CHAPTER 1
Overview

Framing our strategies and goals for the parkDC: Penn Quarter/ Chinatown Pricing Pilot

1 Overview

The District's motivation and goals for the project, an outline of the strategies and technologies behind demand-based parking pricing, and the process used to assess the parkDC: Penn Quarter/Chinatown Parking Pricing Pilot's effects

1.1 PARKING FOR A GROWING DISTRICT

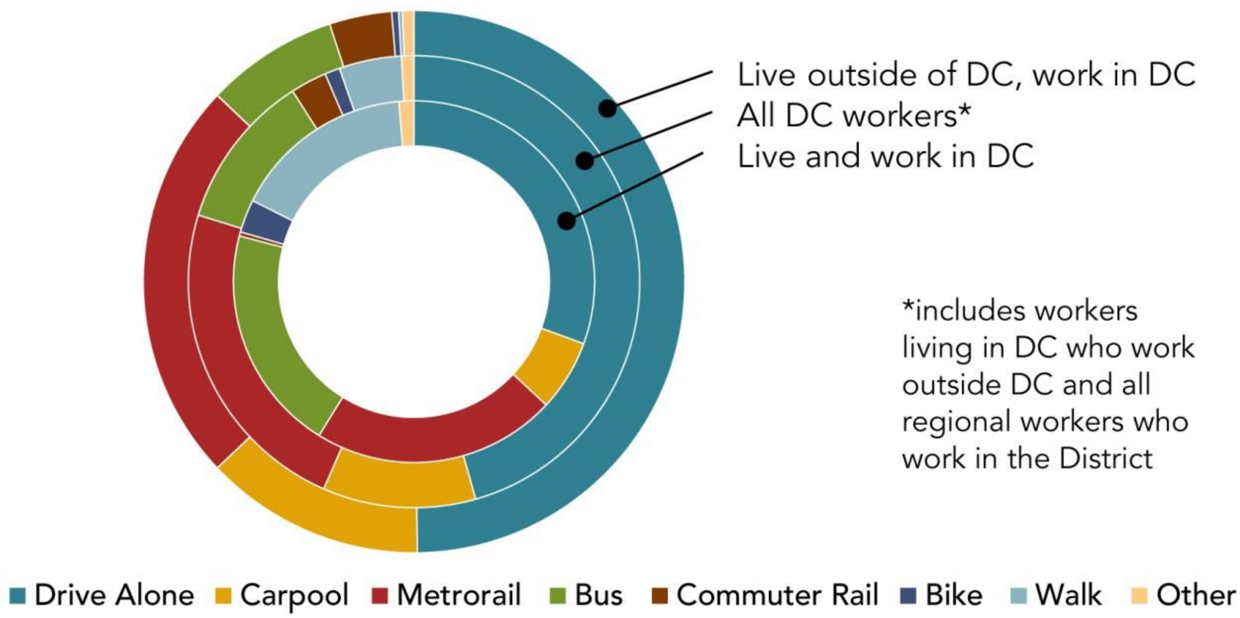
Washington, DC (referred to as the District) has experienced a sustained resurgence in housing and employment over the past decade. Due in part to its location at the center of the sixth largest metropolitan area in the United States, the District's population of over 700,000 almost doubles during daytime with an influx of more than 500,000 commuters and 125,000 visitors.[1] Although the District's multimodal transportation system is made up of robust transit, bicycle, and pedestrian infrastructure, many continue to travel by automobile. Over half of workers who live outside of the District travel to the District by car—whether alone or by carpool (Figure 1-1). In addition to commuters and visitors, the boom in online shopping and use of rideshare services has contributed to an uptick in commercial and individual demand

[1] District Department of Transportation. District Mobility: Multimodal Transportation in the District. January 2017. https://districtmobility.org.

for pick-up/drop-off zones and curbside loading zones.[2,3] Balancing the competing parking needs of residents, commuters, visitors, and businesses has been and will continue to be a growing challenge for the District.

