Parking at Transit-Oriented Multi-Family Residential Developments

Measuring Parking Utilization at Residential TOD sites in Portland, Oregon

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Field Area Paper

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INTRODUCTION

In Portland, new high-density residential development is occurring along inner city transit routes and adjacent to established single-family neighborhoods. While higher density development is generally allowed in these locations as a result of various state, regional, and municipal policies, residential neighborhood associations have frequently raised objections to various aspects of the proposed developments, including the ratio of parking spaces to dwelling units. Many of these developments exhibit parking ratios of less than one parking space per dwelling unit. Residents are concerned that tenants of the new developments will park in their neighborhood due to insufficient on-site parking.

This paper discusses the current practices toward planning for parking and the implications that these practices have on quality of life, affordable housing, land use efficiency, and transportation planning. I begin by describing the policies and practices employed by the City of Portland, Oregon, then compare and contrast the Portland experience with the policies and practices typical of the rest of the country. I then describe the market response to Portland's parking regulations in the last ten years and the observed utilization of on-site parking at five typical high-density infill developments in the City of Portland, conducted in general accordance with established methodology. Finally, I provide analysis of my observations and conclusions about the Portland way of planning for parking.

CITY OF PORTLAND PARKING POLICY AND PRACTICES

While most cities still require a minimum number of parking spaces for most, if not all, development, the City of Portland is a notable exception because it established parking maximums and employs reduced or eliminated parking requirements for most development in the City. Specifically, Portland has no minimum parking requirements for all development in designated growth centers and sites well served by transit[1] (Portland Municipal Code, Chapter 33.266). By eliminating minimum parking requirements along transit corridors, the City of Portland allows real estate developers to choose how many parking spaces to provide by taking into account market demand for parking and the cost of land and development. For example, the developer of a condominium or higher-income apartment building may desire to develop at least one parking space per dwelling unit because of current market expectations for that type of unit, whereas a developer of entry-level or workforce housing may not be able to make developments "pencil out" with the same parking ratios.

The current parking regulations (or lack of regulations in some areas) in the City of Portland reflect state and regional goals toward reducing automobile dependency and more specifically toward reducing the number of parking spaces per capita by ten percent in metropolitan areas. These goals stem from Senate Bill 100, which became law in 1973. Senate Bill 100 required local government plans to be consistent with statewide planning goals. Over the next three years, the State created 19 planning goals, including Goal 12 – Transportation (DLCD). This goal simply calls for providing a

[1] There is no minimum parking requirement for sites located less than 500 feet from a transit street with 20-minute peak hour service.

"safe, convenient, and economic transportation system" while considering the needs of the "transportation disadvantaged" (OAR 660-015-0000(12)). In 1991, the Oregon Department of Land Conservation and Development adopted administrative procedures for the goal, which included more specific objectives, such as the reduction in parking spaces and vehicle travel per capita. The goals stated in the Portland Transportation System Plan similarly acknowledge the role of parking in achieving land use efficiency and improving transportation options in the region. (See Appendix A)

The intent of reducing the number of parking spaces is to achieve more efficient and transit-supportive land-use development and reduce the cost of infill development, which in turn reduces development pressures outside the Urban Growth Boundary and preserves regional open space and farmland. The regulations also allow the real estate development market to respond to the fact that approximately 14 percent of Portland households do not own a vehicle (Figure 1).

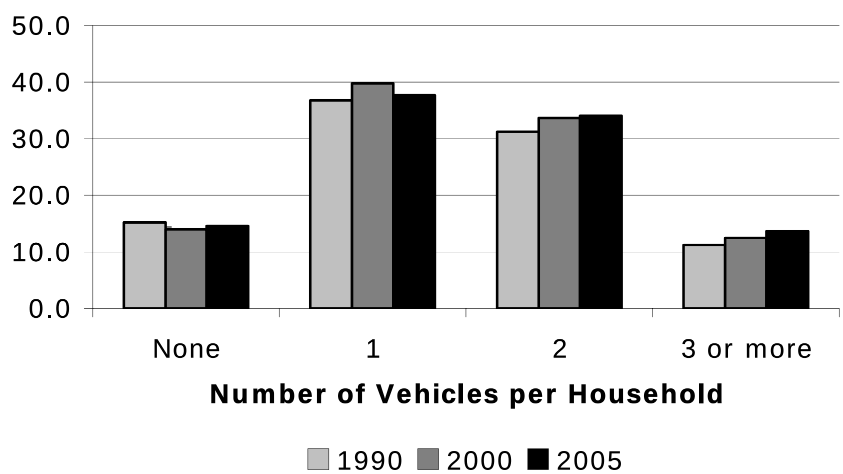

Figure 1: Vehicles Per Household, Portland, Oregon (Source: US Census Bureau)

As shown in Figure 2, TriMet, the regional transit service provider, has an expansive system of Frequent Service bus lines that provide service frequencies of every 15 minutes or better during peak hours. All development on sites within 500 feet of a Frequent Service bus line in the City of Portland is exempt from minimum parking requirements. Additionally, there are several other bus lines operated by TriMet that provide between 15 and 20-minute service headways and thus, also qualify for the parking exemption. Generally, most of the land adjacent to these bus routes appears to be underdeveloped with one and two-story structures and surface parking, yet zoned for much higher intensity development of three to four stories, as a result of City policies to increase density on transit corridors and within growth centers. Thus, there exists a potential for significant amount of development to occur under these policies and regulations that could have many implications for parking supply and quality of life in Portland neighborhoods.

Since 1995, over 7,200 dwelling units have been constructed within 500 feet of ten frequent service bus routes in the City, signaling a tremendous market response to the development opportunities along these corridors. TriMet's *Transit Investment Plan FY2007* indicates expansion of the miles of frequent service routes in the region as one of its top four priorities in the next few years, offering greater opportunity for continued transit-supportive high-density infill development. According to Portland city planners, parking ratios of new developments along transit corridors are gradually decreasing to the point where 0.6 to 1.0 parking spaces per unit is typical while only a handful of developments are including close to no parking.

