Utilizing Shared Parking to Mitigate Imbalanced Supply in a Dense Urban Neighborhood: a Case Study in Vancouver, British Columbia

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ABSTRACT

Excess off-street parking can have a range of impacts, including undesirable effects on housing costs, urban form, mode choice, and overall density. In urban residential areas, excess off-street parking can coexist with on-street parking congestion, due to restrictions in parking access, non-market pricing, and other factors. This paper examines the potential for shared parking to address such an imbalance in parking supply using a case study of the West End, a high-density residential neighborhood in Vancouver, British Columbia. The West End's Residential Parking Permit program has faced parking shortages and congestion, with on-street parking consistently reaching 90% occupancy. At the same time, off-street residential parking facilities in the neighborhood have occupancy rates consistently below 50%. In this analysis, we use on-street and off-street parking stall inventory and occupancy data to investigate the impacts of making off-street stalls available to RPP users in a shared parking program. Results show that on-street parking congestion could be greatly reduced by introducing a relatively small number of off-street stalls from select residential buildings to the RPP program. Methods to unlock currently underutilized off-street parking supply are also discussed.

1 INTRODUCTION

Land dedicated exclusively for moving and housing automobiles is the largest allocation of city space in most North American cities *(1, 2)*. Parking provision can dictate building design, with impacts on residential and commercial density, the convenience of walking, cycling, or transit, and a city's overall urban form and character. Greater parking supply and lower parking price are both associated with higher auto mode share *(3, 4)*. In Vancouver, British Columbia, parking vacancy rates in strata properties are roughly 20-40% *(5)*. Excess parking can encourage driving by increasing opportunities to find parking at the end of trips, and also discourage other travel modes by making the built environment primarily hospitable to private motor vehicles *(3)*.

Overabundant parking supply also creates financial burdens through direct construction costs and indirect opportunity costs of other land uses *(6)*. In Metro Vancouver, construction of on-site parking can range from $20,000 to $45,000 per stall, in addition to maintenance and operation costs *(5)*. Structured parking in the US costs around $15,500 per stall *(7)*. Construction costs are higher in dense areas of the city where parking is often built underground. A study in King County, Washington found that excess parking development (0.4 stalls of unused parking per unit) added $400,000 to project costs on average *(8)*. Parking made up 10-20% of construction costs, but only 6% was recovered through parking fees, which likely are added to tenant rent.

Parking research and policy recommendations over two decades have focused on assessing and reducing the oversupply of off-street parking *(9–11)*. During this time, cities have experimented with various strategies to reduce parking requirements for new construction and also utilize the unused existing supply *(12, 13)*. North American cities like Denver, Portland, and Seattle, along with international examples like Stockholm, Zurich, and Tokyo have ambitious policies and strategies to reduce or eliminate new parking construction, mitigate parking demand, and use parking restrictions to encourage alternative travel modes *(14–17)*.

1.1 City of Vancouver Parking Policy

In the Greenest City 2020 Action Plan, Vancouver has prioritized reaching a mode share of at least 50% for walking, cycling, and transit and reducing residential driving distances by 20% by the year 2020 *(18)*. In Transportation 2040, the City of Vancouver's long range transportation plan, parking management is identified as "one of the biggest opportunities to support a smart and efficient transportation system" *(19)*. Further, the City of Vancouver anticipates nearly 150,000 new residents between 2011 and 2041, a near 25% increase in population *(18)*; addressing parking demand with appropriate strategies and policies is an important step for accommodating new residents while moving forward with transportation and sustainability goals. Three proposed motor vehicle policies are particularly relevant to utilizing parking as a shared resource: M2.1 (Use off-street parking requirements to support reduced auto ownership and use), M2.4 (Approach parking as a shared district resource), and M2.7 (Manage parking in neighborhoods).

The West End neighbourhood has some of the highest residential density in the City of Vancouver. With nearly 217 persons per hectare, the West End is the fourth densest neighborhood in the city, proceeded only by Downtown South (304.9 Persons/ hectare), City Gate (335 Persons/ hectare), and Triangle West (352.2 Persons/ hectare) *(20)*. Using the current residential building stock in the West End as an example, Table 3 illustrates how changing parking bylaws over time can impact parking supply. The City of Vancouver first required residential parking in 1959. Parking requirements were increased in 1964, and specific parking regulations were introduced for the downtown region in 1975. Parking became its own bylaw (6059) in 1987, and parking requirements began to decrease in the 2000s. After nearly 60 years, parking requirements have returned to about where they began. For the current building stock, 60-70% more stalls would be needed to comply with the high-parking bylaws of the 1970's to 2000's than the current bylaws or those of 1959. In addition, the City of Vancouver now offers several options for developers to reduce the amount of parking required for a given project in exchange for amenities (e.g., shared vehicles, shared parking stalls, proximity to rapid transit network) or cash payment.

