Station Park Green ([www.transformca.org/files/StationParkGreenProjEvalRpt.pdf](http://www.transformca.org/files/StationParkGreenProjEvalRpt.pdf))
- The Ohlone ([www.transformca.org/files/OhloneProjEvalRpt.pdf](http://www.transformca.org/files/OhloneProjEvalRpt.pdf))

**Manhattan Core Public Parking Study ([www.nyc.gov/html/dcp/html/mn\\_core/index.shtml](http://www.nyc.gov/html/dcp/html/mn_core/index.shtml))**

In 1982 New York City adopted pioneering rules to manage the supply of off-street parking in Manhattan's Central Business District. In the words of the City Planning Commission's report, these changes were intended to "to institute land use controls over off-street parking which are consistent with environmental policies and sensitive to the concerns of business and development interests in the City."

The most significant change was a shift from minimum parking requirements for new residential development to maximum parking allowances for parking spaces that are limited to residents of the development, known as accessory spaces. Before 1982, off-street parking was mandatory in residential development in the Manhattan Core; since then accessory parking is optional and subject to strict limits on the amount of parking that can be provided – no more than 20% of the number of residential units in Community Districts 1-6 and no more than 35% of units in Community Districts 7 and 8. Accessory parking for other uses is also subject to maximums, and the total number of spaces provided in a development is capped at 225 spaces for any mix of uses. Under the new regulations, only new developments and enlargements may incorporate parking. In addition, the 1982 regulations require special permits for accessory parking exceeding the maximums as well as for new parking in existing buildings and for all public parking facilities.

These regulations have proven to be compatible with a growing, successful Manhattan Core. They allow limited amounts off-street parking to be provided with new development and allow some developments to provide additional parking by special permit. In doing so, the Manhattan Core regulations strike a balance between discouraging auto commuting in a highly traffic-congested part of the city where transit access and walkability are excellent while recognizing that the need for off-street parking remains even when auto commuting is restrained.

However, certain deficiencies in the existing regulations have become apparent over the years since 1982, as has the need for additional data to better understand how off-street parking is utilized within the Manhattan Core. In 2008, with the assistance of a Federal grant, the Department of City Planning launched a study to collect data about off-street parking in the Manhattan Core and to use that information in assessing the zoning regulations. Much of this research was conducted through a survey of users of over 100 public parking facilities. The Manhattan Core Public Parking Study contains the results of that survey and detailed analysis of Census and other data as well as policy goals for a possible update of the regulations.

**Reduced and More Flexible Multi-Family Parking Requirements** (Baker and Leibin 2018) [Toward Zero Parking: Challenging Conventional Wisdom for Multifamily](#) identifies North American cities that are eliminating parking requirements and encouraging more efficient management, and provides guidance for implementing such reforms. For example, officials in Buffalo, New York, removed parking minimums citywide for commercial and residential projects of less than 5,000 square feet (465 sq m), and Hartford, Connecticut, scratched parking minimums across the city for commercial and residential developments, regardless of size. Many other municipalities have removed parking minimums for at least one part of the city or have lowered or removed minimums for certain uses. San Francisco has gone a step further, establishing parking maximums for downtown and nearby areas well served by public transit, capping the amount of parking that developers are allowed to build for multifamily housing.

**Office Complex Travel Demand Management Evaluation** (Spack and Finkelstein 2004) In 2013, trip generation and parking counts were collected at nine Twin City area office complexes with employee travel demand management program. It found that, on average, they generated 34-37% less traffic and need 17-24% less on-site parking than Institute of Transportation Engineers' average data rates.

**Seattle Reduces Parking Requirements** (Rosenberg 2016) Real estate market trends and public policy changes are reducing the number of parking spaces included in new apartments in Seattle. Between 2004 and 2016, the average number of parking spaces built per apartment declined from 1.91 to 1.29 in suburban areas and from 1.57 to 0.63 in City of Seattle. This reflects the high costs of building parking, averaging \$30,000 or more per space, improved travel options, including major rail and bus system expansions, and changing consumer preferences toward more car-free lifestyles. Parking is no longer required for apartment buildings in many districts including Downtown, Capital Hill, the University District and Northgate and parts of Ballard, Fremont and Greenwood.

