



EXAMINING CURB USE CHANGES IN THE BOSTON REGION





BOSTON PUBLIC MARKET

CUSTOMER SERVICE



SEASONAL FRUITS & VE



EXAMINING CURB USE CHANGES IN THE BOSTON REGION

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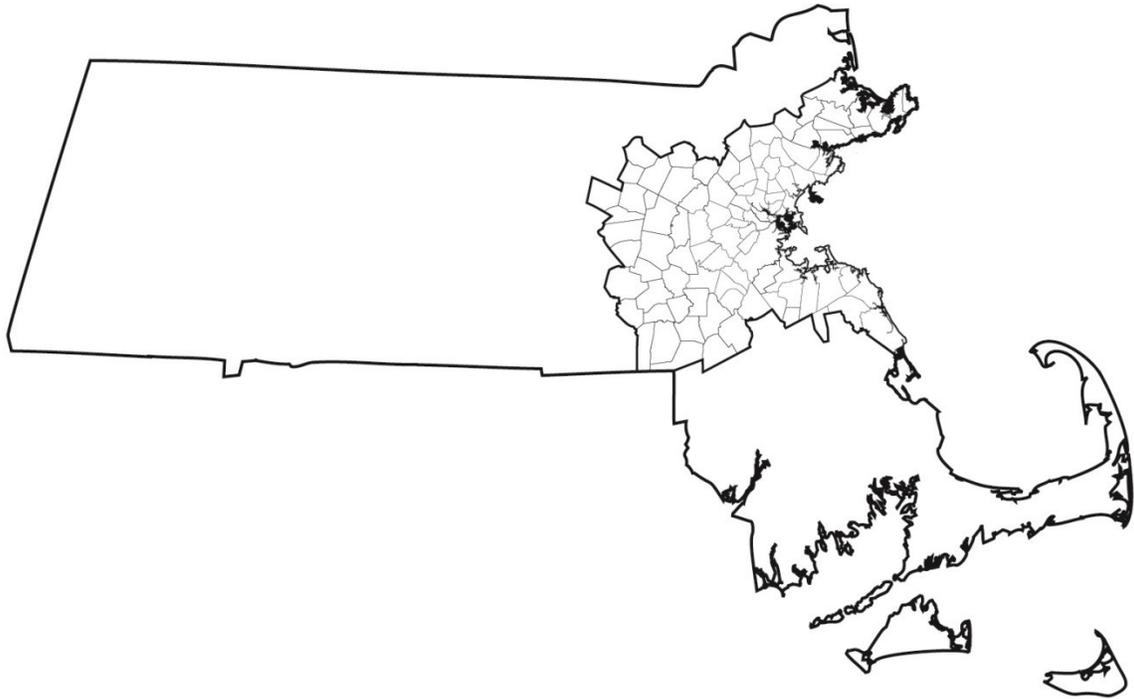
GRAPHICS

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CHAPTER 1

INTRODUCTION

B.T.O. T-4

TOW ZONE



**SUNDAYS
JUNE, JULY, AUG
SPECIAL EVENT**

←

BT-90 7-1

Street Cleaning
1st & 3rd THURSDAY
8am-12noon
Tow Zone.

TOW ZONE



**SUNDAYS
JUNE, JULY, AUG
SPECIAL EVENT**

→

TOW ZONE



←

**North End
Resident
Permit
Parking
Only**

TOW ZONE



→





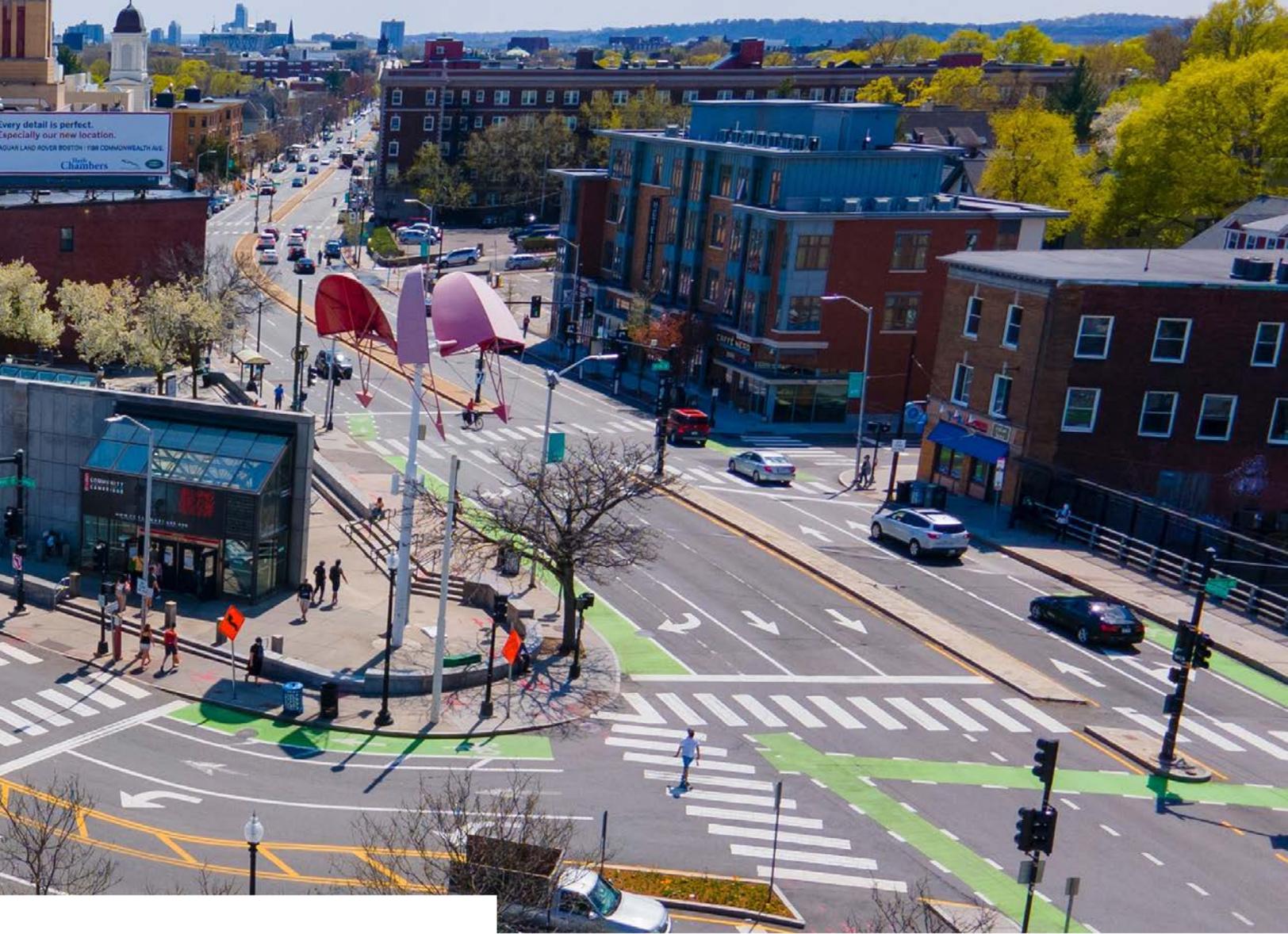
PURPOSE AND OBJECTIVES

This study builds upon the previous Central Transportation Planning Staff (CTPS) guidebook, [*Managing Curb Space in the Boston Region: A Guidebook*](#), which examined curb management examples, best practices, and challenges in the Boston region (Acton et al. 2021). The goal of this study is to provide municipalities with tools and guidance for data collection and analysis of curb management strategies.

To support this goal and to develop insights and recommendations based on real-world conditions, CTPS conducted two case studies. The purpose of these case studies was to calculate a series of metrics that assess curb use interventions and their impacts on parking activity and the usage of public curb space. The first case study focused on the Porter Square Safety Improvement Project in Cambridge, Massachusetts, which introduced parking spaces for people with disabilities, buffered bike lanes, and loading zones along a segment of Massachusetts Avenue. The second case study evaluated the implementation of outdoor dining on Moody Street in Waltham, Massachusetts. For both case studies, CTPS collected data before and after the interventions were implemented and conducted analyses to explore their impacts.

For this phase of the work, the sample sizes chosen were large enough to adequately explore our chosen methodologies but may not be large enough for rigorous statistical analysis. Additionally, these methods were only applied to two case studies, so planners should be cautious when using these results to make generalized statements about other curb management projects in the Boston region. The objective of this report is to demonstrate the effectiveness of the data collection and analysis processes that measure the impact of curb management strategies, culminating in a series of recommendations for planners and other stakeholders for conducting their own curb studies.





CHAPTER 2

SAFETY IMPROVEMENTS IN CAMBRIDGE

THE PORTER SQUARE CASE STUDY

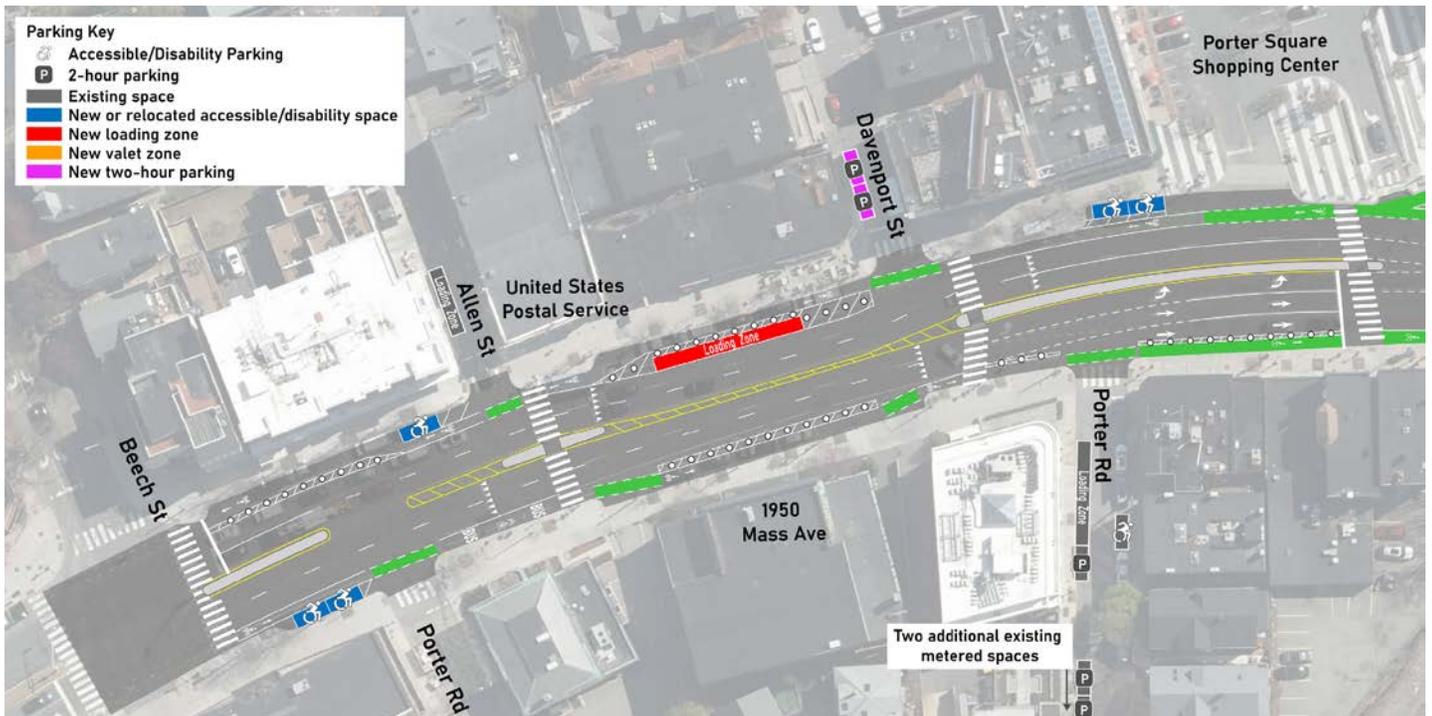
The case study in Cambridge investigated the area of the Porter Square Safety Improvement Project implemented by the City of Cambridge in Summer 2022. The primary objective of the project was “to achieve a safe street design for people of all ages and abilities” by redesigning the curb space of a quarter-mile section of Massachusetts Avenue near Porter Square between Roseland Street and Beech Street (City of Cambridge 2022a). The project upgraded the existing unprotected bike lanes to buffered semi-protected bike lanes, added parking spaces for people with disabilities, created loading zones, and reduced the number of metered parking spaces along the corridor.

For this case study, CTPS examined the impact of curb use changes in the northern segment of the redesign, highlighted in Figure 1 below. CTPS limited the study area to this section to improve the accuracy of vehicle-duration data and to capture shorter trips with frequent 15-minute data collection intervals. Key changes of the redesign in this section include the following:

1. Elimination of 15 two-hour metered parking spaces on Massachusetts Avenue
2. Upgrade of bike lanes to semi-protected cycle tracks on both sides of Massachusetts Avenue
3. Creation of two two-hour metered spaces on Davenport Road
4. Creation of a 30-minute loading zone (an area that permits parking and loading activity) on Massachusetts Avenue between Davenport Road and Allen Street
5. Addition of one new accessible parking space for people with disabilities

CTPS measured curb utilization before and after project implementation to develop insights into how to analyze commercial and noncommercial parking activity in the area. CTPS investigated specific parking behavior, such as vehicle occupancy, capacity, duration, and unauthorized parking.

Figure 1
Case Study Area Within the Porter Square Safety Improvement Project



Source: "MassAve_Redesign_ai_6_6_2022" by the City of Cambridge (2022c).