Table 1. Required parking in West End residential buildings under different City of Vancouver parking bylaws (data from City of Vancouver)

Multi-family Housing Type	Buildings	Units	Residential ft^2 x1,000	Total stalls required by bylaw year						
				1959	1964	1974	1986	1987	2000	2015
Market CO-OP	17	640	626	447	550	712	737	727	768	768
Non-market rental	18	1,625	1,031	736	905	812.5	812.5	812.5	812.5	812.5
Strata	157	6,229	6,033	4,309	5,294	6,856	7,098	7,006	6,757	4,004
Stratified market rental	12	324	300	214	263	341	353	348	336	199
Unstratified market	411	19,293	12,618	9,013	11,072	14,340	14,845	14,653	14,132	8,373
Non-profit rental	3	137	69	49	60	69	69	69	69	46
Other rental	15	1,264	836	597	733	949	983	970	970	554
Total	633	29,512	21,513	15,366	18,877	24,079	24,897	24,587	23,844	14,756
Average stalls per unit				0.52	0.64	0.82	0.84	0.83	0.81	0.50
Additional stalls (%) compared to current bylaw				4%	28%	64%	68%	66%	62%	NA

1.2 Shared and District Parking

Existing parking infrastructure in many cities is oversupplied and inconsistently utilized. In 2011, Metro Seattle surveyed 240 residential developments and found that parking is, on average, oversupplied by 40%: stalls were supplied at 1.4 stalls per unit, but utilized at only 1 stall per unit *(21)*. Suburban developments had 1.6 stalls per unit supply and a 1.2 stalls per unit utilization, while the central business district had 0.8 and 0.6 stalls per unit supply and utilization rates. Residential utilization rates are even lower during work hours. Similar results were found around Metro Vancouver where parking was seen to be consistently oversupplied between 18-35% *(5)*.

Shared parking is the practice through which two or more entities use the same parking stalls to meet their parking requirements *(10)*. Facilities with additional parking sell their excess to neighboring entities, or partner with a building that has a different parking schedule. Ad hoc parking relationships have long existed, as seen in shared parking strategies involving churches and movie theatres, or other venues with irregular hours. Growing costs of parking construction, and improved technologies to aide in the renting and leasing of spaces, are allowing more creative partnerships and making shared parking more feasible. Proximate business and residential properties can now partner to maximize the utilization of existing parking stalls and alleviate the need for new construction. Approaching parking as a system-wide utility allows stalls to be more consistently utilized and can provide greater returns on parking infrastructure investments.

Five approaches to shared parking currently used include:

- alternate schedule partnerships,
- mixed use development,
- leased parking strategies,
- district parking, and
- capped parking.

Alternate schedule partnerships commonly involve one property allowing another nearby business to utilize its parking when closed, or its parking lot is not fully needed. This approach is being used to meet parking requirements without new construction *(22)*.

Mixed use development strategies allow parking minimums to be reduced for land uses with differing parking needs, if the total projected parking demand can be shown to be less than the combined minimums. The Cook Street Apartments in Portland, Oregon used this strategy to reduce required parking construction from 250 to 146 stalls for its 206 residential unit, 15,000 ft^2 retail development *(23)*.

Leased parking strategies allow building owners to make currently unused parking supply available to other users. Building owners generate revenue from unused stalls, and cities satisfy some unmet parking demand without additional infrastructure.

District parking allows new projects to partner with surrounding properties to satisfy parking needs, dependent on distance and excess parking availability, through a formal use agreement. This parking management strategy is now being recommended to help preserve the walkable characteristics of Seattle's Capitol Hill neighborhood *(24)*.

In capped parking strategies, a city identifies a certain quantity of parking for an area, and new projects must remove existing stalls in order to place parking within the development. Capped parking was established in Zurich in 1996, and new projects with off-street parking now must remove on-street parking *(16)*.

Various hurdles, particularly legal and political, commonly impede implementation of shared parking strategies. The Vancouver parking bylaw does not permit parking stalls to fulfill parking requirements for multiple uses; parking can be combined in multi-use developments, but individual minimums must be met without specific authorization by the Director of Planning and the City Engineer *(25)*. Provincially, under the BC Strata Property Act, parking stalls cannot be sold independently from their paired property *(26)*. If non-resident vehicles are parked on private property, insurance and liability for parked vehicles is a concern which would need to be addressed through contractual agreements between building owners and users or between building owners and city programs.

The objective of this paper is to investigate the potential for shared parking to improve existing parking infrastructure utilization and relieve parking congestion, using a case study of the West End neighborhood of Vancouver. Vancouver's Residential Parking Permit program (RPP) aims to provide priority parking for neighborhood residents within a designated zone. For a small annual fee, ($76.37 in the West End) residents in the neighborhood can purchase a permit allowing them to park their registered vehicle in dedicated areas of the surrounding residential blocks. While this program reduces the number of non-resident West End customers and visitors parking on residential streets, the comparatively low permit price has led to consistent congestion and on-street parking shortages as residents choose the streets instead of more expensive off-street parking. As a result, despite on-street parking congestion, off-street residential parking facilities in the neighborhood have consistently low occupancy.

2 METHOD

First, data from the City of Vancouver and the Insurance Corporation of British Columbia (ICBC) are used to estimate off-street parking utilization for multifamily residential buildings in the West End RPP zone and identify potential buildings for a shared parking program. The off-street utilization results are then combined with data from an on-street utilization study to investigate how opening up off-street stalls to the RPP would impact on-street and off-street parking utilization. The analysis method is illustrated in Figure 1.