**Eliminating Minimum Parking Requirements in Small City Downtown** (Qualls 2019)  
*In, [One Line of Your Zoning Code Can Make a World of Difference](#), City Planner Aaron Qualls describes how Sandpoint, Idaho eliminated minimum parking requirements in its downtown.*

In 2009, [as buildings were being bulldozed for surface parking](#) to meet minimum standards in Historic Downtown Sandpoint, Idaho, city leadership took bold action. Downtown area off-street parking requirements were completely eliminated. The decision was preceded by heated debate and was not unanimous. Now, ten years later, what was the result? Since that contentious decision by the Sandpoint City Council, millions have been invested downtown—projects that would not have been feasible, but for the elimination of parking requirements. Several jobs, building renovations, and expansions by local businesses were essentially made possible by adding a single line of code.

Arguably, no city ordinance is more underestimated for its long term impacts than off-street parking requirements. Many cities are now starting to recognize the [negative effects parking minimums](#) can have on housing affordability, historic preservation, the environment, small businesses, walkability and municipal budgets. In Sandpoint, some of these effects were not hypothetical but happening right before our eyes. The 2009 approval of a 60,000 square foot, 3-story bank headquarters in the heart of downtown ended up requiring 218 parking spaces. Because only 110 were provided (which was plenty), the bank was subjected to in-lieu parking fees totaling over \$700,000. Well, being bankers, they soon realized the cheaper alternative was to buy up adjacent properties and demolish the buildings for surface lots. Consequently, small businesses were evicted and the much-beloved downtown historic development pattern was diminished.

This experience caused city leaders to pause, reflect, and [take action](#) to ensure this would not happen again. Now we are realizing the dividends paid over time. That single line of code abolishing off-street parking minimums downtown has enabled four distinct projects that would have been otherwise impractical. Each of these projects has enriched Sandpoint by contributing vibrancy, economic productivity and an increase in tax base.

**Porirua, New Zealand Parking Supply and Demand** (Hulme-Moir 2010)

Most New Zealand cities impose generous minimum parking requirements. A parking study in Porirua, a city of 50,000 residents, found:

- All parking in Porirua City is free.
- Parking supply was heavily underutilized. Mean occupancy was 45% (Thursday) and 35% (Saturday). Average peak-period occupancy was 62%. Only 3 out of 22 lots were considered full (85% occupancy) during peak periods.
- Having additional parking available within 200 meter walking distance substantially reduced demand at a particular parking lot, since some motorists would park off-site.
- Free parking is a substantial cost. Charging users directly for parking would increase driving costs by 30-90% for an average shopping trip and about 100% for average commuting trips.
- Parking facilities use 24% of city land, compared to 7% greenspace and 4% recreation.
- CBC commuters were surveyed concerning their choice between paying for parking, walking 3 minute, or changing modes. The results indicate a -0.6 price elasticity (a 10% price increase reduces parking demand 6%) and a -0.9 walking time elasticity (a 10% walk time increase reduces parking demand 9%).

**Efficient Parking Pricing in San Francisco (SFpark 2014)**

*SFpark* was a federally-funded demonstration of a new approach to managing parking which included detailed project evaluation. It used better information, including real-time data where parking is available, and demand-responsive parking pricing to help make parking easier to find. The evaluation indicated that the program:

- Reduced average parking rates (hourly rates declined more than they increased)
- Parking availability improved.
- It is easier to find a parking space.
- It is easier to pay and avoid parking citations.
- Vehicle miles traveled decreased.
- Greenhouse gas emissions decreased.