Population projections for the region indicate that by 2040, approximately 150,000 more people will live in the District and overall employment will reach approximately 980,000 jobs. Growth in the urban core and surrounding region will increase the number of trips made within, to, from, and through the District. Quantifying, managing, and assessing parking performance along with other aspects of multimodal mobility will play a critical role in sustainably accommodating long-term growth and maintaining the District's competitiveness at a national level.

Figure 1-1. Commute mode share for workers in the District by place of residence (Census Transportation Planning Products, 2006-2010)



[2] Smith, A., and M. Anderson. *Online Shopping and E-Commerce*. Pew Research Center. December 2016. http://www.pewinternet.org/2016/12/19/online-shopping-and-e-commerce.

[3] Rutter, A., D. Bierling, D. Lee, C. Morgan, and J. Warner. How Will e-commerce growth impact our transportation network? *Texas A&M Transportation Institute Transportation Policy Research Center,* 2017. https://rosap.ntl.bts.gov/view/dot/32858

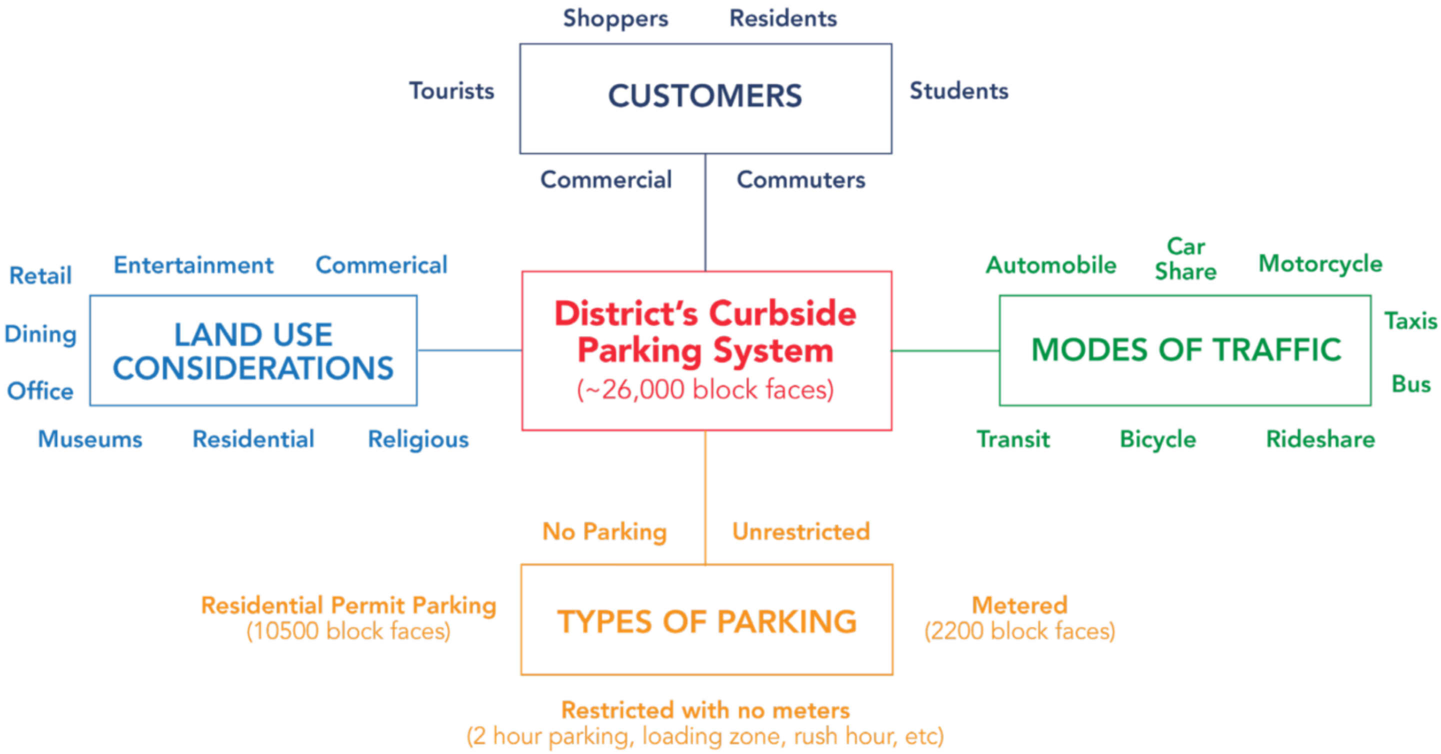
1.1.1 Pressures on the curbside

A city's curbside space is one of its most valuable resources. Proper management of this resource results in greater access, increasing the efficiency and functionality of the space for residents, visitors, and merchants alike. This in turn produces economic and quality of life benefits for everyone.

The District's on-street parking ecosystem is made up of a diverse range of customers in cars, on buses, and in commercial vehicles. The growth of new transportation options like rideshare services provided by Uber, Lyft, and Via is simultaneously expanding access to District neighborhoods and increasing demand for already limited curbside space, as shown in Figure 1-2. Often, these competing demands outstrip the amount of available space, requiring proactive management.

