Parking Strategies for Suburban Mixed-Used Developments

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ABSTRACT

Recent decades have seen many localities revisiting traditional town center-style development as a response to problems caused by sprawl. In some cases, these more compact developments occur in areas that are otherwise primarily suburban in character. Of the many facets of these developments, parking has one of the largest impacts on the compactness, walkability, and accessibility of those developments, but little information, academic or otherwise, exists to inform the planning of parking for mixed-use projects in an otherwise suburban environment. Many localities rely on zoning-based parking minimums, but a lack of situational parking strategies may limit the benefits of these suburban mixed-use projects. In an effort to ascertain trends or best practices in a suburban context, information on eleven mixed-use developments was collected from planners and developers. In addition, quantitative data related to the mix of uses and amount of parking in similar developments was obtained from Urban Land Institute case studies. The analysis revealed that in general, suburban municipalities do not capitalize on potential parking reductions created by mixing uses, do not truly share parking between uses, and do not implement parking regulation in the form of time limits or pricing. In a few cases, there were exceptions to these general trends, with some developments implementing detailed shared parking plans that have thus far been successful in balancing demand and supply. The related quantitative analysis suggests that the most important strategy as it relates to parking is to have a varied mix of uses in the development, with attention to those that have opposite peak times. Based on the case studies and shared parking analyses, recommendations for effective parking strategies for suburban, mixed-use development include: development of a shared parking plan, the use of ULI's *Shared Parking* as a starting point but not a final determinant in those shared parking plans, the use of proffers to require periodic checks on the shared parking supply, and ongoing local parking studies to better understand local need.

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Problem

Chesterfield County, Virginia is a rural-turned-suburban municipality that has recently updated its Comprehensive Plan. One of the goals of the plan is to promote more mixed-use centers in the county. While Chesterfield's recognition of the potential benefits of more clustered, planned developments should be commended, currently few land use tools exist that guide the planning of parking for such developments. Furthermore, the Planning Department has struggled with finding compromises between public acceptability and new, more sustainable growth patterns that they hope to embrace.

This problem is illustrated best by a recent Planning Commission case involving Chester Village Green, Chesterfield's first vertical mixed-use project. A proposed residential building in the development was recently denied. While the denial was primarily due to a request to remove the cash proffer, the case brought to light the question of parking in Chester Village Green. One of the arguments against the proposed development was that it would not be supplying enough parking (Buettner, 2012). A combination of on-street, off-street, and off-site parking accounted for 66 spaces, but 88 were required to meet the need of the 44 proposed dwelling units, as Chesterfield still requires each use to provide its own parking, regardless of development context (Ramsey, 2012).

An estimate of existing parking in Chester Village Green revealed that the number of parking spaces as a whole currently exceeded the total needed for each individual use, even with the proposed residential development included (Ramsey, 2012). But because Chesterfield does not utilize shared parking in the project, and for the most part requires each use to provide its own parking as per the minimums set in the zoning ordinance[1], the proposed residential development was still assessed as not providing enough parking spaces. As Chesterfield County moves forward with encouraging more mixed-use development in the future, some direction is needed as to how the determination of parking requirements can enhance the benefits of this kind of

[1] An exception to this was the age-restricted housing in the development, which was given a parking reduction. The zoning ordinance also allows up to a 10% decrease in required parking where pedestrian infrastructure is provided (Officials of the County of Chesterfield, 1997).

development, and not restrict this kind of clustered growth. This brings up questions with potential applicability beyond just Chesterfield. For example, what is the appropriate rate at which to provide parking for vertical mixed-use developments? What strategies for finding the "right" amount of parking may be utilized? How can these tools be made acceptable to County officials and the general public?

To answer these questions, this thesis takes a close look at parking strategies that are potentially beneficial in a suburban mixed-use environment, and the importance of these context-specific methods. This was investigated through a lit review, which follows in Chapter 1.

Chapter 1: Literature Review

Benefits of mixed-use

Mixed-use development – often considered to be an aspect of "smart growth", New Urbanism, or Traditional Neighborhood development – has increased in popularity over the last few decades as an alternative to traditional, single-use suburban development. New Urbanism in particular emerged in the 1980s as a response to growing dissatisfaction with current patterns of development. As an approach applicable at various geographic levels, its general themes of clustered, more efficient development with a mix of uses encourage finding a solution to problems caused by modern automobile-driven patterns of development that at the same time does not ignore the need for private vehicles (*New urbanism: Comprehensive report & best practices guide*, 2003). When implemented well, mixed-use has benefits beyond curbing sprawl. As Piell (2009) suggests, "mixed-use facilities . . . not only conserve valuable land resources, but also brighten communities and present opportunities for building efficiency, energy efficiency, and sustainability" (p. 1).

Furthermore, there is some evidence that this kind of development pattern may be preferable to many residents. Lovejoy, Handy, and Mokhtarian (2010) surveyed individuals and found that overall neighborhood satisfaction is actually higher among those living in traditional neighborhood style developments than in suburban neighborhoods, even after controlling for potentially skewing social and demographic characteristics.

These benefits of such clustered "smart growth" or "New Urbanist" patterns have been well recognized throughout the academic literature. Litman (2012d) summarizes these benefits, recognizing that these practices can "create more accessible, multi-modal, efficient and livable communities. People who live and work in such communities tend to drive less and rely more on alternative modes than in more automobile-dependent locations". More compact patterns of development tend to increase accessibility by decreasing the distance between different uses, which in turn reduces the amount and cost of infrastructure and public services, and overall vehicle miles traveled (VMT). By potentially creating opportunities for walking and person-to-person interactions, clustered development may also contribute to livability (Litman, 2011a).

The idea of developing in denser, mixed-use patterns is not a new one. Urban settlements throughout history traditionally consisted of a mix of uses in one location (Levitt & Schwanke, 2003). Even in the United States, in the early 1900s, before the advent of the private automobile, "suburban" development was characterized by compact form and access to public transit. As the car became more popular and more accessible to the middle class, these patterns began to change. Since 1945, suburban development has occurred primarily in low-density, sprawling patterns. The result is the norm today: low-density, single-use developments with strict separations between them and designed around automobile accessibility (Atash, 1994).

Although the last few decades have seen a renewed focus on a more compact, mixed-use style of development, it is particularly challenging in suburban areas. Assuming a lack of transit access and typical sprawling suburban patterns nearby, it is unlikely that even the best designed project will truly connect people and places in the project with those outside. While certainly denser developments may be easier to implement in more urbanized areas for this reason, there are some advantages to these projects in more suburban areas. Filion (2001) found that suburban mixed-use developments did enjoy some degree of inter-development synergy not found in single-use developments, and have the potential to "become focal points within the suburban landscape" (p.155). To be truly successful, Filion notes that suburbs need high density corridors with good transit access, not just isolated mixed-use nodes. However, these individual developments are successful at intensifying land uses and encouraging walking within them, and have benefits beyond typical suburban developments. As Atash (1994) claims:

> "By bringing homes, jobs, shopping, and recreation together, planners, designers, and developers could create diverse communities where walking, bicycling, and transit is allowed and, thereby, the dependence on the automobile is lessened. This can mitigate the suburban traffic congestion by reducing the number of vehicle trips and their length" (p. 49).

This is further supported by the Urban Land Institute in their *Mixed-use Development Handbook*, which states that "although these new mixed-use developments have not been dominant, they have become increasingly influential" (Levitt & Schwanke, 2003, p. 3).

Importance of parking in mixed-use developments

While more compact development patterns such as those used in mixed-use or 'smart growth' development promote walking to multiple destinations, parking is still a necessary component of these projects. This is well-recognized in the literature. As the Environmental Protection U.S. Environmental Protection Agency (2006) states: "communities and developers recognize that compact, mixed-use, walkable places need parking to thrive" (p.2). Clearly, retail uses need convenient spaces with high turnover for customers to utilize, and any commercial use or office needs spaces for employees. The U.S. Environmental Protection Agency (2006) further states, however, that because residents and employees in mixed-use developments typically drive less, parking rates can more often than not be reduced and/or shared for uses in such a development, a modification to parking standards that many municipalities currently do not allow. The challenge, then, is getting the parking provision right for mixed-use.

The cost of business-as-usual parking standards

Regardless of the mix of uses in a development (or lack thereof), space devoted to parking carries a high opportunity cost. The land area occupied by parking lots in most municipalities could otherwise be used for nearly any other purpose – whether residential, commercial, open space, or another use – that has value, whereas vast lots of unpriced parking do not. Inflexible parking requirements, particularly in areas where uses are clustered, often force developers to provide unneeded levels of parking. This results in wasted money and space that could otherwise be used to accommodate other, better community resources and land uses. In a worst-case scenario, these standards can actually discourage development because the cost of providing high levels of parking is prohibitive (U.S. Environmental Protection Agency, 2006).

Accurate determinations of parking need are obviously important in the pursuit of compact, mixed-use urban form, but also because parking carries so many direct and indirect costs. The construction costs of parking are estimated as follows:

- Surface parking – $1,000-$4,000 per space;
- Structured parking – $8,000-$20,000 per space; and
- Underground parking – $20,000-$35,000 per space (Ben-Joseph, 2012; Institute of Transportation Engineers, 2010).

Making these costs even more significant is that fact that "it is estimated that the annual cost of all parking spaces (garage, surface, and curb) equals that of car ownership, though vehicle expenses are typically paid by owners, while parking costs are spread out over a more complicated system of support" (Ben-Joseph, 2012, p. 17). Much like the externalities of the act of driving itself, parking spaces create a host of direct and indirect costs that, since most parking is provided for free (or otherwise severely underpriced) are paid for by the community as a whole regardless of whether they use the resource or not.

Parking can take up more than 500 square feet per space in some cases, and differs by location (Figure 1) (Marshall, Garrick, & Hansen, 2008). One study estimated that in multi-family residential areas, parking can take up 30% of the built cover, and up to 60% in commercial developments (Cutter & Franco, 2012). Because the cost of land varies widely, this can result in a cost of $300-$10,000 per space depending on the location (Institute of Transportation Engineers, 2010). On-street parking takes up the least amount of space because it does not require the access roads, landscaping, or curb cuts necessary for off-street lots (Litman, 2012b). Parking for mixed-use developments should fall mainly into the first two bars of Figure 1, representing significant savings in both land used and money spent on parking construction over the fourth bar, which represents parking land use in typical suburban developments.

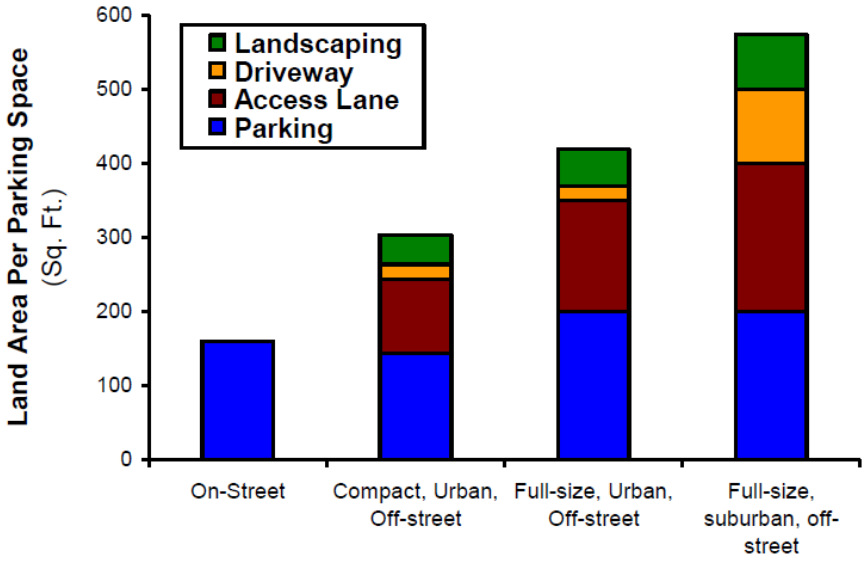


Figure 1: Parking land use by location (Litman, 2012b, p. 11, used under fair use, 2013)

On top of the direct dollar cost, parking inherently has any number of indirect costs. These include congestion from too little, mismanaged, or underpriced parking, urban heat island effects, and potential impacts to local businesses or residents, as well as storm water impacts from large amounts of impermeable surface (Institute of Transportation Engineers, 2010). More surface area devoted to parking and the resulting impervious surface leads to further environmental externalities including increased flood risk, decreased groundwater recharge, and decreased water quality (Cutter & Franco, 2012). Typical parking provision also contributes to sprawl and ultimately to reduced efficiency of alternative travel modes such as walking and biking (Litman, 2012b).

Despite the high direct and indirect costs of parking, patterns of parking provision in the U.S. have generally erred on the side of too much parking, greatly increasing these monetary, societal, and opportunity costs overall. Minimum parking standards in effect create a tax on the square footage of buildings by offsetting any potential increased revenue from more uses with increased construction costs. Furthermore, minimum parking requirements are thought to limit the density at which development can occur (Cutter & Franco, 2012). Parking minimums have been shown to cause oversupply of parking, leading to large, frequently empty lots that limit walkability. For example,Willson (1995) discusses the "golden rule" of 4.0 parking spaces per 1,000 square feet (ksf) of office that so many municipalities have utilized for years and suggests that this ratio, like most standard minimum requirements, is misguided. Multiple parking utilization surveys found peak demand levels at office uses of between 2.0 and 3.0 spaces per ksf.

Problems with typical parking planning

One of the reasons for this parking oversupply is the lack of comprehensive data on parking needs. The result of this lack of information has been that planners and city officials have commonly relied on publications by the Institute of Transportation Engineers (ITE) – *Parking Generation* and *Trip Generation* – to determine the number of parking spaces to provide per use. This is often set as a minimum parking requirement in the local zoning ordinance. This is problematic as most of the numbers in these guides are based on a small number of case studies, many of which are located in suburban areas with uses separated. Therefore, a steadfast

adherence to these suggested standards typically results in parking oversupply (Ben-Joseph, 2012; Shoup, 2005).

Shoup (2005) also suggests that this reliance on the available guidelines may be a product of a lack of instruction in planning education on how to set parking requirements, claiming both that "most texts in regional science, transportation planning, and urban economics…ignore parking" and that "somehow, the urban land use with the biggest footprint and a profound effect on the transportation system has been invisible to scholars in every discipline" (p. 25). Marshall and Garrick (2006) echo this claim, recognizing that parking and its provision is often overlooked in planning academics.

A major component of suburban sprawl and the historic bias toward the private automobile was the growth of parking regulation, particularly in the form of zoning for off-street parking. Suburban parking has typically been based on minimum, zoning-enforced requirements, with the goal of accommodating all drivers and planning for potential changes in use or unusually high peak demands. The justification for what often amounts to an excess of parking in suburban developments is manifold. Municipalities and developers worry about overflow parking from uses with particularly high parking demands, want to plan for possible future uses, and often take requirements from widely accepted parking guidelines (Willson, 1995).

The result of these growth patterns and the uncertainty in planning for parking has been that, for decades, the problem of suburban sprawl has been one of much discussion both in the academic literature and in practice. It is safe to say that Cervero (1988) was correct when he stated in his 1988 article on suburban mixed-use that "suburban traffic congestion has emerged as one of the most pressing problems in the transportation field today and, most probably, will hold center stage in the transportation policy arena for years to come" (p.429). In his article, Cervero criticized the traditional suburban development patterns that consist of single-use centers that, in contrast to varied and well-designed urban centers, require high levels of private vehicle use to get from place to place.

Given that parking minimums have contributed largely to dispersed, single-use, sprawling development patterns common in suburbia, then mixed-use development, when designed with amount and location of parking as a major consideration, presents an opportunity to decrease the amount of land devoted to parking and its associated costs. The remainder of this literature review explores common strategies employed in mixed-use developments to decrease parking demand and supply, which in turn serve to provide a walkable, pedestrian-oriented development, and can potentially reduce the number of vehicle trips taken.

Parking for mixed-use

A well-designed mixed-use development will depend on any number of factors, including the mix of uses, the location, design, and the character of the surrounding area. One of these factors is parking – there is no doubt that parking is inextricably linked to suburban development, single-use or otherwise. As ULI states in their *Shared Parking* manual, "ultimately, great parking alone won't make a mixed-use project successful; however, inadequate or poorly designed parking can limit its potential success" (Smith, 2005, p. 1). Litman (2012b) identifies the (theoretical) differences in parking between traditional suburban development and more compact "smart growth" development (i.e., walkable mixed-use). These crucial differences are summarized in Table 1.

Table 1: Conventional versus compact parking policies

Conventional (Low-Density) Parking Policies	**Smart Growth (Compact) Parking Policies**
Managed for motorist convenience	Managed for transportation network efficiency
Maximum parking supply	Optimal parking supply (not too much or too little)
Free parking preferred	Priced parking preferred
Dedicated (unshared) parking facilities	Shared parking facilities
Adapted from Litman (2012b, p. 16)	

Forinash, Millard-Ball, Dougherty, and Tumlin (2003) stress that the parking should be tailored to the type of development – in this case, mixed-use – and should take into account the development's size, density, pedestrian and transit infrastructure, and the surrounding mix of uses rather than blindly applying the rates meant for isolated uses in suburban environments.

The link between parking and mixed-use has been explored in some of the associated literature. A study that examined the built environment's impact on travel demand identified parking as "a particularly important urban design feature . . . in terms of both supply and location vis-à-vis

streets and buildings" (Ewing & Cervero, 2001, p. 101). Levitt and Schwanke (2003) note that "parking is an integral component of most mixed-use developments and can significantly affect the project's overall operational efficiency, image, and success" (p. 211). In mixed-use developments, the amount, type, price, and location of parking are all factors that directly impact the walkability and land use efficiency of the development, but little discussion exists in the literature regarding the close relationship of the mix of uses and parking provision/regulation. Ewing and Cervero (2001) recognize this lack of parking research in travel studies, indicating its potential to be a high-payoff area in future research.

A study in Puget Sound, Washington, underscores this trend of overlooking parking's role in well-planned mixed-use developments. An examination of projects in 19 different areas in the Puget Sound area found that less than half of the study areas included any elements of parking guidelines in their regulations (although over half had regulatory elements regarding mixed-use/compact development). Looking at 163 individual projects across these areas, fewer than 30% of projects were found to address parking in any way (Kavage, Moudon, Mabry, & Pergakes, 2005). Thus, parking was not only an area rarely addressed across Puget Sound land use regulations, but also was not frequently incorporated into regulations that did address compact development and/or mixed-use, despite the fact that the amount and location of parking plays such a large role in dictating the compactness of a development.

Some localities have realized the importance of parking's role in any development. These note that it can be one of the single largest land uses in any given municipality's footprint, and that providing dedicated parking to meet the peak demand for each individual use has the effect of increasing pollution, making affordable housing less viable, and encouraging sprawling land use patterns that also discourage walking and biking (Chicago Metropolitan Agency for Planning, 2012). Surface parking can be one of the largest sources of dead space in any given area. A smart growth manual released by the Environmental Protection Agency (EPA) (Ewing, 1999) suggests that parking should never exceed nine percent of total surface area in a development for this reason, adding that "beyond that, people sense that the environment is no longer theirs but rather belongs to automobiles" (p.14).

While several guiding documents for parking provision have been developed, including *Parking Generation* by the Institute of Transportation Engineers (ITE) (2010) and *Shared Parking* by the Urban Land Institute (ULI) (Smith, 2005), even these publications base their parking generation and occupancy rates on a very small number of case studies, and do not recommend a hard and fast adherence to these standards. However, Shoup (2005) and others have noted that the limitations of these documents do not prevent many municipalities from adapting the recommended parking levels anyway, for lack of additional guidance.

Approaches for reducing parking

Although the literature regarding parking in mixed-use developments is not extensive, there is some evidence that clustering uses does decrease the actual amount of parking needed. Furthermore, reduced parking may influence reduced driving. As Kavage et al. (2005) state, "a limited parking supply will encourage people to carpool or use transit or nonmotorized modes" (p.45).

A study of six sites in small towns and cities in New England (three mixed-use, three conventional) found that although the mixed-use developments provided less parking in proportion to building areas as compared to the conventional developments, parking was still never fully occupied. Further, the parking required by local zoning regulations was significantly higher than that used during peak times for *all* of the developments (Marshall & Garrick, 2006). Minimum parking requirements are drivers of sprawl and originated from a methodology of providing peak-hour-level parking for a single use in a suburban environment. It is not logical, then, to employ these same rates for more compact, walkable urban form. Furthermore, an overall reduction in parking provided for nonresidential uses has been shown to reduce the number of internal vehicle trips in a mixed-use development (Melia, Parkhurst, & Barton, 2011).

A number of methods exist for use in place of minimum parking requirements. Shared parking in particular is closely associated with mixed-use environments and will be discussed in more detail later. Another method is the setting of maximum parking requirements in the place of, or along with, parking minimums. These limit the amount of parking that can be built by setting ratios per unit, ksf, or other land use measure, in the same way that minimums are set. Benefits of this kind

of parking requirement include reduced environmental impacts, opportunities for more compact urban form, and reduced costs to developers (Forinash et al., 2003).

Where parking maximums may not work in every place or may represent a change too politically unpopular to be feasible in suburban areas, a similar effect may be achieved by simply eliminating minimum standards, thus allowing private developers to set the amount that they see fit (Willson, 1995). Allowing the private market to have a hand in parking provision may also take some of the guesswork out of the equation for localities. Since it is in the developer's best interest to both provide enough spaces for economic success, but also to avoid spending more money than necessary on constructing a land use that does not directly provide any economic benefit in its own right, this is one method of approaching the problem of finding the right amount (Weinberger, Kaehny, & Rufo, 2010).

When removing the minimum requirement altogether or replacing it with a maximum is not possible, communities may choose to review and recalibrate the appropriate minimum standards for mixed-use areas. Having a separate zoning district for denser development areas, or developing neighborhood or site-specific plans with reduced requirements can help address the oversupply problems caused by minimum parking requirements while not removing those minimum requirements entirely (U.S. Environmental Protection Agency, 2006). Area-specific parking requirements in the form of zoning designations can avoid the common pitfalls of using blanket standards for an entire municipality, and "if the zones are chosen well, they can be effective and require little in the way of an institutional overhaul to implement" (Joshua & Dylan, 2010, p. 31).

Real-world applications of these methods are not well documented in the literature, particularly in suburban environments, and certainly they represent a departure from typical suburban planning for parking. However, Marshall and Garrick (2006) optimistically claim that "the debate about parking has shifted in the last decade.…Now the focus is less on providing sufficient parking to meet demand and more on ensuring that parking does not overwhelm the desire for vibrant places" (p.164).

Shared parking

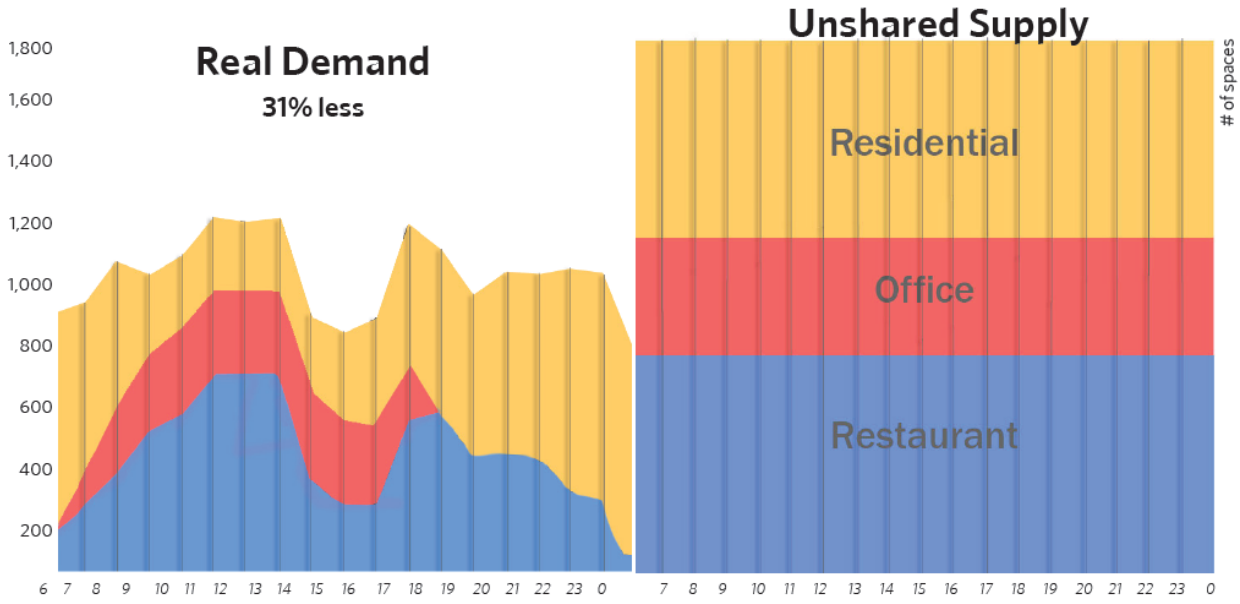
One of the benefits of clustering different uses together, even when the development occurs within an otherwise dispersed suburban environment, is the opportunity for those uses to share parking (Cervero, 1988; Litman, 2012c). Although the commonly cited method of shared parking encouraged by the Urban Land Institute (ULI) was developed in the 1980s and has evolved since, the strategy was originally the norm in early days of parking planning. Historically, downtown centers shared parking spaces rather than reserving specific parking spaces for each individual use (Smith, 2005). It makes sense then, that suburban localities trying to return to the clustered design of villages and town centers through mixed-used patterns should embrace the sharing of parking resources.