**San Francisco Regional Value Pricing Parking Program (<http://regionalparking.mtc.ca.gov>)**

The Value Pricing Pilot Parking Pricing Regional Analysis Project is part of Metropolitan Transportation Commission's 2014-2015 Parking Initiative. The Project uses case studies, academic research, policy analysis and data analysis to address the relationship between parking pricing, policies, parking supply, and parking demand in cities around the Bay Area.

**Key Findings:**

1. Most of the study locations have significant amounts of unused parking, even during the peak periods. Although there is excess demand on some streets at some times, there are almost always significant amounts of unused parking in lots and structures within a few blocks.
2. Many locations do not have pricing policies that effectively balance parking demand across their area. There is a lack of coordination of prices between on-street and off-street parking. Prices for on-street parking are typically lower, or free, while lots and structures tend to have higher prices, which often results in drivers clogging up local business districts while they search for a space.
3. Parking requirements fail to respond to factors affecting demand. Households that are younger or lower income and who have good walk/bike and transit access have lower automobile ownership rates. High parking requirements make housing less affordable.
4. There is little analysis of the costs and alternatives of transit project parking structures. In some cases, housing would provide more transit ridership and revenue than parking structures.
5. Employee programs that charge for parking are the most effective in reducing driving to work. However, many employers are reluctant to charge for parking. Parking cash-out is an attempt to put charging for parking into a more favorable perspective, but is seldom implemented.
6. Regional parking policies are a logical policy approach as part of the Sustainable Community Strategy (SCS). Regional policies can be effective by providing expertise, supporting local analyses and implementation, conditioning funds on local adoption of appropriate parking policies, new innovative programs and increased scrutiny on the use of regional funds.

The study used these results to develop recommended policy reforms and programs to support more efficient parking management.

**Nottingham Commuter Parking Levies (WWF 2017)**

Nottingham, England introduced a workplace parking levy on large employer in 2012. The £379 annual charge is levied on approximately 25,000 spaces, representing 42% of total spaces. In its first three years the levy raised £25.3 million of revenue, which is dedicated to improving the city’s transport infrastructure, including the largest fleet of electric buses. The levy has helped increase public transport mode share to over 40%, and reduce carbon emissions by 33%.

**Downtown Residential Parking Demand Analysis**

Gribb (2015) mapped downtown residential and commercial parking demands, and measured their distance to available on- and off-street parking spaces in downtown Laramie, Wyoming. Street interviews provided information on parking duration, purposes of visit, and downtown destinations. A three-dimensional land use inventory supplied detailed locations of all activities in each building and floor for the 28 blocks of downtown Laramie. The results indicate that the downtown has 2,130 total parking spaces, but most have restricted uses, so only about a quarter of off-street spaces (about 420) are available for overnight use by the 51 downtown housing units that currently lack designated parking. The authors recommend applying various parking management strategies to ensure that parking spaces meet future demands.

**Measuring Parking Supply**

- Hoehne, et al. (2019) estimate that in 2017 the Phoenix, Arizona metropolitan region had 12.2 million parking spaces, 4.04 million inhabitants, 2.86 million registered personal vehicles. They estimate that for every registered non-commercial vehicle there are 4.3 parking spaces of which 1.3 are off-street residential, 1.3 are off-street non-residential, and 1.7 are on-street spaces. This covers approximately 10% of the urban region’s land.
- Davis, et al. (2010) used aerial photographs to estimate the number of off-street surface parking spaces in Illinois, Indiana, Michigan, and Wisconsin. Parking spaces were identified as paved areas with painted stripes, or where more than three cars were parked in an organized fashion, which excluded on-street and structured parking spaces (other than the top floor if the structure has an open roof), and residential parking spaces not in parking lots. They identified more than 43 million parking spaces in these four states, which averages approximately 2.5 to 3.0 off-street, non-residential parking spaces per vehicle.
- Scharnhorst (2018) developed comprehensive parking inventories and cost estimates for New York, Philadelphia, Seattle, Des Moines, and Jackson, Wyoming. Parking was categorized by type: on-street, off-street surface and off-street structured. Table 3 summarizes the results. Where land is less expensive, a greater share of parking is surface, and where it is more expensive, a greater share is surface, but total parking supply tends to increase with density, so supply is often greater where it is less visible.