Figure 2: Trimet's Frequent Service Bus Route Network Map in August 2007

LITERATURE REVIEW

At least since the 1960's, most cities in the U.S. require new development to provide on-site parking to minimize spillover into neighborhoods and reduce traffic congestion caused by drivers searching for an open parking space. The required number of parking spaces is typically set based on parking demand studies for existing developments of the same or similar land use (ITE 2004). Independent variables such as gross floor area, number of employees, number of dwelling units or number of bedrooms are then used to anticipate the parking demand of new developments (ITE 2004).

Typical parking demand for residential uses is set by the number of dwelling units and often refined by number of bedrooms per dwelling unit as a function of the dwelling unit's anticipated occupancy. Prescribed parking ratios vary between urban and suburban municipalities and sometimes vary within a single municipality (Planning Advisory Service 2002). However, parking demand is typically accepted to be an average of at least one space per dwelling unit (Weant & Levinson 1990). This is likely because car ownership in the United States is at or near saturation levels while average household size is decreasing. In 2000, there were 771 vehicles per 1,000 persons, more than double the rate in 1950 (323 vehicles per 1,000 persons) (US Census Bureau 1950 and 2000). Since there is a significant, albeit small, portion of the population that cannot drive due to age restrictions, economic limitations, and physical impairment, there is close to one vehicle for every able driver, thus resulting in the expectation that each new residential development should provide at least one parking space per dwelling unit at a minimum.

Cities typically use one of two sources for developing parking regulations - *other* cities and *Parking Generation*, a report published by the Institute of Transportation Engineers (ITE) (Shoup 2005). Using these sources is cheap and easy compared to the recommended method of conducting parking demand studies at local sites for each land use (Weant & Levinson 1990). ITE maintains a large database of peak parking demand observations that are presented in *Parking Generation* for every major land use. The latest edition includes data for increasingly specific land uses, such as Low/Mid-Rise Apartment in urban locations, which is comparable to the type of development selected for observations in this research paper. Data is provided from 12 study sites for the Low/Mid-Rise Apartment land use in urban locations, and indicates an average peak period parking demand of one vehicle per unit with peak-period demand ranging from 0.66 to 1.43 vehicles per dwelling unit.

The problem with using parking generation numbers from a national database or borrowing other cities' regulations is that parking demand may differ significantly from one residential development to another, and between cities. Additionally, there are a number of factors that may affect parking demand for a particular development proposal and/or site, such as anticipated household incomes, availability of transit service, proximity to commercial services and employment, and the price of parking, among others (Litman 2006a, ULI 2000, ITE 2004, Shoup 2005). Even the most recent edition of *Parking Generation* recognizes the inadequacies of blindly applying parking demand ratios from their database to individual cities (2004).

> "*Parking Generation* is only the beginning point of information to be used in estimating parking demand. Local conditions and area type can influence parking demand. *Parking Generation's* wide array of data blends many site conditions and may not best reflect local conditions. Therefore, surveys of comparable local conditions should always be considered as one of the best means to estimate parking demand to account for local factors." *Parking Generation* (2004)

Recently, parking policies have gained national attention in the planning profession as a way to help create more affordable housing, encourage smart growth, reduce congestion, and develop more walkable, livable communities (Millard-Ball 2002). This attention is the result of several recent publications that criticize the inflexibility and harmful side effects of requiring too many, if any, parking spaces such as Donald Shoup's *The High Cost of Free Parking*, Todd Litman's *Parking Management Best*

Practices, and the Environmental Protection Agency's *Parking Spaces/Community Places: Finding the Balance through Smart Growth Solutions*.

UCLA Planning Professor Donald Shoup has been publishing about the ill effects of current planning practices regarding required parking for more than 25 years (Shoup 1995, 1999, 2005; Shoup and Pickrell 1978). In these works, Shoup criticizes the lack of understanding most planners have of parking ratios, as evidenced by their frequent borrowing of other city's parking codes and use of the *Parking Generation* data (2005). Shoup and others argue that because parking demand is dependent on so many variables, requiring parking spaces based on peak demand of the most automobile-oriented developments often results in too much parking, resulting in side effects that are more harmful than the original "parking problem" (Shoup 2005, Litman 2006a). For example, Shoup argues that minimum parking requirements externalize the cost of providing the parking space to consumers making travel decisions, inducing more automobile travel than is necessary or desired. The induced automobile travel results in additional air pollution, local noise pollution, traffic congestion, and increased demand for "free" parking spaces.

Several studies point to the effect of parking requirements on housing affordability and density. A comparison of housing prices for condominium and single-family units with and without parking in San Francisco found an average increase in housing prices of $39,000 (13 percent) for condominiums and $46,000 (12 percent) for single-family units that included off-street parking, after controlling for other factors (Jia and Wachs 1997). These discrepancies in housing prices made those units without off-street parking unaffordable to 20 percent and 24 percent more San Francisco households, respectively.

As for development costs, a simple model created by one researcher found that when taking into account land costs, construction costs, zoning restrictions and parking typology, housing development in urban/high land-cost areas was less per unit without parking than suburban development. However, providing one parking space per unit in urban areas increases development cost by approximately $33,000 compared to only $10,000 in suburban areas (Russo 2001). Thus, minimum parking requirements have the greatest effect on housing prices in urban/high land-cost areas.

The effect of providing parking on housing affordability in urban areas is even more pronounced for smaller, and generally more affordable, units because the cost of providing parking comprises a larger percentage of the total cost (Litman 2006b). Only one study is known to have compared the characteristics of housing development before and after the implementation of a minimum parking requirement. That study, conducted in Oakland, California in the early 1960's, found that developers responded with 30 percent lower density in multi-family developments and larger unit sizes in order to offset the cost of providing fewer units (Bertha 1964). The overall effect was an 18 percent increase in construction costs per unit.