The City of Cambridge stated that improving safety is the central goal of the Porter Square Safety Improvement Project (City of Cambridge 2022b). Because the focus of this study was to measure changes in vehicle activity and not evaluate whether Cambridge met their safety goals, we did not examine safety impacts as part of this work.

The Porter Square Safety Improvement Project reduced the number of spaces dedicated to vehicle parking in the study area from 29 to 21 (Table 1). At the same time, the number of car-sized equivalent curb spaces dedicated to safer bicycle travel significantly increased from two to 15. The Porter Square project also converted a row of easily accessible, centrally located curb spaces along Massachusetts Avenue from a two-hour metered zone to a 30-minute loading zone.

The number of strictly no-parking spaces also declined from eight to three. These no-parking spaces are typically placed around intersections to increase visibility for both pedestrians and drivers. Before the intervention, about 19 percent of the curb space served as unusable buffer space at intersections. Much of this space was replaced with buffered bike lanes, thereby increasing the amount of potentially useful curb space in the study area from 81 percent to 93 percent.

Table 1
Number of Parking Spaces and Car-sized Equivalent Curb Spaces in Study Area Before and After Intervention

Curb Use	Subtype	Spaces Before	Spaces After	Change
Parking	Two-hour metered	19	6	-13
Parking	30-min loading zone	0	5	+5
Parking	Accessible	2	3	+1
Parking	Loading zone	8	7	-1
Parking Total	N/A	29	21	-8
Bike Lane	Buffered/protected	2	15	+13
No Parking	N/A	8	3	-5
Bus Stop	N/A	3	3	0

Notes: Car-sized equivalent curb spaces are the number of parking spaces that could fit in the equivalent length of curb space.

N/A = not applicable.

Source: Central Transportation Planning Staff.

METHODS

DATA

The foundational data-collection plan follows the Metropolitan Area Planning Council’s (MAPC) guide *How to Do a Parking Study* (Un 2010). Data were collected during ten shifts; five before and five after the curb use change. This resulted in a fairly limited sample size, which may not be representative of typical curb use activity in the study area. Table 2 shows each pair of shifts, the day, time, and collection dates. Each shift before the intervention was paired with a shift after the intervention that took place on a matching day of the week and time interval. Ideally, data collection before and after an intervention would be performed in the same season to avoid confounding factors such as seasonal travel patterns, school schedules, and more.

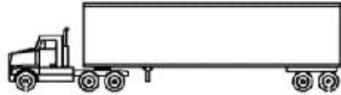
Table 2
Data-Collection Shifts in Cambridge

Day	Before Date	After Date	Shift Time
Thursday	July 21	November 10	6:00 AM–10:00 AM
Saturday	July 31	November 5	10:00 AM–2:00 PM
Tuesday	July 19	November 1	10:00 AM–2:00 PM
Wednesday	July 27	November 9	2:00 PM–6:00 PM
Tuesday	July 19	November 15	6:00 PM–9:00 PM

Source: Central Transportation Planning Staff.

During each shift, the data collector walked along the study route, starting over at the beginning of the loop every 15 minutes. This resulted in 16 rounds of data collection per four-hour shift and 12 rounds for the three-hour shift (Tuesday 6:00 PM–9:00 PM), resulting in a total of 152 loops across the entire case study area. To measure vehicle duration and authorized parking, the data collector recorded the last three digits of vehicle license plates while traveling the loop. To measure commercial activity, data collectors classified vehicles as either commercial or noncommercial following the guidelines by the Urban Freight Lab as shown in Figure 2 (Urban Freight Lab 2020). Data collectors also noted whether vehicles were blocking the bike lane. An example of a data-collection sheet is shown in Figure 3.

Figure 2
Urban Freight Lab's Vehicle Classification Guidelines

COMMERCIAL VEHICLES (CV)		
Delivery Commercial Vehicles (4 subtypes shown below)		
Truck with Trailer (T)		Truck with trailer, three or more axles.
Box Truck (B)		Single-unit trucks, three axles or less.
Cargo Van (CV)		A cargo van is a one-piece unit, while a box truck has a separate cab and cargo box.
Cargo Bike (C)		
Garbage Truck (G)		
Service Commercial Vehicles (Van or Pick-Up Truck) (SV)		
Van (V)		A cargo or service van usually displays a business logo. If such information was not visible, the vehicle was recorded as a 'van.'
Construction Vehicles		
CATEGORIZED AS NON-COMMERCIAL VEHICLES IN THIS ANALYSIS		
Passenger Vehicle (P)		
Taxi (X)		
Motorcycle (M)		
Others (O)		Includes fire and police trucks and vans, and other buses.

Source: "Method Overview and Step-by-Step Process to Conduct a Curb Occupancy Study" by the Urban Freight Lab (2020).

Figure 3
Sample of Field Data Collection Sheet

Time:	6:00 PM			6:15 PM			6:30 PM		
Location:	Last 4 of Plate	Vehicle Type	Blocking Bike Lane?	Last 4 of Plate	Vehicle Type	Blocking Bike Lane?	Last 4 of Plate	Vehicle Type	Blocking Bike Lane?
Begin at the corner of Sugar and Spice Thai, walk 50 ft down Davenport Street to check the no parking zone									
No Parking 1	D960	Passenger Vehicle		D960	Passenger Vehicle		D960	Passenger Vehicle	
No Parking 2	5244	Passenger Vehicle (P)		5244	Passenger Vehicle				
Turn around and head back to Massachusetts Ave, turn right and begin counts									
No Parking 1	—			—					
Loading Zone 1	YH10	Passenger Vehicle		—			ES68	Passenger Vehicle	
2 Hour 1	JA29	Passenger Vehicle		JA29	Passenger Vehicle		JA29	Passenger Vehicle	
2 Hour 2	L870	Passenger Vehicle		L870	Passenger Vehicle				
2 Hour 3	—			—					
2 Hour 4	—			MA22	Passenger Vehicle		MA22	Passenger Vehicle	
Handicap 1	—			—					
Cross Allen Street and turn right on Allen Street to check the loading zone									
Loading Zone 1	—			—					
Loading Zone 2	—			—					
Loading Zone 3	—			—					
Loading Zone 4	—			—					

Source: Central Transportation Planning Staff.

Once the data collection was complete, the sheets were digitized for comparison of the before-and-after data. In these sheets, each occupied parking space was represented as one row. The attributes included were the day of collection, the shift, the spot type (two-hour, 30-minutes, no parking, loading zone, bike lane, bus stop, or an accessible spot), the last few digits of the license plate, vehicle type, and authorization to park in the location.

ASSUMPTIONS

To determine if a vehicle was parked under the parking space’s time limit, we considered the number of consecutive 15-minute time slots where the same vehicle was parked in the same spot. Since the data collector does not record the exact minute of each observation, each time a vehicle is observed it is assumed to have spent 15 minutes in that location. For example, if a vehicle is in the same spot for two collection rounds, then it is assumed that it was there for 30 minutes. Therefore, if the same vehicle is observed in a two-hour space more than eight times (15 minutes * 8 rounds = 120 minutes), or in 30-minute space more than two times (15 minutes * 2 rounds = 30 minutes) it is assumed to have exceeded the time limit.

We used vehicle-duration data to determine whether a vehicle was authorized to park at the location. Any vehicle observed parking within the designated time limit and in a zone where vehicle parking is allowed was considered authorized. We also assumed

that any car parked in an accessible spot was authorized unless the data collector noted otherwise. Any noncommercial vehicles observed in a commercial loading zone for more than 15 minutes, or any commercial vehicles observed in a loading zone for more than 30 minutes were considered unauthorized. If the data collector indicated that a vehicle was blocking a bike lane or located in a no parking zone or bus stop then it was considered unauthorized parking, regardless of how long the vehicle was parked.

There were instances of vehicles that were already parked at the beginning of a shift and others that were parked at the end of a shift. Since the shifts were only three to four hours, it was not possible to determine the exact amount of time these vehicles were parked outside of the collection period. Where possible, we considered enforcement hours noticed on signage in the area when categorizing authorized parking activity. For loading zones, we assumed that the time limits were always enforced. We also assumed the 8:00 AM to 8:00 PM enforcement period applied to the 30-minute loading zone as well.

There were a few additional assumptions made when making this dataset:

1. We assumed that every vehicle with the same license plate was the same vehicle unless otherwise noted by the data collector.
2. In a few instances, a mail truck was identified as a “mail truck” without a license plate. We assumed this was the same vehicle in each instance.
3. We did not have access to parking payment data, so we assumed all vehicles in metered spaces paid the required parking fees.

ANALYSIS AND RESULTS

CHANGE IN ALL VEHICLE ACTIVITY

The first analysis developed summary statistics. We examined the total number of occupied parking spaces and number of unique vehicles that were parked in the study area before and after project implementation. Table 3 shows the results of this analysis. The number of occupied spaces was determined by adding the total number of times a vehicle occupied a spot during each shift, regardless of license plate. The number of unique vehicles was determined by counting the number of unique license plates for the different vehicle types throughout a shift. The table also highlights the percent change from before to after the redesign. The data showed an overall decline in both the number of occupied spots and the number of unique vehicles, especially during the morning and evening shifts. This result is unsurprising considering the amount of curb space in the study area available to vehicle parking declined by 28 percent.

Table 3
Change in All Parking Activity Before and After Curb Use Redesign

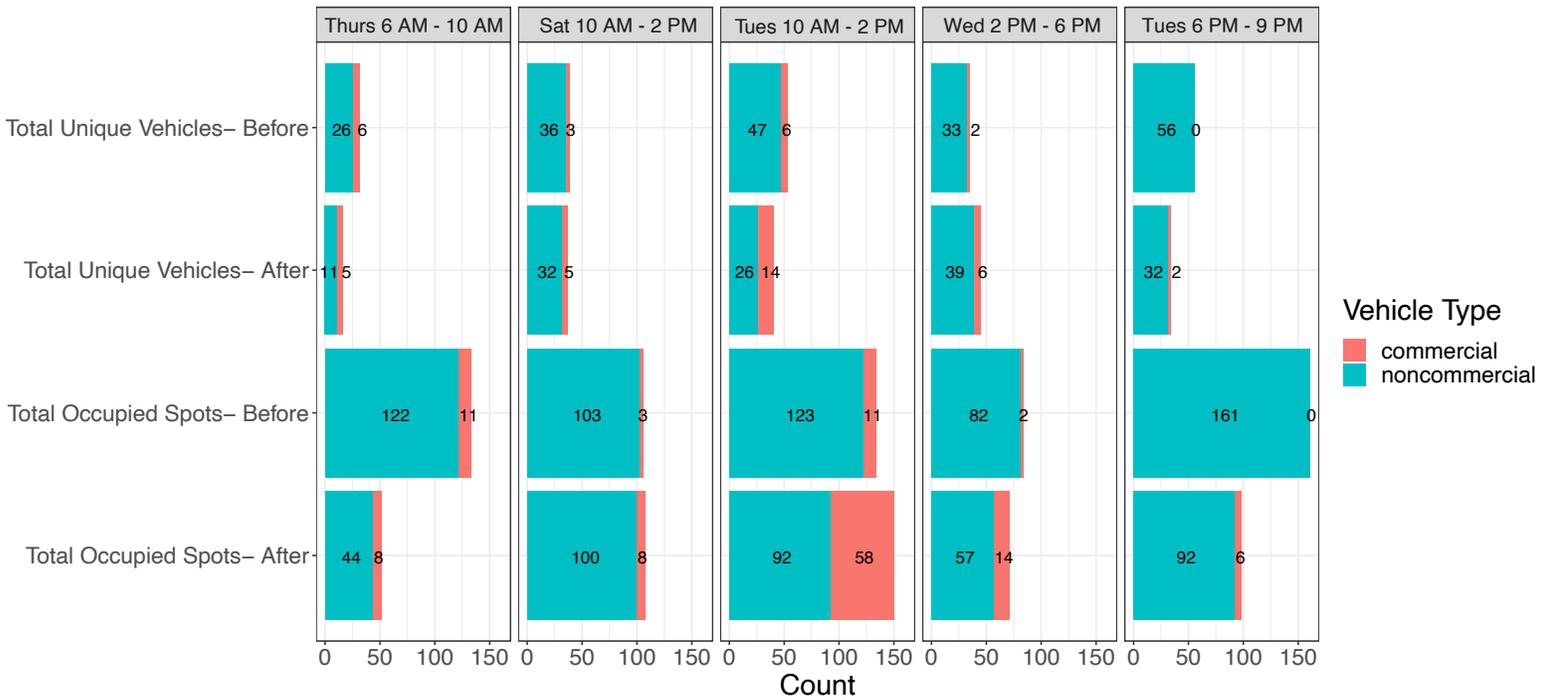
Shift Day	Shift Time	Occupied Spaces Before	Occupied Spaces After	Change in Occupied Spaces	Unique Vehicles Before	Unique Vehicles After	Change in Unique Vehicles
Thursday	6:00 AM-10:00 AM	133	52	-60.9 %	32	16	-50.0 %
Saturday	10:00 AM-2:00 PM	106	108	1.9 %	39	37	-5.1 %
Tuesday	10:00 AM-2:00 PM	134	150	11.9 %	53	40	-24.5 %
Wednesday	2:00 PM-6:00 PM	84	71	-15.5 %	35	45	28.6 %
Tuesday	6:00 PM-9:00 PM	161	98	-39.1 %	56	34	-39.3 %

Notes: Values represents the total number of occupied curb spaces or unique vehicles over an entire shift, which represents three or four hours.
Source: Central Transportation Planning Staff.