Shared parking can work in two ways (a development may utilize one or the other, or both). The first reduces the parking requirements for individual uses that exist near other uses with different peak time periods. In other words, each use takes turns using the majority of a shared pool of parking in shifts. The second way uses can share spaces is in an area where instead of driving to each location, motorists park once and walk to multiple destinations (Childs, 1999).

Both of these sharing situations can be achieved where a variety of uses are clustered. Thus, this parking strategy is a perfect match for the pattern of development encouraged by mixed-use since "shared parking encourages the centralization, consolidation and reduction of a neighborhood's parking facilities, thus improving urban design and allowing more productive land uses" (Weinberger et al., 2010, p.45). Obviously, different land uses have different peak hours and thus different parking needs at different times of day and times of the year. Movie theaters and restaurants, for example, have much different peak parking times than most offices. Litman (2012c) encourages shared parking for these reasons, noting that this strategy capitalizes on the fact that most parking spaces are not needed all of the time by any given land use or group of motorists. Under business-as-usual parking requirements, this situation leads to parking oversupply. As Nelson et al. (2009) state:

> "In mixed-use environments, parking should be treated as a utility, not an on-site private activity. Requiring each landowner in a downtown to provide private parking on his or her parcel is akin to requiring each landowner to drill his or her own water well" (p.15).

When multiple uses are located in the same development, the total parking requirements for that mixed-use site are in theory, much lower than the parking requirements as calculated for each individual use and summed together (Cervero, 1988). Compared with the standard of requiring off-street parking on a use-by-use basis, Litman (2012c) suggests that sharing parking amongst uses can result in a reduction in required parking of 40-60%. To illustrate, the Chicago Metropolitan Agency for Planning (2012) provides a figure showing the differences in parking demands for shared parking schemes (Figure 2). The figure clearly shows how significant parking savings can be when shared among uses based on need per time period, rather than required for each separate use based on the absolute maximum number of spaces needed during that use's peak time.



This graph shows the demand for parking by time of day, which varies for different uses. By sharing parking between uses with different peak demand periods, the total parking necessary is significantly reduced. (Image courtesy of Nelson / Nygaard, 2011)

Figure 2: Potential spaces saved using shared parking vs. unshared (Chicago Metropolitan Agency for Planning, 2012, p. 22, used under fair use, 2013)

Aside from the obvious cost savings from reducing the overall number of parking spaces provided, less parking reduces the amount of space between buildings, and between sidewalks and storefronts. This can encourage walking trips while minimizing sprawl (Cervero, 1988).

In addition to varied peak times of different land uses creating optimal conditions for sharing parking, a certain captive market effect may also decrease the need for parking, allowing it to be shared more effectively. The idea is that the clustering of uses can promote multipurpose trips in which a visitor drives to the development, parks once, and visits multiple locations. While the overall impact of this phenomenon is not well known or documented, mixed-use developments most likely enjoy some degree of multipurpose trips involving the consumer walking between destinations. It also makes sense that those who work or live in the development would patronize local businesses to some degree, saving a vehicle trip when they do so (Levitt & Schwanke, 2003; Smith, 2005). Furthermore, Cervero (1996) suggests the additional benefit of mixed-use buildings helping to spread traffic out over the course of the day (a lower peak commuting hour effect). This variation in peak hours lends mixed-use developments to shared parking arrangements.

In mixed-use developments, the conditions for sharing parking are ideal since the potential for shared parking is highest when uses are clustered together (Litman, 2012c). However, "the concept of Shared Parking is well known, but it is often discouraged by current planning practices. Conventional planning often reflects an assumption that communities want the greatest possible supply of parking provided at the lowest possible price" (Litman, 2012c). However, the belief that shared parking somehow risks undersupplying parking is against the very goals of such a strategy, which include minimizing excess land and resource use while providing adequate parking to support a development economically (Smith, 2005).

It is important to recognize that depending on the type and location of spaces, parking can be shared at different levels. Litman (2012c) identifies unassigned on-street parking as having the greatest sharing potential, while office parking shared by employees or retail parking shared among a variety of shops and restaurants (such as at a mall) or a lot shared between two or more uses with opposite peak times has a secondary degree of sharing. A parking space directly assigned to a resident or to a commercial use is not shared at all. Compared to assigned spaces, shared on-street spaces often have three times the amount of time occupied annually. Because of this, efficiently shared spaces can greatly decrease the necessary amount of parking for a mixed-use development.

Where appropriate, shared parking can also be funded by requiring the developer to provide a fee in lieu of the amount of parking normally required for that building or development (or, the municipality can offer it as an option to developers). This would allow the locality to provide and pay for public parking for the development as a whole rather than requiring a separate private lot for each use (Litman, 2012b). The municipality may set these fees on a case-by-case basis, or by setting a flat fee for parking spaces not provided (Forinash et al., 2003). Regardless of methods used, in-lieu fees can have a number of benefits, including reduced construction costs, better (fuller) utilization of existing parking, and better design which avoids excessive on-site spaces. Planners can maximize the benefits of in-lieu fees by ensuring that the resulting public parking is centrally located and appropriately sized and managed (Forinash et al., 2003).

Several real-world mixed-use developments have successfully reduced the overall parking supply using shared parking. The Market Common in Clarendon, VA is a mixed-use case study that the U.S. Environmental Protection Agency (2006) identified as a model for shared parking. As a development with a mix of residential, retail, and restaurant space as well as adjacent offices, the Market Common would have required 1,504 spaces under the local code, already a reduction from typical parking requirements (which would have set the requirement at over 2,000 spaces). Utilizing a shared parking strategy, the development was able to reduce the requirement to 1,160 spaces (a 25% reduction). This development employed several complementary strategies to ensure the success of this mixed-use shared parking development, including:

- Undesignated spaces – all parking is available for any use;
- Parking costs unbundled from rent for residents ($25 for first car, $75-100 for second);
- Parking is priced; and
- Proximity to transit and bicycle accessibility decreases car use.

Even with the greatly reduced parking requirements, there is some evidence to suggest that the development currently does not fully use the existing parking; both the County and developer intend to count any surplus parking toward future phases of the Market Common development (U.S. Environmental Protection Agency, 2006).

Similarly, the NASA Research Park (NRP) development on the periphery of Silicon Valley in California implemented innovative shared parking strategies. This was allowed, in part because as Federal Land, it is exempt from parking requirements in any city or county code. Under typical minimum parking requirements, such a development would require 7,542 parking spaces. The development instead will include 5,200 spaces, based on expected numbers of people on site at any given time, rather than calculated for individual uses. Supporting strategies include:

- Bicycle and pedestrian paths and infrastructure;
- First-choice priority for on-site homes for employees who work on the site;
- Parking fees weighted so that those who park less pay less; and
- 75% of spaces are shared among *all* uses (U.S. Environmental Protection Agency, 2006).

How should parking be shared?

While much of the literature on shared parking touts its efficiency and applicability to mixed-use developments (in some cases almost treating it as a given), the appropriate ratio at which parking is shared can be difficult to determine and may differ based on the local character and the mix of uses. Piell (2009) identifies shared parking as a challenge in mixed-use developments, cautioning somewhat paradoxically that "shared parking…has to be separated" (Bill Feinberg, as quoted in Piell, 2009, p. 3). The complex relationship between retail and residential uses must be addressed in mixed-use developments, and there is little agreement as to how much parking should be shared, particularly between residential and other uses. Piell (2009) recommends spaces specifically reserved for residents, while on the other hand, several real-world case studies discussed above have found success with up to 100% of the parking shared and available for any use (U.S. Environmental Protection Agency, 2006).

When designed and calculated correctly, shared parking is developed around the peak parking times for each use in the mix. Litman (2012c) has identified peak hours for a variety of uses (Table 2). Uses with weekday peaks could easily share large percentages of overall required parking with those uses with high weekend or evening peaks.

Table 2: Peak parking demands

Weekday Peaks	Evening Peaks	Weekend Peaks
Banks	Auditoriums	Religious institutions
Schools	Bars and dance halls	Parks
Distribution Facilities	Meeting halls	Shops and malls
Factories	Restaurants	
Medical clinics	Theaters	
Offices		
Professional services		
Replicated from Litman (2012b)		

Because the majority of land uses in a suburban, single-use context do not need all of their dedicated parking spaces at all hours of the day, it is logical to overlap or share parking with other uses, particularly when those other uses have peak hours at opposite times. ULI's *Shared Parking* (Smith, 2005) is built around this concept. The methodology identifies separate base needs, both weekday and weekend rates, for each use in a development as if parking was determined separately. It then applies monthly and hourly adjustment to each use in the project based on the peak times. Applications of this methodology will be presented and analyzed in Chapter 3.

Location of parking

The location of provided parking is also a concern in mixed-use developments, since the placement of spaces can directly influence the walkability and aesthetics of a development. Litman (2012c) suggests a hierarchy for types of parking provided in mixed-use developments:

1. On-street parking on main commercial streets (best if regulated, using either pricing or time limits, for maximum turnover);
2. Off-street public parking/additional on-street parking; and
3. Off-street private lots (can still be shared between two uses with opposite peak hours, i.e. a bar and a church).

A discussion of various parking locations follows.

On-street parking

On-street or curbside parking has had a long and complicated history in the US. In the early days of the automobile it was the only parking available, but as private automobile ownership

permeated the middle class, many cities began having problems with curbside parking. It was often found to impede traffic flow or even cause accidents, and meters were often hard to enforce, leading to abuse of on-street spaces by motorists. As early as 1920, cities began restricting this on-street parking (Marshall et al., 2008). Ultimately, required off-street parking that was enforced through zoning became the norm in most U.S. cities. These standards remain in effect in most places today (Shoup, 2005; Weinberger et al., 2010).

On-street parking has not always been considered beneficial, particularly in urban areas after the advent of the automobile. Today, with developments, mixed-use and otherwise, moving toward accommodation of non-motorized travel, some benefits of on-street parking have been identified. It can be considered more efficient than off-street parking because of its higher demand and thus higher occupancy. For this reason, curbside parking can be beneficial to a municipality that prices these spaces accordingly. Due to the convenience factor, curbside parking can also enhance patronage of local businesses. In fact, one of Los Angeles' early curbside parking bans led to a decrease in retail business in the area (Marshall et al., 2008).

Furthermore, and specifically beneficial for mixed use, are the theories that on-street parking can be one of the best ways to share parking, and also that on-street parking is more efficient in terms of land use. The land per parking space ratio is lower for curbside spaces as opposed to those in off-street lots because no access lanes, driveways, or other curb cuts are needed, not to mention the additional landscaping often included in and around surface lots. Access lanes and driveways alone can more than double the amount of land devoted to parking (Marshall et al., 2008).

Large amounts of on-street parking, as either parallel or angled spaces, have been shown to make the overall parking supply in a mixed-use development more attractive and functional (Levitt & Schwanke, 2003). In a mixed-use development, on-street parking can provide a buffer between pedestrians and automobile traffic while also enhancing the pedestrian environment by minimizing the distance between walkways and destinations (Figure 3). Ideally, curbside parking acts as a one-to-one replacement for off-street spaces. Thus, on-street spaces should be counted against the required off-street parking (Ewing, 1999). Allowing developers to count on-street spaces toward the total they are required to provide serves to meet dual goals of reducing the

physical and visual disconnect for pedestrians while minimizing necessary spaces in surface lots that cover so much of the land in developments.

Figure 3: Vehicle-oriented versus pedestrian-oriented parking design (Ewing, 1999, p. 10, used under fair use, 2013)

In support of these on-street parking benefits, a study by Marshall et al. (2008) that analyzed six mixed-use town centers found that on-street parking is highly efficient in regards to both overall land use and cost. They found that curbside parking was the most efficient method of parking provision, in that while off-street surface parking typically required 513 square feet per parking space, on-street spaces typically used less than 176 square feet, about a third of the space required for off-street parking. Much of the difference was due to necessary alleys/access roads and landscaping/parking islands found in surface lots. As an example, the authors explain that in a development with a requirement of 2,000 parking spaces, the development could save more than 2.3 acres of land if just 15% of this parking was provided on-street.

From an economic standpoint, this cost and land savings is significant. Marshall et al. (2008) found that these mixed-use town centers with on-street parking were able to achieve much higher levels of development density, higher floor-to-area ratios, and significantly more leasable building space. Finding a whole host of benefits from curbside parking, the authors stress that:

> "On-street parking is not purely a device to be used in the right environment; rather, it is also a tool to help create that right environment. On-street parking should be used more commonly but especially in situations in which the street is part of the destination and the

> intent is to cause drivers to slow down and recognize that they have reached a place. Results show that these places with on-street parking tend to be safer and more walkable, require less parking, and have much more vitality" (Marshall et al., 2008, p. 51).

While most mixed-use developments do incorporate some on-street parking spaces, the method in which they do so is often different. An EPA advisory document on smart growth (Nelson et al., 2009) stresses that because curbside spaces are the most "valuable" in a development, care should be taken to maximize the number of spaces in this location. One of the easiest ways to do so is by implementing diagonal rather than parallel parking which can increase the number of spaces per block by as much as 30%. Other authors encourage placing a price or time limit – or both – on these spaces for efficient turnover (Litman, 2012a; Weinberger et al., 2010). Shoup (2005) suggests that time limits are generally inefficient and difficult to enforce, noting that pricing is a much better way of encouraging turnover.

Pricing may also encourage reductions in parking demand and thus overall supply. The Institute of Transportation Engineers (2010) suggests that in general, parking demand can be expected to decrease by 3% for every 10% increase in the cost of parking. Furthermore, a study of three suburban mixed-use centers in Toronto found that workers were more likely to walk to other destinations in the development in the project that did not have free parking – where parking was free, they were more apt to drive to other locations in the development (Filion, 2001).

Off-street parking

Mukhija and Shoup (2006) argue that possibly more important than the amount of parking supplied is the location of that parking. For mixed-use developments where pedestrian accessibility is crucial, lots located between sidewalks and building entrances create a sense of disconnect while negatively impacting overall pedestrian access in that it makes places harder to walk to. Instead, the authors suggest locating off-street parking to the rear of buildings to avoid destroying the desired aesthetic of the pedestrian-oriented street front. While this method can be accomplished with access to off-street lots between every building, an even better approach is to provide access to the rear lot from a side street or alley without having gaps between buildings. This has the dual effect of reducing vehicle disruptions of the pedestrian walkway while allowing

the maximum space possible for curbside parking. As discussed previously, increased curb parking in turn provides a buffer between pedestrians and vehicle traffic and maintains the desired 'main street' aesthetic. By attending to the type and location of parking rather than just the gross number of spaces, planners and developers can help influence a better New Urbanist, pedestrian-focused design. As Mukhija and Shoup (2006) state: "market forces can ensure an adequate number of parking spaces, but the economic incentives for good parking design are weak" (p. 305-307).

ULI outlines several potential strategies for off-street parking, including the use of many small surface lots in lieu of several large lots. This prevents the sea of asphalt effect and makes it easy to conceal lots behind buildings or with creative landscaping. Regardless of design, parking should always connect to the development's uses with pedestrian connections (whether those be sidewalks, bridges, or others) and should be located in close proximity to those uses to minimize walking distance and inconvenience (Levitt & Schwanke, 2003).

An American Planning Associate (APA) manual on model codes (Morris, 2009) suggests not only that mixed-use zoning ordinances require off-street parking to be located behind buildings and/or otherwise hidden from the public right-of-way and residential areas outside of the development, but also that they do away with off-street parking requirements altogether under certain conditions. Specifically, APA's recommended approach is not requiring off-street parking for any nonresidential use of 3,000 square feet gross floor area (GFA) or less, and otherwise only requiring off-street parking for the amount of space in excess of 3,000 square feet.

Off-site parking

In a mixed-use development more than anywhere else, treating parking as an on-site, private activity works against the compact, walkable land use this kind of development seeks to provide. Some municipalities have developed ordinances that allow the required amount of parking to be provided off-site, so long as the lot is within walking distance of the development (600-1,000 feet). These facilities may be shared among several uses privately, or treated as public facilities (Nelson et al., 2009).

Structured parking

Although more expensive, it is also possible to establish structured parking/garages to provide more parking spaces on the same footprint. When used in mixed-use developments, these structures should take care to not interfere with the pedestrian-oriented landscape. Some mixed-use developments have utilized bottom floors of parking structures as commercial space or surrounded structures with residential or retail uses (Levitt & Schwanke, 2003). Because the per-space cost is so much higher than that of surface parking, the "'rule of thumb' is that structured parking typically becomes economically viable in high-density suburban areas when property values exceed $30 per square foot of building type" (Bier et al., 2006, p. 7).

Structured parking can be particularly useful in mixed-use developments since the land-per-parking space requirement is reduced. A four-story parking garage, for example, uses about a quarter of the land per space as a surface lot of the same capacity. Despite the large construction cost, structured parking has a lower land cost and allows for greater development density (Litman, 2011b).

Challenges

As mentioned previously, although some guidelines exist for helping planners determine the amount of parking adequate for a development, the scope of these handbooks is limited. What data is available is often outdated and unreliable (Levitt & Schwanke, 2003). And in spite of ITE's cautions against using their calculations as the final word in parking demand, they also assert that their *Parking Generation* report "contains the best available data on the subject of parking demand related to land use" (Institute of Transportation Engineers, 2010, p. 2). In addition, it is common practice to add an additional 10% to ITE base parking numbers to ensure that parking is readily available and easy to access for drivers (Lee, Rees, & Watten, 2010). To their credit, the Institute of Transportation Engineers (2010) does suggest that their data only be used as a starting point for determining parking generation, and that their calculated ranges, not just averages, should be used in parking need calculations. Whenever possible, local characteristics should be taken into account rather than strict reliance on ITE numbers. However, this advice is not always adhered to, since it presents an additional level of complexity to parking calculations.

Beyond the challenge of finding the right number or ratio for parking generation, in a real-world situation, the wide variety of stakeholders can be an additional hurdle. A development with a varied mix of uses means more tenants and kinds of tenants. This results in more people invested in the development in some way, all with different opinions on how much parking to provide and where. ULI gives an anonymous example of a developer involved in a mixed use project who was able to prove that the development could achieve even higher levels of sharing than those found in the ULI *Shared Parking* manual. However, the locality demanded that the development follow the ULI guidelines, resulting in a parking oversupply. Public officials want to build enough parking that nobody ever complains, but the result is often excess parking that mitigates the benefit of mixed-use land use patterns (Levitt & Schwanke, 2003). Furthermore, one study on neighborhood preferences suggests that suburban residents actually do not care as much about the amount of parking provided as they do other neighborhood characteristics like pleasing aesthetics and safety (Lovejoy et al., 2010).

This skepticism on the part of county or city officials is one of the barriers to implementing shared parking in a mixed-use development, and the limited data currently available does little to help this. Furthermore, residents often want to ensure that they always have conveniently-located spaces available for their use when they need it, and so often want dedicated spaces that they would not 'share' with other land uses. This is counterintuitive since residential uses have the potential to share well with offices or other uses with peak hours in the 8am-5pm timeframe (Levitt & Schwanke, 2003). While many municipalities caution against supplying too little parking, Childs (1999) suggests that ultimately, individual drivers and their community as a whole will adapt to the parking that is provided. Just as ample free parking can induce demand for more driving trips, limited parking may encourage ridesharing, a spreading out of peak hours as drivers choose to run errands at other times, or utilization of public transit or alternate modes where available.

Even with guidelines and up-to-date data, the determination of parking appropriate for each individual development is a complex process, often requiring local parking studies, rezonings,

and other considerations or actions. Parking provision for mixed-use is also a complicated balancing act of finding the right amount. As Nelson et al. (2009) recognize:

> *"…too much* parking can be a serious issue, but so can *not enough* parking. Regulating parking supply became common in the first place because of the issues caused when developers provided inadequate parking and parking spilled over into nearby neighborhoods. What is generally needed is 'the right amount' of parking, which can vary widely by place and by time. Good parking systems are carefully balanced to be specific to their settings and are adaptable to changes over time" (p.14).

With these strategies and challenges in mind, particularly as they apply to Chesterfield County or other similar suburban municipalities, three separate but interrelated research questions were developed. These are:

1) How is parking provision determined, and managed, in suburban mixed-use developments?
2) What "best practices", if any, have been shown to be effective in supplying and managing parking?
3) Does an ideal mix of uses exist that allows for greater parking reduction, and thus increased pedestrian utility, based on local observations and/or the ULI shared parking methodology?

Methodology

To address the research questions above, a two-part methodology was developed.

Part one: Survey development and case study identification

With input from Greg Allen, Senior Planner at Chesterfield County's Planning Department, and in part based on common or recommended practices and strategies identified in the literature as being related to parking for mixed-use developments, a brief list of questions was developed. These questions addressed the number and type of uses, the number and location of parking spaces, pricing strategies, and other factors. The questions can be found in Appendix A.

Identifying case studies to explore began again with input from Chesterfield's Planning Department staff. A number of mixed-use projects that they recognized as best practices or good

models for their own future development were suggested as case studies. Several others were identified from the literature, having been recognized in some way as a good or innovative example of suburban mixed-use. From a preliminary pool of cases, a snowball process was allowed wherein some of the planners or developers who were contacted suggested additional developments or cities which had demonstrated exemplary mixed-use planning. A total of 13 case studies were identified as suburban mixed-use developments that were identified in some way, either by the literature or directly by other planners doing similar work, as good examples. Ultimately, eleven of these had contacts that were able to answer the questions.

Collected answers were analyzed for trends in qualitative data as to how the parking requirement had been determined for that development, how/if parking was managed, and general lessons learned. These cases were also compared to the literature to examine how well they followed certain recommended practices. Results are presented in Chapter 2.

Part two: ULI shared parking analysis

During the course of collecting responses, a limitation was identified early on: many of the planners contacted did not have access to, or knowledge of, some of the quantitative information requested regarding number of parking spaces or sizes and types of uses in the development. Developers contacted for this information were largely unresponsive. Due to the lack of detail from most of the planners surveyed, ULI case studies from the case study database (Urban Land Institute, 2010) were explored as an alternative to the quantitative section of the analysis. Specifically looking at case studies of mixed-use development located in suburban or small town locations, numbers and sizes of uses and parking spaces in the development were collected for analysis.

For each case, the methodology described in ULI's *Shared Parking* (Smith, 2005) was used to determine: 1) the amount of base parking needed if parking was provided separately for each use in the development[2], and 2) the amount of parking needed if parking was shared amongst the

[2] Base parking rates provided by ULI were used to be able to compare the relationship between the mix of uses and the required parking consistently across cases.

uses in that development. The shared parking calculation process is described in more detail in Chapter 3.

Results of these shared parking calculations were analyzed, and from there, the development that achieved the greatest potential parking reduction using a shared parking strategy was used as a starting point for a scenario analysis. This analysis used the proportion of uses in the best case development (Downtown Silver Spring, MD), and altered them based on a number of scenarios, with the goal of identifying an optimal allocation of uses that allowed for the greatest parking reduction. This analysis, in addition to looking for an "optimal" balance of uses that can use the least amount of parking, also demonstrates the utility and limitations of ULI's shared parking methodology as a tool for municipalities.