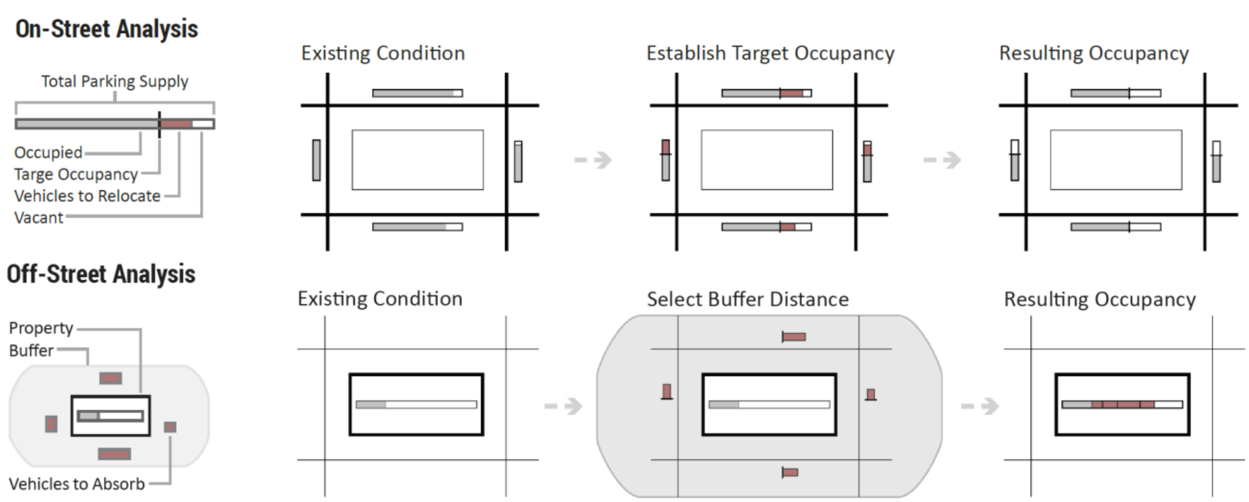

Figure 1. Illustration of analysis method

Property information (name, address, tenure, construction date, number of rooms, number of parking stalls, residential parking permit registrations, and tax coordinates) was obtained from the City of Vancouver by referencing each property's Tax Attribute Report and the corresponding building permits. This process involved manual review of all original building permits, and any listed renovations, in order to calculate all existing off-site parking stalls. Only multifamily residential properties within in the RPP zone with at least 4 units were included in the analysis (630 buildings). Off-street parking includes all structured or surface parking listed in a building's construction documents. Each property's unique tax coordinate was then used to link to existing GIS datasets for spatial analysis.

Vehicle registrations were obtained from ICBC's vehicle ownership registration database. Vehicle ownership for each building is assumed to be the number of vehicles registered at the property address through ICBC. Parking surplus for each building is defined as the difference between off-street parking stalls and vehicle ownership, and the "adjusted surplus" is 95% of the parking surplus, rounded down (a conservative adjustment down to account for vehicles potentially owned but not yet registered at the address or for unusable stalls). Building parking occupancy is calculated as $\frac{\text{Stalls} - \text{Adjusted Surplus}}{\text{Stalls}}$. Buildings with adjusted surplus of at least 50 stalls are selected for inclusion in the hypothetical shared parking program.

To examine the potential impact of shared off-street residential parking with the RPP program, we assess how many parked vehicles need to be relocated from each block to achieve a target occupancy, and then how many of those vehicles can be absorbed by the parking surplus in nearby residential buildings. On-street parking data (number of RPP parking stalls per block and the parking occupancy) were gathered from a weekday (7:30am to 9:00pm) parking survey conducted for the West End Community Plan in August, 2012. Target occupancy of 85% and 65% are selected to represent desired parking availability to avoid parking congestion, slightly higher than target occupancy rates for retail streets *(27, 28)*.

Building catchment areas are based on buffers representing straight-line walking distances of 50m, 100m, and 200m. The longest blocks in the West End are 200m, which is also within Smith and Butchers "Level of Service By Walking" rating for residential uses *(29)*. From a 200m block length, 100m and 50m represent half block and quarter block distances. Vehicles to relocate from a block are assigned to buildings with surplus parking and buffers intersecting the block midpoint, proportionally if there are multiple buffers. Then new occupancy rates are computed for the off-street and on-street stalls. Six scenarios are evaluated – each combination of 2 target occupancies and 3 buffer sizes.

After relocation, distances from blocks with remaining occupancy above 90% to nearest blocks with occupancy below 70% is measured to assess the potential for redistribution of on-street parking in response to the relocated vehicles. The analysis method is not a behavioral model of the decision to use on-street vs. off-street stalls; in a shared parking program, utilization of each will depend on pricing, ease of access, and other factors. Assumptions and limitations of the method are discussed in the Conclusion section.

3 RESULTS

Figure 2 shows the RPP zone and multifamily residential buildings by decade constructed. The RPP zone covers all residential blocks the West End neighbourhood, but it excludes a commercial strip along Robson St. Most of the buildings were constructed in the 1950's through 1980's, coinciding with a period of increasing parking requirements (Table 1).

Figure 3 shows average number of off-street parking stalls per unit for West End multifamily buildings by tenure and decade. Rental properties represent the largest portion of tenures and have the fewest stalls per unit, while strata have the most. As could be expected from Table 1, properties built in the 1970's through 2000's have the most parking per unit. The effects of parking bylaws from the past century are reflected in the neighborhood's off-street parking stock.