The results from Table 3 are displayed in Figure 4 in chart form and are categorized by vehicle type. Since the project changed parking availability for both commercial and noncommercial vehicles, this analysis explores whether the data yielded different results for the different types of vehicles. The chart shows that while overall space occupancy and unique visitors decreased, this trend was not consistent by vehicle type.

For each shift, while we observed that the number of noncommercial occupied spaces declined, there was a dramatic increase in the total number of spaces occupied by commercial vehicles. The data show that this increase in commercial vehicle activity occurred on Massachusetts Avenue between Davenport Street and Allen Street where two-hour metered parking was replaced with a 30-minute loading zone. The data suggest the new loading zone is highly utilized by commercial vehicle operators. This might be explained by the fact that compared to the loading zones on Allen Street and Porter Road, the new loading zone is longer, more visible, and more easily accessed by larger vehicles. The shorter time limit could also encourage faster turnover, increasing the chances that commercial vehicles will find adequate space to maneuver, load, and unload.

Figure 4
Parking Activity Before and After Curb Use Redesign



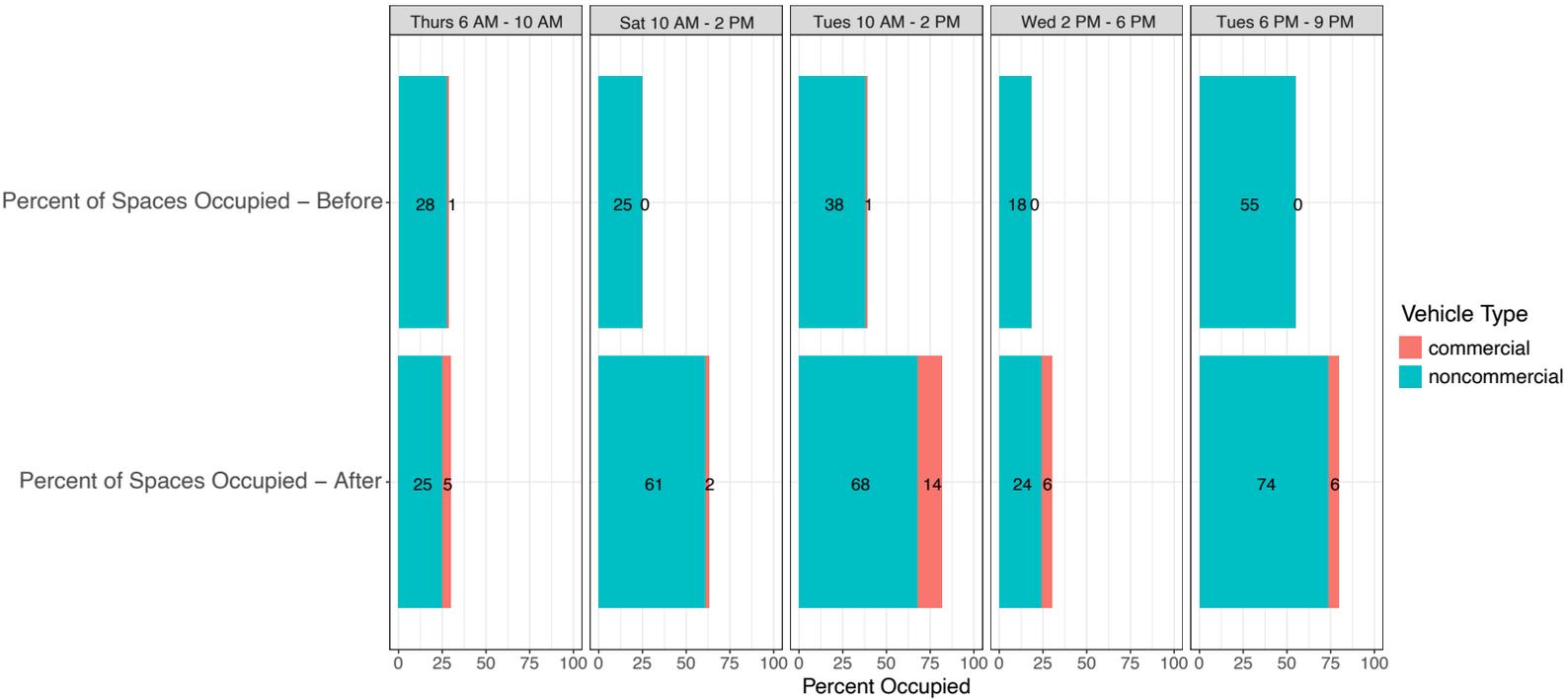
Source: Central Transportation Planning Staff.

CHANGE IN PERCENT PARKING OCCUPANCY

The results in the previous section suggest that when the amount of available parking space decreased, so did the observed number of occupied spaces. The next step was to examine whether the remaining parking spaces were experiencing higher rates of occupancy than before the intervention, especially the two-hour parking spaces, which were most affected in the redesign. The analysis in this section explores this question.

Figure 5 presents the ratio of two-hour parking occupied by vehicles before and after the redesign. The data show an increase in occupancy of the remaining two-hour spaces in every shift, suggesting that the intervention led to a more efficient use of two-hour parking supply. Though the redesign reduced the number of metered spaces, at least one of the six spaces was typically vacant during the data collection. On each occasion when all of the spaces were occupied, there were 30-minute spots available as well as loading zone areas for those needing to park for a brief period of time.

Figure 5
Percent Occupancy of Two-Hour Parking Spaces
Before and After Curb Use Redesign



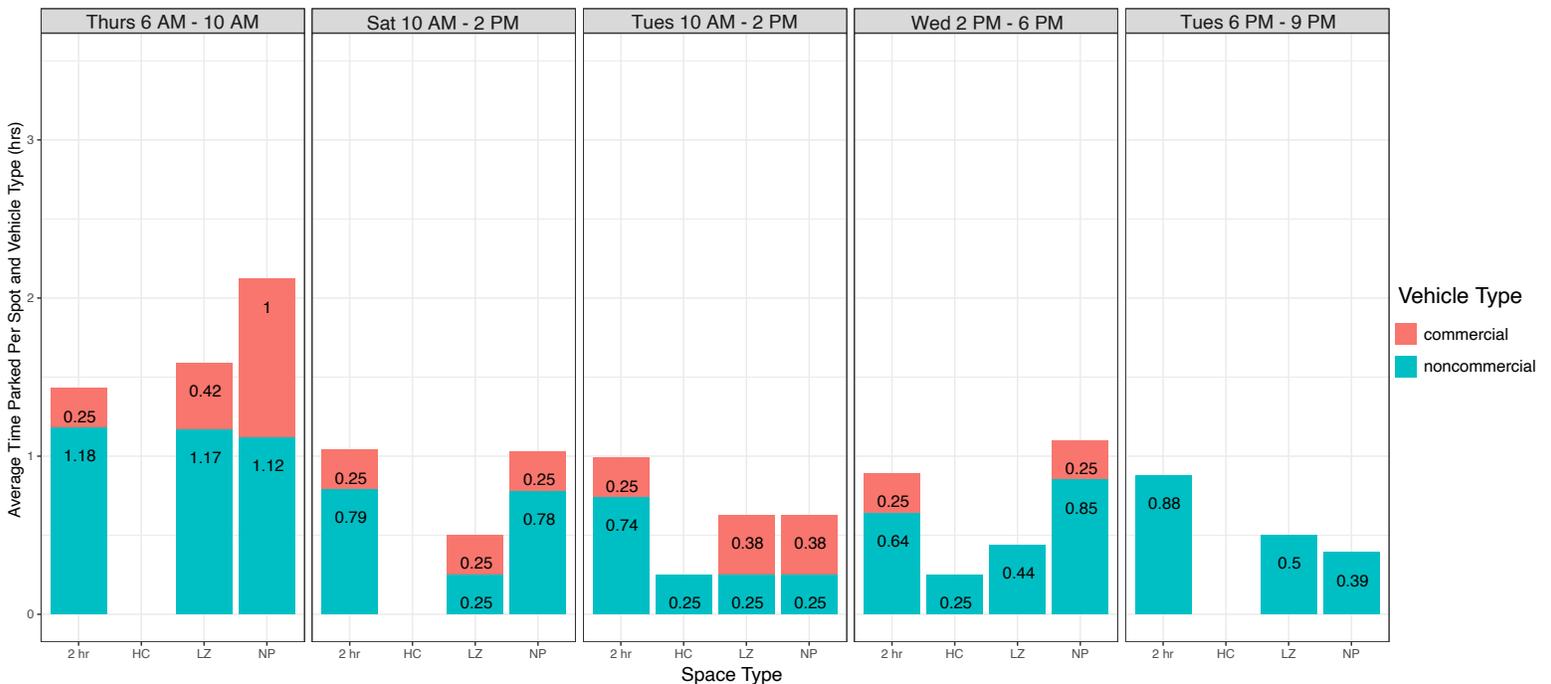
Source: Central Transportation Planning Staff.

Visitors can also access the area via the MBTA’s Red Line and the Fitchburg commuter rail line via Porter Square Station, three bus routes, or a buffered bike lane, and there is also a 300-space parking lot at the Porter Square Shopping Center for Porter Square visitors, all within a one-minute walk from the study area. Considering the many options available to visitors for access to the study area, it seems unlikely that the loss of 12 curb spaces would deter a significant number of people from visiting. Overall, these results suggest that the redesign represents an exchange for improved safety for bicycle travelers in the area with little to no loss in convenience to a small number of vehicle travelers.

CHANGE IN PARKING DURATION

Another area of interest was the effect the redesign had on the amount of time vehicles spent in the study area, including parking activity in zones where vehicle parking is prohibited such as bike lanes, bus stops, and no parking zones. These data are presented in Figures 6 and 7. Figure 6 shows the average duration in hours before the redesign by curb use and vehicle type. Figure 7 shows the same data after the redesign.

Figure 6
Average Parking Duration by Curb Use and Vehicle Type:
Before Curb Use Redesign



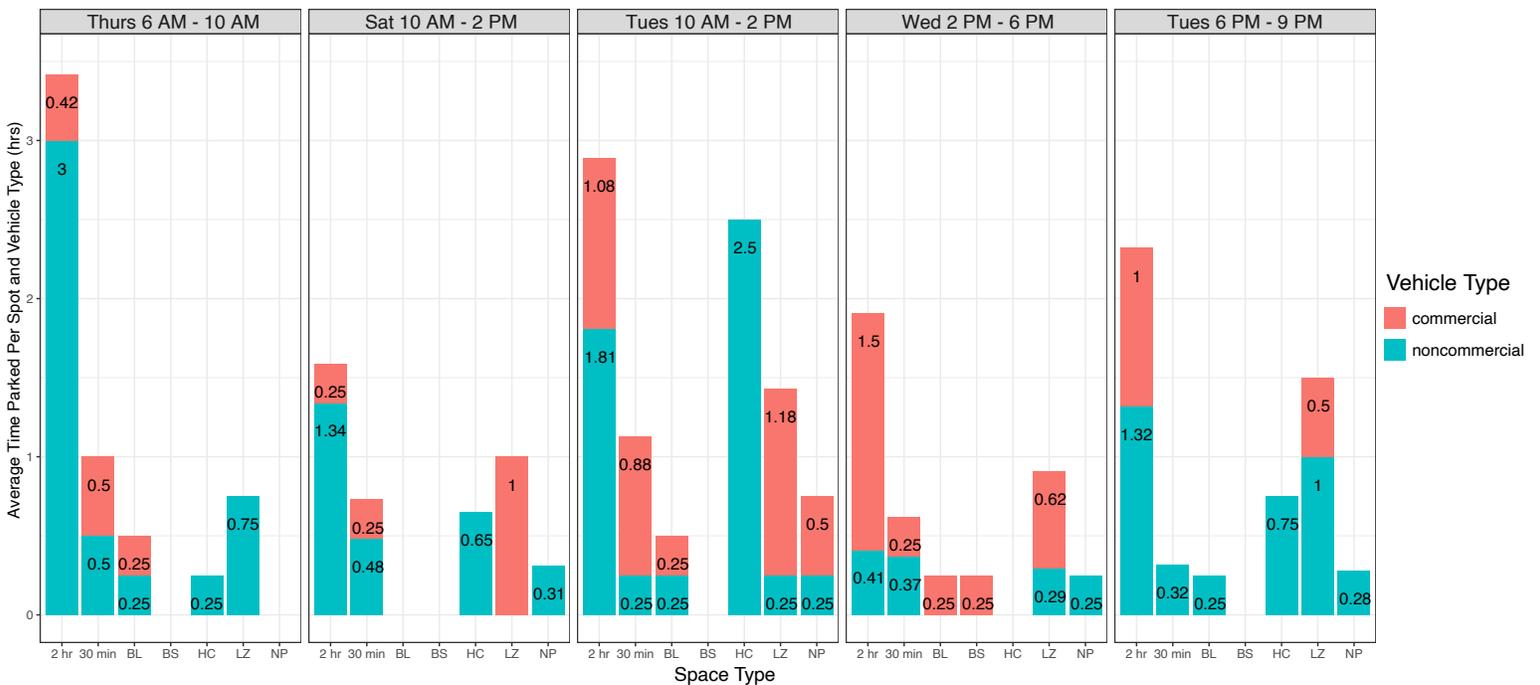
Notes: 2 hr = 2-hour metered parking. 30 min = 30-minute loading zone. HC = accessible parking for people with disabilities.

LZ = loading zone. NP = no parking.

Source: Central Transportation Planning Staff.