Competing demands need to be balanced by analyzing tradeoffs and looking closely at the local context. A solution that works in the downtown core may not be appropriate for a neighborhood center or low-density residential area.

Figure 1-2. Competing demands for limited curbside space



1.1.2 District Parking Assets

The District Department of Transportation (DDOT) manages approximately 1,375 miles of public curbside.[4] At the outset of the project in 2015, the public curbside was allocated to a range of uses, including:

- 100,000 residential permit parking spaces
- 19,000 metered parking spaces
- 1,000 reserved residential on-street Americans with Disabilities Act (ADA) parking spaces[5]
- 600 commercial loading zones
- 460 diplomatic parking spaces
- 450 on-street spaces for hotel guest loading
- 400 valet parking curb spaces
- 200 on-street motorcycle spaces
- 200 tour bus parking locations (on- and off-street)
- 100 reserved mobile roadway vending spaces and 72 stationary roadway vending spaces
- 84 dedicated on-street carshare spaces
- 6 on-street electric vehicle charging spaces

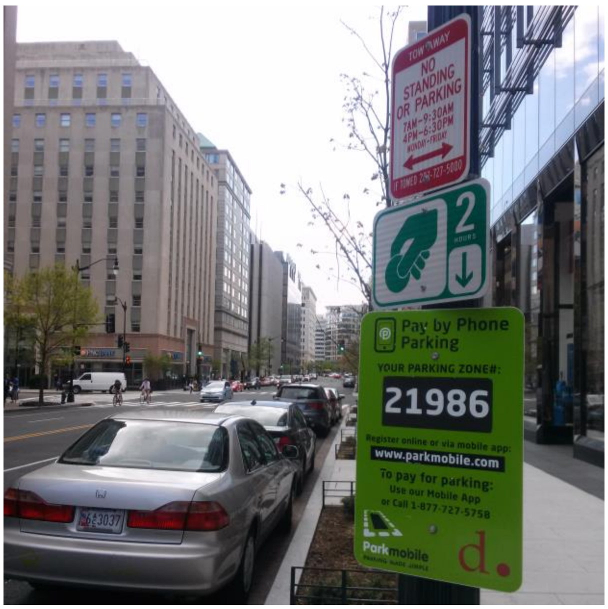
[4] Pérez, B. O. Delineating and Justifying Performance Parking Zones: Data-Driven Criterion Approach in Washington, D.C. Transportation Research Record: Journal of the Transportation Research Board, 2015. 2537: 148-157.

[5] 350 Red Top Meters that are reserved and accessible for the exclusive use of persons with disabilities were installed in the District's Central Business District in 2017.

Along with vehicle storage, the District's curbside accommodates over 3,500 bus stops, 13 Capital Bikeshare stations located in the curb lane, informal and evolving formal rideshare pick-up and drop-off locations, slug line (casual carpool) pickup sites, and the occasional pop-up park.