Of the 630 properties, 46 have parking vacancy of at least 50 stalls and are included in the shared parking analysis. These select 46 buildings have, on average, 140 units, were built between 1960 and 2010, and are predominately market rental (26 of 46). In total there are 7,394 off-street parking stalls in these buildings, more than half of them (3,771) believed to be vacant. The parking surplus ranges from 51 to 143 unoccupied stalls per building. In contrast the RPP zone has on-street 2,747 stalls, 316 of them believed to be vacant. With an average off-street and on-street occupancies of 47% and 88% respectively, there is clear potential for shared parking strategies to help balance existing parking infrastructure utilization.

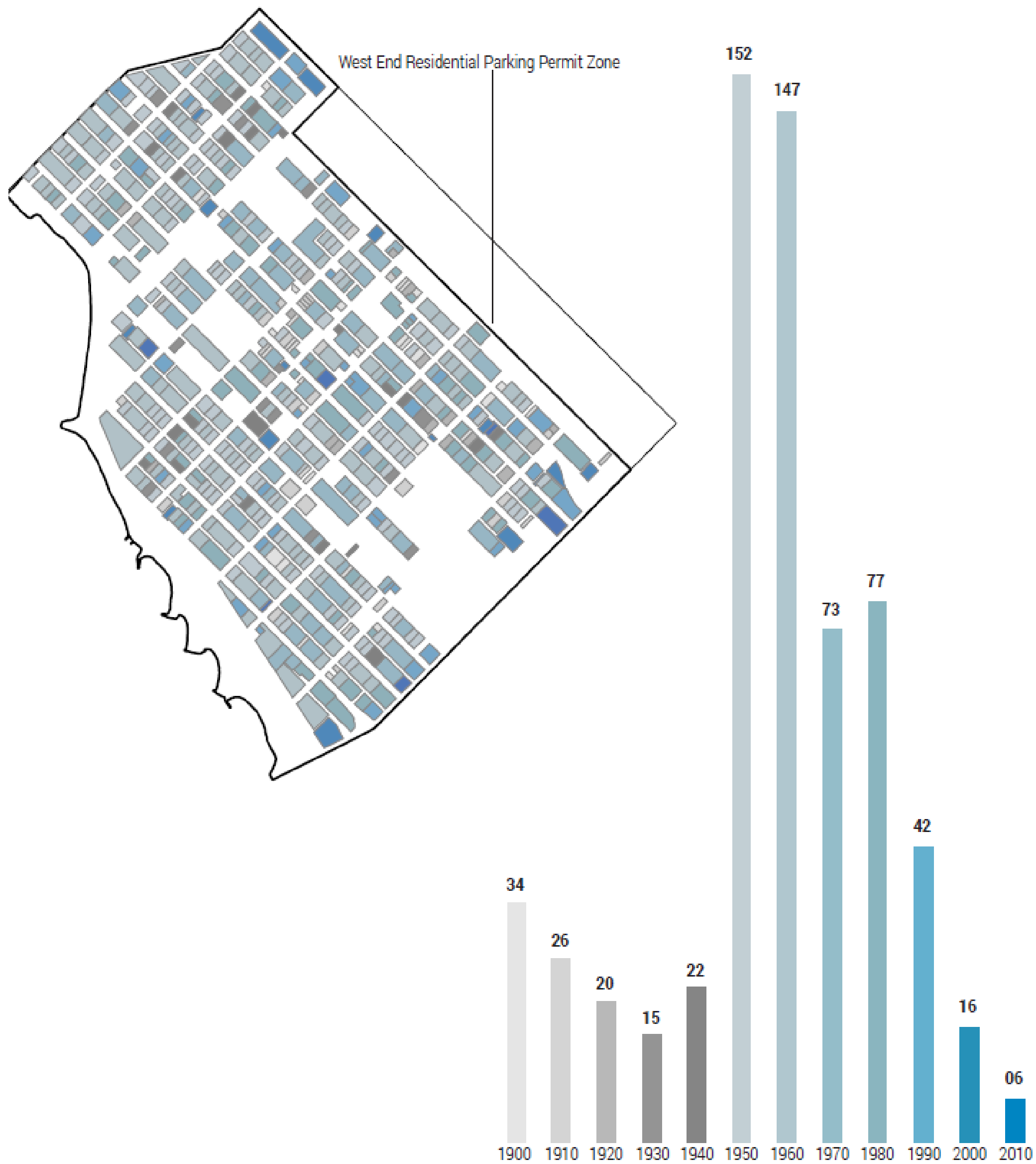

Figure 2. West End multifamily residential buildings by decade constructed

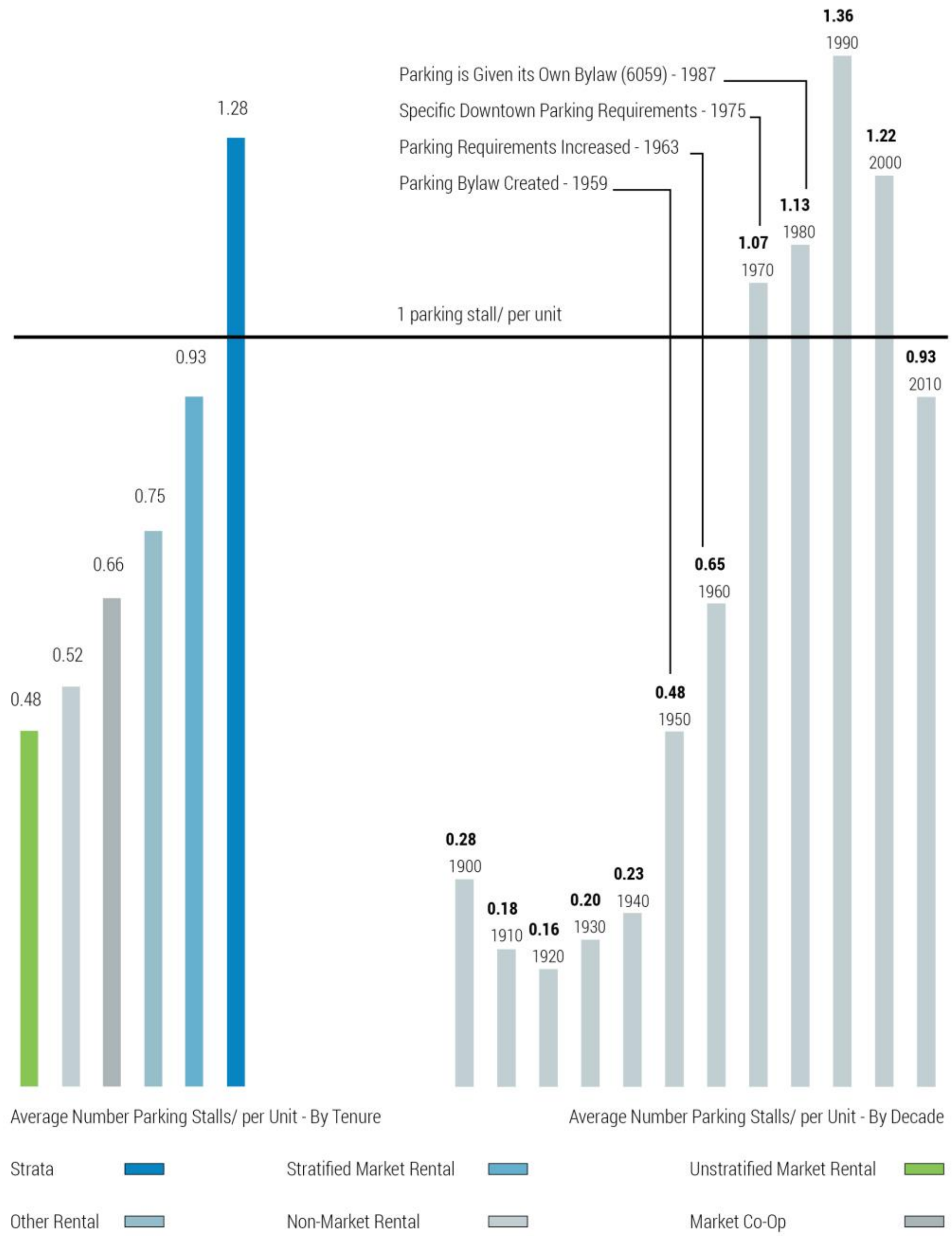

Figure 3. Stalls per unit by tenure and decade for West End multifamily buildings

Figure 4 shows the shared parking results for the 100m buffer/85% occupancy scenario. Most of the RPP zone is covered by a 100m buffer from the 46 buildings with substantial surplus parking, which are fairly well distributed. Even after absorbing the relocated vehicles, parking occupancy in all of the 46 buildings remains below 80%, and most are below 60%. Most streets in the RPP zone reach the target occupancy of 85%, although 33 of the 216 blocks outside the 100m buffers that are still over 90% occupied.