These results show a pattern in which vehicles were parked in spots for longer amounts of time after the redesign compared to before, especially in the two-hour parking spaces. A possible explanation for these results is that before the redesign, vehicles making shorter trips and longer trips both occupied two-hour parking spaces. After the redesign, vehicles making shorter trips began using the 30-minute loading zone while those on longer trips continued using two-hour spaces. However, as with the other analyses, these results are based on a limited sample size. More extensive data should be collected before making a definitive observation about the redesign’s effect on parking duration.

Figure 7
Average Parking Duration by Curb Use and Vehicle Type:
After Curb Use Redesign



Notes: 2 hr = 2-hour metered parking. 30 min = 30-minute loading zone. BL = bike lane. BS = bus stop. HC = accessible parking for people with disabilities. LZ = loading zone. NP = no parking.

Source: Central Transportation Planning Staff.

CHANGE IN UNAUTHORIZED PARKING

The redesign changed the number of metered parking spots in the study area. Because of this, we also wanted to explore if there was a change in the number of authorized parked vehicles. In this study, authorized parking was defined as any vehicle that is observed parking within the designated time limit and in a zone where vehicle parking is allowed. The results of this analysis are shown in Table 4. Our data sample showed that changes to the percent of authorized parking were mixed; during some shifts an increase was observed, while a decline was observed on other shifts. Across all shifts, the percent of parking that was authorized decreased slightly, suggesting that the elimination of parking spaces did not lead to any large changes in the rate of unauthorized parking activity.

Table 4
Authorized Commercial and Noncommercial Parking Activity
Before and After Curb Use Change

Shift Day	Shift Time	Total Authorized Parking Before	Total Authorized Parking After	Percent Authorized Before	Percent Authorized After
Thursday	6:00 AM-10:00 AM	97	41	72.9 %	78.8 %
Saturday	10:00 AM-2:00 PM	71	81	67 %	75 %
Tuesday	10:00 AM-2:00 PM	117	98	87.3 %	65.3 %
Wednesday	2:00 PM-6:00 PM	61	60	72.6 %	84.5 %
Tuesday	6:00 PM-9:00 PM	136	79	84.5 %	80.6 %

Source: Central Transportation Planning Staff.

One of the important aspects of the redesign was the creation of the 30-minute loading zone, improving the area’s ability to accommodate commercial vehicles. For a final analysis, we wanted to see if the data indicated any change in the amount authorized parking activity for commercial vehicles. As shown in Table 5, the data suggests that the redesign of the curb not only led to an increase in commercial parking, but also the share of that parking that was authorized.

Table 5
Authorized Commercial Parking Activity
Before and After Curb Use Change

Shift Day	Shift Time	Total Authorized Parking Before	Total Authorized Parking After	Percent Authorized Before	Percent Authorized After
Thursday	6:00 AM-10:00 AM	5	7	45.5 %	87.5 %
Saturday	10:00 AM-2:00 PM	2	6	66.7 %	75 %
Tuesday	10:00 AM-2:00 PM	6	30	54.5 %	51.7 %
Wednesday	2:00 PM-6:00 PM	1	10	50 %	71.4 %
Tuesday	6:00 PM-9:00 PM	0	6	N/A	100 %

Source: Central Transportation Planning Staff.

PORTER SQUARE FINDINGS

The Porter Square Safety Improvement Project case study opened the door for a fascinating case study. The data collected by CTPS allowed for a wide range of analyses that explored the possible impacts of the redesign on curb usage in this high activity area. These analyses examined the total occupied spaces and number of unique vehicles found in the study area before and after the redesign and sought to answer questions about the occupancy rates of parking spots, the parking duration of people visiting Porter Square, and whether there was a change in the amount of that parking activity was authorized. The details in our data set allowed us to dive deeper into trends based on the types of vehicles present, the time of day or day of the week, and the type of parking spots. While more data should be collected before making strong claims, the results of this case study suggest that the Porter Square redesign led to a more efficient use of remaining curb space for vehicle activity while promoting the area's accessibility for people traveling by bicycle.









CHAPTER 3

PEDESTRIANIZING MOODY STREET IN WALTHAM

THE MOODY STREET CASE STUDY

For the past several years, Moody Street in Waltham has been closed to vehicular traffic from May 1 to October 31. This pedestrianization, or the limiting of roadway space to pedestrians, first occurred in 2020 as a response to the COVID-19 pandemic and is intended to provide more space for safer outdoor dining and support local businesses.

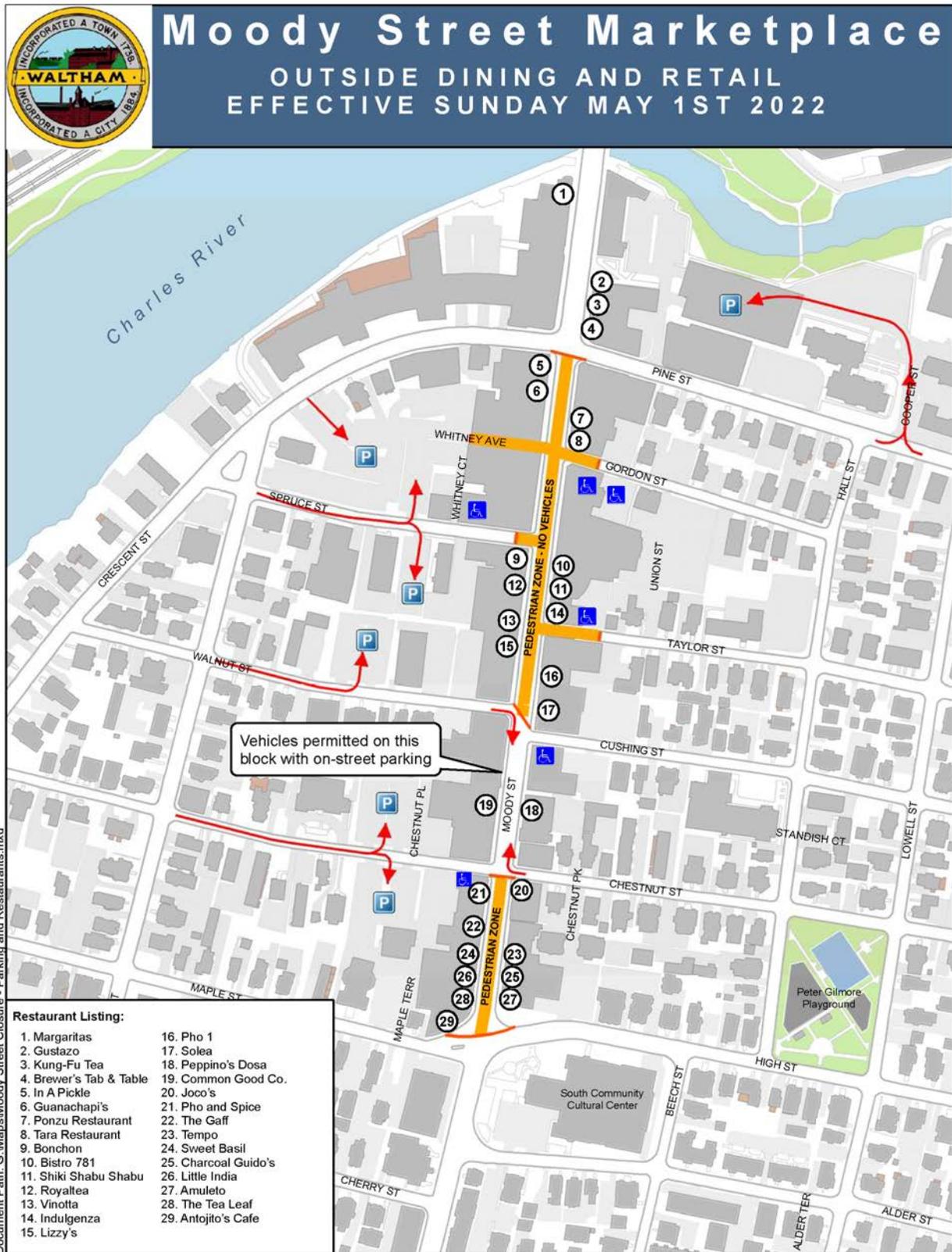
The Moody Street case study represents a significant change to the use of curb space. About 100 curbside parking spaces were replaced with at least 17 outdoor dining installations. Figures 8 and 9 present maps that show these changes and the restaurants participating in the outdoor dining program. These changes have had an impact on parking activity and capacity in the area. In order to understand this impact, CTPS conducted a curb usage case study in 2022 by collecting data on parking utilization before and after the closure of Moody Street to vehicles, as well as utilization data on outdoor dining installations.

Through this case study, CTPS sought to develop methods that address the following research questions regarding the closure of Moody Street to vehicle traffic and the partial replacement of curb space with parklets or dining installations:

1. Is there enough parking?
2. How does the change affect the number of unique people using the curb space per unit of time?
3. Does the change lead to a more effective use of public space?

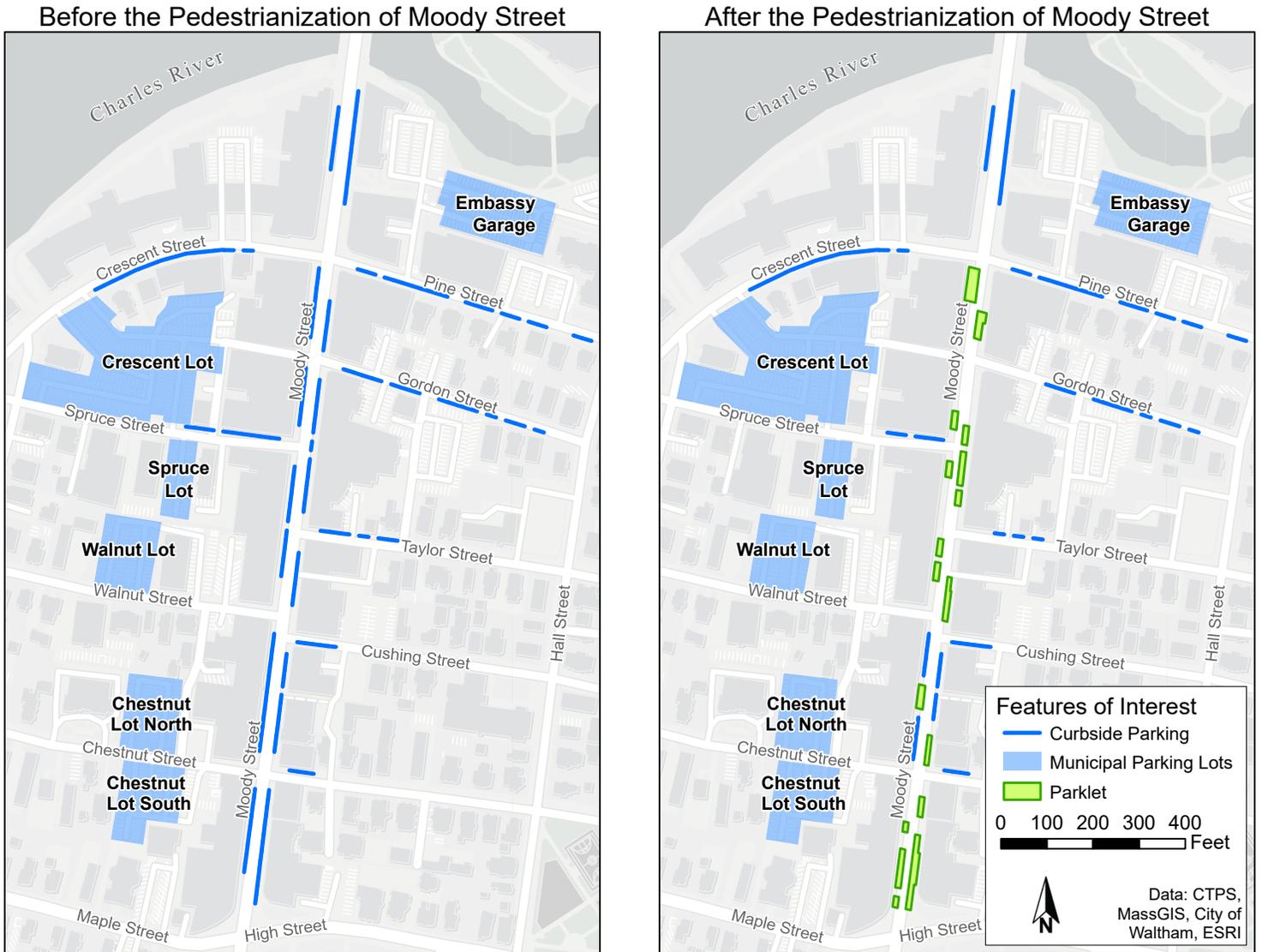
This study provides a deeper understanding of the impact of the Moody Street intervention on parking activity and capacity and how this change has affected the use of public space in the area.

Figure 8
Moody Street Vehicular Traffic Closure, Businesses and Parking Locations



Source: City of Waltham (2021).

Figure 9
Parking and Parklets Locations
Before and After the Pedestrianization of Moody Street



Source: Central Transportation Planning Staff.

METHODS

DATA

Parking Data Collection

In this case study, we collected data during nine shifts, which are shown in Table 6. During the first three shifts, parking data was collected before the closing of Moody Street to establish a baseline of parking activity. After the closing of Moody Street, we collected parking and parklet data during six shifts with comparable days and times to the baseline. The data can be organized into two categories: 1) Monday or Tuesday, representing the weekday from 10:00 AM to 6:00 PM with a one-hour gap between 1:00 PM and 2:00 PM; and 2) Saturday from 2:00 PM to 6:00 PM.