There are several alternatives to the standard parking requirements employed by most cities, including elimination of parking requirements, developing parking demand estimates based on locally observed conditions, building flexibility into parking codes to account for variations in site, neighborhood, and development type, and contingency-based planning (Litman 2006a & 2006b, Shoup 2005, US EPA 2006, Weant & Levinson

1990, Planning Advisory Service 1983). Contingency-based planning requires developers to respond to potential outcomes with contingency plans. For example, in consideration of potential on-site parking deficiencies in the future, the developer may propose charging for on-site parking, subsidize transit passes, and/or employ other methods for reducing parking demand or increasing supply, which must be enacted later on by the property owner if problems develop at the request of the City. Even the City of Los Angeles, well known for its pervasive car culture, is considering alternatives to the standard minimum parking requirements. City planners there recently proposed an ordinance allowing multi-family residences, in addition to commercial and industrial developments, to receive up to 100 percent reductions in required parking through a simplified administrative process "when parking management alternatives are incorporated into a project such as vanpools, ample bicycle storage and shared car programs" (Rothmann 2007). While there are examples of some cities successfully employing alternatives to standard minimum parking requirements, there is still widespread reluctance among planners to eliminate, reduce, or alter them.

Transit providers may have the most to gain from reduced or eliminated parking requirements. The provision of lower parking ratios at transit-oriented developments can increase transit ridership through greater development intensity (Willson 2005). However, transit providers have not paid much attention to parking requirements at transit stations and along transit routes. Most notably, transit-supportive development can "pencil-out" without subsidies typical of transit-oriented development, saving precious public funds for transit service and infrastructure improvements. There is an opportunity to involve transit providers in the discussion of parking requirements and combine dedicated transit service improvements with reduced or eliminated parking requirements along such transit routes to further unsubsidized and transit-supportive private investments in high-density housing.

ITE's *Parking Generation* and the *Transportation Planning Handbook* both offer parking researchers methods for conducting a variety of parking studies (2004, 1999). These methods vary with the time, resources, and goals of the overseeing organization or researcher. *Parking Generation* outlines a thorough method of estimating parking demand for land uses by conducting parking lot counts at regular intervals throughout the day, which has been adapted for use in this study, as described below. The *Transportation Planning Handbook* also provides a thorough method of conducting parking studies, but provides wider applications of its methodology, such as estimating parking demand for a commercial district. Both sources suggest that the preferred method of estimating parking demand is the use of local study sites, where resources permit (ITE 2004, Edwards 1999).

RESEARCH QUESTIONS

The purpose of this research is to measure the market response to no minimum parking requirements and consider the many implications of the lower parking ratios for community development, and land use and transportation planning. In doing so, I hope to answer the following research questions:

- How much parking are developers providing along transit routes?
- How well utilized are on-site parking spaces in these developments?
- What externalities, if any, are apparently resulting from the lower parking ratios?

METHODOLOGY

Parking Generation, published by ITE, includes a detailed methodology for collecting parking utilization data that were generally followed for this study. The four key steps include:

- Select site;
- Determine an independent variable;
- Collect background data; and
- Conduct parking utilization observations.

Select Site

Multi-family development sites were initially identified along several of Trimet's Frequent Service bus routes, as described earlier, which qualify for the City of Portland's parking exemption. Final selection of sites was determined based on most of the criteria suggested in *Parking Generation* (2004). Five sites were selected using the following considerations (See Figure 3):

- Occupancy of development (85 percent or greater is desirable); Independent variables available (i.e. # of units);
- Development should be reasonably mature (at least one year old, but less than 10 years old);
- Minimal or no construction activity on the site or adjacent roadways;
- Ability to access parking facilities during peak hours (9pm-5am);
- Permission from owner or manager of development; and

- Parking ratios typical of infill development within the inner eastside of Portland (0.6-1.0 parking spaces per unit)[2].