As of 2018, DDOT manages the District's 19,000 metered parking spaces with a mix of multi-space and single-space meters that are all network-integrated. DDOT offers customers three payment options at each parking meter – coin, credit/debit card, and pay by cell. The pay-by-cell program has been widely adopted by customers and accounts for over half of parking revenue; it is also the only way to pay for the use of on-street commercial loading zones.

1.2 MAKING THE CASE FOR PERFORMANCE PARKING



Cities and towns across the United States have increasingly identified demand-based pricing, or performance parking (henceforth referred to as demand-based pricing), as a useful tool for effectively managing public parking. Over many decades, the status quo of underpricing on-street parking has led to unintended consequences. Underpricing encourages motorists to cruise for parking when spaces are already occupied. It also encourages driving, disincentivizes use of off-street parking facilities, and discourages turnover at on-street spaces. Vehicles circling for parking or parking illegally contribute to increased congestion and safety concerns in vibrant downtown areas.

While US cities have long acknowledged that parking pricing should reflect demand, traditional, simplistic efforts to balance supply and demand have seen limited deployment. Jurisdictions may differentiate parking rates by neighborhood type, so that meters in central business districts are generally more expensive than in peripheral commercial districts. The District employed a similar pricing scheme in past years, charging $0.75 per hour outside the City's central core and $2 per hour within the core until June 2016. This approach can affect behavior in environments with relatively consistent demand and appropriately set prices, but homogenized pricing usually will not improve parking space utilization within a dynamic central business district.

Smart parking technologies and travel behavior data have transformed how cities approach curbside parking pricing.

Often, the role of local legislative bodies in setting parking prices limits the authority of local parking management entities to set prices based on demand. Jurisdictions that make the necessary legislative changes to set demand-based parking prices generally restrict the breadth of the price changes, in terms of prices and/or locations.

The advent of smart parking technologies and the growing availability of travel behavior data have transformed how cities approach curbside parking pricing. The transition to networked parking assets has enabled jurisdictions to use real-time transaction and citation data to inform operations and better understand demand. The growth of detection technologies ranging from in-ground sensors to mobile and fixed cameras has rapidly expanded the arsenal of available tools for gathering, analyzing, and fusing data from across the transportation system. Real-time monitoring and communication of occupancy information for curbside spaces enables travelers with smartphones to dynamically reroute to available spaces, reducing congestion and pollution caused by circling for parking. Smart parking technologies have also helped convince policy makers of the value associated with the legislative flexibility to set demand-based parking prices.

Pricing pilots in San Francisco, Los Angeles, Seattle, and Indianapolis have demonstrated how performance metrics from responsive data and technology can be successfully used to manage parking pricing and occupancy (Figure 1-3). As the District and other cities look to deploy or expand new smart parking initiatives, the experience from these cities has demonstrated that future pricing programs can afford to take a conservative, sustainable approach to price changes while still realizing the benefits of demand-based pricing.