Chapter 2: Case Studies

This section describes each of the suburban mixed-use developments for which planners or developers completed the author's mixed-use parking questions. Both quantitative and qualitative data was collected. Planners and developers were asked about the types and sizes of uses in the development, the amount of parking provided, methods or resources used to determine and implement that parking provision, and how/if parking was managed using pricing. The questions can be found in Appendix A. The following sections describe each case study, giving a brief history or description of the development when available, listing quantitative characteristics of the development, and continuing with a discussion of the overall parking provided, strategies used to provide and manage that parking, if any, and successes of the development or lessons learned, where applicable.

Chester Village Green, Chester, VA

Figure 4: Chester Village Green aerial image (Google Earth, 2012b, used under fair use, 2013)

Chester Village Green is the first vertical mixed-use development in Chesterfield County. In part due to the suburban nature of the county and its development, the project was a long time in the making and subject to numerous roadblocks and issues. At the time when the development neared completion in 2007, it had been in planning and development for 18 years. The idea for the development had come about in the late 1980s, a time when the New Urbanist style of development was a new concept for a suburban area like Chesterfield County (Hazard, 2007).

The project was designed to recapture the traditional village-style development of the past that would replicate the feeling of a town center neighborhood from the early 1900s. Designed to be walkable and pedestrian-oriented, with residences built on smaller, more densely clustered lots with smaller setbacks on narrow streets, the development includes a detached residential

neighborhood in walking distance from the village center, which includes public space as well as local shops and restaurants with apartments above (Calos, 2008). The development also includes a four-story retirement community (Hazard, 2007). The project planners and developers recognized that New-Urbanist development was not likely to completely replace traditional suburban development, as the desire for single-family residential units on large lots is still prevalent in the area. However, Chester Village Green and developments like it provide an alternative that was not previously commonly available in the greater Richmond area (Calos, 2008).

Chester Village Green is a unique mixed-use development in many ways, one being that it was a project created primarily by the community, with the local citizens and business owners pushing the project along. By 1996 the team had zoned and acquired the majority of the site, but getting developers on board with what was then a new concept for the greater Richmond area – New Urbanism – was another challenge. The developers who initially stepped in to develop the residential portion of the project were originally set on traditional single-family residential homes with large setbacks and backyards, but eventually realized the potential benefits of a denser, New Urbanist style of residential development. They modified their original plans to have homes with porches close to the street, with shared common space and small backyards. Additional residential units were built as apartments above ground floor and retail space (Hazard, 2007).

Obtaining the exact number and size of uses in the development was impossible as the development is currently in flux and subject to change in the type of uses provided in the future. Overall size and number of residential and non-residential buildings/units are provided in Table 3 (Lamson, 2012; Ramsey, 2012).

Table 3: Chester Village Green Characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
29 acres	87,500	279 total – 163 age restricted	1,098	On-street and surface lots

Parking in Chester Village Green

Chester Village Green is unique in its status as Chesterfield County's first (and currently only) vertical mixed-use development. As such, no separate mixed-use development parking standards exist in the County's Zoning Ordinance, and instead, the development was subject to the rate of 4.4 parking spaces per square foot of nonresidential use required for the general shopping center designation (Lamson, 2012). Several additional reductions were allowed, as described below, consistent with the parking section of Chesterfield's Zoning Ordinance which states that:

> "Except for shopping centers, in the case of mixed use developments parking spaces shall be provided on the basis of the sum of the required spaces for each use, or based on site design and the specific mix of uses. A reduction in the required number of parking spaces based on shared use by activities having different time demands for spaces, and/or provision of pedestrian ways between uses, may be granted through site plan and/or schematic plan review" (Officials of the County of Chesterfield, 1997, Sec. 19-512)

The County did not embrace a shared parking strategy for the development. However, it did allow for a reduction in the parking requirement for an age-restricted home. Normally, two spaces are required per dwelling unit; this was reduced to 1.049 spaces per unit on the basis of local market data that suggested that the average tenant of senior rental housing is over 70 years old and may not drive at all, and comparisons to other similar developments that provided only one space per unit, which was found to be adequate. This resulted in 171 spaces required, and 182 provided for the 163-unit senior rental housing complex.

Further parking reductions of up to 10% were allowed concurrent with the provision of sidewalks or other pedestrian connections (Lamson, 2012). This suggests that Chesterfield County does recognize the ability of a mixed-use project to encourage walking trips within the development, and that some of these may replace driving trips.

Overall, the development provides 1,098 parking spaces, as per a parking study conducted in late 2012 for a Board of Supervisors meeting (Ramsey, 2012). Of these, 182 are specific to the age-restricted housing, 84 are located on private and public streets, and the remaining 1,014 supplied in on-site surface lots. When asked if the development allows for "shared" parking, Lamson

(2012) states that the spaces other than those reserved for the senior housing project are shared among uses, i.e., they are not restricted to a specific use. However, the amount of parking required is calculated separately by use. Thus, while the spaces provided are ultimately not restricted to use by the building that provided them, there has been no attempt to calculate shared rates among complementary uses. Also of interest, while on-street spaces are allowed to count toward the total provided by each use, spaces are allotted on a first-come-first-served basis, and once they are allotted to that use, they cannot be counted towards the required parking of another use (Ramsey, 2012).

Lamson (2012) notes in his survey that while the development is nearly built-out, some of the retail uses are currently vacant, and so an accurate assessment of parking standards used is not yet feasible. As the development continues to fill out and evolve, it will be interesting to see how parking requirements are handled. Already, the per-use parking rates have shown some effects as a potential inhibitor to future development in Chester Village Green. As mentioned earlier, a recent Planning Commission case would not allow construction of a residential building. This was in part due to the concern that the proposed building would not be able to provide adequate parking for the number of residential units (Ramsey, 2012).

The issue here is that even counting the required 88 spaces of the proposed multifamily housing development, looking at the parking in the project as a whole, the total number of spaces actually exceeds the number required (1,098 and 1,084, respectively) when summed across all individual uses. However, since Chesterfield County still requires parking to be counted on a per-use basis, there is no consideration of the potential impact of complementary seasonal or temporal requirements of various uses.

West Broad Village, Henrico, VA

Figure 5: West Broad Village aerial image (Google Earth, 2012e, used under fair use, 2013)

West Broad Village, touted as "the Richmond area's first significant embrace of new urbanism" (Slipek, 2013), has been somewhat of a surprise success story. The project began at the height of the recession, and in 2009, the collapse of the housing market and greatly decelerated retail expansion trends threatened the completion of the mixed-use development. Ultimately, funding from the private sector allowed the project to become fully realized (Hirschler Fleischer, 2012).

This mixed-use, New Urbanist development represents a major step away from the single-use development patterns of the largely suburban surrounding area. Located just off of a major thoroughfare that runs through the heavily congested Short Pump area, the self-contained, pedestrian-oriented community serves as a contrast to the surrounding high-traffic areas. It has been designed as an upscale development that includes four and five story mixed residential and commercial buildings, townhomes, offices, retail, big-box stores, a hotel, and a branch of the Children's Museum of Richmond. At 115 acres, it is the first time the Richmond area has seen mixed-use taken on at a large enough scale to truly be noticeable (Slipek, 2013).

In a county that has grown in sprawling, single-use patterns as the population has exploded, West Broad Village represents a new, compact style of growth that is needed in an area that is quickly running out of space. While some have criticized the development for its location on the already congested Broad Street and lack of any real job center – both factors that prevent it from truly embracing the New Urbanist goal of reduced vehicle trips – it is a novel approach to development in a county that has otherwise sprawled outward to accommodate residential and commercial growth (Slipek, 2013). This success has been recognized; West Broad Village was awarded the title of "Community of the Year" and "Mixed-use Community of the Year" in 2010 by the Homebuilding Association of Richmond and Multi-family Pillar of the Industry, respectively (Hirschler Fleischer, 2012). A photo of the street view in West Broad Village, indicative of the on-street parking and mixed-use buildings found throughout, is shown in Figure 6.

Figure 6: West Broad Village (Puckett, 2012)

The general details of the site are indicated in Table 4 (Kennedy, 2012b).

Table 4: West Broad Village characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
115 acres	1,497,069	884 (339 apartments, 545 3 BR townhomes)	6,347	On-street, surface, decks, and townhouse garages

Parking in West Broad Village

Located in Henrico County, West Broad Village follows the Zoning Ordinance-based parking requirements for the Urban Mixed Use designation. This includes the following nonresidential rates:

- 1 space per room for hotels,
- 1 space per 250 square feet retail,
- 1 space per 300 square feet office, and
- 1 space per 150 square feet restaurant.

Residential rates are one space per one bedroom unit and 1.5 for those with two or more bedrooms (Kennedy, 2012b). Based on these rates, the development requires 5,536 parking spaces, but provides 6,347, a difference of 811 spaces. Based on the land needed per space, this difference amounts to 131,382 square feet. Using costs found in the literature this potentially amounts to between $811,000 and $3,244,000 (and most likely more considering the large percentage of West Broad Village parking found in parking structures).

The development did not allow for parking reductions based on density or other factors, and residential and hotel uses have dedicated parking (1,909 spaces total) that cannot be shared with other uses. The remaining spaces in the development are "shared" among uses although there is no indication that any reductions were implemented for uses that can effectively share the same parking supply (Kennedy, 2012b).

Kennedy (2012b) noted that West Broad Village had a challenge when it came to the structured parking. The security and overall design of parking decks was an important consideration, and the Urban Mixed Use design guidelines had to be modified to include procedures for the

appearance of parking decks as well as the location of lighting of both parking areas and streets. This is indicative of a desire to encourage walking within the development. He also notes that due to the suburban nature of the surrounding area, the public needed time to adjust to the structured parking, so much so that in the early days of the development, many businesses offered valet parking to ease the transition. Furthermore, additional parking rules had to be implemented by the developer to ensure that during inclement weather, residents of the West Broad Village apartments used their reserved spaces on top of parking decks rather than the covered public spaces (Kennedy, 2012b).

New Town, James City County, VA

Figure 7: New Town aerial image (Google Earth, 2010c, used under fair use, 2013)

A 365-acre New Urbanist development near Williamsburg, Virginia, New Town began planning and development in the late 1990s. The project is a joint venture between the College of William

and Mary's Endowment Association and a private company. Sixty-four acres of the development constitute the Discovery Business Park which includes office and research and development space, in addition to representing the community center of the project, with a mix of housing units, retail, restaurants, and entertainment. This research and development/community hub also presents opportunities for businesses to link with students, faculty, and resources of the nearby William and Mary campus. The strong link with a nearby college campus has been a unique and beneficial characteristic, and has helped support the vision of New Town. As the project's website claims, "New Town blends the best of yesterday's town planning with tomorrow's technology" (New Town Commercial Association, 2010).

Additional facilities include a variety of housing types situated around an urban-like street grid optimized for pedestrian access and community interaction. The development also includes an open-air mall, and is served by an inexpensive, seven day a week trolley system that loops around the development (New Town Commercial Association, 2010).

The general project characteristics were provided by Leanne Reidenbach (2012), and are displayed in Table 5. Parking spaces are reported for sections 2 and 4 of the development (there are 13 sections total in the development); this portion of the development contains a mix of retail, restaurants, banks, and multifamily residential uses.

Table 5: New Town characteristics

Overall size of development	Nonresidential square footage	Multifamily Residential units	Total parking spaces	Parking location
545 acres (86.5 in sec. 2 & 4)	1,943,999	628 (381 existing apartment and condos, 247 under review)	2069 (for mixed-use center only)	Central surface lots and on street

Parking in New Town

New Town is one of the few projects surveyed that demonstrated the importance of shared parking and that embraced more flexible parking requirements in a mixed-use development. Parking calculations began with base rates from the locality's zoning ordinance and ITE standards, but incorporated some flexibility to these rates as an opportunity for shared parking was identified. The shared parking approach was developed with input from a private consultant as well as ULI (Reidenbach, 2012), and approved in 2004 (James City County Planning

Division, 2011). Because of this, a reduction in parking was allowed with the shared parking methodology, and additional reductions would have been available for public transit access or some kind of alternate transportation plan (as per the zoning ordinance) but this did not apply in the case of New Town (Reidenbach, 2012).

The shared parking methodology used for the New Town project (sections 2 and 4, specifically) involved first determining peak parking need on a block-by-block basis based on the existing or proposed uses as if that use was a standalone building. For these calculations, New Town uses the commonly accepted rates as follows:

- 4 spaces/1000 square feet office
- 5 spaces/1000 square feet retail

Subsequent steps closely followed the steps outlined on ULI's *Shared Parking*: each single use was evaluated to find its need (as a percentage of total parking) for specific hours of the day. Then, each block could be reevaluated by finding the peak hour(s) and multiplying the percentages for parking needed during those times to each individual use. In the case of New Town, 2:00 p.m. and 8:00 p.m. were determined to be the peak times, so the percent of parking needed at those time periods were applied to the base parking rates previously determined. Furthermore, a proffer approved with the site rezoning "requires regular updates to the shared parking plan and review by a subcommittee of the Planning Commission to make sure it's still operating as anticipated" (Reidenbach, 2012, p. 4). The shared parking area of the development is indicated in Figure 8.

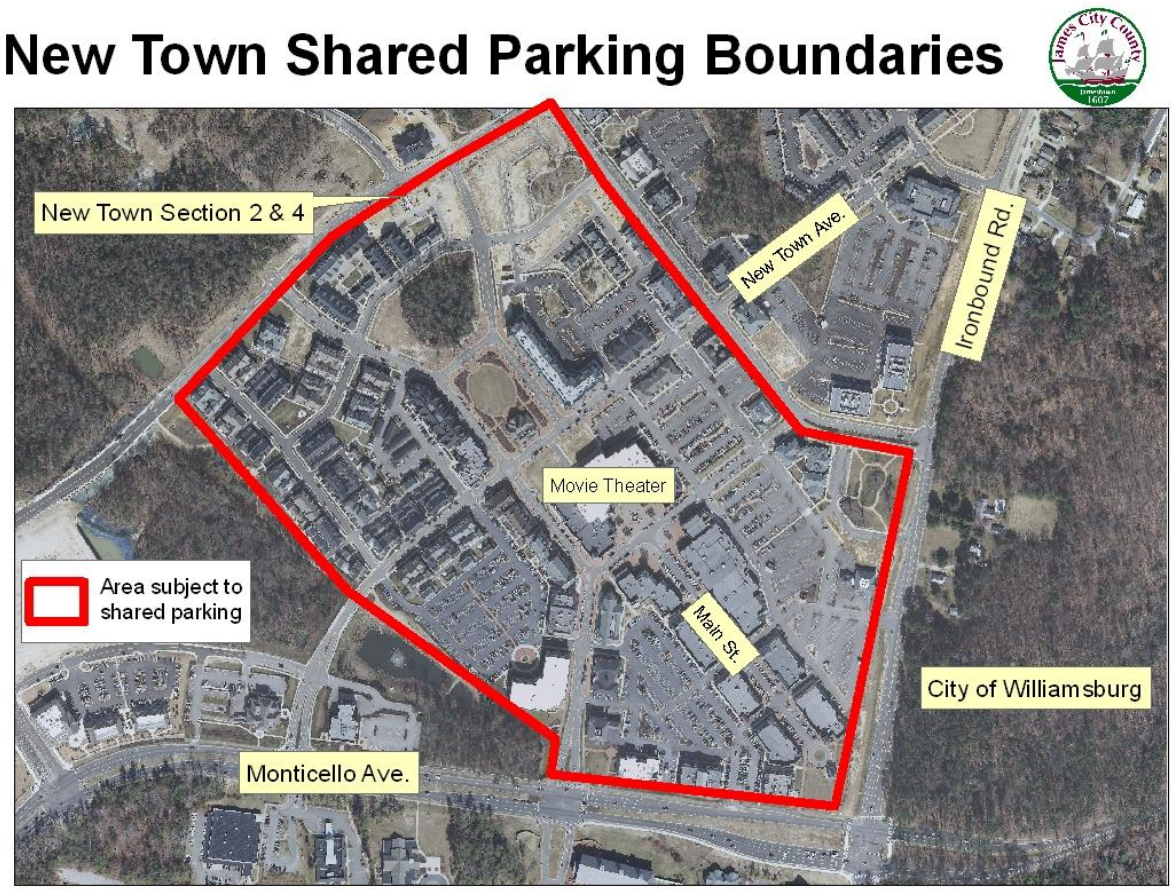


Figure 8: Shared parking in New Town (James City County, 2011, used under fair use, 2013)

In a shared parking memorandum from March 2011, the previously described methodology is outlined, and experiences to date are shared. It was reported that the parking provided by the shared methodology did cause a slight shortage during the 2:00 p.m. time period (although Reidenbach (2012) notes that she doubts the parking has actually been completely full at that time), but a significant excess during the other "peak" hour of 8:00 p.m. Furthermore, the use of shared parking allowed there to be 800 fewer parking spaces (equating to more than 150,000 square feet of impermeable surface) than if parking requirements have been calculated for each use individually (Reidenbach & Murphy, 2011).

The majority of parking in the New Town project is located in off-street lots. Much of it is located in centrally located lots that are maintained by the commercial owners association. The mixed-use area of the development (sections 2 and 4) operate under a specific shared parking plan. Some of the other sections do "share" parking in that there is one large lot provided for all

uses in that section, although the total number of spaces provided was not subject to reductions. In sections 2 and 4 in particular, residential uses do share spaces with nonresidential uses, a unique characteristic compared to most of the other suburban mixed-use developments surveyed.

Because the kind of parking plan used in the New Town project was different from what had previously been the norm in James City County, there were some challenges identified, especially with the sharing component. In some cases, there were requests for dedicated parking spaces by some offices and businesses, which would have removed those spaces from the shared supply, had those requests been entertained. Measures had to be taken to also ensure that employees did not park in prime parking spaces. There was also a need for an attitude shift for New Town business owners, employees, and visitors alike who needed to realize that they may need to walk between uses since this was not a typical strip mall development. Because some businesses have expressed concern, New Town is currently considering placing time limits on some of the parking supply in some areas of the development to increase turnover and thus the amount of parking available for "sharing". This would also address the issue of employees occupying prime parking spaces (Reidenbach & Murphy, 2011). Reidenbach (2012) also noted that the location of New Town near Colonial Williamsburg, the College of William and Mary, and another mixed-use development, High Street, has helped the development and the reduced parking supply work, as has an effective bus system.

In November 2011, an additional report was released to evaluate the shared parking plan as those sections of the New Town project included in the parking plan approached full build-out. It was found at that time that "supply and demand are in balance" and furthermore, that "bus, bicycle and pedestrian usage minimizes parking demand and these uses should all continue to grow" (James City County Planning Division, 2011, p. 2). Time limits are also expected to be put into effect soon where applicable. Overall, the shared parking plan has been a success in that is has allowed significant savings in parking provided while not causing significant undersupply issues (James City County Planning Division, 2011).

As a check on the shared parking calculations provided by New Town (Figure 9), a shared parking calculation was performed based on those numbers provided, and appears in Table 6.

Because New Town's shared parking plan closely followed the methodology recommended by ULI, the numbers are very close. The difference here is that base parking numbers are calculated slightly differently in the ULI methodology, which allows for a smaller base rate. New Town also did not indicate in any shared parking documentation that a peak month calculation was included; this could also have reduced the number of spaces provided. The ULI calculation may also overestimate the spaces needed for offices since individual sizes were unknown, and ULI allows for smaller base rates as office size increased. Although the ULI calculations suggest that a smaller number of spaces would have sufficed for the New Town project, because the development's parking is full at the peak 2:00 p.m. hour, the project appears to have "gotten it right" in terms of parking needed, without grossly oversupplying.

		Block by Block 2 PM Demand	Supply	Difference
2	Office – 54,400	211		
	Retail – 80,600	297		
		508	467	-41
3	Office – 21,100	82		
	Retail – 76,500	282		
	Fitness Center (26,200)	35		
	Residential Units - 3	4		
		403	501	+98
5	Office – 65,000	252		
	Retail – 25,700	95		
	Residential Units – 22/6	29		
		376	360	-16
6/7	Office – 10,600	41		
	Retail – 53,400	197		
	Theater – 2,090 seats	209		
		447	321	-126
8	Office – 18,400	71		
	Retail – 6,500	24		
	Residential Units – 40/18	53		
		148	145	-3
9	Legacy Hall – 250 seats	43	36	-7
10	Office – 7,900	31		
	Retail – 39,600	146		
	Residential Units – 60	22		
		199	239	+40
	Total	**2,124**	**2,069**	**-55**

Figure 9: New Town shared parking calculation (Reidenbach & Murphy, 2011, used under fair use, 2013)

Table 6: New Town ULI shared parking calculation

Use	Ksf or # units	Weekday base requirement			Peak month adj. (Dec)	Peak hour adj. (2pm)	Total spaces
			Rate*	# spaces			
Retail	282,300	Customer	2.9	819	100%	100%	819
		Employee	0.7	198	100%	100%	198
Cinema	2090	Customer	0.19	398	23%	55%	51
		Employee	0.01	21	50%	60%	7
Fitness center	26,200	Customer	6.6	173	90%	70%	109
		Employee	0.4	11	100%	75%	9
Convention center	2,358	Visitor	5.5	13	600%	100%	8
		Employee	0.5	2	70%	100%	2
Office	177,400	Visitor	0.3	54	100%	100%	54
		Employee	3.5	621	100%	100%	621
Residential (rented)	149	Visitor	0.15	23	100%	20%	5
		Resident	1.5	224	100%	70%	157
Total				**2557**			**2040**
Shared parking reduction: -20.2%							
Actual provided: 2069 (29 space difference)							
*Rates based on 1000 ft2 for retail, restaurant, office, fitness center; based on number of units for residential, and based on number of seats for cinema.							

Biltmore Park Town Square, Asheville, NC

Figure 10: Biltmore Park Town Square aerial image (Google Earth, 2010a, used under fair use, 2013)

The Biltmore Park Town Square project represents the first mixed-use community in Asheville that includes condos, townhomes, local and national businesses, a hotel, offices, and open space, all connected by pedestrian trails. Located in a primarily suburban area, the project offers a uniquely urban lifestyle, built to imitate the main street-oriented developments of the past (Private Mountain Communities, 2012). The project was completed in 2009 (Trademark, 2011).

In 2011, the project was recognized by the International Council of Shopping Centers, receiving silver in the category of Innovative Design and Development of a New Project. The project was commended in particular for its preservation of green space and overall thoughtful placemaking (Williams, 2012).

Details of the project were provided by the developer, and are summarized in Table 7 (McIntosh & Szurek, 2013).

Table 7: Biltmore Park characteristics

Overall size of development	Nonresidential square footage	Multifamily Residential units	Total parking spaces	Parking location
42 acres	745,887	193	3,220 (1,888 in garages)	On-street, surface, and garages

Parking in Biltmore Park Town Square

The developer for Biltmore Park conducted a ULI parking study and hired consultants to best determine the number of spaces needed with the inclusion of shared parking. Asheville's Code does have an Urban Village designation that includes an allowance for some parking reductions, such as shared parking. On-street spaces were required to balance at least 50/50 with on-street spaces (structured parking was exempt from this requirement since it is less intrusive and expensive to construct). Once the appropriate number of spaces was determined with help from the consultant, the developer went a step further by getting input from various retailers to ensure that they agreed that the number of spaces to be provided was sufficient for their businesses (McIntosh & Szurek, 2013).

Shared parking determination for the development was based on the varied peak hours of uses. Sharing opportunities were identified in particular between office and retail uses, as well as offices and the local movie theater. The sharing scheme was also unique in that a need was identified for a particularly large office space to have reserved parking during business hours. Because of this, the parking deck closest to the movie theater has some floors that are reserved during the day for that office, but in the evening can be used for other uses, such as the theater. This suggests that shared and reserved parking do not have to be mutually exclusive. Ultimately, the shared parking that was implemented at Biltmore Park allowed for an approximately 13% reduction below the parking that would have been required otherwise. The developer noted that even with that reduction, there have been no undersupply issues, and open parking spaces are generally abundant in the development (McIntosh & Szurek, 2013).

Residential uses do have designated parking. Biltmore Park is somewhat unique, however, in that although parking is not unbundled from residential uses for the most part, the way condo parking

was handled did have the effect of a partial unbundling – one space was bundled with the cost of the condo, but additional spaces could be purchased separately if they were needed.