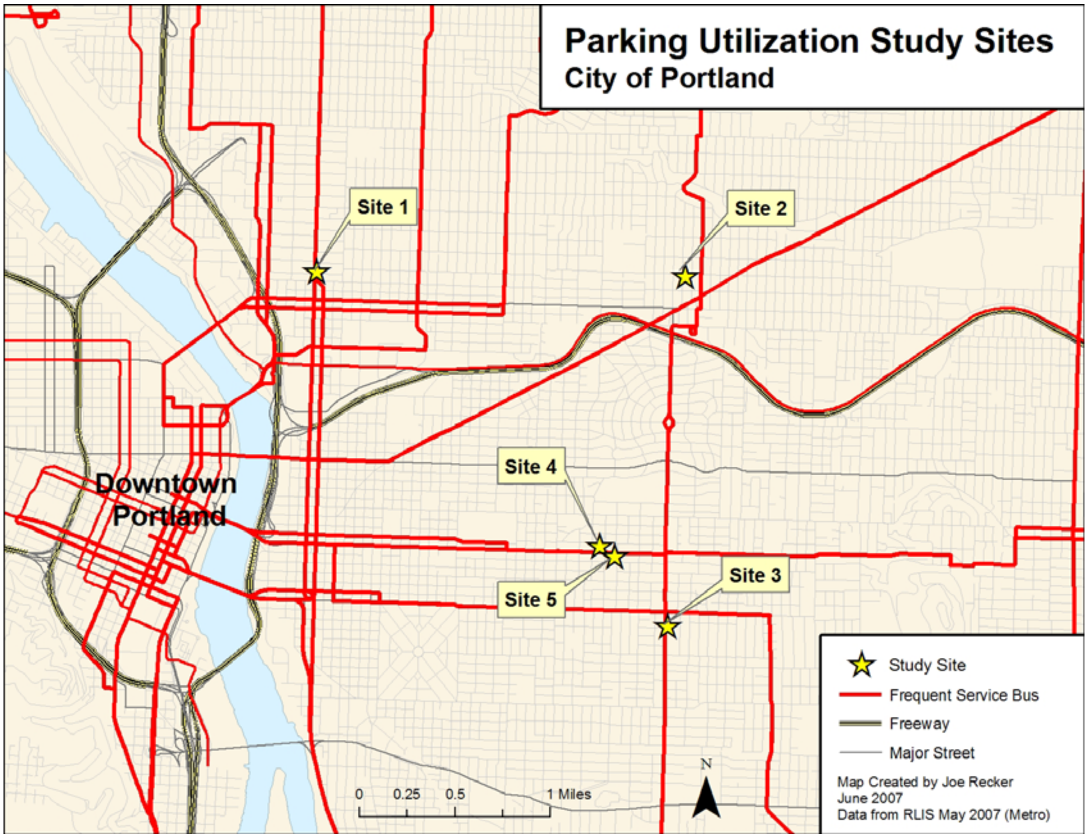

Figure 3: Map of Study Sites

Additionally, *Parking Generation* recommends choosing sites based on the ability to observe all parking associated with the land use (2004). While it is certainly desirable to do this in order to isolate peak period parking demand, the purpose of this study is to measure the effectiveness of zoning regulations with no minimum parking requirements. Thus, while I may not be able to isolate all the peak-period parking associated with a particular development, I may still be able to identify parking issues such as potential spillover parking, inadequate shared-use parking arrangements and other issues associated with inappropriate-sized parking facilities for a particular development.

[2] Based on a discussion with a City of Portland planner.

Determine an Independent Variable

The most common independent variables used in parking demand studies for residential development are number of dwellings units and number of bedrooms. Unit and bedroom counts are provided for each of the sites chosen for this analysis for purpose of comparison, as shown in Table 1.

Table 1: Parking Supply by Site

Site	No. of Units	No. of Bedrooms	Resident Parking Spaces	Shared-use Parking Spaces	Total Parking Spaces on Site	Spaces per Unit	Spaces per Bedroom
1	44	59	17	17	34	0.77	0.58
2	47	58	17	11	28[3]	0.60	0.48
3	46	46	32	3[4]	35	0.76	0.76
4	85	104	34	30	64	0.75	0.62
5	27	30	22	0	22	0.81	0.73

Collect Background Data

Parking Generation recognizes that numerous factors can influence parking demand beyond the independent variable described above (2004). Background data for each of the five sites is summarized in Tables 2 and 3 below. These additional factors include:

- Occupancy;
- Transit availability;
- Carshare access;
- Development type;
- Neighborhood census data; and
- Parking pricing.

[3] There are a total of 37 parking spaces on-site, but nine spaces are reserved for an off-site use throughout the day. Thus, for purposes of this study, only 28 parking spaces are counted toward this development.

[4] Three parking spaces are reserved for 30-minute office parking for the manager's office, but are commonly used by residents and visitors for loading/unloading for cars.

Table 2: Census 2000 Block Group Data by Site

Site	Median Household Income (1999)	Households with No Vehicles			Means of Travel to Work		
		Renters	Owners	All	SOV, Carpool	Transit	Walk/ Bike
1	$27,589	54%	0%	46%	59%	12%	26%
2	53,170	19	0	9	70	20	6
3	45,000	13	3	6	70	20	4
4, 5	26,285	40	0	32	52	24	17
City of Portland	40,146	26	3	14	76	12	7

Table 3: Site Characteristics

Site	Year Built	Tenure/ Occupancy	Income-Restricted	Parking Availability	Housing Density	Car share	Type of Transit Available
1	1996	Apartment (100% Occupied)	Yes (100%)	Free/ some parking restricted during commercial hours	53 du/acre	No	1 frequent service bus line
2	2002	Apartment (100% Occupied)	Yes (40%)	Free/ some parking restricted during commercial hours	47 du/acre	Yes	2 frequent service bus lines; 1 LRT line
3	2005	Apartment (100% Occupied)	No	$20-30 per space	65 du/acre	Yes	4 bus lines (2 frequent service; 2 express bus lines)
4	1995	Apartment (100% Occupied)	Yes (80% of units)	Free/ some parking restricted during commercial hours	69 du/acre	Yes	1 frequent service bus line
5	2005	Condo (96% Occupied)	No	Parking independently owned	92 du/acre	Yes	1 frequent service bus line

Conduct Parking Utilization Observations

Parking Generation recommends conducting parking utilization observations during peak hours and various other times throughout the day to establish the variation in parking utilization throughout the day. However, residential peak-period parking utilization is well established as between approximately 9pm to 5am (ITE 2004, Weant & Levinson 1990). One peak-hour observation was made per site on four separate occasions, in addition to two non-peak-hour observations on separate occasions for each site, for a total of six observations per site. Observations were made on the following days of the week in the month of May:

- Saturday night/Sunday morning (3-5am)
- Sunday midday (1-3pm)
- Sunday night/Monday morning (12am-2am)
- Wednesday night/Thursday morning (3-5am)
- Thursday evening (5-8pm)
- Thursday night/Friday morning (11pm-1am)

SITE DESCRIPTIONS

Site 1

Site 1 is a four-story mixed-use development of 44 income-restricted apartments, a full-service bank and child daycare. Thirty-four parking spaces are located in a parking lot behind the building. Half of the parking spaces are reserved for residential tenants and the other

Photo of Site 1

half are reserved for the commercial ground floor uses only during business hours (roughly 9:00 am to 5:00 pm Monday thru Friday and 9:00 am to 6:00 pm on Saturday). All parking spaces are available to residential tenants during peak residential parking demand.

Site 2


Photo of Site 2

Site 2 is a mixed-use development with 47 residential apartments and a public library branch on the ground floor. It is located on the edge of a pedestrian-oriented mixed-use district with a variety of personal services, retail, restaurant, and entertainment uses within walking distance. There are 37 parking spaces on-site, but only 28 spaces are available to the residential tenants and library patrons. Of the 28 parking spaces, 17 are available to residents at all times while the remaining 11 are restricted to library patrons during operating hours. Residents are given one parking pass per unit for the on-site parking on a first come, first serve basis.

Site 3


Photo of Site 3

Site 3 is a 46-unit multi-family development with 35 on-site parking spaces, of which 32 are available for rent to tenants of the building for $20-$30 per space. Each of the 32 spaces was rented by tenants of the building at the time of this study. The remaining three parking spaces are reserved for loading/unloading and manager's office use. This site is located midblock, fronting on an arterial with no street parking. A side street runs perpendicular to this arterial directly in front of the site close to a mid-block pedestrian crossing signal, allowing easy access to unrestricted street parking spaces.