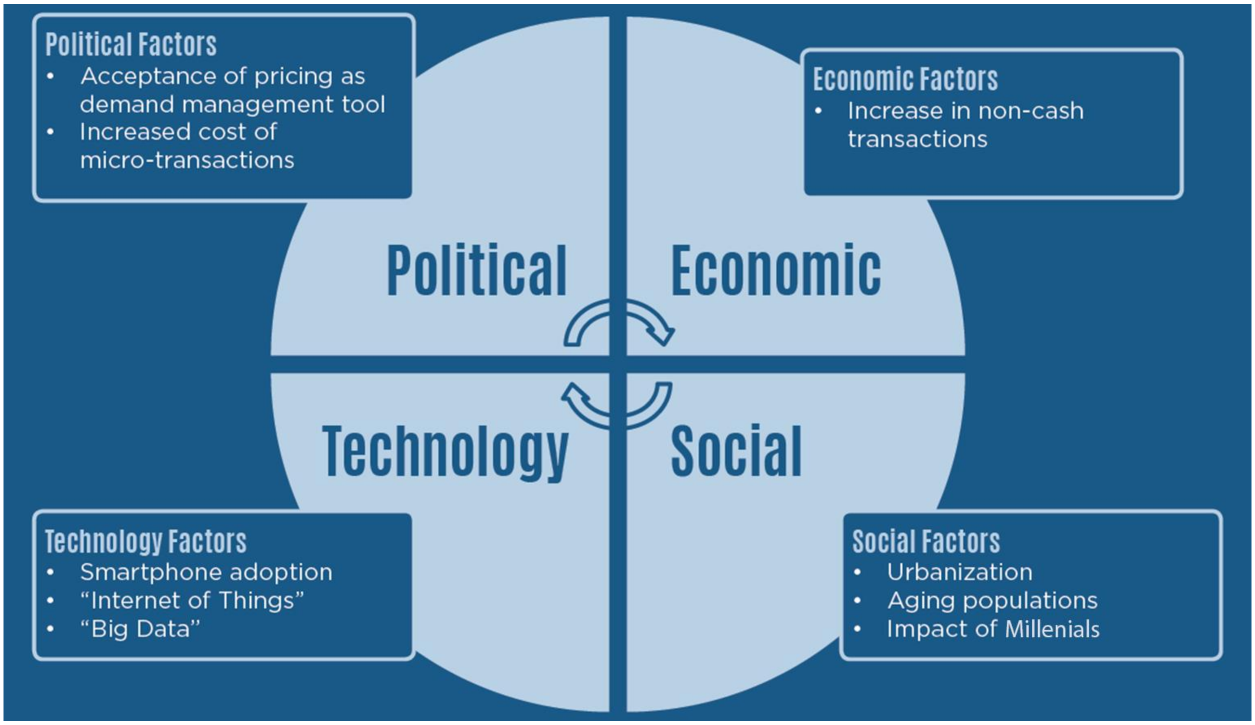
Figure 1-3. Notable demand-based pricing programs in the United States

In addition to technological advances, a range of political, economic and social factors have contributed to the rise of demand-based pricing. As evidenced by the increasing popularity of high occupancy toll (HOT) lanes and demand-based transit fare structures, policymakers nationwide have accepted pricing as a demand management tool (Figure 1-4).

Figure 1-5 outlines some of the political, economic, social and technological factors that have made smart parking increasingly viable.

Figure 1-4. Demand-based roadway pricing has been implemented in Virginia in the form of high occupancy toll (HOT) lanes

Figure 1-5. Political, economic, social and technological factors have all contributed to the adoption of demand-based pricing



1.2.1 The District responds to curbside challenges

DDOT investigated demand-based pricing as a mechanism for addressing curbside challenges well before the technological advances that enabled San Francisco and other major US cities to implement their current programs. In 2008, the Council of the District of Columbia enacted vital legislation providing DDOT with greater flexibility to set and adjust meter rates and related enforcement days and hours, adjust parking fines, and establish zone-specific parking management targets in defined zones.

While the District was in the legislative vanguard of demand-based pricing, the technology needed to catch up. The District's 12-year transition to network-integrated parking meters between 2005 and 2017 enabled DDOT to estimate parking occupancy using payment transactions as a proxy. However, early payment data was not granular enough to distinguish meter usage patterns by block or meter. DDOT's successful application for federal funding from the Federal Highway Administration's (FHWA) Value Pricing Pilot Program made it possible to test new technologies and approaches for effectively measuring parking occupancy. The Program supports a variety of strategies to manage congestion, including tolling highway facilities through congestion pricing, mileage-based car insurance, and parking pricing. DDOT's grant application proposed to implement demand-based pricing to manage metered curbside spaces in the District's congested downtown business district and tourist areas. DDOT applied the FHWA funding to a next generation application of demand-based parking pricing: the parkDC: Penn Quarter/Chinatown Parking Pricing Pilot (parkDC Pilot).