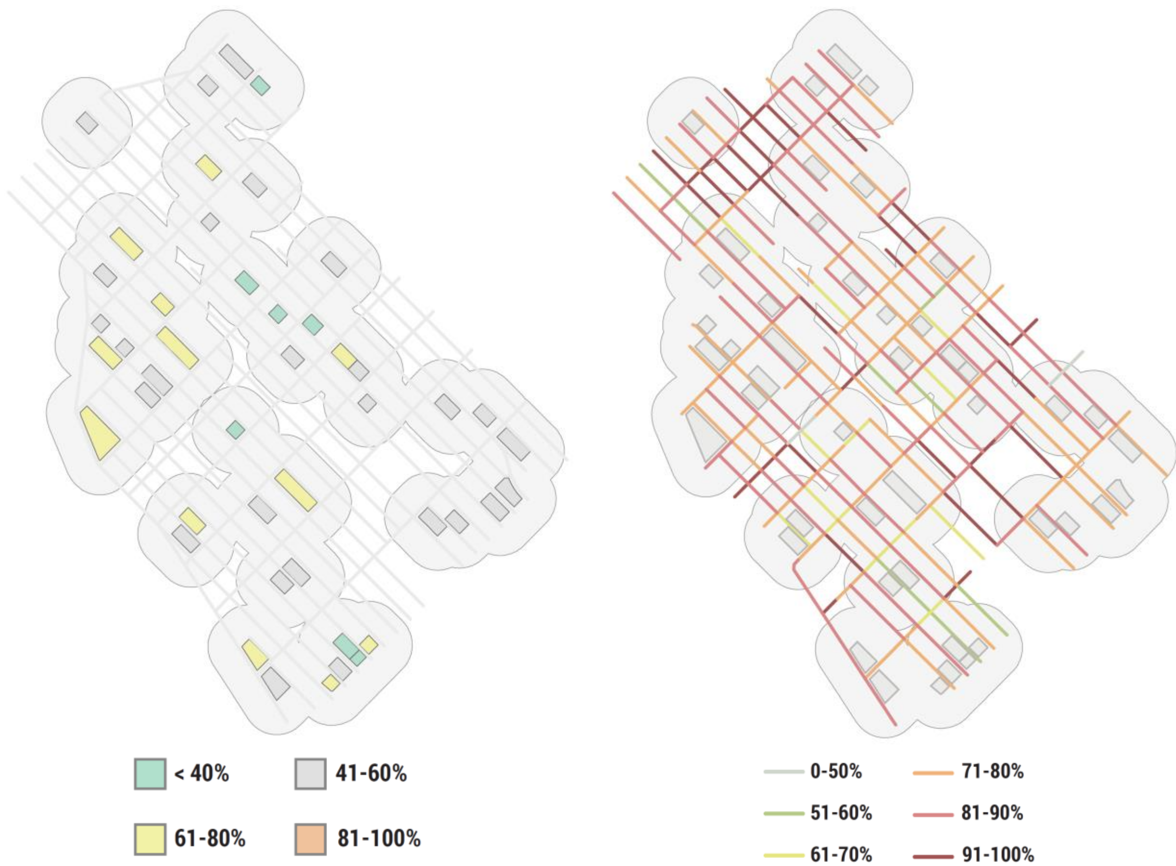

Figure 4. Shared parking analysis results for 100m buffer and 85% on-street occupancy

Shared parking results for all six scenarios is given in Table 2 (off-street stalls) and Table 3 (on-street stalls). The range in number of vehicles relocated is wide across scenarios: 122 to 757. However, even in the high-relocation scenario, final building occupancy remains quite low (average below 60%, with occupancy increases of up to 11%) - Table 2. In contrast, the on-street parking condition has the potential to improve substantially (Table 3). Average on-street occupancy in the RPP zone falls from 88% to as low as 60%. With small buffer sizes (walking distances), many blocks remain at high-occupancy over 90%, but the potential for redistribution of on-street parking is fairly high, as indicated by the moderate average distances from remaining high-occupancy to low-occupancy blocks. The redistribution distance is shorter in scenarios with lower overall average occupancy, as expected.

Table 2. Summary of off-street results for each scenario

Target occupancy	Buffer (m)	Vehicles relocated	Remaining vacancies	Average final occupancy (%)	Average change in occupancy (%)
0.85	50	122	3,649	49	2
0.65	50	317	3,454	52	5
0.85	100	205	3,566	50	3
0.65	100	554	3,213	56	8
0.85	200	279	3,492	51	4
0.65	200	757	3,014	58	11

Base condition: 3,771 vacant of 7,394 total stalls, 47% average occupancy

Table 3. Summary of on-street results for each scenario

Target occupancy	Buffer (m)	Vehicles relocated	Average final occupancy (%)	Average change in occupancy (%)	Remaining high-occupancy blocks*	Average distance to low-occupancy block* (m)
0.85	50	122	85	3	76	200
0.65	50	317	78	10	76	89
0.85	100	205	81	7	33	175
0.65	100	558	67	21	33	71
0.85	200	279	78	10	NA	NA
0.65	200	757	60	28	NA	NA

Base condition: 316 vacant of 2,747 total stalls, 88% average occupancy
"High-occupancy" blocks are >90%, "low-occupancy" blocks are <70%

The distribution of buildings and blocks by final occupancy for each scenario is shown in Figure 5 and Figure 6 respectively. Figure 5 shows that only in the highest-relocation scenario (65% occupancy/ 200m buffer) does any building become high-occupancy (over 90%). Figure 6 shows that high-occupancy blocks are greatly reduced in all the scenarios, particularly with buffers/walking distances of 100m or more. Overall Figure 5 and Figure 6 support the previous results that shared parking could potentially greatly reduce on-street parking congestion with relatively small impacts on off-street parking facilities.