Site 4

Site 4 is a mixed-use development, containing 85 dwelling units and 26,000 square feet of ground floor commercial space, including a specialty grocery store, restaurant, and retail shops. There are 64 parking spaces on-site, of which, 30 are reserved for the grocery store between the hours of 9 AM and 9 PM, and available to residential tenants afterward who must display a parking sticker provided at a ratio of one per unit at no additional cost. The remaining 34 parking spaces are available to residential tenants who display the parking sticker during any time of the day. The site occupies upwards of 75 percent of the block.

The site is also located in the middle of a thriving nightlife/entertainment district with several bars and restaurants open till 2 AM. The neighborhood is moderately dense with a mixture of predominantly single-family homes on small lots interspersed with low-rise apartments.

Photo of Site 4

Site 5

Site 5 is a mixed-use development with 27 loft-style condominium units and ground floor commercial space including a restaurant and retail. There are 22 parking spaces on the ground floor that are individually owned by residential condominium owners. At the time the building was completed, parking spaces were “unbundled” from the dwelling units so that homebuyers could opt not to purchase a garage parking space. All garage parking spaces are currently under ownership.

The site is also located in the middle of a thriving nightlife/ entertainment district with several bars and restaurants open till 2 AM. The neighborhood is moderately dense with a mixture of predominantly single-family homes on small lots interspersed with low-rise apartments. Ample street parking exists along a park and school, just one block south of the development, offering residents who don’t own a parking space assurance of street parking.

Photo of Site 5

PARKING UTILIZATION OBSERVATIONS

A summary of the parking utilization observations is provided below in Table 4, while the data for all observations is provided in Appendix B. The observations are grouped as either mixed-use or single-use sites. While the overall parking ratios provided per development are similar (with the exception of Site 2), the parking ratio of dedicated residential parking to number of dwelling units becomes apparently quite low (approximately 4 parking spaces per 10 dwelling units) for the mixed-use sites. In these developments, the operating characteristics of the shared parking spaces are crucial for optimizing residential use of on-site parking. These operating characteristics are discussed in more depth below.

Table 4: Observed Parking Utilization by Site

	PARKING RATIO	PEAK-PERIOD MIN	PEAK-PERIOD MAX	PEAK-PERIOD AVG	NON-PEAK-PERIOD MIN	NON-PEAK-PERIOD MAX	NON-PEAK-PERIOD AVG
MIXED-USE SITES							
Site 1							
Overall	0.77	41%	56%	49%	24%	88%	55%
Residential	0.39	50%	86%	73%	29%	93%	60%
Site 2							
Overall	0.60	71%	93%	85%	75%	86%	80%
Residential	0.39	100%	100%	100%	87%	100%	93%
Site 4							
Overall	0.75	63%	75%	70%	67%	72%	70%
Residential	0.40	85%	97%	90%	68%	97%	82%
SINGLE-USE SITES							
Site 3							
Overall	0.76	69%	86%	74%	54%	57%	56%
Site 5							
Overall	0.81	68%	73%	70%	36%	50%	43%

The overall peak-period utilization varied from 56% to 93% for all sites, suggesting a significant difference in parking demand between sites. Taking into account site characteristics may help explain these differences. For instance, Site 1 is a 100 percent income-restricted development and also exhibited the lowest parking utilization rates. This observation supports research that lower-income households own fewer vehicles, on average, than higher income households. Meanwhile, the higher parking utilization observed at Site 2 may simply be a function of a lower parking supply rate compared to the other four sites.

While Site 2 approached near full utilization of on-site parking, the other sites show less than full utilization. These observations support a finding that a parking supply of approximately four parking spaces per five dwelling units (0.80 parking space/unit) may adequately support parking demand and still minimize spillover parking at each of these developments. This is in contrast to applying ITE *Parking Generation* rates to the sites based on their land use (see Figure 4). While the observed parking utilization rate is far lower than what most cities require for residential development in urban areas, the more significant implication is that the developers of these sites provided adequate parking supply without a requirement to do so.