The role of structured parking in Biltmore Park Town Square is crucial. The developer noted that a walkable development of this scale is simply impossible to construct without the use of parking decks. Because so many uses are clustered in a smaller space than in traditional, more distributed suburban patterns, the amount of parking needed to serve these uses, even with the potential reductions, is prohibitive to the walkable, dense nature of the development if it was provided only in surface lots. Structures can help reduce the walking distance between uses and keep the site visually appealing to pedestrians. In the case of Biltmore Park, there were some challenges with the structured parking. It took time to "train" consumers how to evenly utilize the provided structured parking and understand its benefits. In the same vein, residents were generally resistant to parking in their assigned structured spaces when street parking was more convenient. The developer recommends stronger enforcement from the beginning (McIntosh & Szurek, 2013).

Biltmore Park's shared parking strategy utilized parking studies to determine the appropriate amount to provide based on local conditions. A ULI shared parking calculation was performed using the site data provided to see how closely this matched with the actual number of spaces provided at the site. The shared parking calculation is shown in Table 8.

Table 8: Biltmore Park Town Square ULI shared parking calculation

Use	Ksf or # units	Weekday base requirement			Peak month adj. (Dec.)	Peak hour adj. (2pm)	Mode adj. (hotel only)	Total spaces
			Rate*	# spaces				
Retail	119,057	Customer	2.9	346	100%	95%		329
		Employee	0.7	84	100%	100%		84
Restaurant	91,534	Customer	15.25	1,396	100%	65%		908
		Employee	2.75	252	100%	90%		227
Hotel	165	Guest	1.0	165	67%	60%	66%	44
		Employee	0.25	42	100%	100%		42
Cineplex	3,750	Customer	0.19	713	23%	55%		91
		Employee	0.01	38	50%	60%		12
Office	303,317	Visitor	0.3	91	100%	100%		91
		Employee	3.5	1,062	100%	100%		1,062
Residential	193	Guest	0.15	29	100%	20%		6
		Resident	1.5	290	100%	70%		203
Total				**4,508**				**3,099**
Shared parking reduction: -31.35%								
Actual provided: 3,220 – 121 more								
*Rates based on 1000 ft2 for retail, restaurant, office, fitness center; based on number of units for residential, and based on number of seats for cineplex.								

The shared parking calculation suggests that Biltmore Park may have reduced their parking even slightly more than what was done as a result of the developer's and consultant's parking study. That being said, given the size of the development and total parking spaces, this 121 space increase represents less than a four percent increase over what is estimated by this ULI calculation. Furthermore, as a local parking study was conducted to inform the total amount of spaces to provide, and as the developer reports the parking being all but full during the holiday season and for movie premiers, it is fairly safe to assume that in this case, the development provided an appropriate amount of parking. Even ULI (Smith, 2005) suggests that local studies are preferable to the *Shared Parking* data when available, so it would appear that Biltmore Park did "get it right" based on the survey response and the closeness of the ULI shared parking calculation to the actual.

Phillips Place, Charlotte, North Carolina

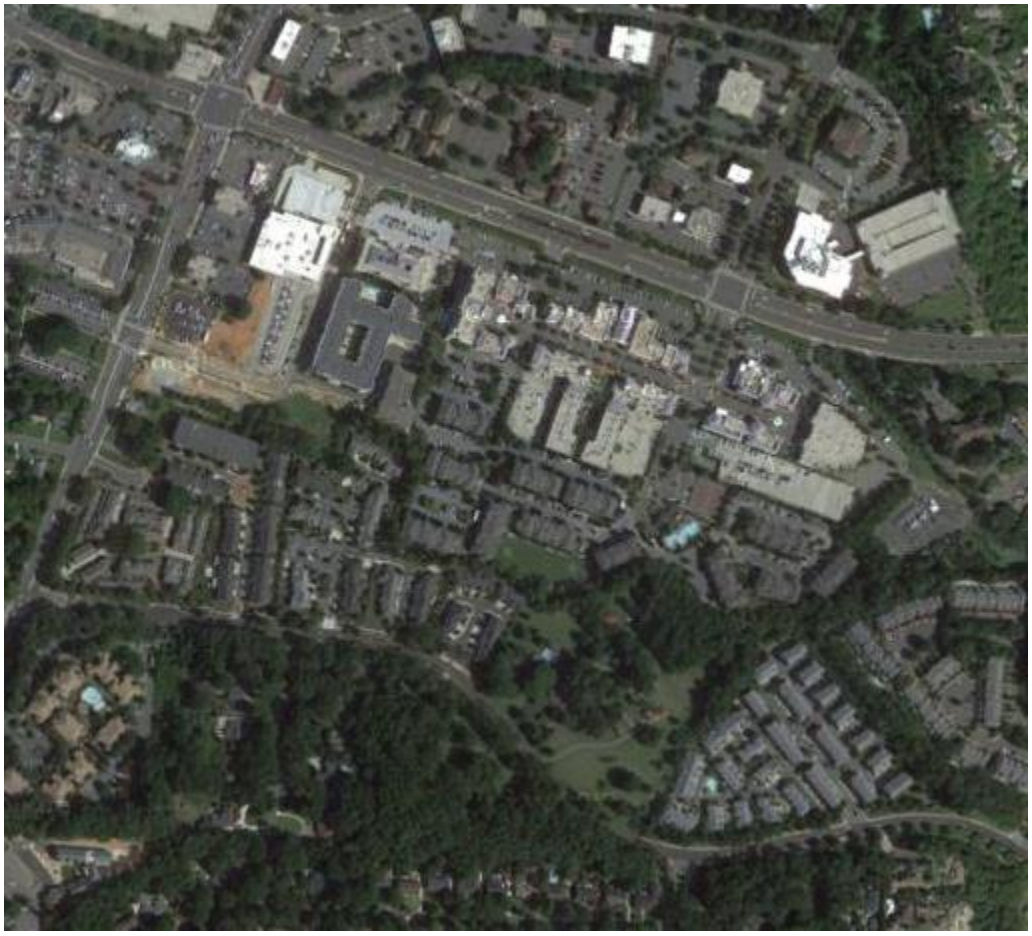


Figure 11: Phillips Place aerial image (Google Earth, 2012c, used under fair use, 2013)

Phillips Place was the first development of its kind in Charlotte, NC, in the late 1990s. It was developed as a mixed-use town center in what was otherwise a low-density suburban area. Located a short distance from downtown Charlotte, Phillips Place consists of a vertical mixed-use main street of specialty retail and apartments, anchored on either end by a 124-room hotel and a movie theater. Additional apartments are located behind the main street corridor.

A somewhat complicated rezoning process (Charlotte had no mixed-use zoning classification at the time) that changed the parcel from its previous designation of multifamily residential, was eventually approved. The developer was able to prove that replacing some of the residential uses with retail would cut down the peak hour traffic from the development, while avoiding placing residences near power lines, and provide retail uses not currently present in the area, all while still providing the multifamily residential the city originally wanted in that area.

Care was taken to make the development aesthetically pleasing and pedestrian-oriented. Strategies included orienting storefronts inward to the development's main street rather than the major arterial on which the development's entrance is located, and providing traffic circles and angled parking along the streets, which were lined with brick sidewalks, street furniture, and streetlights. Parking provision also includes two-level parking structures for both retail and residential uses (upper level and lower level, respectively). The site does not include shared parking (Levitt & Schwanke, 2003).

Overall, Phillips Place has demonstrated how an insular, mixed-use development can enjoy a large degree of success. It was touted by ULI as demonstrative of "how the relatively dense mix of a variety of uses can create synergy and a whole that is greater than the sum of its parts" (Levitt & Schwanke, 2003, p. 335). Leasing of both residential and retail uses occurred very quickly, the hotel occupancy rate is higher than the average rate for the area, and retail sales per square foot are higher than the average for other similar commercial centers. The development is limited, as most suburban mixed-use projects are, by the fact that it is disconnected (from a pedestrian standpoint) from the surrounding area. In spite of this, the development has provided a strong model for Charlotte, as well as mixed-use developments in other primarily suburban communities (Levitt & Schwanke, 2003).

General site characteristics are presented in Table 9 (Wilkinson, 2013).

Table 9: Phillips Place characteristics

Overall size of development	Nonresidential square footage	Multifamily residential units	Total parking spaces	Parking location
34.49 acres	141,000	402	1,359 (min. required)	Structures, surface, and on-street

Parking in Phillips Place

Based on information obtained from the Charlotte Planning Department, shared parking was not utilized for the Phillips Place project, and the parking minimums as described in the municipality's Zoning Ordinance were used to determine the parking needed. The total number of parking spaces provided in the development is not known, although based on standards in the Ordinance and the site rezoning, a minimum of 1,359 spaces were required. The rezoning did not

allow for parking reductions, and in fact the project was required, as are all developments in the locality, to meet or exceed this parking minimum (Wilkinson, 2013).

Using the information provided by the survey respondent and with additional information from ULI's Phillips Place case study, a rough shared parking calculation was performed (Table 10).

Table 10: Phillips Place ULI shared parking calculation

Use	Ksf or # units	Weekend base requirement			Peak month adj. (Dec)	Peak hour adj. (8pm)	Total spaces
			Rate*	# spaces			
Retail	52,776	Customer	3.2	169	100%	65%	101
		Employee	0.8	43	100%	75%	28
Restaurant	28,224	Customer	17	480	100%	100%	431
		Employee	3.0	85	100%	100%	78
Cinema	940	Customer	0.26	245	67%	100%	120
		Employee	0.01	10	80%	100%	8
Hotel	124	Visitor	0.9	112	67%	80%	67
		Employee	0.18	23	100%	55%	18
Residential (rented)	402	Visitor	0.15	61	100%	100%	61
		Resident	1.5	603	100%	98%	591
Total				**1,831**			**1,503**
Shared parking reduction: -17.9%							
Code required: 1,359 (144 spaces less)							
*Rates based on 1000 ft2 for retail, restaurant; based on number of units for residential, rooms for hotel, and on number of seats for cinema.							

This suggests that based on the local code, Phillips Place actually requires less parking than what is projected by the ULI shared parking calculation. However, since the planner was unable to provide the actual number of spaces included in the development, there is no way to know for sure how closely actual parking provided follows (or doesn't follow) the ULI shared parking rate. Charlotte's Code of Ordinances does actually include large parking reductions for mixed-use. However, Phillips Place is zoned as a Commercial Center, which is subject to general minimum parking requirements.

Birkdale Village, Huntersville, NC

Figure 12: Birkdale Village aerial image (Town of Huntersville, 2011, used under fair use, 2013)

Birkdale Village is a suburban mixed-use development, originally constructed from 1999 to 2003 on land that was previously horse pasture (Crosland Southeast, 2012). The project was unique for the area at the time due to the fact that it required a major rezoning to build a development of such density as to be economically viable, on land that was previously designated rural. The development was designed to be a return to past, village town-center style development while being oriented around modern commercial uses, residents, and workers. While in development, the site garnered so much retail interest that a second phase had to be changed from entirely residential to accommodate more vertically-integrated mixed-use (Million, 2004).

The resulting development was a 52-acre pedestrian-oriented village containing a mix of residential, office, and retail space, with over 80 percent of apartments being vertically oriented above commercial uses. The town center-style development includes an urban-like street grid system, large amounts of open space, and parallel and on-street parking with additional parking behind buildings and in parking decks. The latter are divided between public parking and reserved residential spaces (Million, 2004).

Birkdale Village has seen large amounts of success – residential, office, and commercial rents are consistently higher than market averages. Furthermore, within its first year, the development established itself as the new town center for the surrounding area due to a number of social and community events (Million, 2004). Shortly after completion in 2003, Birkdale Village won the 2004 International Design and Development Award from the International Council of Shopping Centers, one of nine developments to do so, including impressive centers from around the world (Crosland Southeast, 2012).

General characteristics of the development are outlined in Table 11 (Hodges, 2012).

Table 11: Birkdale Village characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
52 acres	305,200	297	2,449	Majority in structures, 205 on-street

Parking in Birkdale Village

Parking provided in the Birkdale development was based on the municipality's zoning ordinance, and did not make exceptions for mixed-use development. The minimum parking requirements had to be met or exceeded for approval of the site plan. In general, one space was required for every 1,000 square feet of commercial space, and for each bedroom for residential units. About fifty percent of the parking in the development is unrestricted and can be freely utilized among all uses (Hodges, 2012). However, as parking provided in the development exceeds the minimum requirements put forth in the Zoning Ordinance, it would appear that no shared parking reductions were used.

To assess how many spaces may have been saved had the Birkdale development chosen to implement some shared parking considerations; a shared parking calculation was done based on the ULI methodology. Not enough information was available to determine the ULI-recommended base rates (as seats in the cinema and portion of office space in the office/retail outparcel was unknown). However, using the base parking rates given in Birkdale's site plan, peak month and hourly rates could be applied. The resulting shared parking calculation is shown in Table 12.

Table 12: Birkdale Village shared parking calculation

Use	Base parking req. (Birkdale site plan)	Provided	Peak month adj. (Dec)	Peak hour adj. (7p.m. weekend)	Total
Cinema	150	799	67%	90%	91
Large retail	161	352	100%	75%	121
Retail	139	240	100%	75%	105
Restaurant	99	120	100%	100%	99
Retail/office outparcels	160	204	100%	40%	64
Residential	446	529	100%	100%	446
Surplus (on-street)	-	205	-	-	-
Total	***1,155***	***2,449***			***926***

Birkdale Village already provides 1,294 spaces above what is required in the local Code of Ordinances, or a 112% increase over the required minimum. The base rate already provides 229 spaces over what might have been required had the possibilities for shared parking been taken into account, bearing in mind that this shared parking calculation is based on ULI standards and does not take into account possible local factors that merited more parking. The planner, for example, did note that parking is relatively full on weekends and during the holiday season (Hodges, 2012).

Although Birkdale Village appears to have overprovided parking based on numbers alone, it should be noted that the project provides the majority of this parking in structures, thus somewhat limiting negative pedestrian impacts and the amount of impermeable surface. Hodges (2012) also noted that the structured parking has been beneficial to the development despite its initial cost.

Rocketts Landing, Richmond, VA

Figure 13: Rocketts Landing aerial image (Google Earth, 2012d, used under fair use, 2013)

An in-progress New -Urbanist development located on the James River just east of downtown Richmond, Rocketts Landing was, until recent years, an abandoned brownfield site. The site was originally Richmond's first port, which was later turned into an industrial district after railroads and interstates replaced the need for the port in the 1920s. The site was torn down and abandoned in the 1970s, until assuming its current role as an infill, mixed-use site (Rocketts Village, n. d.)

Zoning for the Rocketts Landing site was difficult because the planning of the project was divided between the City of Richmond and Henrico County. Henrico County typically develops in suburban patterns that did not initially support a mixed-use development like Rocketts

Landing, and even Richmond's more urban-oriented zoning codes did not originally allow for the proposed density and mix of uses in the project area. A rezoning was required that changed the site to urban mixed-use.

The site plan incorporated four separate sections of the development with open space and considerations for riverfront environmental preservation throughout. Festival Plaza represents the public gateway into the project from the city, The Square is a commercial mixed-use civic center and includes residential, retail, office and restaurant uses, Village Commons serves as community gathering space surrounded by mixed-use buildings, and East Village is a residential area with apartments, condominiums, and townhomes ("AIA Richmond Chapter 2007 Design Awards: Honor Award Winner," 2007).

Construction on the mixed-use project began in 2005, and when complete, will include 2,000 residential units, 500,000 square feet of office space, 200,000 square feet of retail, and a private marina, all while revitalizing one of Richmond's oldest districts (H&A Architects and Engineers, n. d.). A sketch of the development is shown in Figure 14.

Figure 14: Rocketts Landing Sketch (H&A Architects and Engineers, n. d., used under fair use, 2013)

As Rocketts Landing is currently in progress, the local planner was able to provide information specific to Land Bay 4b, which has been completed. The size and mix of uses and parking is reported in Table 13 (Kennedy, 2012a).

Table 13: Rocketts Landing characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
9.83	63,3000	291 (249 condominiums, 42 townhomes)	731	On-street, surface, decks, townhouse garages, and off-site

Parking in Rocketts Landing

Henrico County does have an Urban Mixed Use zoning designation in their Code of Ordinances, with specific parking requirements set for this kind of development (Officials of the County of Henrico, 2010), and those were utilized to determine the parking rates for Rocketts Landing. These identify minimum requirements for several nonresidential uses that are reduced slightly from the requirements normally required. However, the Urban Mixed Use designation does not allow for on-street parking to be counted against the total required, although off-site parking within 1,000 feet of a building's front entrance may be counted against the requirement. Residential parking requirements are not reduced for mixed-use developments. Mixed-use developments may apply for a reduction in the number of spaces required, but uses sharing that parking must be located on the same lot, parking may not be reduced to less than 70% of that required by individual uses, and parking must be located within 400 feet of the entrance(s) of the uses. Otherwise, parking is calculated individually for each use, and summed to obtain the total requirement for the development (Officials of the County of Henrico, 2010, Sec. 24-96).

Despite the slightly reduced parking requirements, no shared parking scheme appears to have been considered for the development. The residential units have a large portion of the parking assigned to them specifically (333 spaces out of a total of 731 for the development) with the remaining spaces "shared" among uses. Furthermore, based on the required parking rates in the zoning ordinance, 568 spaces were required for this phase of the Rocketts Landing development, but 731 were provided, a difference of 163 spaces. At a size of 9 feet by 18 feet, this represents

land equivalent to 26,406 square feet, or over 40% of the provided leasable commercial and office space in this phase. Based on costs found in the literature, this could mean an additional $163,000 to $652,000 spent on parking that may have otherwise been used for additional leasable space.

As an additional check on these numbers, some assumptions about the ratio of office to commercial space were made, and the square footages and numbers of residential units provided by the planner (Kennedy, 2012a) were inserted into the recommended ULI shared parking calculations to determine if these numbers were in line with recommendations for shared parking (Table 14).

Table 14: Rocketts Landing ULI Shared Parking Calculation

Use	Ksf or # units	Weekday base requirement			Peak month adj. (Dec)	Peak hour adj. (7pm)	Total spaces
			Rate*	# spaces			
Retail	24,227	Customer	2.9	71	100%	75%	54
		Employee	0.7	17	100%	95%	17
Office	39,023	Customer	0.29	12	100%	2%	1
		Employee	3.43	134	100%	10%	14
Residential	291	Visitor	0.15	44	100%	100%	44
		Resident	1.7	495	100%	97%	481
Total				**773**			**611**
Shared parking reduction: -21%							
Actual provided: 731 (120 spaces more)							
*Rates based on 1000 ft2 for retail, office; based on number of units for residential uses.							

It should also be noted that this shared parking calculation may overestimate required parking in the development as it assumes that the space not in the large, 39,000 square foot office building was commercial space, but the survey (Kennedy, 2012b) answers provided suggested that more of this space (designated retail in Table 14) could be office. Since office and residential uses are nearly opposite in terms of hourly parking requirements, this would have reduced the number further. As it stands, Rocketts Landing still provides 120 spaces more than recommended by ULI.

Southern Village, Chapel Hill, NC

Figure 15: Southern Village aerial image (Google Earth, 2010d, used under fair use, 2013)

In the late 1980s, at the time when the New Urbanist mentality was gaining momentum, the town of Chapel Hill was planning future development in the southern area of the town, with goals of environmental preservation, public transit access, and avoiding sprawl. In the early 1990s, a plan was set to model development on an identified 300-acre site as a mixed-use village. A careful planning process was undertaken to design the site in a way that echoed the villages common in the early 20th century – based around people, not cars. In addition to a walkable pedestrian community, the development team also designed the project around transit and associated park-and-ride facilities. The location of commercial and civic uses and jobs along the main street contributed to the pedestrian and bicycle access desired. Through transit access and careful

design and location of features, the development team hoped to reduce the number of average daily trips by half (Bryan Properties, 2006).

Due to the unique nature of the development at the time, selling properties to potential homeowners was a challenge. Since all existing neighborhoods in the area were of a traditional suburban character, the smaller, more compact residential lots in Southern Village were a hard sell at first. However, as the first phase was completed and the village began to take shape, demand increased. Ultimately, the combination of various residential uses with retail and restaurants – most of which were local businesses – as well as public services including a daycare, elementary school, and church, created a unique, attractive community that has flourished since. The development was completed in 2005 (Bryan Properties, 2006).

General characteristics of the Southern Village development appear in Table 15 (Waldorf, 2013).

Table 15: Southern Village characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
312 acres (25 in Village Center)	181,749	1158 (535 single-family homes, 250 apartments, 373 condos and townhomes)	Unknown (approx. 1,078)	Surface, on-street, underneath buildings

Parking in Southern Village

According to the developer, an exact count of the number of spaces provided in Southern Village is unknown, although parking was provided at a general rate of 2.5 spaces per 1,000 square feet of use, which represented a reduction from the locality's maximum requirements (Waldorf, 2013). For nonresidential uses only, the parking requirements were reduced by half, and both on and off-street parking was allowed to be counted against the requirement for residential and nonresidential uses. Furthermore, the special use permit specified off-street parking to be located behind buildings where possible (Brown, 1996).

Chapel Hill is unique in that the Code of Ordinances specifies both parking minimum and maximum requirements, and for districts zoned as "Town Center" there are no minimums. Furthermore, the Code allows for sharing of up to half of the spaces of one use to fulfill the

needs of another, so long as they have opposite peak hours (Officials of the Town of Chapel Hill, 1971). Shared parking does appear to have been taken into consideration in the Southern Village plan; Waldorf (2013) notes that parking was reduced from the maximum based on both proximity to a park-and-ride lot as well as the ability to cross utilize parking by complementary uses. The exception to this is residential uses, which have their own designated parking. Furthermore, the developer reports that parking is generally maxed out during daytime weekday hours.

A quick check based on the ULI shared parking methodology suggests that Southern Village provides even less parking than what might be recommended by ULI (although the ULI method may overestimate slightly since the exact restaurant-to-retail ratio and number of cinema seats are estimates based on information provided). These calculations are presented in Table 16.

Table 16: Southern Village ULI shared parking calculation

Use	Ksf or # units	Weekday base requirement			Peak month adj. (Dec)	Peak hour adj. (2pm)	Total spaces
			Rate*	# spaces			
Retail	29,197	Customer	2.9	85	100%	100%	85
		Employee	0.7	21	100%	100%	21
Restaurant	18,397	Customer	15.25	281	100%	65%	183
		Employee	2.75	51	100%	90%	46
Fitness center	5,000	Customer	6.6	33	90%	70%	21
		Employee	0.4	2	100%	75%	2
Office	129,155	Visitor	0.3	39	100%	100%	39
		Employee	3.5	453	100%	100%	453
Residential (rented)	623	Guest	0.15	94	100%	20%	19
		Resident	1.5	935	100%	70%	655
Total				**1,994**			**1,524**
Shared parking reduction: -23.6%							
Actual provided: 1078 (est.) – 446 spaces less							
*Rates based on 1000 ft2 for retail, restaurant, office, fitness center; based on number of units for residential, and based on number of seats for cinema							

Overall, Southern Village capitalized on the maximum parking requirements in Chapel Hill's Code, as well as additional reductions for shared parking and transit access, to allow for a very low level of parking based on the size and type of uses provided in the development.

Baxter Village, Fort Mill, SC

Figure 16: Baxter Village aerial image (Google Earth, 2012a, used under fair use, 2013)

In an effort to better manage growth in Fort Mill, a small town in South Carolina, the Close family, the town's largest benefactor and owners of 7,000 acres of land in the area, developed the "Clear Springs Plan" as a model of an alternative to traditional suburban development. The plan included goals of more compact development and open space conservation, and eventually led to the formation of the Clear Springs Development Company to manage and implement the plan.

After implementing a permanent easement to preserve 2,300 of the family's original 7,000 acres as green space, the remaining acreage was divided into several office parks, light industrial parks, and mixed-use neighborhoods. The first of these mixed-use neighborhoods to be

developed in 1998 was Baxter Village, a 1,000 acre project that included a variety of housing choices as well as commercial, office and civic uses, and with additional green space preserved within the development and accessible by a system of pedestrian trails. Forty acres of the project serves as the walkable town center.

Baxter Village has been recognized in a variety of ways as a mixed-use success story; it has been renowned as an excellent example of smart growth by the Sierra Club, has been commended by local planners to be a strong model for community planning, and in 2001 the project was awarded the South Carolina Stewardship Award for its ability to provide a place for people that also practices environmental preservation (Miller, 2006).