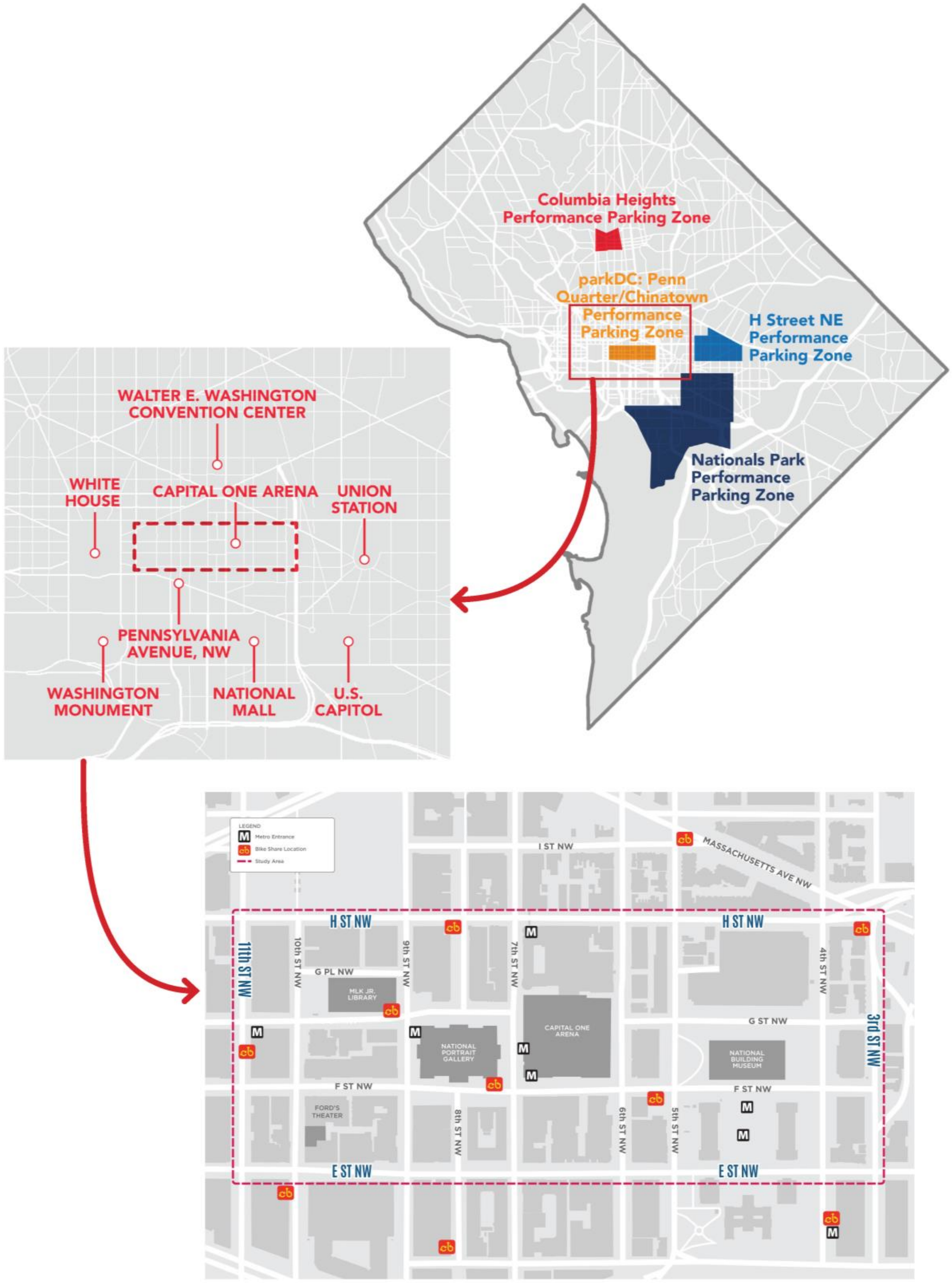
Through the parkDC Pilot, DDOT aimed to advance the state-of the practice for parking performance pricing in two ways:

- **Multimodal Focus**. Applying pricing principles to loading zones in addition to passenger vehicles
- **Asset Lite Approach**. Developing the program at a significantly lower price point than current state-of-the-practice.