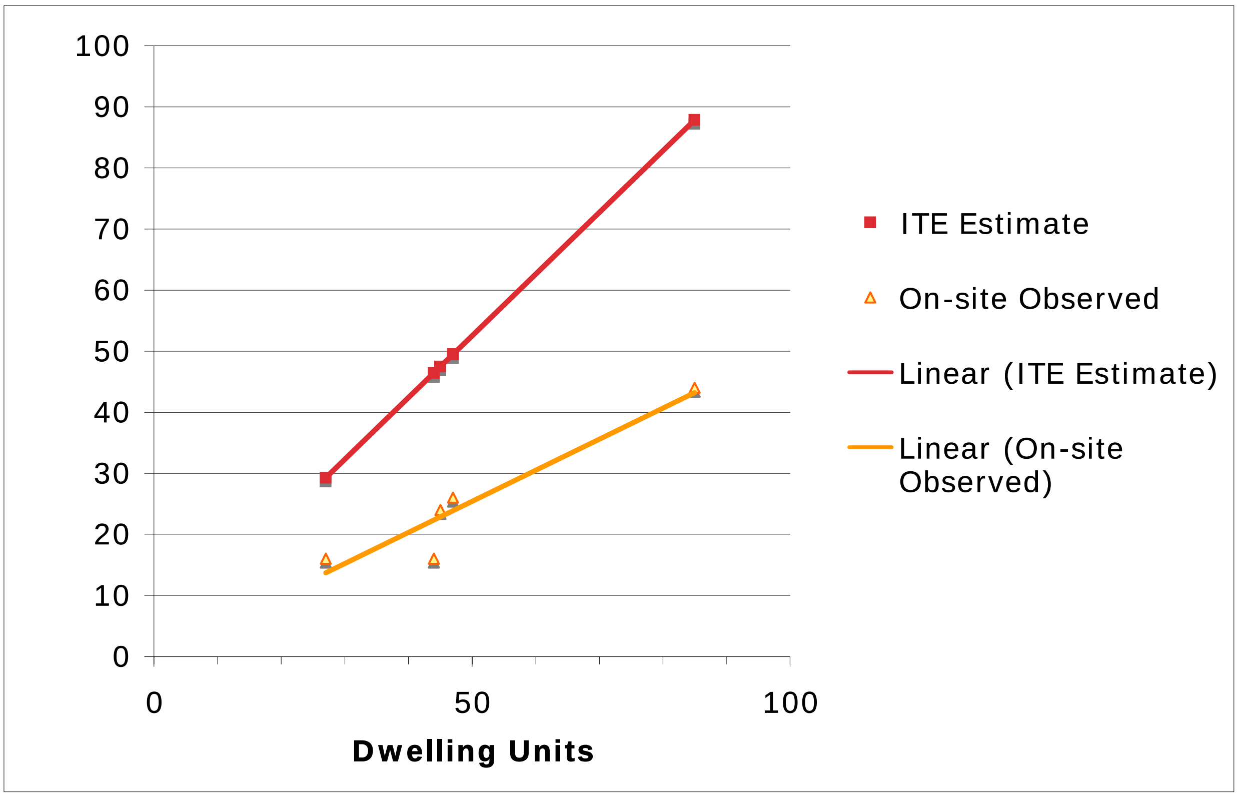

Figure 4: Comparison of ITE Parking Demand Estimates with Observed Parking Utilization

Shared Use Sites

Sharing parking facilities allow two or more uses with different peak parking demands to more efficiently utilize one parking supply. Residential parking is rarely shared with commercial uses because multifamily parking facilities are often characterized by assigned parking spaces, especially when they are leased or owned. Each of the following sites (Sites 1, 2, and 4) with shared use parking exhibited unassigned residential parking, allowing for more effective utilization of the shared parking supply.

Another consideration for these shared used sites is the availability and use of alternative forms of transportation. All sites were highly transit accessible and exhibited relatively high utilization of transit, bicycling, and walking as modes of transportation to work, according to the 2000 Census (see Table 1 above). Thus, some residential tenants are likely parking their vehicles on-site or in the neighborhood while utilizing another form of transportation to work.

While the parking utilization observations of this study focused on the residential peak-period (9PM – 5AM), two non-peak-period observations were also made to gain insight into the variation of parking utilization throughout the day.

Site 1

Peak-period observations indicate 41 to 56 percent utilization of the on-site parking while non-peak period observations indicate 24 to 88 percent utilization. The wide variation in non-peak period observations reflect that one observation was made on a Sunday afternoon when all businesses were closed and the other observation was made on a weekday afternoon when all businesses were open. Even when the parking facility was observed at 88 percent full, only 36 percent of street parking spaces adjacent to the site (Area “A” in Figure 5) were being utilized, thus suggesting that parking supply was sufficient with minimal spillover.

This site appears to adequately accommodate the parking demand of all uses on the site. The low utilization rates observed during peak-periods suggest that the residential

Figure 5: Aerial photo of Site 1 and parking observation areas.

portion of the development does not take full advantage of the parking facilities. This development may have accommodated more dwelling units and still successfully shared the parking facility. Very-low car ownership among households in this Census Block Group (54 percent of households in this census block do not own a vehicle) combined with this being a 100% income-restricted apartment building are likely contributing to the low parking demand in addition to the presence of alternative modes of transport with access to employment, shopping, and other destinations.

Site 2

Peak-period observations indicate 71 to 93 percent utilization of the on-site parking while non-period observation indicate 75 to 86 percent utilization. The parking reserved for residential use was nearly 100 percent occupied during every peak- and non-peak-period observation, signaling a parking deficiency on-site. As expected from this high utilization rate, street parking was also well utilized adjacent to the site, particularly in Areas “A” and “C” in Figure 6. Being located on the edge of a business district, there are very few competing land uses for residential peak-period parking, indicating that most, if not all street parking in these areas is attributable to this site. However, the shared use of street parking with adjacent commercial uses in the district allowed for

Figure 6: Aerial photo of Site 2 and parking observation areas.

greater transit-supportive density at this site with little to no intrusion into adjacent residential areas. Eventually, additional mixed-use developments in the commercial district with such low parking ratios may result in spillover parking into adjacent residential neighborhoods. This effect seems to be far away as there is still considerable peak-period parking capacity.

Site 4

Peak-period observations indicate 63 to 75 percent utilization of the on-site parking and 36 to 50 percent utilization during non-peak period observations. Despite the lower overall utilization during the non-peak period, residential parking was nearly fully utilized during each of the peak-period observations and one weekday observation in the early evening. Additionally, observations of street parking on adjacent streets indicate a parking deficiency surrounding the site.

Street parking adjacent to the residential building (Area "B" in Figure 7) entrance averaged close to 90 percent utilization during peak periods. While some of the parking demand may be caused by late-night commercial uses, two of the parking observations occurred at least two hours past closing time for all commercial businesses in the area and still showed high utilization of street parking adjacent to the site, averaging 77 percent utilization.

Figure 7: Aerial photo of Site 4 and parking observation areas.

A potential reason for the low utilization of on-site parking and high utilization of street parking during the peak period is the less-than-optimal shared parking arrangement. With half of the parking spaces restricted for commercial use till 9 PM, most residential tenants driving home from work will likely park in the street once the on-site residential parking becomes or appears full. A weekday observation of the on-site parking at 8 PM found nearly the on-site residential parking 97 percent utilized versus only 43 percent utilization of the on-site commercial parking, which suggests that prohibiting residential use of shared parking till 9 PM may unnecessarily exacerbate the spillover effects. Additionally, competition with adjacent commercial patrons for street parking surrounding the site appears to exacerbate the apparent parking shortage in the neighborhood.

Single-Use Sites

The remaining sites in this study were residential-use only and also exhibit priced parking. While neither site exhibited full utilization of available parking spaces, all available parking spaces were leased and assigned to residential tenants at the time of the observations. The fact that all parking spaces were leased and reserved may be more indicative of the parking demand than the observed utilization at these sites. If the cost of providing the parking spaces was fully covered by the rent paid for the spaces, it would be reasonable to expect developers to provide additional parking in future developments without a requirement to do so. However, determining the cost of providing a parking space has always been a difficult calculation to make because of the variety of opportunity costs (increased revenue-generating density versus improved site amenities that also increase revenue) and the difficulty in separating land and parking facility construction costs from those of the rest of the development.