We collected parking data in one-hour intervals due to the availability of data collectors and the large size of the study area. We used a more frequent 30-minute interval for monitoring parklets. A one-hour interval for parking is not ideal for accurately calculating turnover or vehicle duration (since observations can have an error of nearly one hour), so we instead relied on vehicle occupancy and the number total unique vehicles metrics. As was the case with the Porter Square Case Study, pre- and post-pedestrianization data would ideally be collected in the same season, and more expansive data collection is needed to draw strong conclusions about the impact of the closure.



Table 6
Data-Collection Shifts in Downtown Waltham

Date (2022)	Day	Time	Before/ After Street Closure	Activity	Average Temperature (degrees)	Collection Interval
April 23	Saturday	2:00 PM–6:00 PM	Before	Parking	54	1 hour
April 25	Monday	2:00 PM–6:00 PM	Before	Parking	50	1 hour
April 26	Tuesday	10:00 AM–1:00 PM	Before	Parking	52	1 hour
June 18	Saturday	2:00 PM–6:00 PM	After	Parking	66	1 hour
June 21	Tuesday	10:00 AM–1:00 PM	After	Parking	67	1 hour
June 21	Tuesday	2:00 PM–6:00 PM	After	Parking	68	1 hour
July 9	Saturday	2:00 PM–6:00 PM	After	Parklets	70	30 minutes
July 11	Monday	2:00 PM–6:00 PM	After	Parklets	84	30 minutes
July 12	Tuesday	10:00 AM–1:00 PM	After	Parklets	86	30 minutes

Source: Central Transportation Planning Staff.

The data collection process for parking data was based on the steps in MAPC’s parking study guide, summarized here (Un 2010):

1. Plan the data collection walking route in the preferred mapping software, limiting the length to under two miles per data collection hour. (Figure 10 is a map given to data collectors to help them navigate the data-collection route for collecting parking data in this case study.)
2. Create a spreadsheet following the data-collection route with each row representing a parking space or parking space-sized equivalent of curb space. Label the rows by the curb regulation and include instructions for turns to assist with navigation. (See Figure 3 for an example.)
3. Field test the data-collection sheet by collecting one round of data at a leisurely pace while timing yourself and noting any errors. Revise and conduct further field tests until the sheet is ready.
4. Provide data collectors with instructions (either paper or digital), the route map, and a permission letter from the local authority.

Figure 10
Walking Route for Parking Data Collection in Downtown Waltham



Source: Central Transportation Planning Staff.

Parking Data Processing

Once the parking data-collection process was complete, the next step was to process and analyze the data by first combining all datasets into one spreadsheet following the example demonstration dataset shown in Table 7. The table contains the following data:

1. The first two columns contain location attributes with separate IDs for each city block and section of curb space. The spreadsheet contains the location of each Block ID. (For easier spatial analysis and map creation, planners can create and join the data to a GIS layer instead.) These location data allow for filtering the data by location, enabling the analysis of individual city blocks or groups of blocks.
2. In the "Parking Allowed" column, "1" denotes where parking is allowed and "0" where parking is not allowed. This enables the sorting, filtering, and analysis of unauthorized parking. Since unauthorized parking is not the focus of this case study, we removed all "0" spaces for this analysis.
3. Other columns represent the time of each round of data collection. Contained in these columns is the partial license plate data or a "0" if no vehicle is present.

Table 7
Prepared Parking Dataset Demonstration

Block ID	Space ID	Parking Allowed	10:00 AM-11:00 AM	11:00 AM-12:00 PM	12:00 PM-1:00 PM
1	1	1	0	2AL	2AL
1	2	1	0	1WE	0
1	3	1	2KX	2KX	0
1	4	0	0	0	0
2	1	0	0	6BT	0
2	2	1	KKR	KKR	1CR

Source: Central Transportation Planning Staff.

ANALYSIS

Parking Data Analysis

Some basic analysis was performed on the data with little processing and simple math. Table 8 is an example that shows how the data was used for a vehicle-occupancy analysis. To prepare the data for this analysis, we replaced all vehicle license plate values with a "1." To conduct an analysis of the number of unique vehicles, we replaced license plate values with a "1" only when a vehicle was seen for the first time. Finally, since we were only concerned with authorized parking in this case study, we removed any rows with "0" values in the "Parking Allowed" column.

Using the data, prepared as demonstrated in Table 8, we performed a simple parking-utilization analysis by totaling the numbers in each column. In this example, the sum of the "Parking Allowed" column shows that there are four spaces in the study area and that two vehicles parked there between 10:00 AM and 11:00 AM, resulting in a 50 percent utilization.

Parking data in this form are flexible, enabling the exploration of a variety of additional questions. For example, we can determine the average utilization over time by finding the average sum of each column, limit the analysis to a specific block, or keep only "Parking Allowed" equal to "0" to analyze unauthorized parking activity.

Table 8
Demonstration of Simple Occupancy Analysis of Parking Dataset

Block ID	Space ID	Parking Allowed	10:00 AM-11:00 AM	11:00 AM-12:00 PM	12:00 PM-1:00 PM
1	1	1	0	1	1
1	2	1	0	1	0
1	3	1	1	1	0
2	2	1	1	1	1
Totals:		4 Spaces	2 Vehicles	4 Vehicles	2 Vehicles
Utilization:		N/A	50 %	100 %	50 %

Source: Central Transportation Planning Staff.

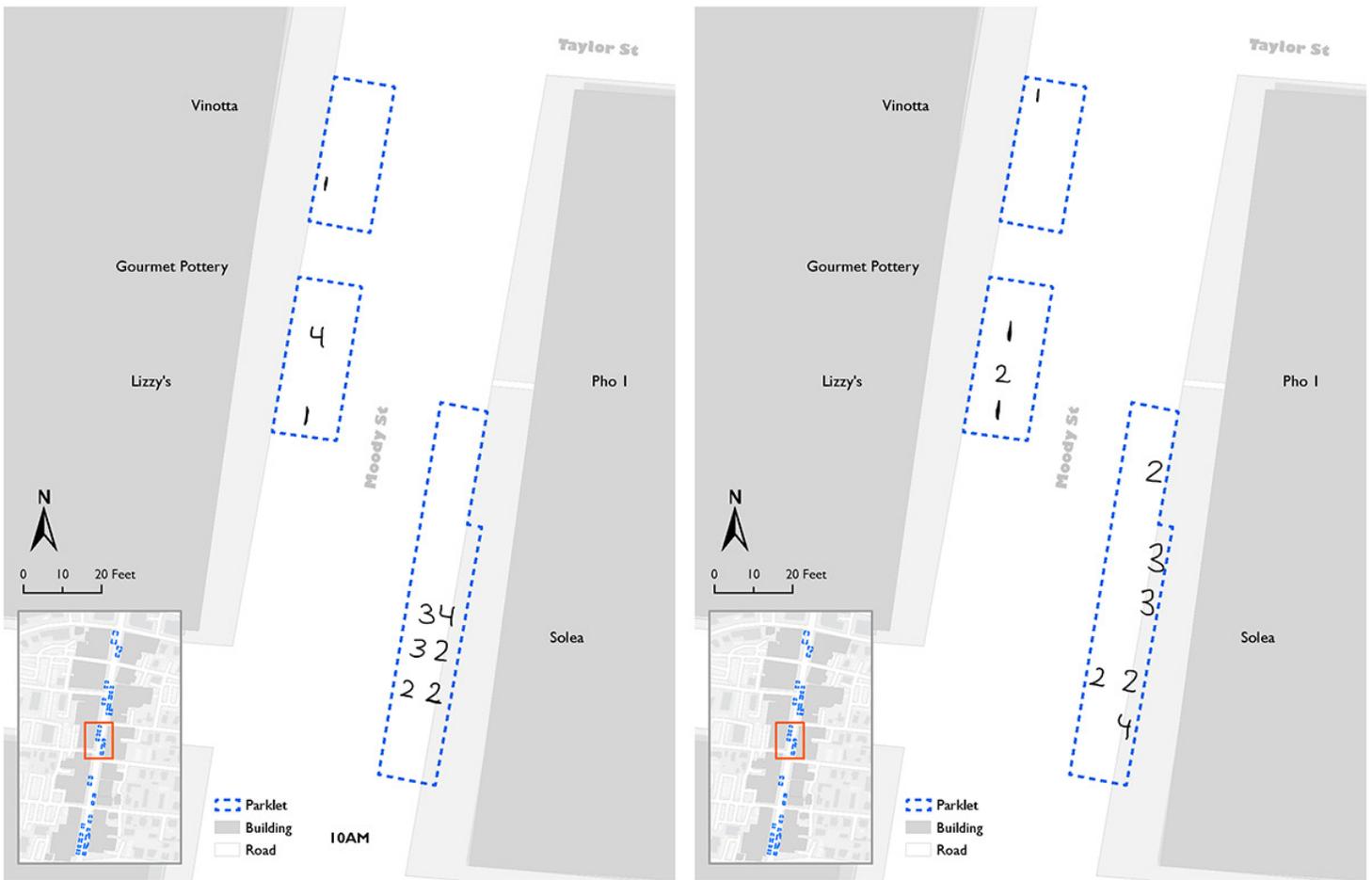
Parklet Data Analysis

In this case study, CTPS developed a method to measure activity in the outdoor dining installations on Moody Street. This method not only measures the number of people visiting each parklet, but also estimates the number of unique visitors to the parklet. The steps for collecting and analyzing parklet data are summarized as follows:

1. Collect data necessary to create single block maps of each parklet and identify which parking spaces were replaced. This can be accomplished through site visits to establish the locations of each parklet. Take multiple pictures of each installation, mark the parking spaces that were replaced by the parklets in the parking data-collection sheet, and sketch the parklet boundaries on aerial imagery.
2. Create maps showing the approximate footprint of each parklet as shown in Figure 11.
3. Instruct data collectors to type or write on the map the number of people sitting at a table in roughly the location of the table inside the parklet as shown in Figure 11. This enables us to estimate the number of unique visitors over time by comparing the position of the numbers between each round and noting when a number remains in the same location. So, if the data collector records numbers in the same location it is likely to represent the same group of people.
4. Create a spreadsheet where rows represent parklets and columns represent time. For occupancy simply add all values in each parklet. To calculate the number of unique visitors only add numbers that are not observed in the previous round.

Figure 11 details an example of how to estimate the number of unique visitors in each parklet. The map on the left represents a count of parklet visitors at 10:00 AM and the map on the right is a count at 10:30 AM. Notice that both maps contain a "1" at the bottom of the Lizzy's parklet and the pair of "2"s in the bottom half of the parklet outside the Solea restaurant. While it is possible that these are new visitors it is likely that they are the same party represented on both maps, so we can subtract them from the number of unique visitors to their respective parklet.

Figure 11
Example of Data Collection Maps of Parklet Activity



Notes: Numbers represent the number of people sitting at tables and their approximate location.
 Source: Central Transportation Planning Staff.

Curb Space Usage per Hour

While the previous analyses for this case study explored the intervention's impacts on the number of vehicles present in the study area, it is also important to understand how it impacts the number of people visiting the area. Thus, we wanted to calculate how many unique people use an area of curb space per unit of time, a measure of curb productivity. For this study, we used an hour as the unit of time. By calculating this metric both before and after a curb change, we can determine the effectiveness of a curb change intervention.

For example, to calculate the number of unique visitors per hour of an area with a mix of parking spaces and parklets, we count that 50 vehicles use the parking spaces per hour and 50 people use the parklets per hour. We then convert the vehicles value to number of people by multiplying the 50 vehicles by the average number of people each vehicle trip carries. This value is 1.67 people per vehicle trip as described by the National Household Travel Survey (FHWA 2018). The result is 83.5 people per hour. Next, we combine vehicle and parklet usage to get the number of people using the curb space throughout the area per hour, which in this example equals 133.5.

RESULTS

PARKING

The pedestrianization of Moody Street reduced the available parking supply in the study area by approximately 12 percent, from 854 to 768 spaces, by eliminating approximately 100 of the 185 parking spaces on Moody Street. We wanted to examine this intervention's impact on parking utilization in the study area and explore whether there were instances of supply exceeding demand. The results of these analyses can indicate whether the change is successful, or if it discourages pedestrian activity on Moody Street.