**Table 28 Parking Spaces and Costs in Five U.S. Cities (Scharnhorst 2018)**

	New York	Philadelphia	Seattle	De Moines	Jackson
Population	8,537,673	1,567,872	704,352	215,472	10,529
Parking Spaces	1,965,377	2,172,896	1,596,289	1,613,659	100,119
Spaces Per Capita	0.2	1.4	2.3	7.5	9.5
Spaces Per HH	0.6	3.7	5.2	19.4	27.1
Total Value	\$20.55 billion	\$17.46 billion	\$35.79 billion	\$6.42 billion	\$711 million
Value Per HH	\$6,570	\$29,974	\$117,677	\$77,165	\$192,138

- Chester, et al. (2015) estimate Los Angeles County parking supply from 1900 to 2010, and studied how parking infrastructure affects urban form and relates to changes in automobile travel. They estimate that in 2010 there were 18.6 million designated parking spaces in the County, approximately 3.3 spaces per automobile, including 1.0 residential, 1.7 nonresidential, and 0.6 on-street spaces (Figure 6). In total, 14% of Los Angeles County's incorporated land is devoted to parking, which is greater than roadway rights-of-way.
- Akbari, Rose and Taha (2003) used high-resolution orthophotos to estimate the surface area for various categories of land-use types in Sacramento, California. They found that pavement covers about 35% of the surface area of most residential areas and 50–70% in non-residential areas. The portion of land devoted to parking ranged from 5% in lower-density residential areas up to 32% in industrial and commercial areas.

### **European Parking Management (Kodransky and Hermann 2011)**

Many European cities are implementing innovative parking policies, as described in *Europe's Parking U-Turn: From Accommodation to Regulation*. The report examines European parking over the last half century, through the prism of ten European cities: Amsterdam, Antwerp, Barcelona, Copenhagen, London, Munich, Paris, Stockholm, Strasbourg and Zurich. It found:

- Parking is increasingly linked to public transport. Amsterdam, Paris, Zurich and Strasbourg limit parking supply in new developments based on proximity to transit services. Zurich increased parking fees and improved transit services. As a result, between 2000 and 2005, transit mode share increased 7% and automobile mode share declined 6%.
- European cities increasingly charge for on-street parking. In Paris, the on-street parking supply has been reduced more than 9% since 2003, and of the remaining stock, 95% is priced. Along with other transport improvements, this reduced driving by 13%. Parking reforms are considered a more feasible way to reduce vehicle traffic.
- Revenue gathered from parking tariffs is being invested to support other mobility needs. In Barcelona, 100% of revenue goes to operate Bicing—the city's public bike system. Several boroughs in London use parking revenue to subsidize transit passes for seniors and the disabled, who ride public transit for free.

### **A Recommended Approach to Neighborhood Management: Parking Benefit Districts**

Pricing is the most efficacious means of managing on-street parking when occupancy routinely exceeds practical capacity. A *Parking Benefit District* (PBD) program could be made available to neighborhoods facing parking challenges, regardless of whether the neighborhood is currently covered by an RPP. Such a program should incorporate the following components:

*Allow neighborhoods to opt-in.* Neighborhoods could elect (through an adopted administrative process) to create a PBD. If the neighborhood is currently covered by an RPP, the PBD would replace the RPP (or applicable portion thereof).

*Employ price-based regulation and associated elements.* Variable pricing is necessary to effectively manage on-street parking in high-demand neighborhoods. New technology would be deployed to allow for variable pricing, user information, and enhanced enforcement. The hours during which parking is priced would be evaluated and modified as necessary. Conventional strategies, such as provision of loading zones, would be reevaluated and adjusted appropriately.