The details for the size and kinds of uses in Baxter Village were provided by the local planning department (Pettine, 2012) and included in Table 17.

Table 17: Baxter Village Characteristics

Overall size of development	Nonresidential square footage	Residential units	Total parking spaces	Parking location
1033 acres (town center is 20 acres)	430,000 (100,000 sq. ft. is an elementary school)	Between 20 and 30 (2 apartments in village center, the rest are detached granny flats)	Approx. 1318 (plus 126 spaces at the school)	Surface lots and on-street.

Parking in Baxter Village

Where one might expect a mixed-use development with an established village center to reduce the overall number of spaces provided in the project from base requirements, Baxter Village used set rates from the York County's Subdivision Ordinance and then increased them where possible. In addition, parking is largely unshared, with separate calculations. Residential and nonresidential uses may "share" the provided on-street spaces, but otherwise shared parking was not embraced, even in the mixed town center. This is particularly interesting, because the locality does have some understanding of the potential for sharing parking. The planner responding to the survey did note that in one instance, shared parking was allowed explicitly between a day care and a restaurant as they had opposite peak times. The planner noted that this worked well due to the nature of the uses (Pettine, 2012).

Finally, it is important to note that Baxter Village on the whole is a residential neighborhood, with primarily horizontal mixed-use; it includes residential, commercial, and a school in close proximity, but does not necessarily combine them vertically. The exception to this is the mixed-use town center, but there are only two second floor residential units in this part of the development, located above a restaurant.

Mayfaire Town Center, Wilmington, NC

Figure 17: Mayfaire Town Center aerial image (Google Earth, 2010b, used under fair use, 2013)

Mayfaire Town Center is a mixed-use project containing a variety of retail, restaurant, and entertainment uses along with condominiums, apartments, and single-family residential options. The uniqueness of the location for a project of this size and character has been noted. One article pointed out that the development would look perfectly at home in a larger, more urbanized area

like Charlotte or Washington, D.C. (Southeast Discovery, 2012). Green space and pedestrian and bicycle accessibility are prominent features of the development.

The popularity of both the retail and lifestyle components of the project has made the project a success from the viewpoint of economic development; the huge tax base of the development has made it like a city within a city, and it is projected to be the most popular location for developers in the foreseeable future (Faulkner, 2012).

The general size and characteristics of the Mayfaire development appear in Table 18 (Rahe, 2012). Numbers reflect the expected sizes/amounts at-build-out and thus are somewhat approximated.

Table 18: Mayfaire Town Center characteristics

Overall size of development	Nonresidential square footage	Multifamily residential units	Total parking spaces	Parking location
400 acres (130 acres preserved as green space)	1,380,000	500	6,432	On-street and surface lots

Parking in Mayfaire Town Center

The parking situation in the Mayfaire development is unique because of the way parking is treated in the Land Development Code. Unlike most suburban localities, Wilmington specifies both parking minimum and maximum requirements for the majority of land uses. In the Mixed Use zoning designation, there is no minimum requirement, only the maximum. However, this number is also allowed to be exceeded if spaces are above the ground floor in parking structures or if certain pervious parking requirements are met (City of Wilmington, 1985).

Although the code does allow for additional reductions based on transit access or increased bicycle parking, no reductions were requested for the Mayfaire project, and although using the Code resulted in 5,672 required spaces, an additional 760 spaces were provided. There was also no attempt at a shared parking plan, a fact which is attributed to a site design that did not effectively allow for sharing between complementary uses. The exception is a movie theater that shares with nearby retail uses. Residential units do not share parking and are assigned spaces. The overall number of spaces provided by the development is based on the maximum allowed

and thus far does not appear to be full at any time, although parking is the most saturated during the peak holiday shopping season (Rahe, 2012).

Old Trail Village, Crozet, VA

The design and development of Old Trail Village came about, in part, from the Crozet Master Plan that was adopted by Albemarle County in 2004, as the required rezoning of the parcel to Neighborhood Model District was felt to fit well with the goals of the Plan. At the onset, the project was designed to "consist of a mixed-use community that embraces both vehicular and pedestrian uses, prioritizes environmental sensitivity, incorporates the rich architectural heritage of the area, and produces an outstanding place in which to live, work and play" (Beights Development Corporation, 2005, p. 3).

As per the project's rezoning application, at full build-out, the development will consist of a mixed-use village center with dense, multifamily residential. Development density will then decrease with increased distance from the center, with single-family residential uses near the perimeter. Pedestrian access was also a large consideration from the beginning. The project includes both sidewalks and walking/bicycle trails, with the goal of allowing pedestrians to travel from the farthest reaches of the development to the village center in no more than 15 minutes. Furthermore, the development encourages the preservation of green space, the provision of walkable connections to the rest of the community, opportunities for local businesses, and multiple housing options to support diversity and affordable housing (Beights Development Corporation, 2005).

General characteristics of the development were provided by an Albemarle County planner and are displayed in Table 19 (Yaniglos, 2013).

Table 19: Old Trail Village characteristics

Overall size of development	Nonresidential square footage	Multifamily residential units	Total parking spaces	Parking location
237 acres	110,991 (rezoning increases possible sq. ft. to 250K)	256 (apartments/condos)	1762 (approx.)	Surface lots and on-street

Parking in Old Trail Village

Old Trail Village is unique in that the village center area of the development does utilize some manner of shared parking and is subject to some parking reductions. In particular, 80,000 square feet of nonresidential uses which include a small boutique hotel, an assisted living facility, and several additional uses all share a pooled parking supply of 430 spaces. This may seem high for the amount of space – this breaks down to more than five spaces per thousand square feet of nonresidential space, which is high for retail as well as for age-restricted housing, since many of the residents may not drive. That being said, the developer did conduct a parking analysis for the development which allowed for less parking than normally required by the local Zoning Ordinance, so the discrepancy may very well be justified. The survey respondent also notes that ITE and ULI parking rates were taken into consideration in conjunction with the requirements from the local Zoning Ordinance (Yaniglos, 2013).

The parking determination in Old Trail Village is somewhat unique in that the required parking is determined on a block-by-block basis based on the Zoning Ordinance, and may vary based on the uses on that block and whether shared parking is requested. Based on the Ordinance, up to 30% of the parking provided can be shared between uses. However, because parking must be provided on the lot for which it is to be used, sharing is only really possible in the village center. Currently, the majority of the residential development has consisted of single family residential and townhomes, with few apartments approved as of yet that could potentially share this parking. The development was also required to have 300 on-street spaces throughout (Yaniglos, 2013).

As the Old Trail development is still fairly new and so far consists of mainly residential uses, the planner notes that it will be interesting to see how the parking situation works out as more people move into the development. For example, there is a pool in the Village Center, it should be interesting to see if the nature of the development prompts new residents to walk to these facilities, or if they choose to drive within the development (Yaniglos, 2013).

Case study synthesis

The key features of each of the case studies were extracted and are presented in Table 20 for comparison. Few of the developments surveyed implemented any kind of parking reduction,

although some did mention small deductions or the possibility of reductions via the local code, had they been requested.

Although not discussed in the table as it was not available from every survey respondent, the method in which these mixed-use projects were implemented from a regulatory standpoint differed by location. Some localities simply rezoned to some variation of an existing mixed-use zoning district. Others were implemented as a planned unit development or relied on a special use permit to allow particular uses in the development.

Table 20: Case studies summary characteristics

Case	Shared parking?	Other reductions?	Parking free?	Parking location				How parking rate determined?	Ever full?
				Surface	On-street	Structured	Off-site		
Chester Village Green	No	Yes – 10% reduction for ped. access; reduction for age restricted residential	Yes	✓	✓			Local ordinance	Community events
West Broad Village	No	No	Yes		✓	✓		Local ordinance (mixed-use designation)	Unknown
New Town	Yes	No	Yes	✓	✓			Shared parking methodology	Nearly (2pm weekday)
Biltmore Park Town Square	Yes	Yes – reduction in off street required (w/on-street balance)	Yes	✓	✓	✓		ULI parking study and hired parking consultants	Nearly (weekends, movie premiers, holiday season)
Phillips Place	No	No	Unknown		✓	✓		Local ordinance (meet or exceed rate)	Unknown
Birkdale Village	No	No	Yes	✓	✓	✓		Local ordinance	Nearly (Saturdays, holidays)
Rocketts Landing	No	No	Yes	✓	✓	✓	✓	Local ordinance (mixed-use designation)	Unknown
Southern Village	Yes	Yes – for transit access	Yes	✓	✓	✓		Special use permit	Daytime weekday
Baxter Village	Yes*	No	Yes	✓	✓			Local ordinance (exceeded)	Nearly (Thurs., Fri., Sat. night in summer)
Mayfaire Town Center	No	No	Yes	✓	✓			Standard "industry" ratios – code maximums	Never (busiest during holiday shopping)
Old Trail Village	Yes**	Yes – for mix and density of uses	Yes	✓	✓			Local ordinance + ITE & ULI rates + parking analysis	Unknown
*Only in the case of a daycare and restaurant sharing space – not for whole development.									
**Shared parking allowed in theory in Village Center. Currently, majority of use is residential, so sharing is limited.									

Only two of the developments – New Town and Biltmore Park Town Square – indicated implementation of truly shared parking on a wide scale after a careful analysis of parking needs. Although this sample is too small to make any certain claims, the results so far are positive and indicative of success. In the case of New Town, the development has now existed for several decades, over which the shared parking agreement has been revisited and reviewed, and thus far has been shown to be in balance with needs. Biltmore Park has enjoyed similar success, reporting that even with a reduced parking supply, shortages have not been an issue. These two cases support the common claim in the literature that parking reductions such as shared parking will not cause issues of undersupply.

Two of the developments specially addressed parking maximums existing in the local code (Southern Village and Mayfaire Town Center). Southern Village in particular seems to have had success with the parking maximum, it having allowed the development to provide parking at a level even below what may have been recommended with a shared parking calculation, and at a level that is appreciably full during peak hours.

Overall, parking regulation via time limits or pricing is lacking in the surveyed developments, which is not surprising given the suburban character of these municipalities. Free parking is a given in these developments, and only in one case, New Town, was there any mention of the possibility of time limits on prime spaces (in the future). This may stem from suburban attitudes toward parking – pricing parking is always politically unpopular, and local merchants may also worry about business decreasing if parking is priced (although some studies have shown this to be unfounded and that the opposite is more likely to be true) (Shoup, 2005).

As seen in the literature review, the location of parking and the amount of land taken up by surface parking can have as much of an impact as the number of spaces provided. The developments surveyed were analyzed for percent of spaces occurring in each of three locations – street, surface lots, and parking structures – and for how much of the overall development acreage was occupied by surface parking (lots and street spaces). Two of the cases did not provide enough information to be included in this analysis. Results are reported in Table 21.

Table 21: Parking composition of case study sites

Development	Acres	Number of parking spaces				Acres in surface parking	% of site area in parking	Percent of parking by location		
		Total	*On-street*	*Off-street*	*Structured*			*On-street*	*Off street*	*Structured*
Chester Village Green	29	1,098	84	1,014		4.29	14.8%	7.7%	92.4%	0.0%
West Broad Village	115	5,257	539	852	3,866	5.17	4.5%	8.5%	13.4%	60.9%
New Town (sec. 2&4)	87	2,069	304	1,765		7.79	9.0%	14.7%	85.3%	0.0%
Biltmore Park Town Center	42	3,220	666	666	1,888	4.95	11.8%	20.7%	20.7%	58.6%
Phillips Place	34	1,359	1,359			5.05	14.7%	unknown		
Rocketts Landing (1st phase)	10	474	33	37	404	0.26	2.7%	4.5%	5.1%	55.3%
Baxter Village (town center)	20	1,318	100	1,218		5.35	26.8%	7.6%	92.4%	0.0%
Mayfaire Town Center	400	6,432	6,432			23.92	6.0%	unknown		
Old Trail Village	237	1,762	300	1,462		6.54	2.8%	17.0%	83.0%	0.0%

Greater amounts of land devoted to surface parking detract from the walkability of a development and allow for fewer uses to be clustered together. The majority of the developments surveyed had less than 15% of the land coverage in parking spaces, which is somewhat surprising given that most of the developments did not provide parking reductions (although this calculation takes into account parking spaces only – not access roads or curb cuts). The EPA's nine percent or less rule (Ewing, 1999) is met by five out of the nine developments in Table 21, and all but one is within six percent of that goal. Of the two developments that did have a shared parking plan, New Town just met the 9% rule and Biltmore Park was just above it, at a little under 12%. This may seem contradictory since Biltmore Park utilizes structured parking, but the development is also about half the size of New Town and has a much smaller total area in parking. Sites with more than 10% of their parking supply located in on-street spaces also tended to have lower area covered by parking.

A major trend in the case studies was the lack of information known on the part of the planning department in terms of the square footage in uses or many of the factors related to parking. While this represented a limitation to this study, it is also telling in regards to the trends found in the literature. With few exceptions, the planning departments surveyed has limited information available as to how parking for mixed-use developments was determined, or in some cases, even how many spaces were present in the development. This is worrying because parking has such a large impact on development patterns. Particularly in a mixed-use development, a lack of shared parking or any reductions in minimum requirements may perpetuate car use and limit future infill. If there is further growth in these kinds of developments and each use is required to provide its own parking, the clustered, walkable aspects of these developments may be at risk.

Related to this previous point, some planners surveyed had interesting responses regarding the question of shared parking implementation. When asked if shared parking had been implemented in their development, many answered in the affirmative, but at the same time indicated that parking had been supplied to meet or exceed the per-use requirement found in the local ordinance. They were identifying parking that was not specifically restricted to a certain use as "shared" in that visitors, employees, or residents could park in any of the spaces, however, the overall number of spaces in the development was calculated individually by use and was not

reduced in any way (in some cases, the number of spaces provided for each use was actually more than required for that use). This indicates a problem not just because many suburban mixed-use projects do not utilize shared parking, but because some planners may not even be aware of the concept or how it may be used to enhance their developments.

While the overall lack of knowledge and/or conscious planning for parking is discouraging, it is not unprecedented. Shoup (2005), for example, references a survey that asked planners what information they use to set parking requirements for workplaces – the vast majority surveyed nearby localities, the second largest source was ITE data, with five percent responding they simply didn't know, and even fewer referencing the use of an actual parking study. Similar patterns were seen here, with only two developments implementing shared parking studies, and the vast majority stating that they relied on the local code, not knowing how those rates were determined. Several did reference ITE or ULI rates as part of the information under consideration.

Also interesting is the fact that many of these developments surveyed have won awards, been singled out by ULI, or were recommended personally by other survey respondents as developments that exemplified well-designed, innovative, replicable mixed-use developments. These accolades are not undeserved, as most of these developments do represent an alternative to the typical suburban development model. However, rarely, if ever, is parking brought up for discussion in these publications. This makes sense on the one hand – good parking regulation or efficient reductions are not exciting. Attractive site design, popular retail options, and exciting residential opportunities are components that appear to be more newsworthy and garner more recognition. However, knowing the large role that parking can play in the design and walkability of a project, those projects that provide and regulate their parking in a way that is innovative and efficient should be receiving recognition from peers to indicate those projects as being worthy of replication.

Chapter 3: Shared Parking Analysis – ULI Methodology

Using both the data obtained firsthand from surveys, when detail allowed, as well as data available from the Urban Land Institute's case study database (Urban Land Institute, 2010), shared parking calculations were performed for a number of suburban, mixed-use developments. This was done to determine how much parking could be shared based on the size and type of uses in the development. Full mixed-use parking calculations can be found in Appendix B.

ULI's *Shared Parking* (Smith, 2005) methodology was used for this analysis, as this represents the most thorough, researched method of determining shared parking. There was no other method found in the literature that was able to break down base rates and peak times at a level of precision equal to that found in ULI's guide. Multiple developments discussed in Chapter 2 used the ULI method of calculating parking, or some variation thereof. As a tool for localities, it represents, at a minimum, a series of peak times that can serve as a starting point for implementing parking reductions. In addition to identifying potential parking reductions based on use, this analysis will identify strengths and weaknesses of this method for determining shared parking.

The parking calculations performed and analyzed in this chapter use the size and quantity of actual uses from ULI development cases and cases from Chapter 2, when information was available. The shared parking calculations themselves use ULI's base parking rates for easy comparison. Although in the real world a municipality will most likely use the parking standards found in local land use regulations, the objective of this analysis was to observe how the mix of uses impacts the potential for shared parking. For this reason, using a common set of base parking rates allowed for more direct comparisons and analysis between the developments.

An example of the ULI methodology for calculating shared parking is presented in Table 22 to demonstrate how the calculation is performed. This example calculates the potential shared parking reduction for the Downtown Silver Spring development. The method follows the following steps:

1. Every use in the development is categorized into one of ULI's categories for which they have determined base parking rates. These include[3]:
    a. Community shopping center (all retail unless given separate designation)
    b. Fine/Casual dining
    c. Family Restaurant
    d. Cineplex[4]
    e. Health club
    f. Convention center
    g. Hotel
    h. Residential, rental
    i. Residential, owned
    j. Office <25,000 square feet
    k. Office 25,000-100,000 square feet
    l. Office 100,000-500,000 square feet
2. Base parking rates were applied to each use based on the square footage for most uses, on number of units for residential uses, number of rooms for hotels, and number of seats for cineplexes. ULI separates rates into both an employee/resident component and a visitor component for each use.
3. Parking rates were determined for each individual use using the appropriate multiplier (i.e., per 1,000 square feet) and required parking was then calculated for each individual land use for both weekdays and weekends.
    a. Some assumptions had to be made to complete this step. ULI gives different base rates (and sometimes, peak hours) for two different types of restaurants and multiple office sizes, for example. When the size bracket for overall office square footage was unknown, or the split between two kinds of restaurants was unknown, the higher base rate was used. This may lead to an overall overestimation of shared parking requirements in some cases, and highlights the need for local knowledge in using this method effectively. Since the same assumptions were

[3] Only uses applicable to this project are listed here; ULI offers parking rates for several additional land use types.
[4] Cineplex parking rates are based on number of seats; when unavailable, seats were estimated using a ratio of 2,636 seats to 16 screens, or 164.75 seats per screen, as per Gilbert (2006).

made across all calculations, results are still comparable for the purposes of this research.

4. Based on the highest sum (weekday or weekend) and the use(s) with the highest number of required spaces for that day, a peak month and peak hour could be identified. Where a use had multiple peak months or hours, the peak time was determined by the second highest-requirement use, then the third, etc. Often, several possible peak hours were identified and parking needs calculated for each to determine the true peak time.
5. Peak month and hour rates in the form of percentages were multiplied on the individual base rates for each use, and again, the total was summed to determine the actual amount of parking needed based on the uses in the development.
    a. Hourly and monthly adjustments represent the amount of parking needed for each use at that time. For example, an office may need 100% of its base parking on a weekday at 1:00 p.m. when the greatest number of employees and visitors are likely to be there, but only needs 1% at 10:00 p.m. on that same day, since the office will be closed.
    b. ULI recommends applying additional rates for modal split and noncaptive rates (i.e., a reduced rate because in a mixed-use development, some visitors/employees/residents will be "captured" by nearby land uses after visiting/working at/living at another use in the development). However, as these rates require detailed data and local knowledge/expert opinion, these rates could not be applied in this analysis. The one exception is hotels, for which ULI suggests a standard 66% mode adjustment rate and so could be included.

Results of the example calculation (for the Downtown Silver Spring development) are shown in the final column of Table 22. This total number of spaces represents a 29% reduction over parking spaces if they were calculated for each individual use.

Table 22: Example shared parking calculation (ULI methodology – Downtown Silver Spring)

Use	Size/ number	Unit	Rate type	Weekday		Weekend		Peak Month	Peak Hour	Mode adjustment	Total spaces needed
				Rate	*Spaces*	*Rate*	*Spaces*	*Dec.*	*7pm*		
Retail	175278	ft^2	Visitor	2.9	509	3.2	561	100%	95%	-	484
			Employee	0.7	123	0.8	141	100%	95%	-	117
Restaurant	110502	ft^2	Visitor	15.25	1686	17	1879	100%	100%	-	1686
			Employee	2.75	304	3	332	100%	100%	-	304
Cineplex	2966	seats	Visitor	0.19	564	0.26	772	23%	80%	-	104
			Employee	0.01	30	0.01	30	50%	100%	-	15
Health Club	25000	ft^2	Visitor	6.6	165	5.5	138	90%	90%	-	134
			Employee	0.4	10	0.25	7	100%	75%	-	8
Hotel	179	rooms	Visitor	1.0	179	0.9	162	67%	75%	66%	60
			Employee	0.25	45	0.18	33	100%	20%	-	9
Residential (owned)	200	units	Visitor	0.15	30	0.15	30	100%	100%	-	30
			Resident	1.7	340	1.5	300	100%	97%	-	330
Office	185000	ft^2	Visitor	0.3	56	0.03	6	100%	2%	-	2
			Employee	3.5	648	0.35	65	100%	10%	-	65
Total:					**4689**		**4456**				**3348**
Potential reduction with shared parking: -28.6%											

Local application of shared parking methodology

The utility of the ULI shared parking methodology as a tool for parking reduction can be explored through an application of the method to one of the case studies presented in Chapter 2. The most detail provided in a development that did not utilize a shared parking strategy came from West Broad Village. The uses, rates, and parking required for the development are reported in Table 23.

Table 23: West Broad Village development details

Use	sq.f.t/number of units	Rate	Total spaces required
Retail	322,814	1/250 ft^2	1292
Furniture retail	16,740	1/750 ft^2	23
Restaurant	109,425	1/150 ft^2	730
Hotel	400	1/room	400
Fitness center	70,000	unknown	522[5]
Office	648,809	1/300 ft^2	2163
Residential 1BR	205	1/unit	205
Residential 2+ BR	134	1.5/unit	201
Total			**5536**
Actual spaces provided			**6347**
Numbers provided by Kennedy (2012b)			

For comparison, Table 24 shows the base parking for this project were ULI base rates used.

[5] Rate not provided; number of spaces assumed from spaces remaining.

Table 24: West Broad Village, ULI base parking

Use	GLA/number of units	Rate type	Weekday		Weekend	
			Rate	***Spaces***	***Rate***	***Spaces***
Retail	339554	Customer	2.9	985	3.2	1087
		Employee	0.7	238	0.8	272
Restaurant	109425	Customer	15.25	1669	17	1861
		Employee	2.75	301	3.0	329
Hotel	400	Guest	1.0	400	0.9	360
		Employee	0.25	100	0.18	72
Fitness center	70000	Customer	6.6	462	5.5	385
		Employee	0.4	28	0.25	18
Office	241739	Visitor	0.3	73	0.03	8
		Employee	3.5	847	0.35	85
Office (100-500ksf)	407070	Visitor	0.21	86	0.02	9
		Employee	2.73	1112	0.27	110
Residential (rented)	339	Guest	0.15	51	0.15	51
		Resident	1.5	509	1.5	509
Total				**6861**		**5156**

Table 23 and Table 24 indicate the importance of local knowledge where available in determining parking rates. Because West Broad Village fell within an Urban Mixed Use (UMU) zoning district, some of the base parking rates were already slightly reduced from what would have otherwise been required. ULI base rates give a much higher starting number. However, it is important to see how ULI's calculated shared rates compare to the reduced base rate, and actual number of spaces provided, in the development. This is shown in Table 25.

Table 25: West Broad Village shared parking calculation

Use	Rate type	Base requirement (weekday)	Peak month adjustment	Peak hour adjustment	Mode adjustment	Total spaces
			Dec	*2pm*	*Hotel only*	
Retail	Customer	985	100%	100%		985
	Employee	238	100%	100%		238
Restaurant	Customer	1669	100%	65%		1085
	Employee	301	100%	90%		271
Hotel	Guest	400	67%	60%	66%	107
	Employee	100	100%	100%		100
Fitness center	Customer	462	90%	70%		292
	Employee	28	100%	75%		21
Office	Visitor	73	100%	100%		73
	Employee	847	100%	100%		847
Office (100-500ksf)	Visitor	86	100%	100%		86
	Employee	1112	100%	100%		1112
Residential (rented)	Guest	51	100%	20%		11
	Resident	509	100%	70%		357
Total		**6861**				**5585**
Shared parking reduction: 18.6%						

Based on the number of spaces recommended by ULI, West Broad Village could have achieved a very similar reduction, and one that is even slightly lower, by implementing reduced parking rates. However, West Broad Village did not only supply the amount of spaces required by its UMU zoning designation, but instead provided 811 spaces more (762 more than the ULI recommendation) and intends to provide an additional 464,000 square feet of structured parking with future development (future development is already taken into account in above calculations).