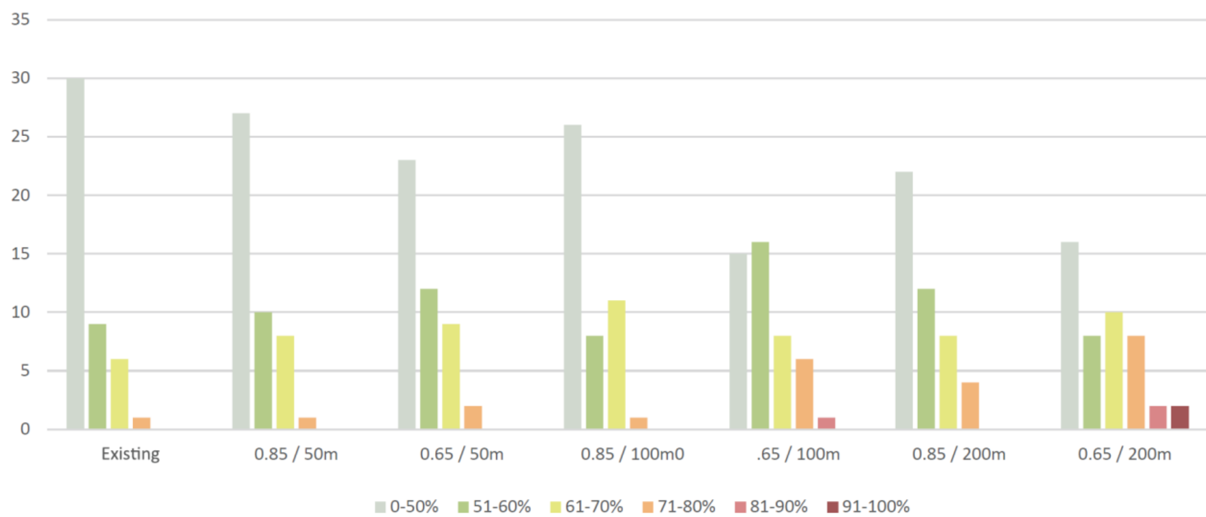

Figure 5. Number of buildings by final occupancy for each scenario

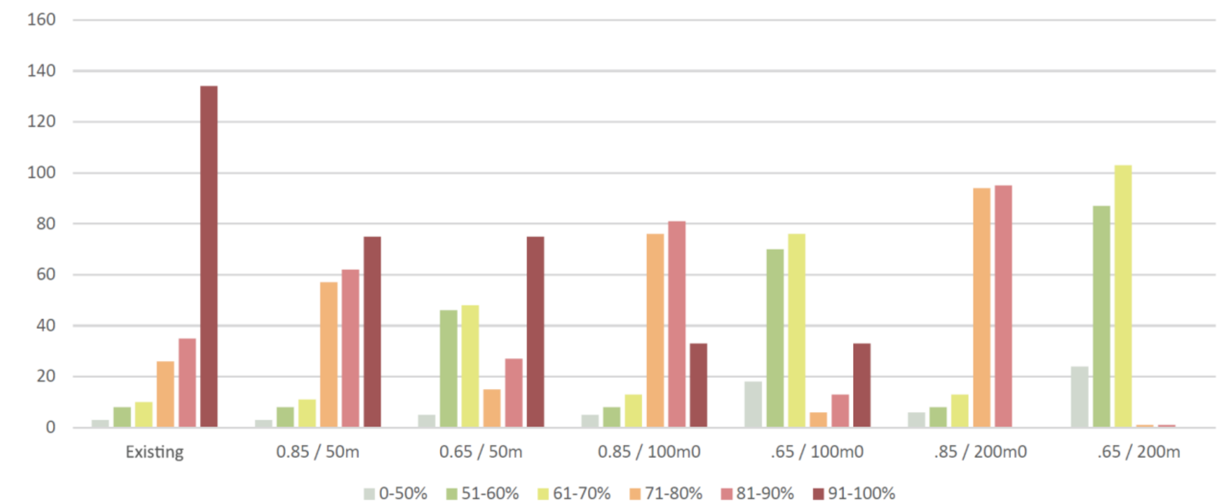

Figure 6. Number of blocks by final occupancy for each scenario

4 CONCLUSIONS

The West End neighborhood currently has 16,000 registered vehicles – 15,000 of which have access to at least one of the 22,000 off-street parking stalls in the neighborhood's residential buildings. Despite this access to off-street parking, 6,000 RPP permits have been issued for the neighborhood's 2,747 on-street RPP parking stalls. This imbalance of supply and demand has resulted in frequent on-street parking shortages throughout the West End, with average parking occupancy rates consistently reaching 90%. If the RPP program were limited to those without access to off-street parking, only 1,000 West End vehicles would need the on-street RPP stalls, and much of the existing stock could be repurposed as short term parking supply. Alternatively, increasing the RPP price would likely shift some of the demand to the off-street facilities. While limiting the number of RPP permits or increasing the permit price are potential solutions, political pressure and concerns about equal access to public resources make both of these options challenging. With this in mind, incorporating some of the neighborhood's off-street parking into the RPP may offer a less contentious solution.

The results presented in this paper show that a shared parking program has the potential to dramatically reduce the West End's on-street parking congestion with minimal increases in parking occupancy of select large multifamily buildings in the neighborhood. In addition to easing on-street parking congestion, this potential partnership between the RPP program and private buildings could better utilize existing infrastructure, generate revenue for building owners, and also increase availability of short term parking for caretakers and visitors – an issue commonly voiced by West End residents.

The analysis in this paper uses a number of simplifying assumptions, and the estimated occupancy on individual streets and in individual buildings should be interpreted with caution. The number of vehicles registered to a building is an imperfect measure of parking occupancy; future analysis would benefit form a multi-day utilization study at each building. Multi-family parking utilization data can be generated by first counting the number of parked vehicles in a building and then using video cameras to monitor vehicle entrances and exits over weekdays and weekends. Utilization data collected this way would show utilization rates throughout the day, as well as how many residents use on-street parking instead of on-site parking.

Although the number of RPP permits registered to each building is known, use of the permits for on-street parking is not. Some RPP holders likely park on-street rather than in their building, so actual off-street parking occupancy is likely lower than assumed in this analysis. For the 46 selected buildings, subtracting the RPP permits would increase parking surplus by on average 20 stalls per building; thus, neglecting RPP permit-holders is conservative with respect to the findings presented above. On the other hand, increasing supply of RPP stalls through a shared parking program could induce additional demand for RPP stalls, which would lead to higher final on-street occupancy than modeled here. As noted above, the analysis did not account for possible redistribution of on-street parking after occupancy on some blocks fell with relocation. Equilibrium on-street occupancy could be more evenly dispersed than modeled here, but a more detailed model would need destination information as well as parking utilization.

On-street and off-street parking do not always serve the same purpose. Commonly, off-street stalls are used for long-term storage, while on-street stalls have high turnover uses in commercial areas and lower turnover uses in residential areas with dedicated on-street residential parking (such as the RPP). In this analysis, off-street stalls are considered a direct substitute for on-street stalls in the RPP. This assumption will not apply to all parking demand, and its accuracy depends on the off-street surface parking offering a similar level of convenience to on-street parking.