Site 3

Peak-period observations indicate 69 to 86 percent utilization of the on-site parking while non-peak-period observations indicate 54 to 57 percent utilization. The variation between peak- and non-peak-periods suggests that while the majority of households likely own a vehicle, a large percentage of workers residing there are utilizing alternative forms of transportation to get to work and other weekday destinations.

The closest available street parking is not very convenient as residents must cross a busy arterial and compete with other residential uses on the arterial with constrained parking supply. While a pedestrian crossing signal is provided at this crossing, the act

Figure 8: Aerial photo of Site 3 and parking observation areas.

of crossing a busy arterial and waiting for the signal is still considered inconvenient enough for most residents to choose paying $20 to $30 for on-site parking. The average peak-period utilization of this side street (Area "B" in Figure 8) was fairly high at 76 percent, but still low enough to usually have an available parking space. Considering the number of developments that this side street serves, it is surprising that it is not more fully utilized on a consistent basis. In fact, street parking Area "A", further from this site, was more highly utilized than Area "B" in Figure 8. Thus, the parking supply provided at this site appears to be adequate enough to minimize spillover effects where they are most likely to occur.

Site 5

Peak-period observations indicate 68 to 73 percent utilization of the on-site parking while non-peak-period observations indicate 36 to 50 percent utilization. Thus, while every parking space is owned, either the actual parking demand for the site is less than the parking supply or parking is not being efficiently utilized during the peak-period due to individual ownership. It is difficult to discern parking spillover caused by this development with spillover parking of adjacent residential uses in this moderate-density neighborhood. Street parking in Area "D" of Figure 9 exhibited the highest parking

Figure 9: Aerial photo of Site 5 and parking observation areas.

utilization of four local side streets, but it also has fewer street parking spaces available than other side streets with fewer residential uses. Even so, Area "D" of Figure 9 averaged less than 70 percent utilization during the residential peak periods, suggesting that minimal spillover is occurring.

The non-peak period observations indicate that nearly half of those persons parking on-site use their vehicle with some regularity. More importantly, the other half appears to not use their vehicles. As mentioned earlier, this could be the result of high alternative transportation use in combination with some residents working from home.

A more efficient utilization of the parking could result from common ownership of the parking supply and renting of those spaces to the highest-bidding residents. The revenue from the parking rent could help offset the homeowner association fees and ensure that those on-site parking spaces are more fully utilized. Regardless, the strong impetus for developers to provide a one-to-one ratio of parking suggests that condominium developments pose the least threat to residential spillover parking. However, even if less parking is provided, this will likely result in more affordable home ownership opportunities, as explored by Jia and Wachs in their study of the relationship of parking requirements and affordable housing in the San Francisco Bay Area (1998).

CONCLUSIONS

When left to the market, more efficient and dense development will occur in inner city locations. The externalities of lower parking ratios as part of infill development along transit routes may include greater competition for street parking along the fringe of adjacent lower density neighborhoods when some or all on-site parking of mixed-use buildings is restricted from residential use. In some neighborhoods, street parking management such as residential permit districts and parking meters may help to reduce parking demand, as indicated by some researchers. Better on-site parking management, such as market pricing and reconsideration of shared parking agreements may also reduce demand for street parking.

Infill development is continuing to occur in the vicinity of those surveyed here. One such development is a 123-unit condominium building with underground parking. The size of the site coupled with the market expectations led the developer to include 126 parking spaces for the building, just slightly more than one parking space per unit. Other condominium developments seem to supply just less than one parking space per unit. In talking with one such developer, he stated that while he thinks there should be at least a small minimum parking requirement to prevent buildings from not providing any parking, the flexibility afforded by the current regulations allowed his projects to happen, whereas the typical high minimum parking requirements that most cities pose would have prevented them.

The market response to no-minimum parking requirements along transit routes in inner-Portland appears to minimize spillover parking effects while meeting local, regional and state goals for more dense infill development. The implications of this trend are greater transportation options as more people reside in close proximity to high frequency transit service and an established bicycle network. The non-peak-period parking observations at these developments suggest that many residents are leaving their vehicles at home and utilizing these alternative transportation options, resulting in lower regional pollution, lower infrastructure costs, less land consumption, and improved transportation choices for all area residents.

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APPENDIX A: PARKING POLICIES

(TAKEN FROM THE CITY OF PORTLAND TRANSPORTATION SYSTEM PLAN)

Policy 6.25 Parking Management

Manage the parking supply to achieve transportation policy objectives for neighborhood and business district vitality, auto trip reduction, and improved air quality.

Objectives:

A. Implement measures to achieve Portland's share of the mandated 10 percent reduction in parking spaces per capita within the metropolitan area over the next 20 years.

B. Consider transportation capacity and parking demand for all motor vehicles in the regulation of the parking supply.

C. Develop parking management programs and strategies that improve air quality, reduce congestion, promote alternatives to the drive-alone commute, and educate and involve businesses and neighborhoods.

Policy 6.26 On-Street Parking Management

Manage the supply, operations, and demand for parking and loading in the public right-of-way to encourage economic vitality, safety for all modes, and livability of residential neighborhoods.

Objectives:

A. Support land uses in existing and emerging regional centers, town centers, and main streets with an adequate supply of on-street parking.

B. Maintain existing on-street parking in older neighborhoods and commercial areas where off-street parking is inadequate, except where parking removal is necessary to accommodate alternatives to the automobile.

C. Support carpooling in commercial districts by providing convenient, affordable, and adequate on-street spaces.

D. Develop and maintain on-street parking meter districts to provide for customer turnover, reduce on-street parking use by commuters, efficiently allocate parking among diverse users, encourage the use of alternatives to the automobile, and provide a funding source for transportation projects within the districts.