This example suggests that where a development implements parking reductions other than shared parking, it can achieve a reduced amount of parking on par with ULI calculations. However, because there are no built-in peak time adjustments for these UMU parking requirements, they are limited in their flexibility and are not tailored to the other uses available in the development. Because of this, West Broad Village reflects what has been indicated in the literature – a desire to avoid undersupplying parking. This is manifested in an increase in parking supplied that potentially mitigates the benefits created by the UMU's reduced parking rates.

This example indicates the value of the ULI shared parking methodology, possibly beyond other mixed-use specific reductions. Because the rates are based around the peak hours of various uses, it avoids the potential problem of having set reductions that, while in theory allow for significant parking reductions in mixed-use projects, may also encourage localities to provide additional non-context-specific parking to avoid the problem of undersupply.

Determining the optimal mix of uses for sharing parking

To attempt to determine a mix of uses that allows the greatest reduction in required parking based on the ULI shared parking methodology, shared parking calculations were performed on data from 13 case studies, from both surveyed developments in Chapter 2 and the ULI Development Case Studies database (Urban Land Institute, 2010). Developments included in the following analysis are shown in Table 26. ULI's base parking rates were used to avoid any discrepancies between cases that already had some kind of reduction built into their base rates. The overall parking reduction recommended by ULI over the base rate could then be graphed as compared to development composition. Development composition is presented as a percent based on square footage in each use. Figure 18 shows the composition of developments as compared to this possible percent reduction based on the ULI shared parking methodology.

Table 26: Case studies for shared parking analysis

ID	Development	Acres	Base parking (ULI rates)	Parking needed w/shared (ULI)	Potential reduction
1	West River Commons	1.11	205	199	2.93%
2	Euclid Terraces	3.2	231	215	6.93%
3	Clayton Lane	9.5	2344	2061	12.07%
4	Paseo Colorado	10.9	4718	3884	17.68%
5	Rockville Town Square	12.5	3393	3063	9.73%
6	Excelsior and Grand	16	1822	1755	3.68%
7	Downtown Silver Spring	22	4689	3348	28.60%
8	Southern Village (Village Center)	25	1994	1524	23.57%
9	Phillips Place	35	2022	1600	20.87%
10	Birkdale Village	52	2923	2145	26.62%
11	Bayshore Town Center	52	5690	5159	9.33%
12	San Elijo Hills Town Center	70	1302	1145	12.06%
13	Miami Lakes Town Center	90	1589	1291	18.75%

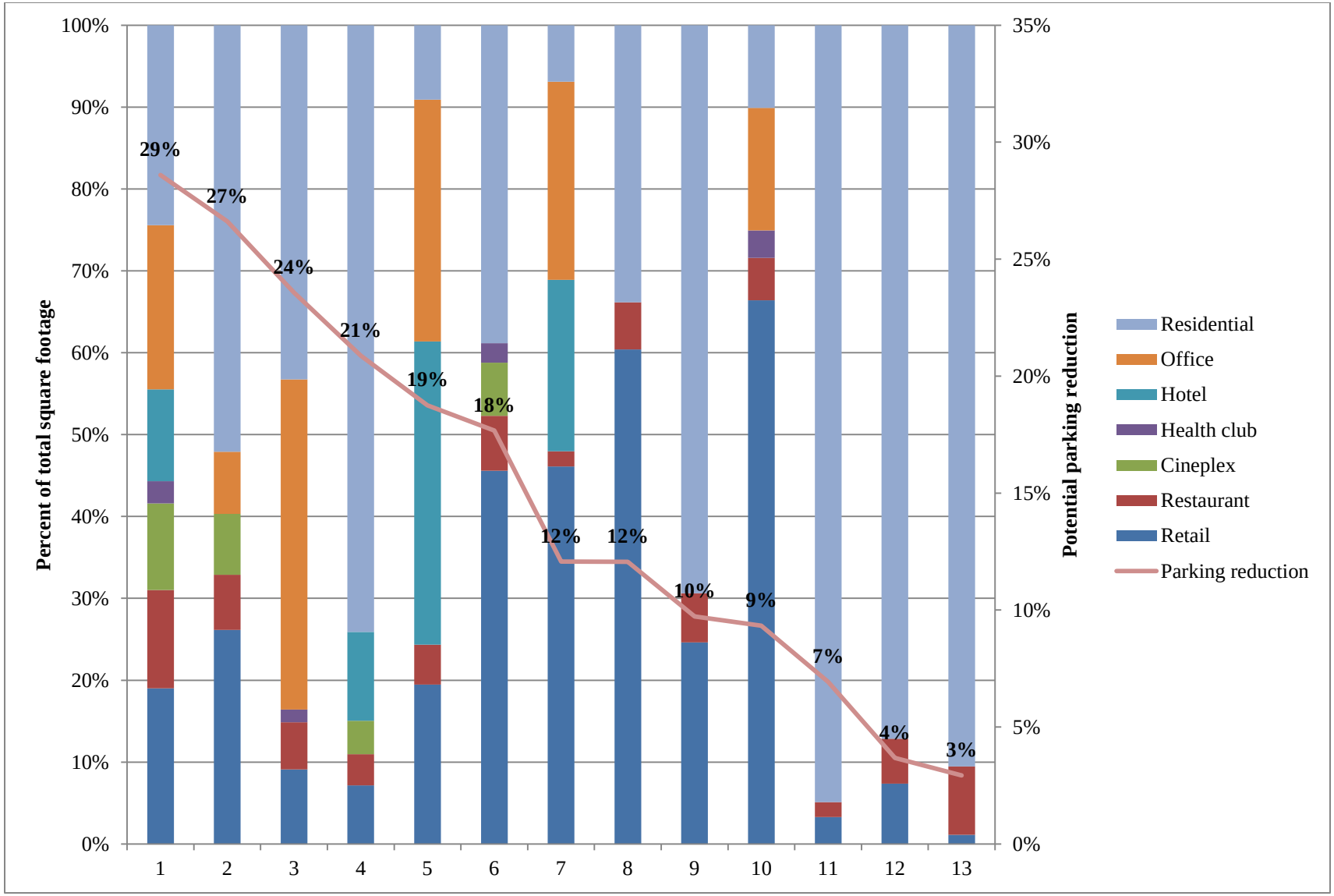


Figure 18: Parking reductions by development composition (case studies from Table 26)

As may be expected, developments with particularly large proportions of residential with few opposite peak time uses to balance them tend to allow for very small potential parking reductions. Consider bars 11-13 in Figure 18, each representative of one development. Because residential and restaurant uses tend to have large parking needs in the evening, uses with peak daytime uses are needed to balance them out if shared parking is desired. Residential uses also have no seasonality in terms of parking need, and are generally full or nearly full during non-business hours (i.e., before 9:00 a.m. and after 6:00 p.m. on weekdays, and on weekends) (Smith, 2005). In addition, when retail dominates the development there tends to be a somewhat smaller opportunity for shared parking reductions, most likely due to its consistently large parking demand during a large portion of daytime and evening hours.

Office uses generally only need all of their parking capacity during business hours, so when these uses occur with residential units, a greater opportunity for shared parking exists, and can be seen in bars 1-3 in Figure 18. Although they generally make up a smaller portion of the development, hotels and cineplexes appear to occur in developments with greater possible parking reductions, probably due to their unique seasonality and hourly requirements.

The greatest opportunities for sharing parking occur in developments with a mix of uses and where one use does not dominate the majority of the development. This is shown in a different way in Table 27, which indicates the uses in each development, ranked by potential parking reduction. Retail and residential uses are not included in the table as sites were selected based on the inclusion of those two uses at a minimum. As one might expect, the highest parking reduction opportunities based on ULI's shared parking methodology occur in developments with a varied mix of uses – the highest potential reduction found was for a development which included the most types of uses, regardless of size. All of the developments for which parking reductions of 20 percent or more were calculated contained at least three additional uses on top of retail and residential.

Table 27: Development composition by potential parking reduction (ULI methodology – case studies from Table 26)

Shared parking reduction	Use				
	Office	***Restaurant***	***Cinema***	***Health Club***	***Hotel***
28.60%	✓	✓	✓	✓	✓
26.62%	✓	✓	✓		
23.57%	✓	✓		✓	
20.87%		✓	✓		✓
18.75%	✓	✓			✓
17.68%		✓	✓	✓	
12.07%	✓	✓			✓
12.06%		✓			
9.73%		✓			
9.33%	✓	✓		✓	
6.93%		✓			
3.68%		✓			
2.93%		✓			

Finally, for each case study development in Table 26, the relationship between the area of individual use types and the percentage of parking required by those uses was examined for the four most commonly occurring uses. Results are displayed in Figure 19.[6] Note that, for example, in the retail portion of the figure (upper left) each point represents one of the 13 case study developments. Regardless of the balance of surrounding uses, the relationship between square footage in retail uses and the amount of parking needed as a portion of the whole shows a strong linear relationship. There is evidence to indicate that in most mixed-use developments, retail uses require a slightly lower portion of the total parking provided than their share of the development area. In other words, retail does not inform the overall parking need as much as some other uses, such as restaurants.

[6] The health club use was not included in this figure as it comprised such a small portion of developments which contained one that it did not have any discernible trend or impact, and detracted from the other uses.

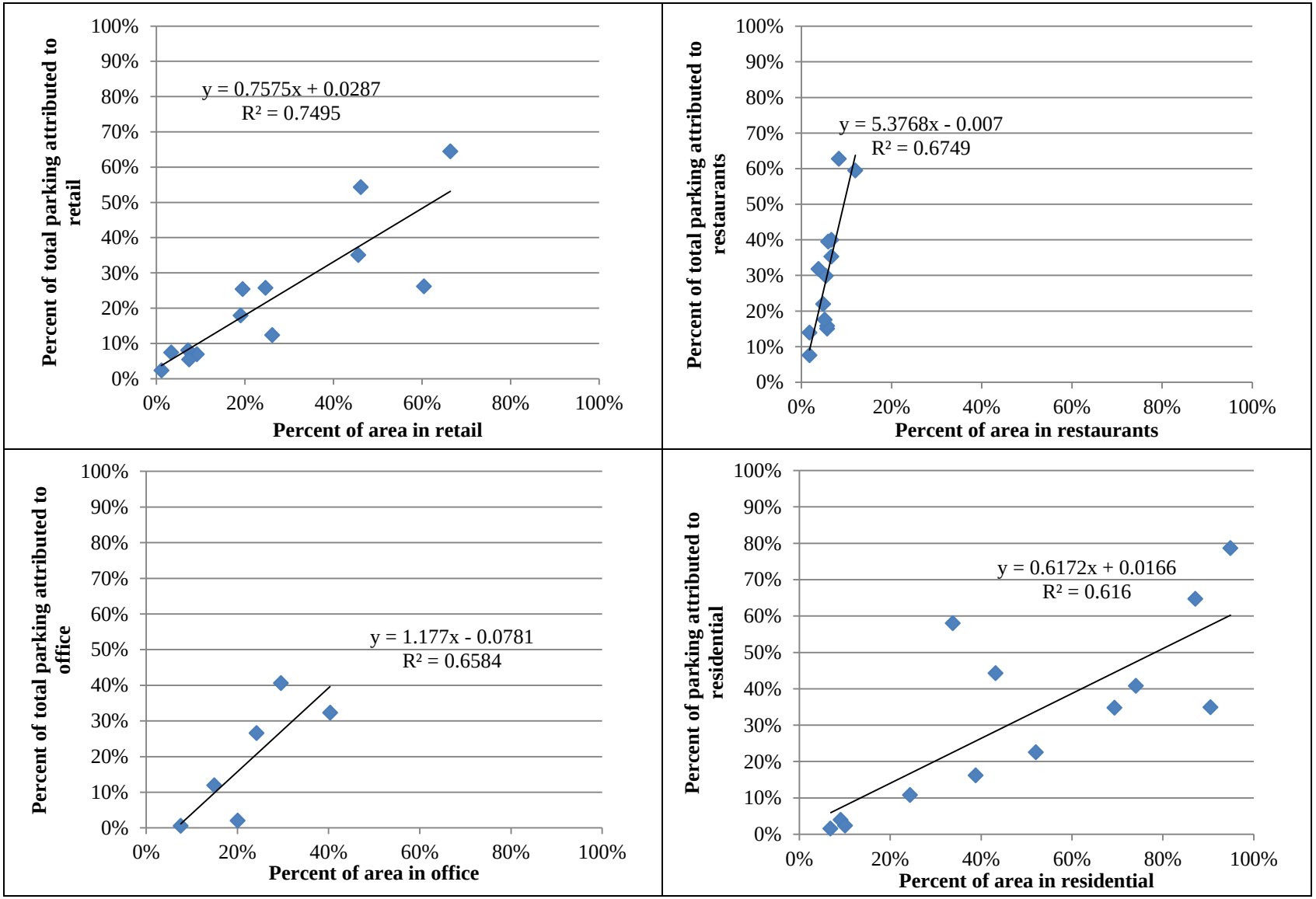


Figure 19: Percent of total parking spaces by use as a function of portion of total square footage

Several trends are clear: the restaurant use tends to dominate the development's parking quickly as compared to its overall size – in the most extreme case the restaurant required over 60% of the parking needed for the development even though it occupied only 10% of the gross square footage. This makes sense as restaurants have a very high parking requirement during their peak hours. However, as seen previously in Figure 18, restaurants are not necessarily correlated with low levels of shared parking. Therefore, it stands to reason that restaurants can easily be a component of a parking-efficient mixed-use development, but should be balanced with uses with opposite peak times.

Residential and retail uses demand more parking as their areas increases, but not as much as restaurants. Both had a percent parking to percent square footage ratio of less than 1:1 when a linear regression was fitted to the points. This indicates that these uses do not have a large parking need per square foot, but opposite peak uses should still be provided to avoid limiting the potential for shared parking, as seen in Figure 18. Fitting a linear regression to the office use resulted in a near 1:1 ratio. Offices will need a proportion of the parking space approximately equal to the proportion of the development that they occupy.

Overall, ULI shared parking calculations suggest that a diverse mix of uses, and not allowing one use to dominate the development, can lead to large amounts of shared parking and thus an overall reduction in a development's parking supply, without risking undersupply.

Scenario analysis

While the analysis to this point has allowed some insight into what uses work well together in terms of utilizing the same parking supply, further steps were taken to explore whether an optimal mix of uses exists that reduces parking to the greatest extent, regardless of peak hour. Using the same ULI shared parking methodology, a number of scenarios were developed to better test if an "ideal" mix truly exists that allows for greatest parking reduction using a share parking strategy.

The scenario analysis was performed by first identifying the development from the previous shared parking analysis with the greatest potential parking reduction (Downtown Silver Spring). The proportions of area in each use were used as the starting points for the remaining analyses. Then, certain uses were increased or decreased, with the remaining uses adjusted

proportionately, to mimic certain scenarios, i.e., a retail-based shopping center style development, an office park style development, etc. The results of these calculations are shown in Appendix C. Note that since parking is not based on square footage for residential, hotel, and cineplex uses, an average square foot per unit ratio was calculated for each of those uses so that the area proportion could be used across the board.

Ultimately, this scenario analysis reinforced the findings from the previous section, implying that a greater variety of uses results in a greater potential reduction in the amount of parking spaces needed. A description of each scenario and the resulting number of required spaces are reported in Table 28. The resulting composition/parking reduction graph is presented in Figure 20.

Table 28: Scenario descriptions

Scenario	Description	% retail	% restaurant	% cineplex	% hotel	% residential	% office	Parking reduction
Base case	Uses proportions from greatest parking reduction found in previous analysis (Downtown Silver Spring development).	19.55%	12.32%	10.90%	11.51%	25.09%	20.63%	30.41%
Average composition	Averaged the proportions in each use across cases; used these as scenario proportions.	26.03%	5.76%	2.22%	6.20%	49.19%	10.59%	18.72%
Basic composition	Adjusted proportions from base case to only those found in every case (retail, restaurant, and residential)	34.32%	21.63%	-	-	44.05%	-	1.31%
Basic composition + office	Same as basic composition, but included office (most common use after original three).	25.19%	15.88%	-	-	32.34%	26.59%	18.16%
Increased retail	Retail increased to 50% of area and remaining uses adjusted accordingly.	50.00%	7.66%	6.77%	7.15%	15.59%	12.82%	23.22%
Increased residential	Residential use allowed to max out area representing two floors of residences above retail and restaurant uses.	14.10%	8.89%	7.86%	8.30%	45.97%	14.88%	27.21%
Large cineplex	Increased cineplex use to represent a 20-theater cinema. Remaining uses adjusted proportionally.	18.32%	11.55%	16.50%	10.78%	23.52%	19.33%	12.15%
No cineplex	Removed cineplex from development, adjusted other uses proportionately.	21.94%	13.83%	-	12.91%	28.16%	23.16%	20.23%
Office park	Increased office use to 50% of square footage, adjusted remaining uses accordingly.	14.27%	9.00%	-	8.40%	18.32%	50.00%	16.03%

Scenario	Description	% retail	% restaurant	% cineplex	% hotel	% residential	% office	Parking reduction
Shopping center	Greatly increased retail use, with mid-size cineplex (10 screens) and residential and restaurant uses slightly reduced. Meant to mimic common suburban mixed-use development that still has a "shopping center" focus.	62.00%	10.00%	8.00%	-	20.00%	-	19.21%
Base optimization	Optimizes the base case by adjusting proportions in each use until the greatest parking reduction was achieved, without making any use so large as to require a change in peak time (and thus a subsequent increase in needed parking.	19.55%	2.32%	10.90%	31.51%	25.09%	10.63%	40.73%

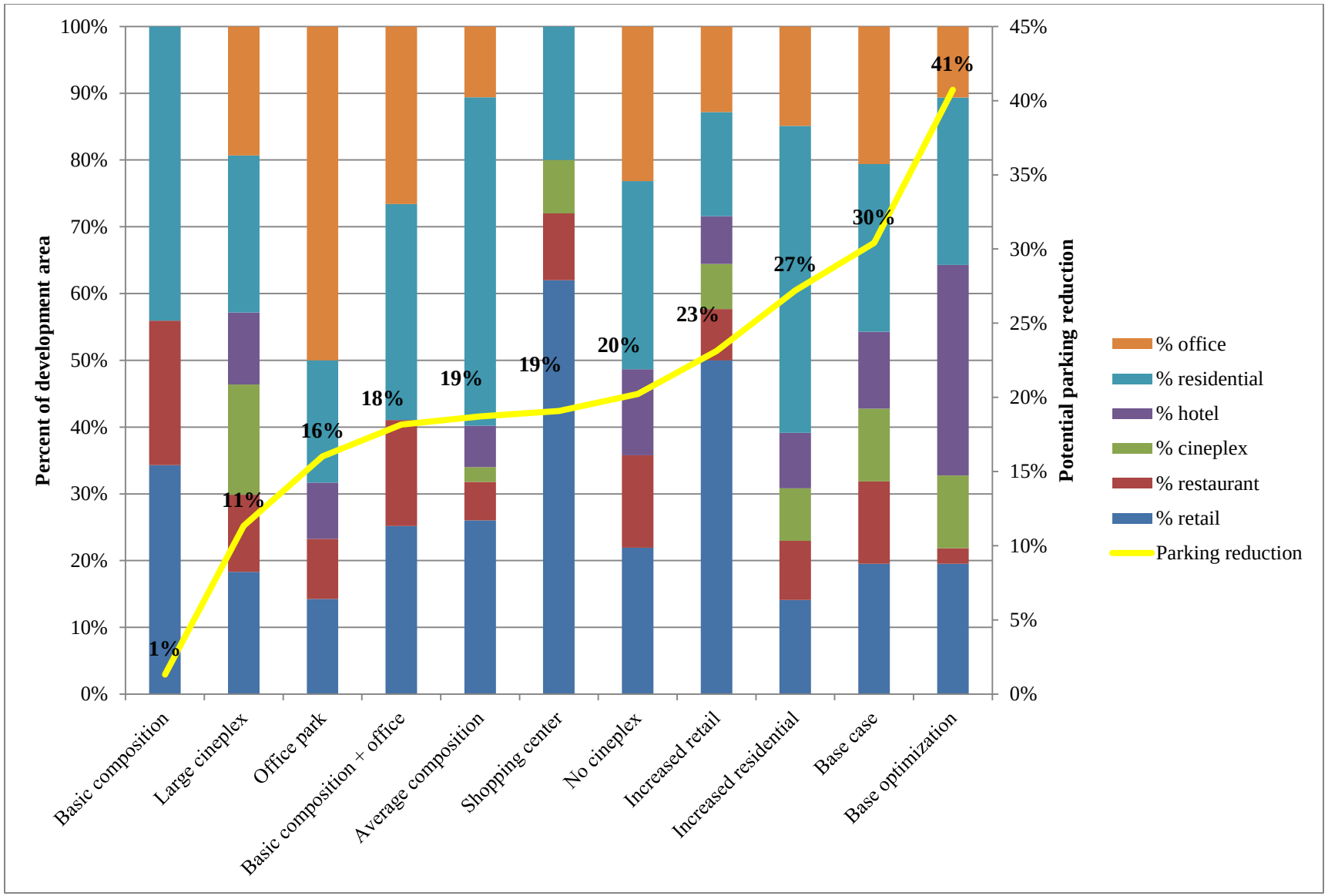
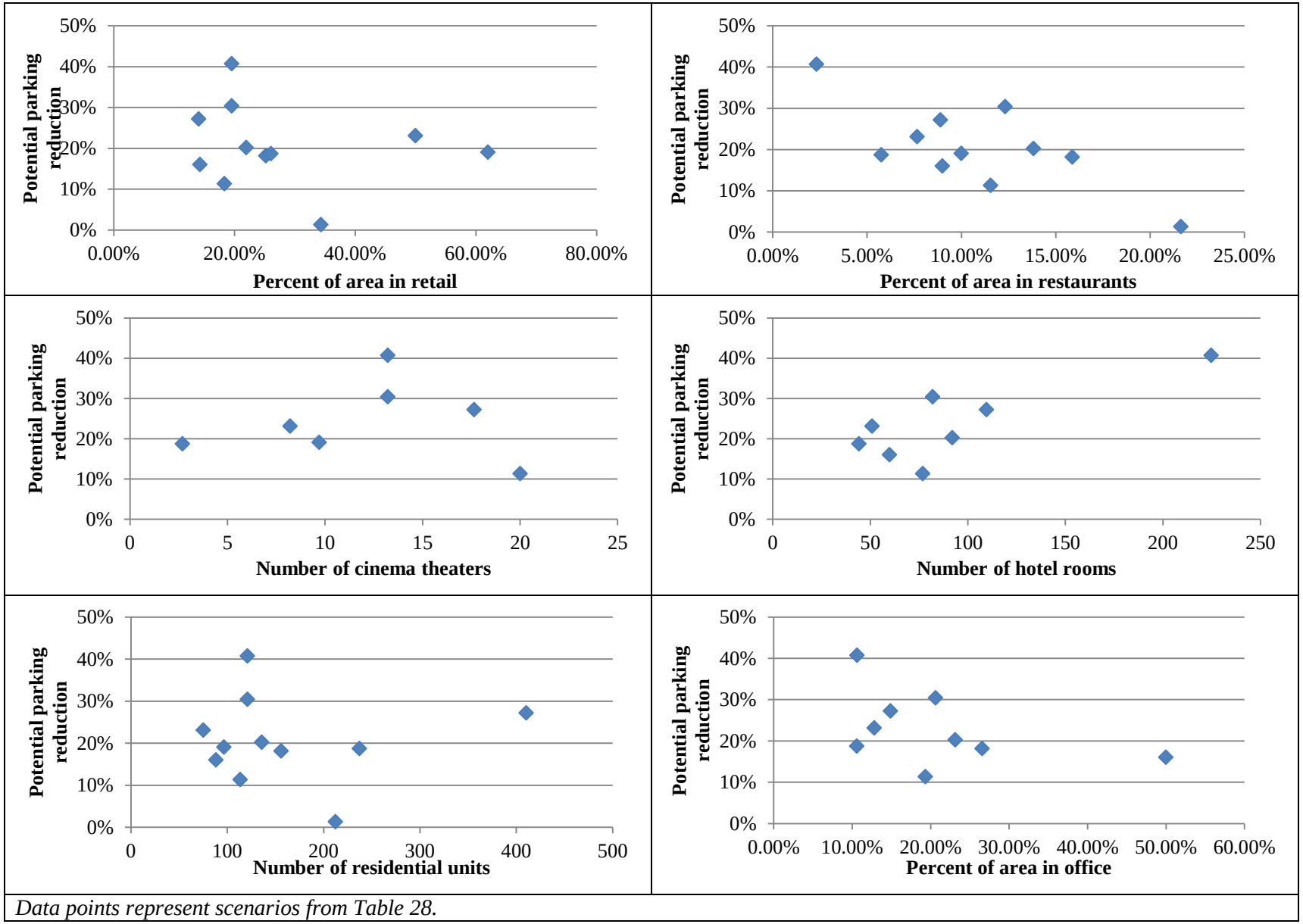


Figure 20: Scenario analysis - parking reductions based on development composition (scenarios from Table 28)

Overall, the results found in the scenario analysis reflect those seen in the previous case study analysis. Inclusion of only residential, retail, and restaurant uses do not allow for high levels of shared parking, in part because these uses all have relatively large evening needs. Since the amount of parking needed revolves around the absolute peak time, all three uses will have high need during several post-5:00 p.m. hours, and thus there is little opportunity for sharing. However, including an office use at around a quarter of the total development area increases the potential amount of shared parking to about 19% (see the fourth bar in Figure 20). Because an office has a peak time opposite that of residential and somewhat opposite of retail and restaurant uses, it is needed to balance these uses out if less parking is desired.