*Expand metering to areas with peak parking demands in excess of 85%.* All blocks with practical capacity issues warrant price-based management. Expansion of metering into areas traditionally designated as “residential” could potentially be paired with an exemption for preferential permit holders (priced at higher than current rates, as discussed above) at all or some times of day.

*Provide parking privileges to preferential permit holders at an appropriate price point.* Residents of the neighborhood would be permitted to purchase monthly permits for on-street parking on residential streets in the neighborhood. Permits should be priced at a high enough level to appropriately value on-street space and reduce demand for on-street parking (by encouraging offstreet parking, reduced vehicle ownership, etc.).

*Invest a portion of net new revenues within the neighborhood and involve the community in prioritizing expenditures.* This is the central element of PBDs. By pairing the PBD concept with price-based regulation there is even greater opportunity for neighborhoods to reap the benefits of pricing—through improved parking reductions and a reduction in traffic volumes, as well as through funding available to invest in local transportation projects.

*Recognize the limits of fully addressing peak demand in residential areas.* In many neighborhoods, demand for overnight on-street parking is especially high. Overnight parking demand is likely to be managed to some extent by higher preferential permit fees, but even a price-based PBD program must recognize the limits of using price during very late hours when enforcement is more of a challenge. It is important to note that on-street occupancies in excess of 85 percent may be more tolerable during the late-night periods, when traffic volumes are light, and businesses and other activities are less dependent on prioritizing short-term parking and ensuring sufficient availability.

These strategies represent a significant change for any neighborhood. As such, neighborhoods should be involved in choosing the amount and type of price-based regulation and supporting strategies that are desired in a given area. Because more aggressive strategies will provide more revenue, higher levels of benefit should be returned to those neighborhoods that are most willing to proactively manage on-street parking through price-based regulation and restructured residential permit parking.

## Conclusions

Current parking planning practices are inefficient, resulting in economically excessive parking supply, increased automobile traffic, and more dispersed destinations, contributing to various economic, social and environmental problems. There are many reasons to use management strategies that result in more efficient use of parking resources, in order to address parking problems without expanding supply.

Parking facilities that serve multiple destinations and are efficiently regulated or priced to favor higher value users (for example, delivery vehicles and customers over commuters and residents) tend to be efficiently used. On-street metered parking and commercial parking are particularly suitable for this type of management, and so should be favored over unpriced, off-street parking that serves a single destination.

This guide describes more than two-dozen management strategies that result in more efficient use of parking resources. These strategies are technically feasible, cost effective, and can provide many benefits to users and communities. Although all of these strategies have been implemented successfully in some situations, they are not being implemented as much as economically justified, due to various institutional barriers. Parking management implementation requires changing the way we think about parking problems and expanding the range of options and impacts considered during planning.

Most parking management strategies have modest individual impacts, typically reducing parking requirements by 5-15%, but their impacts are cumulative and synergistic. A comprehensive parking management program that includes an appropriate combination of cost-effective strategies can usually reduce the amount of parking required at a destination by 20-40%, while providing additional social and economic benefits.

Management solutions represent a change from current practices and so various obstacles must be overcome for parking management to be implemented as much as optimal. Current planning practices are based on the assumption that parking should be abundant and provided free, with costs borne indirectly, incorporated into building construction costs or subsidized by governments. Current parking standards tend to be applied inflexibly, with little consideration of demographic, geographic and management practices that may affect parking requirements. Parking management requires changing current development, zoning and design practices. This requires that public officials, planners and the public change the way they think about parking problems and solutions, and become familiar with the full menu of parking management strategies available and the benefits they can provide. It requires an institutions and relationships, such as transportation management associations, and activities to improve enforcement and addressing potential spillover impacts.

This guide summarizes the book *Parking Management Best Practices*, by Todd Litman, published by Planners Press in 2006. If you find this guide useful, please purchase the book, which contains more detailed information.

## References and Resources for More Information

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