Parking Utilization By Time of Day

The data collected for this case study allowed us to examine the changes in parking activity at a fine granularity. Figure 12 presents the total number of vehicles observed in the study area before and after the pedestrianization of Moody Street, split up by the time of day in hour-long increments. Despite the small sample size, the results of this analysis can encourage discussion about the effects of the intervention on activity in the study area. For example, after the intervention, we observed a pattern of eight percent fewer vehicles between 10:00 AM and 1:00 PM on Mondays and Tuesdays. The reason for this pattern is not immediately clear, but one possible explanation is that the closure of Moody Street to vehicle traffic may have reduced the convenience

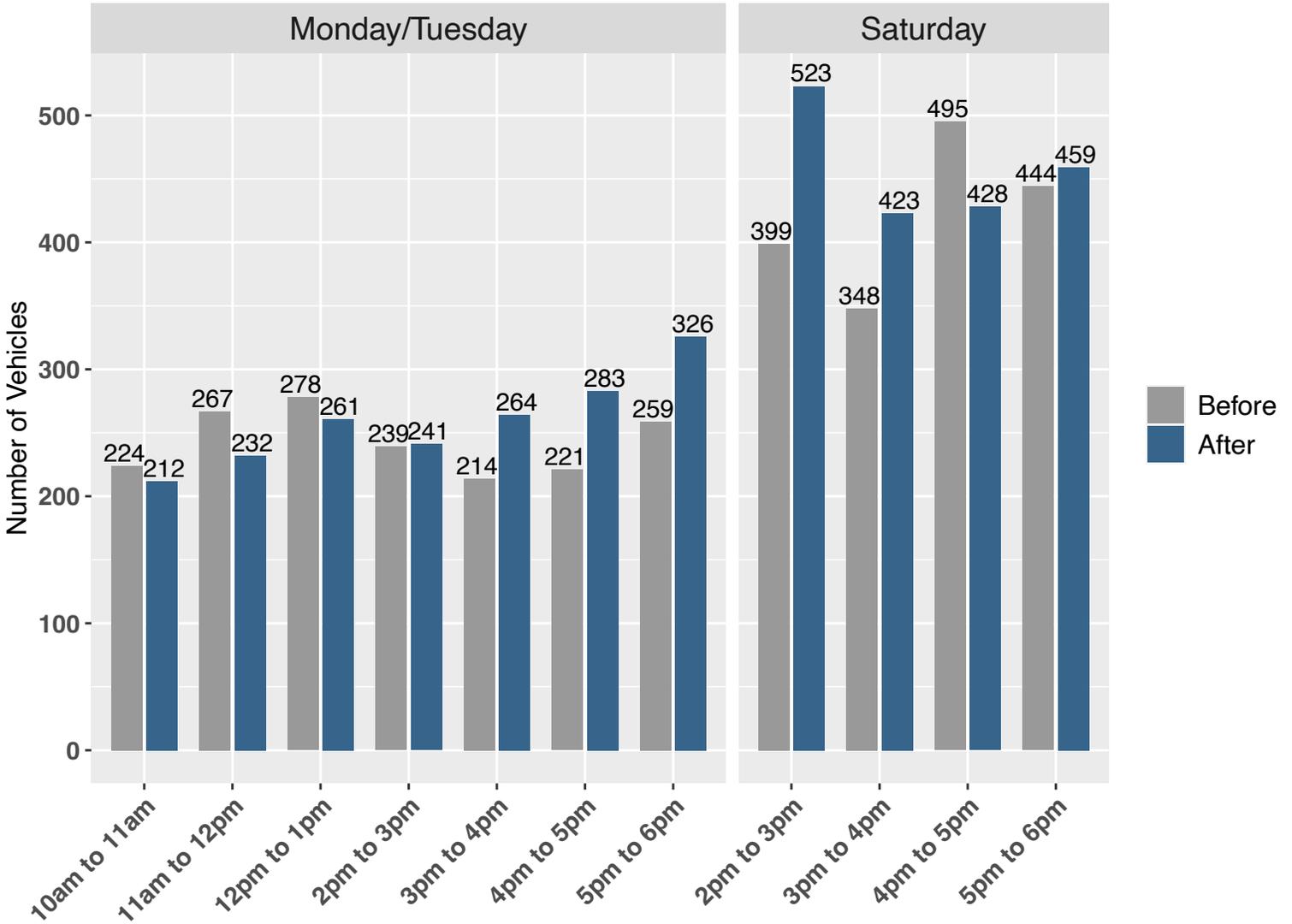
of visiting downtown for midday trips (e.g., lunch, personal care, medical services, and shopping), while increasing the attractiveness of visiting downtown for evening trips that may include outdoor dining.

The reverse is true between 3:00 PM and 6:00 PM, which coincides with the evening peak travel period, when Moody Street is likely to experience the greatest amount of vehicle traffic. After the intervention, there were 26 percent more vehicles during this time period. These results could suggest that the intervention increased the attractiveness of Moody Street as an after-work destination to eat, drink, and socialize. Perhaps, the lack of vehicle traffic turned Moody Street into a refuge allowing visitors to avoid the noise and stress caused by evening congestion. As with the previous case study, further data collection and analysis should be conducted before making any strong claims.

In addition to the raw values of parked vehicles, it was also important to examine the change in the occupancy percentage of available parking by time of day, to see if the reduction in parking supply led to demand that exceeded the capacity of the study area. These results are presented in Figure 13. They show that even if the number of total vehicles decreased, there were instances when the utilization of the spaces increased but never exceeded the capacity.

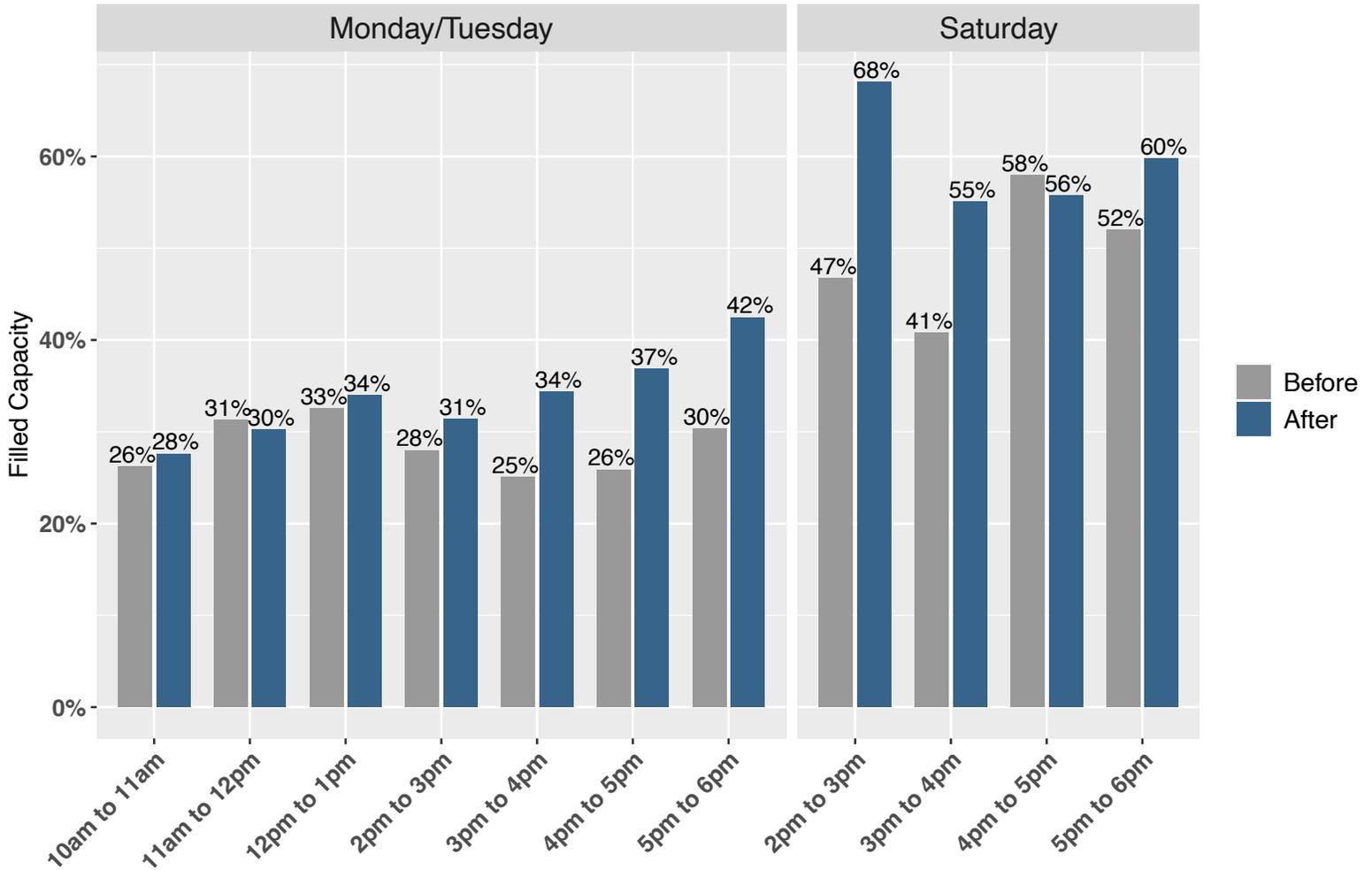


Figure 12
Total Vehicles in Moody Street Study Area by Time and Day



Source: Central Transportation Planning Staff.

Figure 13
Total Parking Utilization in Moody Street Study Area by Time and Day

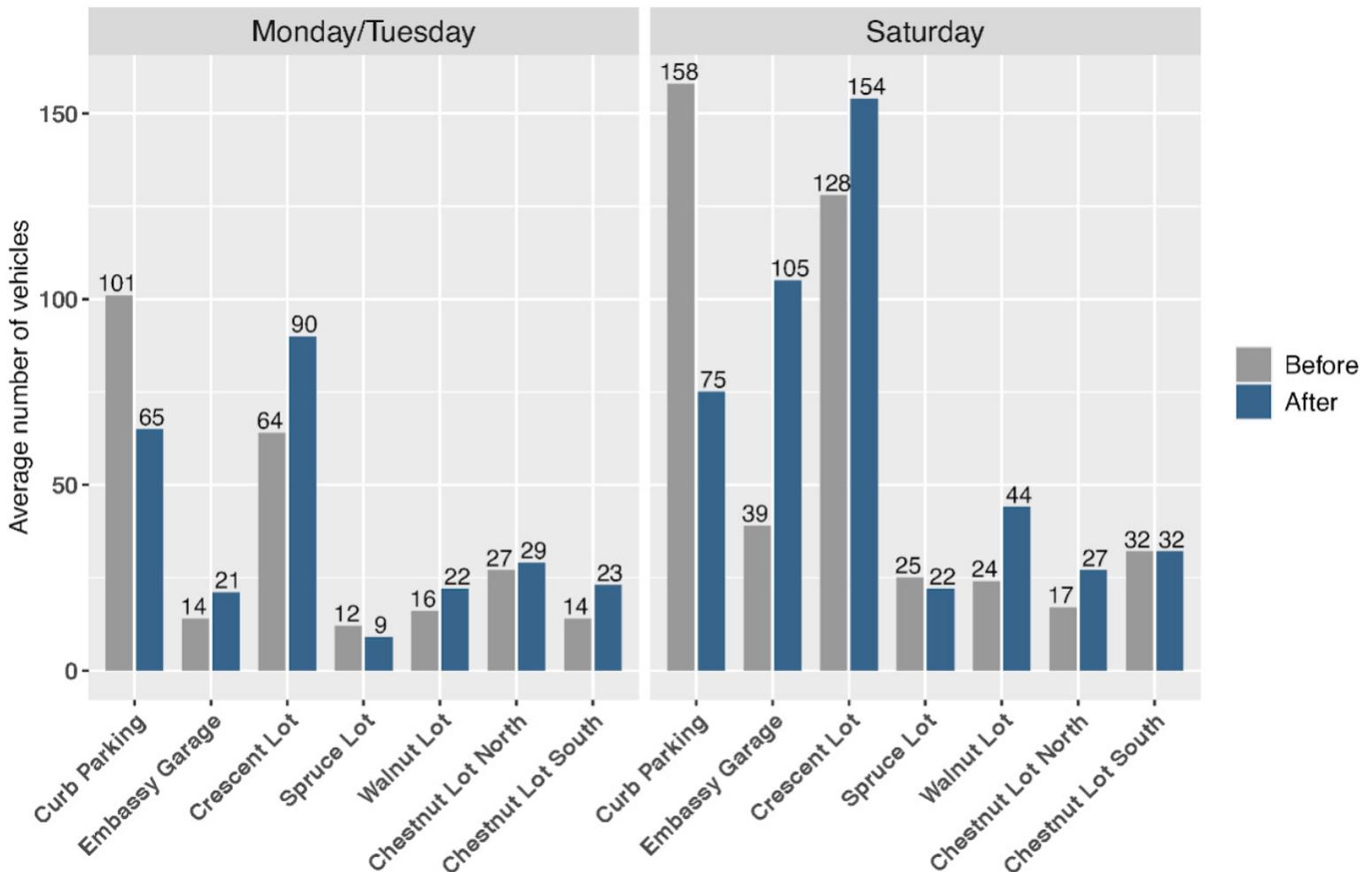


Source: Central Transportation Planning Staff.