To better observe the impact of each use on the overall parking need, a series of graphs was generated and presented in Figure 21. Each point represents one of the scenarios, and shows the relationship between that hypothetical development's area in a given use and the calculated parking reduction.

Similar to the square footage versus parking relationships presented in the previous case study analysis (Figure 19), scatterplots of the area in each use and the potential parking reduction for hypothetical scenarios seek to identify a relationship between the area in each use and the potential for shared parking. In general, there was no clear trend found between the area in an individual use and the potential parking reduction for the whole development. This makes sense as it is the existence of two or more uses with varying peak times that determines the potential reduction in parking spaces, not one use on its own. The one exception is restaurants, which exhibit a slight inverse relationship between their area and the potential parking reduction of the development. Based on the results of the previous case study-based shared parking analysis, this is logical since restaurants have an extremely high peak need, and are correlated with a high number of required parking spaces, especially when there are not enough uses with opposite peak times to balance out the overall parking need.



Data points represent scenarios from Table 28.

Figure 21: Potential parking reduction by size/number of uses

The optimization scenario highlights a use of the shared parking methodology beyond calculating the needed parking for a set of uses. It can also be used as a planning tool up front to adjust the size or number of uses if minimizing parking is a goal. This may be useful to developers who wish to increase the leasable portion of the project while decreasing unprofitable free parking, and while still avoiding undersupply. The example optimization is shown in Table 29 (base composition) and Table 30 (optimized composition).

Table 29: Best case parking from shared parking calculations

Use	**Percent of total area**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Total spaces	Dec	7pm	Hotel only	
Retail	19.55%	97737	Customer	2.9	284	100%	0.95		270
			Employee	0.7	69	100%	0.95		66
Restaurant	12.32%	61617	Customer	15.25	940	100%	1		940
			Employee	2.75	170	100%	1		170
Cineplex	10.90%	13	Customer	0.19	414	23%	0.8		77
			Employee	0.01	22	50%	1		11
Hotel	11.51%	82	Guest	1	83	67%	0.75	0.66	28
			Employee	0.25	21	100%	0.2		5
Residential (owned)	25.09%	121	Guest	0.15	19	100%	1		19
			Resident	1.7	206	100%	0.97		200
Office	20.63%	103158	Visitor	0.3	31	100%	0.02		1
			Employee	3.5	362	100%	0.1		37
Total	***100%***	***500000***			***2621***				***1824***
Shared parking reduction: -30.4%									

Table 30: Optimized composition for maximum parking reduction

Use	Percent of total area	Sq. ft./ # units	Rate type	Weekday		Peak month adj.	Peak hour adj.	Mode adj.	Total spaces
				Rate	Spaces	Dec	2pm	Hotel only	
Retail	19.55%	97737	Customer	2.9	284	100%	95%		270
			Employee	0.7	69	100%	100%		69
Restaurant	2.32%	11617	Customer	15.25	178	100%	65%		116
			Employee	2.75	32	100%	90%		29
Cineplex	10.90%	13	Customer	0.19	414	23%	55%		53
			Employee	0.01	22	50%	60%		7
Hotel	31.51%	225	Guest	1	225	67%	60%	0.66	60
			Employee	0.25	57	100%	100%		57
Residential (owned)	25.09%	121	Guest	0.15	19	100%	20%		4
			Resident	1.7	206	100%	70%		145
Office	10.63%	53158	Visitor	0.3	16	100%	100%		16
			Employee	3.5	187	100%	100%		187
Total	***100 %***	***500000***			***1709***				***1013***
Shared parking reduction: -40.7%									

Obviously, most mixed-use projects are not developed with the goal of reducing parking as much as possible. However, given a general composition for a development, the ULI shared parking methodology can be used to "test" adjustments to the mix of uses to obtain a greater reduction. When a development grows in a more piecemeal fashion, ULI's shared parking calculations can be utilized in a similar way to estimate what type of land use would allow the least amount of parking to be added to the development.

Limitations

The methodology recommended in ULI's *Shared Parking* is useful in that it offers a starting point for determining what is possible in terms of parking for any given development. Given its carefully researched peak time adjustments, the basic methodology is theoretically applicable to both large-scale mixed-use developments and smaller developments which may only include two or three uses (although this research has shown that a greater variety of uses generally contributes to more effective shared parking applications).

Some limitations should be noted. For one, ULI assigns the same hourly and monthly need and parking base rates to all retail uses. This assumes, in effect, that a big-box store will have the same parking need as a smaller, local retail use. Although these rates come from multiple sources and appear in this way to be well-researched, it still seems counterintuitive to assign the same peak times to every retail use when it is obvious that some will differ. ULI's *Shared Parking* guide is also limited in the number of uses it offers rates and peak hours for. Certain civic uses are not included at all, such as libraries and other community buildings. It is also unclear how one might approach applying rates for age-restricted residential uses that may require fewer spaces. For reasons such as these, municipalities would have to have the resources to perform their own local parking studies for any uses not included in ULI's shared parking methodology.

ULI suggests that uses that do not fit into one of their provided classifications for which they provide rates and peak times (shopping center, office, residential, etc.) may be built into the shared parking calculation by slightly modifying the rates of the most closely related use. However, the guide also cautions against customizing parking rates for individual tenants (Smith, 2005). There is no clear guidance, then, for how to handle uses that may diverge from the peak times of broader use categories, or that do not fit clearly into a predefined category.

There is a need for local knowledge to most effectively use the shared parking methodology. Adjustments for mode choice and captive trips, for example, may look very different depending on the surrounding environment, and may allow for greater parking utility in some cases. For this reason, a lack of local knowledge when using ULI's tool may still result in an oversupply, particularly if the development enjoys access to alternative transportation modes. On the other hand, ULI notes that their rates and peak adjustments are appropriate for the majority of developments, but allows that some locations may find these to be inadequate. Factors like local competition and gradual increases or decreases in patronage may lead to parking undersupply under the ULI rates (Smith, 2005). This suggests that the ULI *Shared Parking* guide should not supersede local parking knowledge.

Chapter 4: Conclusions

The results of this study have answered the original research questions as follows:

How is parking provision determined, and managed, in suburban mixed-use developments?

The suburban mixed-use developments surveyed in this study and presented in Chapter 2 generally used local codes, whether or not they include any kind of mixed-use zoning designation or opportunities for parking reductions. This follows closely with what the literature suggests in terms of general trends in planning for parking, for mixed-use developments or otherwise.

No survey respondent mentioned giving the developer freedom in determining the parking to provide, although one case, Biltmore Park Town Square, did rely on developer-funded consultants and parking studies to determine the amount, while following certain regulations in the local code. In other cases, developers did not have a role in determining parking to provide. This is not surprising, as doing so may require additional rezonings or changes to the local ordinance itself, and as this approach is not always prevalent in the mixed-use parking literature. However, Shoup (2005) and others have supported this method of determining parking provision. Since it is in the developer's best interest to provide enough parking, but to also decrease costs where possible, this method could potentially avoid large over or undersupply, and may allow the developer to provide more profitable land uses on space that would otherwise be parking lots. As seen in the case of Biltmore Park, the developer was able to arrive at a number of spaces that is appreciably full at some peak times, but never undersupplied.

Developments differed in terms of where parking was supplied. About half did provide parking in structures – either freestanding garages or underneath/on the ground floor of multistory buildings. This is a factor that relies heavily on land and construction costs, and so will most likely differ by location.

Regulation of existing parking was one area in which there was full agreement across the case studies – spaces were not regulated for turnover in any discernible way, either with time limits or pricing. This is perhaps unsurprising given the suburban nature of the municipalities – pricing of curbside spaces is more common in urban areas. However, as several of the survey respondents

did mention having trouble keeping local employees or residents of the development from parking in the most convenient curbside spaces, there is at least some anecdotal evidence that time limits or prices may be beneficial, even in suburban mixed-use areas.

What "best practices", if any, have been shown to be effective in supplying and managing parking?

Five of the case studies did implement at least partial shared parking, with one additional case claiming reductions were given for good pedestrian access and age-restricted housing. Only two of those truly stood out as having adapted parking to work in sync with the overall site design and goals – these were New Town and Biltmore Park Town Square. Given the successes expressed by both of those developments, and the reductions in parking supply achieved without undersupply issues, this study does suggest that shared parking is an important component of any mixed-use development. This is also supported by the literature. Reducing the parking should be coupled with pedestrian-friendly design to ensure success.

There was no evidence to support best practices in terms of location of parking. Those developments that provided parking in structures extolled the benefits of parking garages. They have less of an impact on the pedestrian environment and can be hidden underneath other uses or "wrapped" by other uses to limit their visual impact. However, the lack of structured parking does not seem to automatically prevent success – consider New Town, where parking is located only in surface lots and curbside spaces. The development achieved the literature-identified goal of no more than 9% land surface cover in parking, probably due to the fact that the development utilized centrally-located lots for much of their parking instead of more, smaller lots for each building.

Certainly structured parking can provide benefits to a mixed-use development if it is practical to implement. In some cases, the construction cost may be prohibitive. This means that a development that does not invest in parking structures should be careful in the way off-street parking is designed and located such that walking is encouraged within the development and curbside parking makes up a significant portion of the parking. Ideally, curbside spaces should be allowed to count against off-street requirements, at least partially, to further avoid oversupply and overly large, unattractive surface lots and increased impermeable surface.

Many of the survey respondents and/or associated local ordinances did note the importance of locating the majority of surface parking behind buildings to avoid negatively impacting the pedestrian environment.

No best practices were identified across the cases for regulation of parking, and some problems were identified with the lack of any kind of time limit or price on parking. New Town did identify a possible need to implement time limits on prime parking spaces in the near future. Necessary regulation of parking spaces will most likely be a product of local parking behavior and the location of parking in the development. However, where much of the parking is provided in conveniently-located on-street spaces, some kind of parking regulation, either in the form of time limits or pricing, or both, should be utilized to keep development residents and employees from occupying those spaces for long periods of time, particularly during peak hours for surrounding commercial uses.

Some of the sites did regulate parking in terms of limiting it to one use (primarily for residential uses). While this seems counterintuitive to the goals of mixed-use and shared parking, it may work if those spaces are not limited in that use's off-hours. Consider Biltmore Park Town Center, which identified a need to reserve some spaces for a large office, but was able to remove the limit in off-peak hours for use by other commercial tenants. Similar strategies could be implemented in other developments when residents or employees have trouble parking near their residence or place of work, so long as those spaces are not reserved when they are unneeded. This only strengthens the argument for local parking studies and carefully planned shared parking strategies, and suggests that shared parking does not have to be an all or nothing situation.

Does an ideal mix of uses exist that allows for greater parking reduction, and thus increased pedestrian utility, based on local observations and/or the ULI shared parking methodology?

A greater number of developments would need to be surveyed to have any confidence in recommending an exact ratio of uses, and most likely this simply does not exist – the uses will probably be a factor of local needs, economic factors, and community goals. Local travel

behavior and attitudes towards parking and walking will also impact the number of spaces needed in a development. As indicated in the optimization problem in Chapter 3, it is possible to find an ideal mix starting from a general project composition, but because there is some use at each peak time that will use the least amount of parking, ultimately, efforts to minimize parking will just decrease that use until the project is forced into a new peak time and the necessary parking increases again. ULI's methodology can be used to observe how different uses affect the parking needed by others due to the relationship across months and times of day.

Despite the local component in determining the mix of uses and the amount of parking to provide, some general recommendations can be made. It was observed in the ULI shared parking analyses that developments dominated by one use such as retail or residential often need a larger amount of parking and have fewer opportunities to share, since most of the uses in the development will have the same peak hours. Hence, the peak need will be provided, which may be full at those peak times, but will probably be mostly empty during off hours.

Based on peak hours developed by ULI and applied to the test cases in Chapter 3, there are certain uses that work well together to efficiently share a significant portion of parking. Most uses common across developments have their peak month in December (retail, restaurants, residential (all year) and offices (all year except summer)). However, uses such as cineplexes and hotels tend to have a lower requirement in December, with their peaks occurring in summer and spring months, respectively. Including these types of uses in a mixed-use development may allow for slight parking reductions. This is reflected in the real-world case studies found in Chapter 2; most suburban mixed-use developments surveyed included a hotel or a movie theater, or both.

Hourly peaks have a greater influence on shared parking strategies. Offices often have a large parking requirement, but only need the majority of that parking during the 8:00 a.m. to 5:00 p.m. time block. It is appropriate, then to have office and residential uses located in close proximity since the latter will generally have its peak hours before 8:00 a.m. and after 6:00 p.m. Similarly, movie theaters have greatest needs on weekends in the evening, so can also effectively share space with offices. Restaurants tend to have high evening peaks, especially those that constitute

fine dining with a bar, and family restaurants have high lunchtime peaks. Thus, restaurants of different types may effectively share parking with each other in some cases, and in the grand scheme of the development, could share well with office or retail spaces in the evening and residential or cinema spaces during the day.

From a base parking per square footage/unit perspective, residences, offices, and restaurants generally have high parking requirements, but if these all occur in a mixed use environment, even in otherwise suburban areas, a large reduction in required parking is almost always possible. As seen in Chapter 3, a balanced mix of uses generally allows for the greatest parking reductions. Thus, mixed-use developments should avoid oversaturating a development with only residential, office, or retail uses, and instead should seek to encourage diversity.

Limitations and recommendations for future study

The largest challenge in this project was the difficulty in obtaining detailed, accurate information, particularly when it came to quantitative data, i.e., the size and number of uses in a development, and sometimes the total number of parking spaces as well. This added a level of uncertainty to the shared parking calculations performed in Chapter 3. Furthermore, while planners contacted were generally happy to answer the survey to the best of their ability, developers who were contacted to supplement this information were generally unresponsive, with a small number of exceptions.

One strategy to obtain an accurate count of parking spaces would be to send a survey team to physically count spaces in each development studied. Specific site documents such as site plans and approved development plans for each development and parcel in the development would most likely also need to be obtained to attain accurate square footage and type of uses. This is particularly important as planning departments, and in some cases, even the developers, reported square footage in the development lumped into two general categories of residential and nonresidential (on occasion, other significant uses like movie theaters and hotels were separated out) which made it difficult to apply the ULI shared parking methodology. This is one area in which the detail of information provided by ULI case studies was superior, although again, the

accuracy of all of the cases is somewhat in question. It would be ideal to obtain ULI's methodology for collecting this information for future studies.

An additional survey question that would have been useful and should be included in future studies of a similar nature is the space in residential square footage. Even though parking for residential uses is generally based on the number of units and/or bedrooms, the area in residential use would have been a useful metric for the kinds of analyses performed in Chapter 3. Furthermore, the parking provided by individual use would have been a beneficial metric to obtain to better compare with ULI recommendations.

Ultimately, in order to make a strong argument for shared parking and other reductions in suburban mixed-use developments, more developments need to be identified that have had success doing so. While this project was able to identify a few cases in which shared parking or other reductions were developed and implemented well, no case followed all of the recommended strategies suggested by the literature in terms of surface area devoted to parking, parking reduction opportunities, and regulation of parking spaces.

Epilogue: Strategies for Chesterfield County

This research began as a way to address the question of how to provide parking for a mixed-use development in the otherwise suburban municipality of Chesterfield County. With goals of moving toward more clustered developments in the future, the county has an opportunity to develop a new understanding of how parking can work for or against the overall success of a development.

From this research, several best practices have been identified as appropriate for Chesterfield as the county moves forward in embracing more clustered, mixed-use development. The following recommendations are made:

1. Utilize shared parking in mixed-use projects

Chesterfield's goal to increase the number of clustered, mixed-use developments represents a departure from the single-use development that currently dominates growth in the county. It makes sense, then, that parking should also move away from single-use minimum standards. Chesterfield County is already moving toward more context-based parking in some ways. The local zoning ordinance already allows slight reductions for shopping centers and village centers as compared to single-use retail developments. In Chester Village Green, a parking reduction was allowed for the age-restricted residential component. Shared parking could be the next step in reducing the number of spaces, and thus costs and land, for mixed-use developments in the future.

As an example, the parking estimate from the Planning Commission case described in the Problem section was used to estimate the spaces that may have potentially be saved using ULI's shared parking adjustments. Although the Planning Department was unable to provide specific details regarding size and number of uses, peak time adjustments could still be applied to the base requirements. The age-restricted units were kept at 100% peak adjustment since the required spaces already represented a reduction over standard residential. Sharing residential parking could potentially lead to greater reductions. The results of this estimated shared parking reduction are presented in Table 31.

Table 31: Estimated shared parking reduction, Chester Village Green parking

Use	Required parking	Provided parking	Classification	Peak adjustment (5pm weekday)	Required spaces
Proposed apt. building	88	66	Residential (rental)	85%	75
Festival park apts.	214	214	Residential (rental)	85%	182
Festival park commercial	152	152	Retail	95%	145
Chester Village Senior Apartments	171	182	Age restricted residential	100%	171
Chester Village condominiums	36	36	Residential (owned)	85%	31
Chester Library	69	113	Retail*	95%	66
Walgreens	60	64	Retail	95%	57
Animal hospital	21	21	Retail	95%	20
Office	35	35	Office	50%	18
Office/community building	3	3	Office	50%	2
Island Architects	10	10	Retail	95%	10
Village shops	51	51	Retail	95%	49
Argent Federal Credit Union	16	16	Bank	100%	16
Countryside ice cream	3	3	Retail	95%	3
Bank of Virginia/Ray's restaurant	38	35	Bank (19 spaces)	100%	19
			Restaurant (19 spaces)	75%	15
Chester Arts Center	117	97	Retail*	85%	100
Total	**1084**	**1098**			**979**

* ULI does not have a specific rate for either of these uses. They are assumed to approximately imitate retail peak times for the purposes of this estimation. This further demonstrates the importance of local parking knowledge for a development such as this.

Although Chester Village Green currently requires approximately 1084 spaces, it will not allow a new residential development to be constructed unless it provides enough spaces to accommodate the use's need as if it were in a single-use environment. Not only does this estimation indicate that the development as a whole exceeds the current requirement, proposed residential included, but if the development were to share parking among uses (age-restricted development excluded) it could potentially supply enough parking at approximately 100 spaces less than the current requirement. Although this is only an estimate based on some general assumptions, Table 31 demonstrates the potential reduction that could be achieved if parking is provided on pooled, shared basis, rather than a per-use basis, for Chesterfield's future similar projects.

2. Use ULI's *Shared Parking* as a planning tool, but not as a hard and fast rule

As in the estimate above, ULI allows a starting place for understanding how uses can work together to allow less parking than if those spaces were provided on a per-use basis. However, local knowledge is important when these reductions may lead to undersupply, or on the other hand, when less parking may be provided due to mode choice or captive trips. This is related to the third recommendation.

3. Perform local parking studies for current developments, mixed-use and otherwise

Chesterfield County has already recognized that when multiple uses are located in the same area, i.e., in a strip shopping center, the required number of spaces can normally be reduced slightly without risking undersupply. Parking studies for developments of all types and sizes would allow the county to better assess where and if parking is over or undersupplied. This may help to inform the actual amounts of parking needed for future developments, and help to refine shared parking calculations, should they choose to use them.

4. Require periodic evaluation of the shared parking as a proffer for the planned unit development (PUD)

Because Chesterfield County's Traditional Neighborhood Development zoning district does not allow for parking reductions specific to that district, future mixed-use projects hoping to utilize a shared parking strategy will most likely have to be implemented as a PUD. (Alternatively, Chesterfield County could begin the process of adding to or modifying current zoning districts so

that some district exists that allows shared parking by default.) In addition to cash proffers, Chesterfield County could emulate New Town's approach in requiring a proffer on mixed-use developments that use shared parking. The proffer would require the Planning Commission to reevaluate the parking periodically to ensure that supply and demand are in balance. Although this represents a larger cost in terms of staff time, the New Town experience is indicative of its potential for success. Furthermore, if one of Chesterfield's issues is changing the public's (and some government officials') expectations of parking, then a promise to check and adjust parking as needed may help increase acceptability of such a strategy.

Chesterfield County is already in the process of taking some small steps toward reduced parking and increased mixed-use. The strategies proposed above, which have been supported anecdotally in this research and/or in the literature, could help Chesterfield or other primarily suburban localities to better address the symbiotic relationship between parking and development patterns, and to capitalize on the potential benefits of clustering uses together.

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Appendix A: Mixed-Use Parking Survey

Development: Click here to enter text.

Name of respondent: Click here to enter text.

Email: Click here to enter text.

1. What is the overall size of the development?
   Click here to enter text.

2. Please provide the gross floor area (GFA) of all nonresidential development within the project (specific to each use, if possible – i.e., restaurants, retail, etc.).
   Click here to enter text.

   2a. How much of the total GFA is in tenant spaces of more than 5,000 square feet each, and how large is the largest tenant space?
   GFA in spaces > 5,000 sq. ft.: Click here to enter text.
   Largest tenant space: Click here to enter text.

3. Please provide the number of apartment/condominium units within the project.
   Click here to enter text.

   3a. For multifamily residential uses, how many units are 1 bedroom, 2 bedroom, 3+ bedroom, or studio apartments?

1 BR	Click here to enter text.
2 BR	Click here to enter text.
3+ BR	Click here to enter text.
Studio	Click here to enter text.

4. How much parking is provided by the development as a whole (number of spaces)?
   Click here to enter text.

4a. What standards or examples (if any) were used to determine the amount of parking to provide (ITE, ULI, other municipality as example, etc.)?
Click here to enter text.

5. Were parking reductions allowed (for density, access to transit, etc.)?
   Click here to enter text.

6. Where is parking located (on-street, off-street, off-site, etc.)?
   Click here to enter text.

   6a. Number of spaces in each location?
   Click here to enter text.

   6b. What size are the individual parking spaces (please indicate if this differs by parking type/location)?
   Click here to enter text.

7. Is parking shared among uses? If so, how much parking is shared, and how much is designated for individual uses?
   Click here to enter text.

   7a. Do residential uses "share" parking with nonresidential uses?
   Click here to enter text.

   7b. How was the amount or proportion of shared parking determined?
   Click here to enter text.

8. Is parking unbundled from residential costs?
   Click here to enter text.

9. Is all parking free for drivers?
   Click here to enter text.

   9a. If not, what portion or type of parking is priced and what is the price?
   Click here to enter text.

10. How was the parking requirement for the mixed-use development implemented (zoning ordinance, form-based code, other)?
    Click here to enter text.

11. During what times of day/days of the week/times of the year is the parking full (if known)?
    Click here to enter text.

12. If desired, please include anything else you would like to share (challenges, lessons learned, observed impacts of the development, etc.).
    Click here to enter text.

Thank you for your assistance!