Policy 6.27 Off-Street Parking

Regulate off-street parking to promote good urban form and the vitality of commercial and employment areas.

Objectives:

A. Consider eliminating requirements for off-street parking in areas of the City where there is existing or planned high-quality transit service and good pedestrian and bicycle access.

B. Encourage the redevelopment of surface parking lots into transit-supportive uses or development or to include facilities for alternatives to the automobile.

Explanation: Surface parking lots discourage compact development because they are space extensive. Existing parking lots can transition over time to provide less automobile parking and encourage better development and the use of alternatives. Examples include: making parking lots more efficient by including carpool and motorcycle parking, redeveloping parking as transit facilities such as bus waiting areas, removing parking for more development, or placing parking in structures rather than surface lots.

C. Limit the development of new parking spaces to achieve land use, transportation, and environmental objectives.

Explanation: This objective was implemented in 2000 when parking maximums for non-residential uses throughout the City were adopted into Title 33.

APPENDIX B: PARKING OBSERVATIONS DATA

Site 1 Observation Data

Day - Time	On-Site Parking: Resident (#)	(%)	Non-Resident (#)	(%)	Total (#)	(%)	Street Parking Area "A" (#)	(%)
Total Available	14		20		34		11	
Sun - 4:45AM	7	50%	7	35%	14	41%	6	55%
Sun - 1:30PM	4	29%	4	20%	8	24%	4	36%
Mon - 12:15AM	10	71%	6	30%	16	47%	5	45%
Thurs - 3:30AM	12	86%	7	35%	19	56%	9	82%
Thurs - 4:45PM	13	93%	14	70%	27	79%	4	36%
Thurs - 10:45PM	12	86%	6	30%	18	53%	5	45%

Note: Shading denotes peak-period observations.

Photo (left): Aerial Photo of Site 1 and Adjacent Streets

Site 2 Observation Data

Day - Time	On-Site Parking						Street Parking					
	Resident		Non-Resident		Total		Area "A"		Area "B"		Area "C"	
	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
Total Available	15		13		28		10		17		25	
Sun - 5:00AM	15	100%	5	38%	20	71%	5	50%	1	6%	13	52%
Sun - 2:00PM	13	87%	11	85%	24	86%	8	80%	12	71%	20	80%
Mon - 12:30AM	15	100%	11	85%	26	93%	5	50%	0	0%	13	52%
Thurs - 3:45AM	15	100%	10	77%	25	89%	3	30%	0	0%	13	52%
Thurs - 7:00PM	15	100%	6	46%	21	75%	5	50%	5	29%	24	96%
Thurs - 11:00PM	15	100%	9	69%	24	86%	5	50%	4	24%	13	52%

Note: Shading denotes peak-period observations.

Photo (left): Aerial Photo of Site 2 and Adjacent Streets

Site 3 Observation Data

Day - Time	On-Site Parking						Street Parking							
	Resident		Mgr's Office		Total		Area "A"		Area "B"		Area "C"		Area "D"	
	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
Total Available	32		3		35		31		17		13		14	
Sun - 5:15AM	23	72%	1	33%	24	69%	18	58%	15	88%	5	38%	2	14%
Sun - 2:30PM	17	53%	2	67%	19	54%	28	90%	15	88%	10	77%	10	71%
Mon - 12:45AM	21	66%	3	100%	24	69%	-	-	15	88%	7	54%	4	29%
Thurs - 4:00AM	28	88%	2	67%	30	86%	25	81%	11	65%	9	69%	1	7%
Thurs - 7:30PM	20	63%	0	0%	20	57%	27	87%	13	76%	9	69%	10	71%
Thurs - 11:30PM	26	81%	0	0%	26	74%	26	84%	11	65%	6	46%	9	64%

Note: Shading denotes peak-period observations. (-) denotes missing data.

Photo (left): Aerial Photo of Site 3 and Adjacent Streets

Site 4 Observation Data

Day - Time	On-Site Parking						Street Parking													
	Resident		Non-Resident		Total		Area "A"		Area "B"		Area "C"		Area "D"		Area "E"		Area "F"		Area "G"	
	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
Total Available	34		30		64		20		27		18		12		15		6		19	
Sun - 5:30AM	33	97%	11	37%	44	69%	13	65%	19	70%	12	67%	2	17%	9	60%	3	50%	10	53%
Sun - 3:00PM	23	68%	20	67%	43	67%	14	70%	27	100%	17	94%	12	100%	13	87%	7	117%	17	89%
Mon - 1:00AM	31	91%	12	40%	43	67%	15	75%	26	96%	18	100%	10	83%	7	47%	5	83%	15	79%
Thurs - 4:30AM	29	85%	19	63%	48	75%	16	80%	24	89%	14	78%	2	17%	11	73%	1	17%	17	89%
Thurs - 8:00PM	33	97%	13	43%	46	72%	20	100%	27	100%	20	111%	13	108%	13	87%	7	117%	19	100%
Fri - 12:00AM	30	88%	10	33%	40	63%	14	70%	26	96%	18	100%	7	58%	12	80%	6	100%	14	74%

Note: Shading denotes peak-period observations.

Photo (left): Aerial photo of Site 4 and adjacent streets

Site 5 Observation Data

Day - Time	On-Site Parking Total		Street Parking Area "A"		Area "B"		Area "C"		Area "D"	
	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)	(#)	(%)
Total Available	22		25		27		17		14	
Sun - 5:30AM	15	68%	9	36%	15	56%	7	41%	8	57%
Sun - 3:30PM	11	50%	22	88%	11	41%	9	53%	11	79%
Mon - 1:30AM	16	73%	10	40%	13	48%	7	41%	-	-
Thurs - 5:00AM	16	73%	13	52%	13	48%	8	47%	11	79%
Thurs - 7:45PM	8	36%	26	104%	24	89%	17	100%	14	100%
Thurs - 11:45PM	15	68%	10	40%	13	48%	6	35%	9	64%

Notes: Shading denotes peak-period observations. (-) denotes missing data.

Photo (left): Aerial photo of Site 5 and adjacent streets