Parking By Location

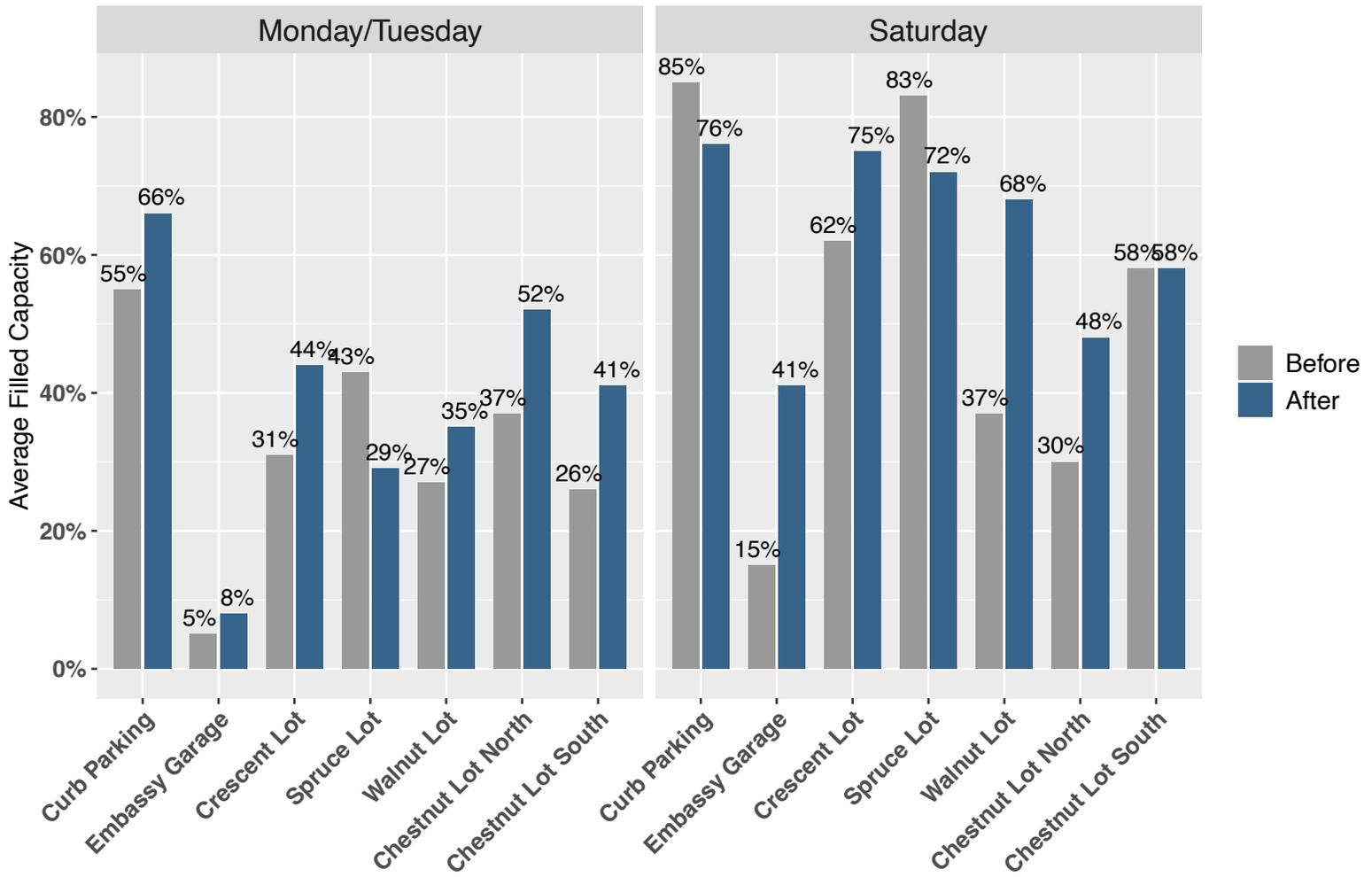
Unlike the previous case study, the data collected for this case study included parking counts for the lots and garages surrounding the main area of interest. With this information, we were able to explore how activity patterns changed in these neighboring lots when parking access to Moody Street was eliminated. Figure 14 presents the average number of vehicles in the study area by location on Monday/Tuesday and Saturday both before and after the intervention. Additionally, Figure 15 presents the same data as a percentage of total parking capacity at each location. In both charts, “Curb Parking” represents all curbside parking in the study area. These preliminary findings reveal a pattern: on both Monday/Tuesday and Saturday the pedestrianization of Moody Street led to a movement of vehicles from curbside parking into nearby off-street municipal lots and garages.

Figure 14
Average Number of Vehicles in Study Area by Location and Day



Source: Central Transportation Planning Staff.

Figure 15
Average Parking Utilization in Study Area by Location and Day



Source: Central Transportation Planning Staff.

On Monday/Tuesday, the majority of vehicles move into the Crescent Lot in the northern portion of the study area. This pattern, seen in the results by time of day, suggests that midday trips on weekdays are concentrated in the northern half of the study area. People making these trips, as previously discussed, are the least likely to benefit from outdoor dining and may be inconvenienced from having to park farther away from their destination. However, the results show that this potential inconvenience is not enough to reduce the number of trips to the study area, as the decline in curbside parking was more than offset by the number of additional vehicles in the municipal lots.

Finally, observations described in Figure 15, which shows the average parking utilization for each location by capacity, reveal that there is enough parking space in every off-street lot to absorb the additional demand from the decline in curbside parking capacity. The data suggest that the Embassy Garage may be acting as overflow capacity, since curb parking along with the nearby Crescent and Spruce lots are nearing capacity with average utilization across these locations at 74 percent. However, it is important to emphasize that even with the relatively greater demand on Saturday, there is still plenty of capacity in the Embassy Garage, as the average utilization only reached 41 percent after the intervention.

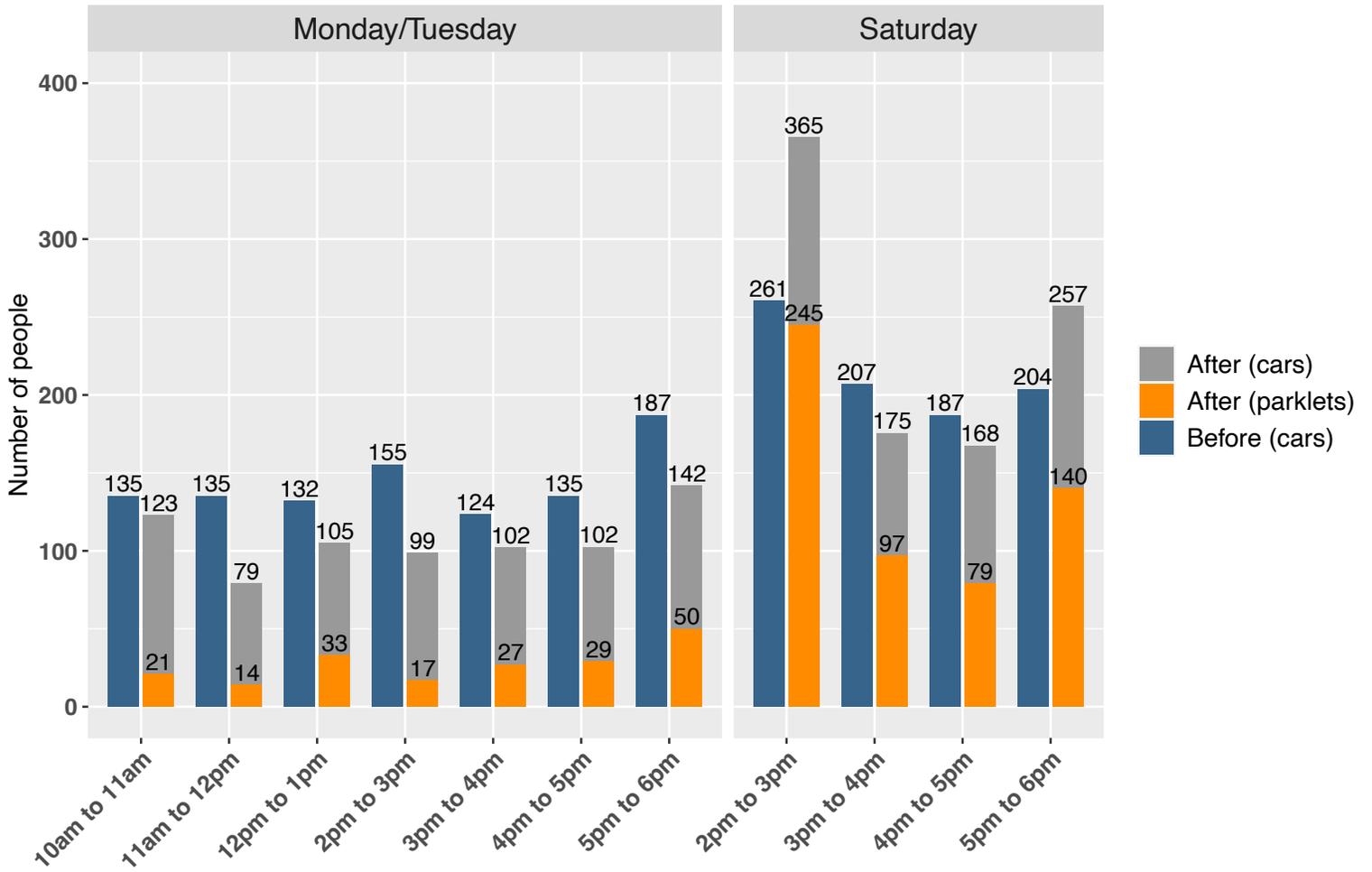
CURB SPACE USAGE PER HOUR

This section presents the analysis of the impact of closing Moody Street to vehicles in terms of the hourly number of unique people using the curb space. These results are shown in Figures 16 and 18. Figure 16 displays the hourly number of unique people using the curb space (both people in vehicles and people using the parklets) by time of day across the entire study area. Figure 18 displays the results for specific locations (or blocks) shown on the map in Figure 17.

Hourly Curb Space Usage By Time of Day

Since one of the goals of pedestrianizing Moody Street is to encourage activity in the parklets, it was interesting to get a sense of the usage rates at different times of day. As shown in Figure 16, the data suggest that the hourly rate of visitors throughout the entire study area on Mondays and Tuesdays was consistently lower following the closure of Moody Street to vehicles, but on Saturday, we observed overall greater numbers of people visiting per hour than before and substantially more parklet usage than during the week. These data also suggest that the popularity of parklets varies significantly depending on the time and the day of the week. Popularity peaks on weekend mornings and evenings.

Figure 16
Number of Unique People Using Curb Space in the Moody Street Study Area
by Time and Day



Source: Central Transportation Planning Staff.

Hourly Curb Space Usage By Location

As with the parking utilization analyses, we wanted to explore the change in the number of unique users of curb space by location as well as by time of day. Instead of breaking the area up by type of parking, we split Moody Street into five segments, or blocks, and measured the changes at each one. Figure 17 is a map that shows the boundaries of these segments. The only block that retained some curbside parking after the pedestrianization of Moody Street was Block 4; the others only have parklets. Parklet projects typically replace immediate and adjacent curb parking around the installations and rarely involve eliminating all curb parking along an entire city block. This makes Block 4 an interesting micro case study since, unlike the rest of Moody Street, much of the curbside parking remained after the intervention, allowing vehicles to park in 18 of the original 25 spaces on the block.

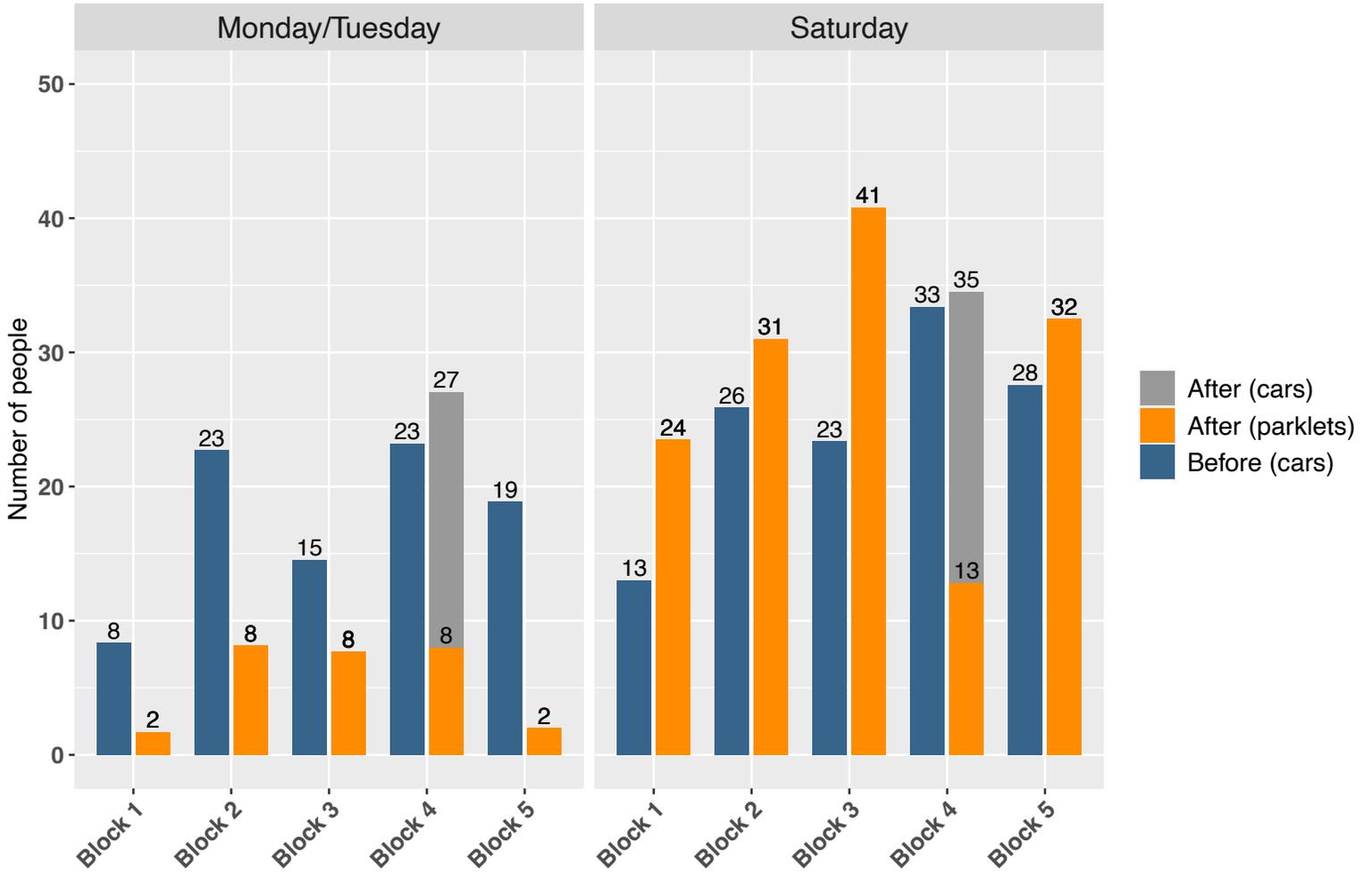
Figure 18 presents the curb space usage data by location and compares all-day average changes in hourly usage between the blocks on Moody Street. Overall, these data follow patterns established by the time-of-day analysis where the Monday and Tuesday data exhibited declines in hourly usage while the Saturday data showed increases. The only exception to this pattern was Block 4, which experienced an increase in curb space usage per hour on Mondays and Tuesdays. While allowing vehicles into Block 4 reduces the safety, noise, and comfort benefits enjoyed by the rest of Moody Street, it also boosts the usage of the block's curb space.