1.3 TAKING THE NEXT STEP: THE PARKDC: PENN QUARTER/CHINATOWN PRICING PILOT

After obtaining the FHWA grant, DDOT refined and implemented its demand-based pricing program. When developing the grant application for the pilot program in 2012, DDOT used predictive geography to select a diverse, congested, and vibrant pilot area with competing modes and land uses. The area chosen falls within the Penn Quarter and Chinatown neighborhoods (Figure 1-6).

Figure 1-6. The Penn Quarter/Chinatown Pilot Area



The pilot area is in the heart of the District between the National Mall to the south, the White House to the west, the Convention Center to the north and Union Station to the east. Located within the Penn Quarter and Chinatown neighborhoods, it comprises three subareas, defined by the major Metro Stations serving them: Metro Center, Gallery Place/Chinatown, and Judiciary Square (Figure 1-7).

- The Metro Center subarea to the west encompasses commercial office space with ground level retail and a tourist hub featuring Ford's Theatre, numerous souvenir shops, and major tour bus stops. The central library is also located in this subarea.
- The Gallery Place/Chinatown subarea is an entertainment destination centered on 7th Street NW with bars, restaurants, nightlife, and the Capital One Arena. This subarea also overlaps the historic Chinatown neighborhood, with the famous Friendship Archway and an exclusive pedestrian phase (pedestrian scramble) at the intersection of 7th Street and H Street NW. The National Portrait Gallery draws additional visitors to this subarea.
- The Judiciary Square subarea to the east is home to various federal and municipal courthouses and large federal office buildings. This subarea also has residential buildings, the National Building Museum, and a connection to I-395 just outside the pilot area.

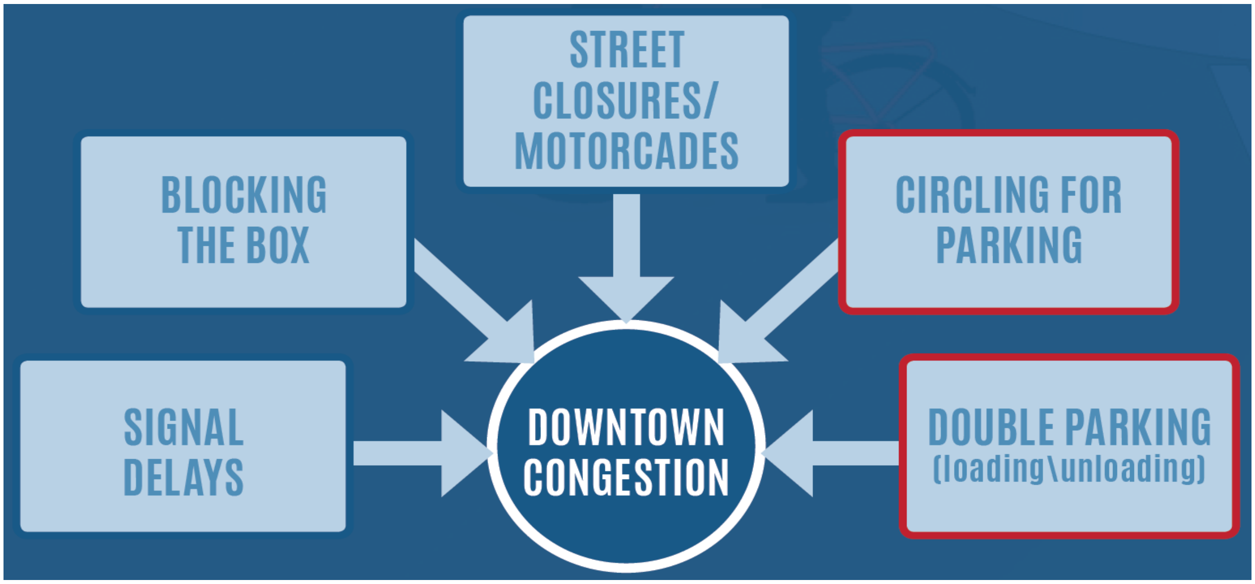
Figure 1-7. Pilot Area Subareas: Metro Center (west, mixed-use commercial), Gallery Place/Chinatown (central, mixed-use entertainment) and Judiciary Square (east, institutional)