Questions/comments about this survey may be directed to:
Erin Puckett
Graduate Student, Urban and Regional Planning, Virginia Tech
erinp1@vt.edu

Appendix B: Shared Parking Calculations

Shared parking calculations for the analysis found in Chapter 3 of this paper were calculated using ULI's rates and methodology. Data were collected from both project surveys and ULI case studies found in the ULI Development Case Studies database (Urban Land Institute, 2010). Individual shared parking calculations for each development can be found in subsequent tables (Table 32 – Table 44).

Table 32: Shared parking calculation, West River Commons

West River Commons, Minneapolis, MN **1.11 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***7pm***	
Retail	927	Customer	2.9	3	3.2	3	100%	75%	3
		Employee	0.7	1	0.8	1	100%	80%	1
Restaurant	6998	Customer	9.0	63	12.75	90	100%	95%	86
		Employee	1.5	11	2.25	16	100%	100%	16
Residential (rental)	53	Guest	0.15	8	0.15	8	100%	100%	8
		Resident	1.5	80	1.5	80	100%	97%	78
Residential (owned)	3	Guest	0.15	1	0.15	1	100%	100%	1
		Resident	1.7	6	1.7	6	100%	97%	6
Total				**173**		**205**			**199**
Shared parking reduction: -2.9%									

Table 33: Shared parking calculation, Euclid Terraces

Euclid Terraces, Oak Park, IL **3.2 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***7pm***	
Retail	4565	Customer	2.9	14	3.2	15	100%	75%	12
		Employee	0.7	4	0.8	4	100%	80%	4
Restaurant	2526	Customer	9	23	12.75	33	100%	70%	24
		Employee	1.5	4	2.25	6	100%	95%	6
Residential (owned)	93	Guest	0.15	14	0.15	14	100%	100%	14
		Resident	1.7	159	1.7	159	100%	97%	155
Total				**218**		**231**			**215**
Shared parking reduction: -6.9%									

Table 34: Shared parking calculation, Clayton Lane

Clayton Lane, Denver, CO **9.5 acres**										
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Mode adj.**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***2pm***	***Hotel only***	
Retail	310479	Customer	2.9	901	3.2	994	100%	100%	-	901
		Employee	0.7	218	0.8	249	100%	100%	-	218
Restaurant	12409	Customer	15.25	190	17	211	100%	65%	-	124
		Employee	2.75	35	3.0	38	100%	90%	-	32
Hotel	196	Guest	1.0	196	0.9	177	67%	60%	-	53
		Employee	0.25	49	0.18	36	100%	100%	66%	49
Conference center/banquet	5325	Guest	30	160	30	160	100%	65%	-	104
Office (<25 ksf)	5572	Visitor	0.3	2	0.03	1	100%	100%	-	2
		Employee	3.5	20	0.35	2	100%	100%	-	20
Office (100-500 ksf)	157302	Visitor	0.24	38	0.03	5	100%	100%	-	38
		Employee	3.1	488	0.31	49	100%	100%	-	488
Residential (owned)	25	Guest	0.15	4	0.15	4	100%	20%	-	1
		Resident	1.7	43	1.7	43	100%	70%	-	31
Total				**2344**		**1969**				**2061**
Shared parking reduction: -12.1%										

Table 35: Shared parking calculation, Paseo Colorado

Paseo Colorado, Pasadena, CA **10.9 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***8pm***	
Retail	466400	Customer	2.9	1400	3.2	1554	100%	65%	1011
		Employee	0.7	341	0.8	388	100%	90%	350
Restaurant	68470	Customer	15.25	1045	17	1164	100%	100%	1164
		Employee	2.75	189	3	206	100%	100%	206
Cineplex	2307	Customer	0.19	439	0.26	600	67%	100%	402
		Employee	0.01	24	0.01	24	80%	100%	20
Health Club	24393	Customer	6.6	161	5.5	135	90%	80%	98
		Employee	0.4	10	0.25	7	100%	50%	4
Residential (rental)	387	Guest	0.15	59	0.15	59	100%	100%	59
		Resident	1.5	581	1.5	581	100%	98%	570
Total				**4249**		**4718**			**3884**
Shared parking reduction: -17.7%									

Table 36: Shared parking calculation, Rockville Town Center

Rockville Town Square, Rockville, MD **12.5 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***7pm***	
Retail	258874	Customer	2.9	751	3.2	829	100%	75%	622
		Employee	0.7	182	0.8	208	100%	80%	167
Restaurant	63019	Customer	15.25	962	17	1072	100%	95%	1019
		Employee	2.75	174	3.0	190	100%	100%	190
Residential (rental)	492	Guest	0.15	74	0.15	74	100%	100%	74
		Resident	1.5	738	1.5	738	100%	97%	716
Residential (owned)	152	Guest	0.15	23	0.15	23	100%	100%	23
		Resident	1.7	259	1.7	259	100%	97%	252
Total				**3163**		**3393**			**3063**
Shared parking reduction: -9.7%									

Table 37: Shared parking calculation, Excelsior and Grand

Excelsior and Grand, St. Louis Park, MN **16 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***8pm***	
Retail	35170	Customer	2.9	102	3.2	113	100%	65%	74
		Employee	0.7	25	0.8	29	100%	75%	22
Restaurant	26155	Customer	15.25	399	17	445	100%	100%	445
		Employee	2.75	72	3	79	100%	100%	79
Residential (rental)	337	Guest	0.15	51	0.15	51	100%	100%	51
		Resident	1.5	506	1.5	506	100%	98%	496
Residential (owned)	323	Guest	0.15	49	0.15	49	100%	100%	49
		Resident	1.7	550	1.7	550	100%	98%	539
Total				**1754**		**1822**			**1755**
Shared parking reduction: -3.7%									

Table 38: Shared parking calculation, Downtown Silver Spring

Downtown Silver Spring, Silver Spring, MD **22 acres**										
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Mode adj.**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***7pm***	***Hotel only***	
Retail	175278	Customer	2.9	509	3.2	561	100%	95%	-	484
		Employee	0.7	123	0.8	141	100%	95%	-	117
Restaurant	110502	Customer	15.25	1686	17	1879	100%	100%	-	1686
		Employee	2.75	304	3	332	100%	100%	-	304
Cineplex	2966	Customer	0.19	564	0.26	772	23%	80%	-	104
		Employee	0.01	30	0.01	30	50%	100%	-	15
Office	185000	Visitor	0.3	56	0.03	6	100%	2%	-	2
		Employee	3.5	648	0.35	65	100%	10%	-	65
Fitness center	25000	Customer	6.6	165	5.5	138	90%	90%	-	134
		Employee	0.4	10	0.25	7	100%	75%	-	8
Hotel	179	Guest	1.0	179	0.9	162	67%	75%	66%	60
		Employee	0.25	45	0.18	33	100%	20%	-	9
Residential (owned)	200	Guest	0.15	30	0.15	30	100%	100%	-	30
		Resident	1.7	340	1.5	300	100%	97%	-	330
Total				**4689**		**4456**				**3348**
Shared parking reduction: -28.6%										

Table 39: Shared parking calculation, Southern Village

Southern Village (Village Center), Chapel Hill, NC **25 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***2pm***	
Retail	29197	Customer	2.9	85	3.2	94	100%	100%	85
		Employee	0.7	21	0.8	24	100%	100%	21
Restaurant	18397	Customer	15.25	281	17	313	100%	65%	183
		Employee	2.75	51	3	56	100%	90%	46
Health Club	5000	Customer	6.6	33	5.5	28	90%	70%	21
		Employee	0.4	2	0.25	2	100%	75%	2
Office	129155	Visitor	0.3	39	0.03	4	100%	100%	39
		Employee	3.5	453	0.35	46	100%	100%	453
Residential (rental)	623	Guest	0.15	94	0.15	94	100%	20%	19
		Resident	1.5	935	1.5	935	100%	70%	655
Total				**1994**		**1596**			**1524**
Shared parking reduction: -23.6%									

Table 40: Shared parking calculation, Phillips Place

Phillips Place, Charlotte, NC **35 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	8pm	
Retail	52776	Customer	2.9	154	3.2	169	100%	65%	101
		Employee	0.7	37	0.8	43	100%	75%	28
Restaurant	28224	Customer	15.25	431	17	480	100%	100%	431
		Employee	2.75	78	3.0	85	100%	100%	78
Cineplex	1648	Customer	0.19	314	0.26	429	67%	100%	211
		Employee	0.01	17	0.01	17	80%	100%	14
Hotel	124	Guest	1	124	0.9	112	67%	80%	67
		Employee	0.25	31	0.18	23	100%	55%	18
Residential (rental)	402	Guest	0.15	61	0.15	61	100%	100%	61
		Resident	1.5	603	1.5	603	100%	98%	591
Total				1850		2022			1600
Shared parking reduction: -20.9%									

Table 41: Shared parking calculation, Birkdale Village

Birkdale Village, Huntersville, NC **52 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Late Dec***	***8pm***	
Retail	176200	Customer	2.9	511	3.2	564	80%	50%	164
		Employee	0.7	124	0.8	141	90%	75%	101
Restaurant	49600	Customer	15.25	757	17	844	95%	100%	720
		Employee	2.75	137	3	149	100%	100%	137
Cineplex	2636	Customer	0.19	501	0.26	686	100%	100%	501
		Employee	0.01	27	0.01	27	100%	100%	27
Office	54000	Visitor	0.3	17	0.03	2	80%	0%	1
		Employee	3.5	189	0.35	19	80%	0%	11
Residential (rental)	300	Guest	0.15	45	0.15	45	100%	100%	45
		Resident	1.5	446	1.5	446	100%	98%	438
Total				**2754**		**2923**			**2145**
Shared parking reduction: -26.6%									

Table 42: Shared parking calculation, Bayshore Town Center

Bayshore Town Center, Glendale, WI **52 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***1pm***	
Retail	831000	Customer	3.2	2660	3.6	2992	100%	100%	2660
		Employee	0.8	665	0.9	748	100%	100%	665
Restaurant	65000	Customer	15.25	992	17	1105	100%	75%	744
		Employee	2.75	179	3	195	100%	90%	162
Health Club	42000	Customer	6.6	278	5.5	231	90%	70%	176
		Employee	0.4	17	0.25	11	100%	75%	13
Office	187000	Visitor	0.3	57	0.03	6	100%	45%	26
		Employee	3.5	655	0.35	66	100%	90%	590
Residential (rental)	113	Guest	0.15	17	0.15	17	100%	20%	4
		Resident	1.5	170	1.5	170	100%	70%	119
Total				**5690**		**5541**			**5159**
Shared parking reduction: -9.3%									

Table 43: Shared parking calculation, San Elijo Hills Town Center

San Elijo Hills Town Center, San Marcos, CA **70 acres**									
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Dec***	***7pm***	
Retail	104835	Customer	2.9	305	3.2	336	100%	75%	229
		Employee	0.7	74	0.8	84	100%	95%	71
Restaurant	10000	Customer	15.25	153	17	170	100%	100%	153
		Employee	2.75	28	3	30	100%	100%	28
Residential (owned)	368	Guest	0.15	56	0.15	56	100%	100%	56
		Resident	1.7	626	1.7	626	100%	97%	608
Total				**1242**		**1302**			**1145**
Shared parking reduction: -12.1%									

Table 44: Shared parking calculation, Miami Lakes Town Center

Miami Lakes Town Center, Miami Lakes, FL **90 acres**										
Use	**Sq. ft. or # of units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adjustment**	**Peak hour adjustment**	**Mode adj.**	**Total Spaces**
			Rate	***Spaces***	***Rate***	***Spaces***	***Late Dec***	***3pm***	***Hotel only***	
Retail	90738	Customer	2.9	264	3.2	291	80%	100%	-	212
		Employee	0.7	64	0.8	73	90%	100%	-	58
Restaurant	22799	Customer	15.25	348	17	388	95%	40%	-	133
		Employee	2.75	63	3	69	100%	75%	-	48
Office	137670	Visitor	0.3	42	0.03	5	80%	45%	-	16
		Employee	3.5	482	0.35	49	80%	100%	-	386
Hotel	200	Guest	1	200	0.9	180	50%	60%	66%	40
		Employee	0.25	50	0.18	36	100%	100%	-	50
Residential (rental)	46	Guest	0.15	7	0.15	7	100%	20%	-	2
		Resident	1.5	69	1.5	69	100%	70%	-	49
Total				**1589**		**1167**				**994**
Shared parking reduction: -37.4%										

Appendix C: Scenario Analysis

Shared parking calculations were performed for the scenarios described in Chapter 3. The calculations and results follow. Health clubs were removed from these scenarios since generally they make up a very small percent of total area and therefore do not determine the needed parking to the extent of other uses. Scenarios are presented in Table 45 – Table 55.

Table 45: Base scenario

Base scenario: The best case from Chapter 3/Appendix B (Downtown Silver Spring) was broken out into area proportions and used as the starting point for the majority of the scenarios.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm		
Retail	19.55%	97737	Customer	2.9	284	3.2	313	100%	95%		270
			Employee	0.7	69	0.8	79	100%	95%		66
Restaurant	12.32%	61617	Customer	15.25	940	17	1048	100%	100%		940
			Employee	2.75	170	3	185	100%	100%		170
Cineplex	10.90%	13	Customer	0.19	414	0.26	567	23%	80%		77
			Employee	0.01	22	0.01	22	50%	100%		11
Hotel	11.51%	82	Guest	1	83	0.9	74	67%	75%	0.66	28
			Employee	0.25	21	0.18	15	100%	20%		5
Residential (owned)	25.09%	121	Guest	0.15	19	0.15	19	100%	100%		19
			Resident	1.7	206	1.7	206	100%	97%		200
Office	20.63%	103158	Visitor	0.3	31	0.03	4	100%	2%		1
			Employee	3.5	362	0.35	37	100%	10%		37
Total	**100%**	**500000**			**2621**		**2569**				**1824**
Shared parking reduction: -30.4%											

Table 46: Average composition scenario

Average composition scenario: This scenario used the average composition of all cases from Appendix B to adjust square footages. This method was found to be less optimal than the base case, and was not used for the remainder of the scenarios.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm		
Retail	26.03%	130167	Customer	2.9	378	3.2	417	100%	95%		360
			Employee	0.7	92	0.8	105	100%	95%		88
Restaurant	5.76%	28806	Customer	15.25	440	17	490	100%	100%		440
			Employee	2.75	80	3	87	100%	100%		80
Cineplex	2.22%	3	Customer	0.19	85	0.26	116	23%	80%		16
			Employee	0.01	5	0.01	5	50%	100%		3
Hotel	6.20%	44	Guest	1	45	0.9	40	67%	75%	0.66	15
			Employee	0.25	12	0.18	8	100%	20%		3
Residential (rental)	49.19%	237	Guest	0.15	36	0.15	36	100%	100%		36
			Resident	1.5	356	1.5	356	100%	97%		346
Office	10.59%	103158	Visitor	0.3	16	0.03	2	100%	2%		1
			Employee	3.5	186	0.35	19	100%	10%		19
Total	**100%**	**500000**			**1731**		**1681**				**1407**
Shared parking reduction: -18.72%											

Table 47: Basic composition scenario

Basic composition scenario: This scenario includes only the three uses found in every case study.										
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm	
Retail	34.32%	171579	Customer	2.9	498	3.2	550	100%	95%	523
			Employee	0.7	121	0.8	138	100%	95%	132
Restaurant	21.63%	108170	Customer	15.25	1650	17	1839	100%	100%	1839
			Employee	2.75	298	3	325	100%	100%	325
Residential (owned)	44.05%	212	Guest	0.15	32	0.15	32	100%	100%	32
			Resident	1.7	362	1.7	362	100%	97%	352
Total	**100%**	**500000**			**2961**		**3246**			**3203**
Shared parking reduction: -1.3%										

Table 48: Basic composition + office

Basic composition scenario + office: This scenario includes those uses found in every case study plus office, the second most commonly-occurring use.										
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm	
Retail	25.19%	125958	Customer	2.9	366	3.2	404	100%	95%	348
			Employee	0.7	89	0.8	101	100%	95%	85
Restaurant	15.88%	79409	Customer	15.25	1211	17	1350	100%	100%	1211
			Employee	2.75	219	3	239	100%	100%	219
Residential (owned)	32.34%	156	Guest	0.15	24	0.15	24	100%	100%	24
			Resident	1.7	266	1.7	266	100%	97%	259
Office	26.59%	132944	Visitor	0.3	40	0.03	4	100%	2%	1
			Employee	3.5	466	0.35	47	100%	10%	47
Total	**100%**	**500000**			**2681**		**24035**			**2194**
Shared parking reduction: -18.2%										

Table 49: Retail scenario

Retail scenario: In this scenario, half of the development square footage is applied to retail, remainder is redistributed proportionately.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	6pm		
Retail	50.00%	250000	Customer	2.9	725	3.2	800	100%	80%		640
			Employee	0.7	175	0.8	200	100%	85%		170
Restaurant	7.66%	38294	Customer	15.25	584	17	651	100%	90%		586
			Employee	2.75	106	3	115	100%	100%		115
Cineplex	6.77%	8	Customer	0.19	258	0.26	352	23%	60%		142
			Employee	0.01	14	0.01	14	50%	100%		7
Hotel	7.15%	51	Guest	1	52	0.9	46	67%	75%	0.66	16
			Employee	0.25	13	0.18	10	100%	60%		6
Residential (owned)	15.59%	75	Guest	0.15	12	0.15	12	100%	60%		8
			Resident	1.7	128	1.7	128	100%	90%		116
Office	12.82%	64111	Visitor	0.3	20	0.03	2	100%	5%		1
			Employee	3.5	225	0.35	23	100%	5%		2
Total	**100%**	**500000**			2312		2353				1809
Shared parking reduction: -23.1%											

Table 50: Large residential scenario

Large residential scenario: This scenario does not adjust residential uses to the initial 500,000 square feet, but instead assumes all residential can occur in two floors above retail and restaurant uses. Residential uses are scaled to (retail+restaurant square footage *2).											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm		
Retail	14.10%	130477	Customer	2.9	379	3.2	418	100%	95%		361
			Employee	0.7	92	0.8	105	100%	95%		88
Restaurant	8.89%	82258	Customer	15.25	1255	17	1399	100%	100%		1255
			Employee	2.75	227	3	247	100%	100%		227
Cineplex	7.86%	18	Customer	0.19	553	0.26	756	23%	80%		102
			Employee	0.01	30	0.01	30	50%	100%		15
Hotel	8.30%	110	Guest	1	110	0.9	99	67%	75%	0.66	37
			Employee	0.25	28	0.18	20	100%	20%		6
Residential (owned)	45.97%	410	Guest	0.15	62	0.15	62	100%	100%		62
			Resident	1.7	698	1.7	698	100%	97%		678
Office	14.88%	137714	Visitor	0.3	42	0.03	5	100%	2%		1
			Employee	3.5	482	0.35	49	100%	10%		49
Total	**100%**	**500000**			**3958**		**3806**				**2881**
Shared parking reduction: -27.2%											

Table 51: Large cineplex scenario

Large cineplex scenario: This scenario maximizes the cineplex to 20 screens and adjusts other uses proportionately.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Late Dec	8pm		
Retail	18.32%	91593	Customer	2.9	266	3.2	294	80%	50%		118
			Employee	0.7	65	0.8	74	90%	75%		50
Restaurant	11.55%	57744	Customer	15.25	881	17	982	95%	100%		933
			Employee	2.75	159	3	174	100%	100%		174
Cineplex	16.50%	20	Customer	0.19	627	0.26	858	100%	100%		858
			Employee	0.01	33	0.01	33	100%	100%		33
Hotel	10.78%	77	Guest	1	77	0.9	70	50%	80%	0.66	19
			Employee	0.25	20	0.18	14	100%	55%		8
Residential (owned)	23.52%	113	Guest	0.15	18	0.15	18	100%	100%		18
			Resident	1.7	193	1.5	193	100%	98%		190
Office	19.33%	96673	Visitor	0.3	30	0.03	3	80%	0%		0
			Employee	3.5	339	0.35	34	80%	0%		0
Total	**100%**	**500000**			**2708**		**2747**				**2401**
Shared parking reduction: -11.3%											

Table 52: No cineplex scenario

No cineplex scenario: This scenario removes the cineplex and adjusts other uses proportionately.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	1pm		
Retail	21.94%	109692	Customer	2.9	319	3.2	352	100%	100%		319
			Employee	0.7	77	0.8	88	100%	100%		77
Restaurant	13.83%	69154	Customer	15.25	1055	17	1176	100%	75%		792
			Employee	2.75	191	3	208	100%	90%		172
Hotel	12.91%	92	Guest	1	93	0.9	83	67%	55%	0.66	23
			Employee	0.25	24	0.18	17	100%	100%		24
Residential (owned)	28.16%	136	Guest	0.15	21	0.15	21	100%	20%		5
			Resident	1.7	231	1.7	231	100%	70%		162
Office	23.16%	115776	Visitor	0.3	35	0.03	4	100%	45%		16
			Employee	3.5	406	0.35	41	100%	90%		366
Total	**100%**	**500000**			**2452**		**2221**				**1956**
Shared parking reduction: -20.2%											

Table 53: Office park scenario

Office park scenario: This scenario increases office to 50% of total square footage and adjusts remaining proportions. Cinema is also removed.											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	2pm		
Retail	14.27%	71373	Customer	2.9	207	3.2	229	100%	95%		197
			Employee	0.7	50	0.8	58	100%	100%		50
Restaurant	9.00%	44996	Customer	15.25	687	17	765	100%	65%		447
			Employee	2.75	124	3	135	100%	90%		112
Hotel	8.40%	60	Guest	1	60	0.9	54	67%	60%	0.66	16
			Employee	0.25	15	0.18	11	100%	100%		15
Residential (owned)	18.32%	88	Guest	0.15	14	0.15	14	100%	20%		3
			Resident	1.7	151	1.7	151	100%	70%		106
Office	50.00%	250000	Visitor	0.3	75	0.03	8	100%	100%		75
			Employee	3.5	875	0.35	88	100%	100%		875
Total	**100%**	**500000**			**2258**		**1513**				**1896**
Shared parking reduction: -16.0%											

Table 54: Shopping center scenario

Shopping center scenario: This scenario manually increases retail, includes a 10-theater mid-size cineplex, removes office and hotel, and slightly decreases restaurant and residential to make up the balance.										
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	7pm	
Retail	62.00%	310000	Customer	2.9	899	3.2	992	100%	75%	744
			Employee	0.7	217	0.8	248	100%	80%	199
Restaurant	10.00%	50000	Customer	15.25	763	17	850	100%	95%	808
			Employee	2.75	138	3	150	100%	100%	150
Cineplex	8.00%	10	Customer	0.19	304	0.26	416	67%	80%	223
			Employee	0.01	16	0.01	16	50%	100%	8
Residential (owned)	20.00%	96	Guest	0.15	15	0.15	15	100%	100%	15
			Resident	1.7	164	1.7	164	100%	97%	160
Total	**100%**	**500000**			**2516**		**2851**			**2307**
Shared parking reduction: -19.1%										

Table 55: Optimized base scenario

Optimized base scenario: This scenario took the best parking reduction - the base case - and manually adjusted area percentages (column B) until a better reduction was achieved (within realistic parameters and without decreasing the rate so much as to force a different peak time that would re-increase the final reduction).											
Use	**Percent of development**	**Sq. ft./ # units**	**Rate type**	**Weekday**		**Weekend**		**Peak month adj.**	**Peak hour adj.**	**Mode adj.**	**Total spaces**
				Rate	Spaces	Rate	Spaces	Dec	2pm		
Retail	19.55%	97737	Customer	2.9	284	3.2	313	100%	95%		270
			Employee	0.7	69	0.8	79	100%	100%		69
Restaurant	2.32%	11617	Customer	15.25	178	17	198	100%	65%		116
			Employee	2.75	32	3	35	100%	90%		29
Cineplex	10.90%	13	Customer	0.19	414	0.26	567	23%	55%		53
			Employee	0.01	22	0.01	22	50%	60%		7
Hotel	31.51%	225	Guest	1	225	0.9	203	67%	60%	0.66	60
			Employee	0.25	57	0.18	41	100%	100%		57
Residential (owned)	25.09%	121	Guest	0.15	19	0.15	19	100%	20%		4
			Resident	1.7	206	1.7	206	100%	70%		145
Office	10.63%	53158	Visitor	0.3	16	0.03	2	100%	100%		16
			Employee	3.5	187	0.35	19	100%	100%		187
Total	**100%**	**500000**			1709		1704				1013
Shared parking reduction: -40.7%											