Key next steps in creating a shared parking program in the West End include: identifying site and building design characteristics that are conducive to shared private/public parking, designing pricing schemes, analyzing business cases for the city and the building owners, and examining the relevant legal requirements. Preliminary analysis suggests a large number of off-street stalls could be made available relatively easily, with little to no site modification, by using surface parking. In doing so, building owners could lease the stalls to either the city's existing RPP program or directly to users. Analysis of the business case for building owners must also consider the challenges of shared parking such as insurance, liability, and the pricing of on-street and off-street stalls. Once the preliminary shared parking program designs have been developed, further work should undertake more detailed modeling of parking demand under different program designs including neighborhood access, site design, circulation, and elastic demand. In dense urban neighborhoods with markedly imbalanced parking supply, such as Vancouver's West End, shared parking is a potentially powerful strategy to ease parking congestion without losing valuable land.

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6 REFERENCES

1. Baas, C. Rethinking A Lot: The Design and Culture of Parking. *Material Culture*, Vol. 45, No. 2, 2013, pp. 79–82.
2. Rose, L. S., H. Akbari, and H. Taha. *Characterizing the fabric of the urban environment: A case study of Greater Houston, Texas*. Publication LBNL-51448. Lawrence Berkeley National Laboratory, Berkeley, California, 2003.
3. McCahill, C., N. Garrick, C. Atkinson-Palombo, and A. Polinski. Effects of Parking Provision on Automobile Use in Cities: Inferring Causality. Presented at the 95th Annual Meeting of the Transportation Research Board, Washington, D.C., 2016.
4. Hess, D. Effect of Free Parking on Commuter Mode Choice: Evidence from Travel Diary Data. *Transportation Research Record: Journal of the Transportation Research Board,* Vol. 1753, 2001, pp. 35–42.

5. Metro Vancouver. *Apartment Parking Study*. Vancouver, B.C., Canada, 2012.
6. Blanc, B., M. Gangi, C. Atkinson-Palombo, C. McCahill, and N. Garrick. Effects of Urban Fabric Changes on Real Estate Property Tax Revenue. *Transportation Research Record: Journal of the Transportation Research Board*, Vol. 2453, 2014, pp. 145–152.
7. Litman, T. *Transportation Cost and Benefit Analysis: Techniques, Estimates and Implications*. Victoria Transport Policy Institute, Victoria, Canada, 2009.
8. Rowe, D. Minimum Efforts. *Parking Professional*, Vol. 29, No. 11, 2013.
9. Marsden, G. The evidence base for parking policies-a review. *Transport Policy*, Vol. 13, 2006, pp. 447–457.
10. Litman, T. *Parking Management: Strategies, Evaluation and Planning*. Victoria Transport Policy Institute, Victoria, Canada, 2013.
11. Weinberger, R. Death by a thousand curb-cuts: Evidence on the effect of minimum parking requirements on the choice to drive. *Transport Policy*, Vol. 20, 2012, pp. 93–102.
12. City of Vancouver. *The City of Vancouver Transportation Plan*. Vancouver, B.C., Canada, 1997, pp. D6 & D11-14.
13. City of Vancouver. *Downtown Transportation Plan*. Vancouver, B.C., Canada, 2002.
14. Weinberger, R., J. Kaehny, and M. Rufo. *US parking policies: An overview of management strategies*. Institute for Transportation and Development Policy, New York, NY, USA, 2010.
15. Kolozsvari, D., and D. Shoup. Turning small change into big changes. *Access Magazine*, Vol. 1, 2003.
16. Kodransky, M., and G. Hermann. *Europe's Parking U-Turn: From Accommodation to Regulation*. Institute for Transportation and Development Policy, New York, NY, USA, 2011.
17. Barter, P. A. *Parking policy in Asian cities*. Lee Kuan Yew School of Public Policy, 2010, pp. 10–15.
18. Metro Vancouver. *Metro Vancouver 2040: Regional Growth Strategy*. Vancouver, B.C., Canada, 2015.
19. City of Vancouver. *Transportation 2040 Plan: A transportation vision for the City of Vancouver*. Vancouver, B.C., Canada, 2012.
20. City of Vancouver. *West End Community Plan*. Vancouver, B.C., Canada, 2012.
21. VIA Architecture. *Right Size Parking - Model Code*. 2013.
22. City of Waltham. Off-Street Parking Requirements. Municipal Code Article V: Section 5.2, 2008.
23. City of Portland. Parking and Loading: Parking Spaces By Use. Municipal Code 32.66, 2015.
24. Capitol Hill EcoDistrict. *District Shared Parking: Program, Policy, and Technology*. Seattle, WA, 2015.
25. City of Vancouver. Parking Bylaw. Bylaw 6059, 2014.
26. Province of British Columbia. Strata Property Act. 2015.
27. Shoup, D. The Price of Parking. *Parking Today*, Vol. 14, 2009, pp. 22–23.
28. Pierce, G., and D. Shoup. Getting the prices right: an evaluation of pricing parking by demand in San Francisco. *Journal of the American Planning Association*, Vol. 79, 2013, pp. 67–81.
29. Smith, M. S., and T. A. Butcher. How Far Should Parkers Have to Walk? *Parking*, Vol. 47, No. 4, 2008.