Figure 17
Parking and Parklet Locations after Intervention



Source: Central Transportation Planning Staff.

Figure 18
Average Number of Unique People Using Curb Space



Source: Central Transportation Planning Staff.

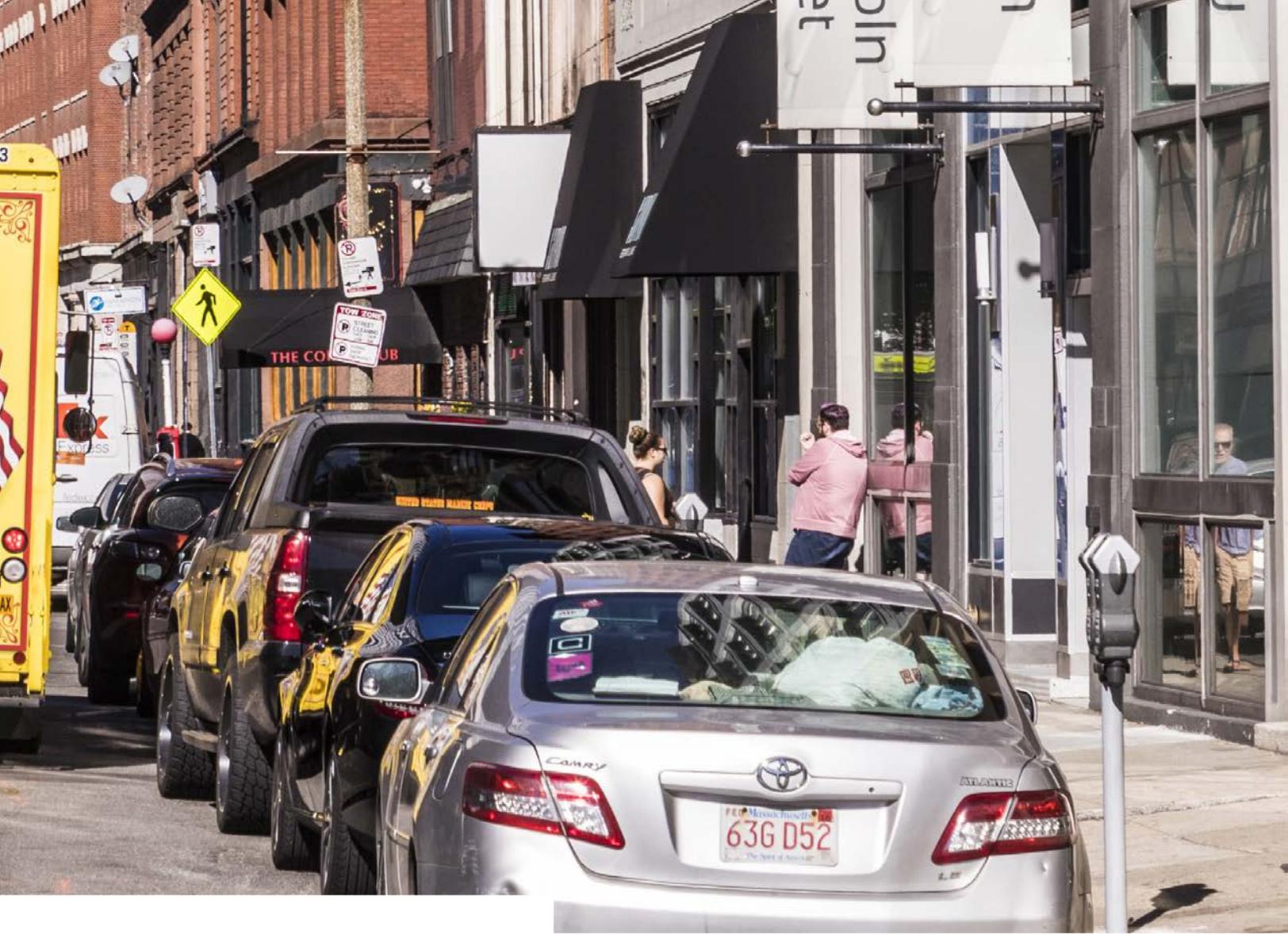
MOODY STREET FINDINGS

In conclusion, this study on the pedestrianization of Moody Street in Waltham led to interesting analyses about the effects of this type of intervention on parking activity. We were able to explore how removing access to curbside parking spots changed how people occupy the remaining spaces and utilize parking in nearby municipal lots. The introduction of parklets to allow for outdoor dining presents visitors with a new way to interact with the space and, according to our analyses, had a minimal impact on parking activity and capacity in the area. Despite a 12 percent reduction in parking supply, there were no instances where parking demand exceeded supply in the project area. Interestingly, while much of the convenient curb parking along Moody Street was eliminated, thereby requiring most visitors to park in nearby lots and walk farther to their destination, the total number of vehicles observed in the study area increased.

The preliminary results of this case study indicate that the project traded previously empty parking spaces in municipal parking lots for a safe, quiet, and pleasant outdoor social space that benefits both visitors and local businesses. Waltham created a popular, safer, and enjoyable public space for the community while supporting local businesses and without negatively impacting parking availability in the area.







CHAPTER 4

RECOMMENDATIONS AND CONCLUSIONS

SUMMARY OF METRICS

Across the two case studies, many analyses were conducted to explore various metrics assessing curb management strategies. The focus of the work on these strategies is to provide planners with tools that they can adapt to analyze the effectiveness of their own projects.

CHANGE IN PARKING ACTIVITY

Both case studies involved an exploration of how the number of vehicles parked in the study area changed after the interventions were implemented. In the Porter Square study, this change was presented as both a change in the total number of occupied spots and as the number of unique vehicles present. Additionally, since one important aspect of the project was the introduction of a new loading zone, we also sorted the data to compare the activity of commercial and noncommercial vehicles. The Moody Street study included an analysis of the parking activity by time of day and, because we had parking counts of surrounding lots, we also looked at the change in parking by location.



CHANGE IN PERCENT OCCUPANCY

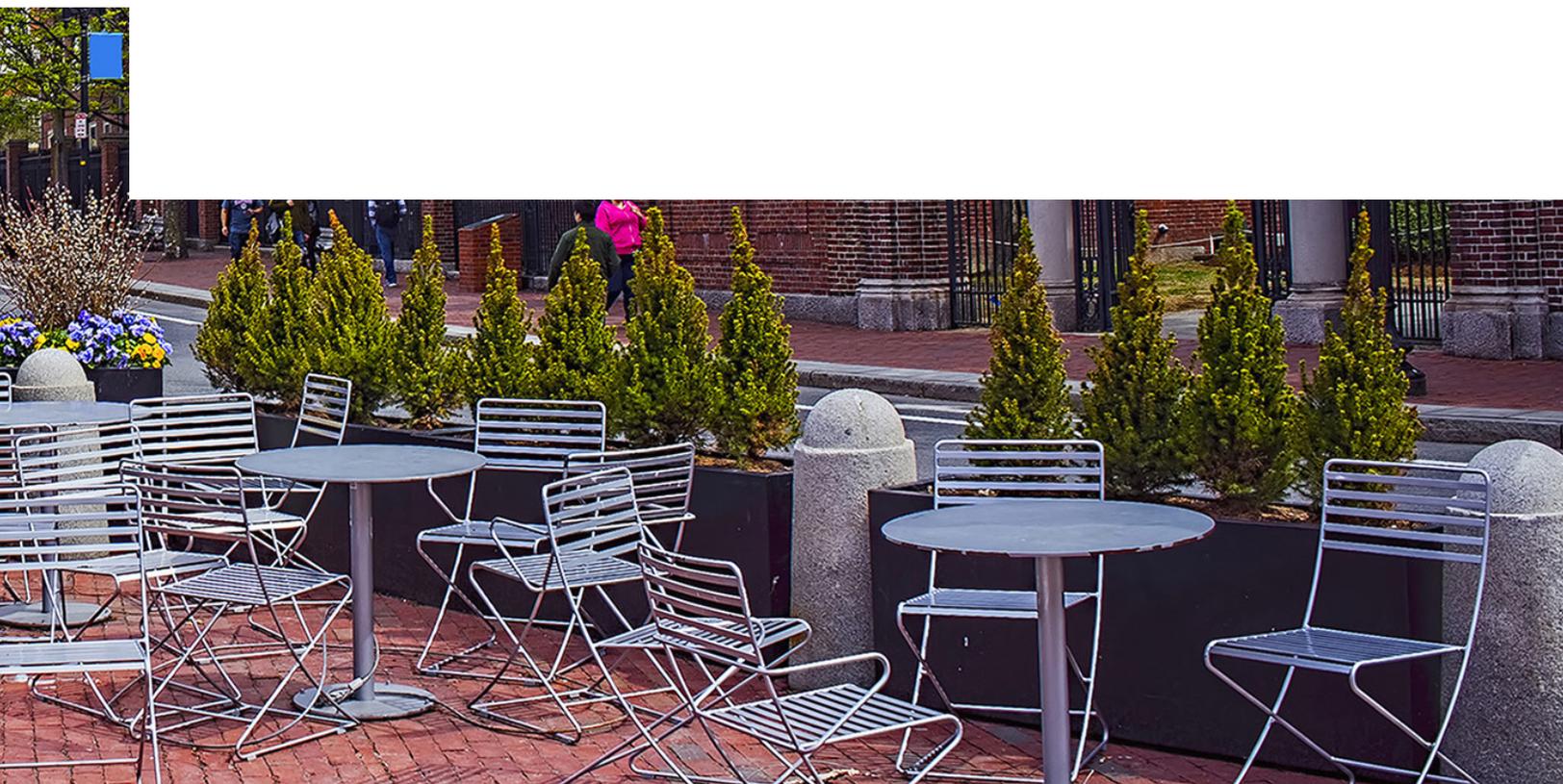
Both case studies also examined the percentage of the available parking spaces that were occupied by vehicles. The Moody Street case study made the same time and location distinctions as with the change in parking activity analyses. In the Porter Square study, we decided to look specifically at the two-hour parking spaces, since those were the space types that were most affected by the redesign.

CHANGE IN PARKING DURATION AND AUTHORIZATION

Two metrics that were unique to the Porter Square case study were the change in parking duration and change in unauthorized parking. In this study, authorized parking was defined as any vehicle that is observed parking within the designated time limit and in a zone where vehicle parking is allowed. Since the redesign involved both the loss of parking spaces and the transformation of curb space to different types of parking, these analyses are intended to help us paint a fuller picture of how drivers were interacting with the space.

CURB SPACE USAGE PER HOUR

The hourly curb space usage analyses were unique to the Moody Street case study. We were not only examining the change in the number of people parking, but also the activity of those visiting the new parklets in the study area. As a result, we developed a method to estimate how many unique visitors came to the study area by combining these two populations.



CURB STUDY RECOMMENDATIONS FOR PLANNERS

Planners seeking to conduct a curb study in their municipality should refer to [*Managing Curb Space in the Boston Region: A Guidebook*](#) and consider the following lessons learned before and during the study process:

1. Limited case studies, such as the ones presented in this report, are not sufficient for inferential statistical methods. In these cases, it is best to focus on a broader set of questions and trends. With smaller study sites and greater resources, planners should consider increasing the scope and span of data collection to confirm and refine their findings.
2. Evaluate curb metrics with context. Curb space usage per hour, for example, can be a valuable way to evaluate the impact of curb projects, however it should be accompanied by a broader evaluation of the project that considers other benefits. In the case of Moody Street, we observed a slight decline in the overall hourly number of unique people using the curb space, which may be an acceptable tradeoff after considering the increased use of municipal lots and the other benefits of pedestrianizing the street, such as improved safety, increased social interaction and sense of community, and support for local businesses.
3. Be mindful of the resources required to conduct a similar study in your municipality. For studies similar to the ones presented, we recommend a maximum of 150 parking spaces per data collector per hour. For areas with higher turnover or shorter time limits, a higher frequency of data collection may be necessary.
4. Have a flexible study timeline if planners wish to collect before-and-after data. Timelines for projects that change curb use are often unpredictable, so it is best to anticipate delays in the study timeline.
5. Consider adjacent spaces and off-street parking lots in the study design process. In the Waltham case study, we observed an increase in off-street parking demand following the elimination of curb parking.

CONCLUSION

This pair of case studies demonstrates to planners and municipal officials in the Boston region how a small team with limited resources can measure the effects of curb use changes in their municipality. Both studies evaluated curb space changes by exploring different methods for conducting parking studies. In Cambridge, CTPS studied the impact of a curbside parking redesign by evaluating commercial and noncommercial vehicle activity, parking spot occupancy, parking duration, and instances of unauthorized parking. In Waltham, CTPS expanded standard parking study methods to include parklet activity and hourly curb usage to measure the effects of pedestrianizing portions of Moody Street and replacing curb parking with parklets. While there were limitations for both of these studies, including the amount of data collected and the ability to explore how these curb management strategies interact with the broader communities in which they are situated, CTPS was able to explore many data collection and analysis methods and make recommendations to planners who would like to conduct similar studies for their municipalities in the future.



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