The multimodal pilot area comprises 120 block faces and serves an array of residents and visitors. The pilot area is home to approximately 5,000 residents, 1,000 businesses and 23,000 employees. Many of the 21.3 million annual visitors to the District visit the pilot area to explore museums, attend sporting events, or enjoy a meal. The pilot area's transportation system supports this high demand by providing access to diverse transportation modes including:

Mode	Served by...
Personal Vehicles	A robust, gridded roadway network, 1,000 metered parking spaces, two reserved on-street car sharing spaces, and access to freeways and major arterials
Commercial Vehicles	30 on-street loading zones and 10 tour bus stops
Transit Vehicles	Three major metro stations and 38 bus stops
Bicycles	Six Capital Bikeshare stations and bicycle lanes on several streets crossing the study area
Pedestrians	A robust, gridded sidewalk network and active streetscape

The diverse land uses and multimodal character of the pilot area make it an ideal "sandbox" for testing a range of parking practices and innovations to rebalance parking supply and demand. Limited on-street parking that is underpriced compared to area parking garages and frequent motorist interactions with buses, pedestrians, and cyclists all contribute to the pilot area's parking puzzle. The diverse land uses within the area are an ongoing draw for residents and visitors, some of whom will continue to drive to the area despite limited parking supply. When demand for on-street parking outweighs supply, motorists inevitably end up circling the block to find a space and some resort to double parking. These behaviors contribute to downtown congestion and its associated ills, including safety concerns, air pollution, and economic inefficiency (Figure 1-8).

Figure 1-8. Factors contributing factors to downtown congestion



DDOT's initial site visits to the pilot area confirmed that circling for parking and double parking contribute to congestion in this already busy area. Film footage collected from automobiles and bicyclists showed how high demand for on-street parking can lead to double parked or illegally parked automobiles, commercial vehicles, and tour buses; unsafe conditions in on-street bicycle lanes; and aggressive vehicle maneuvers. While demand-based pricing cannot address every element contributing to downtown congestion, it can help to alleviate double parking and cruising for parking.

1.3.1 Setting our sights: project goals

DDOT's primary goal for the Penn Quarter/Chinatown Pricing Pilot was to improve the parking experience for customers by rebalancing parking supply and demand in the pilot area. DDOT aimed to meet this goal by using a mix of widely accepted parking practices, such as smart meters and alternative payment options, and cutting-edge techniques like real-time parking availability information and demand-based pricing (Figure 1-9). DDOT was able to pursue this goal because of the authority granted by the District Council to set and modify on-street parking prices (further described in Chapter 2).

Figure 1-9. The Smart Parking Spectrum

Widely Accepted →			Cutting Edge
Smart Meters	Alternative Payment Options (pay-with-mobile devices)	Demand-Based Pricing	Real-time parking availability information

At the beginning of the pilot, DDOT developed a concept of operations plan to further outline the goals and objectives for the project (Figure 1-10), along with management and technical approaches required to achieve each goal.

Figure 1-10. DDOT Penn Quarter/Chinatown Pricing Pilot goals & objectives

Reduce time to find an available parking space

- Increase parking availability
- Provide parking availability information to customers in real time
- Improve parking regulatory signage

Reduce congestion and pollution, improve safety, and encourage use of other modes

- Reduce double parking
- Reduce circling for parking
- Encourage travel by other modes
- Improve operations of commercial loading zones

Develop parking management solutions through a cost-effective asset-lite approach

- Test different parking occupancy detection solutions
- Explore effectiveness of fusing parking data from various sources to provide accurate real-time availability information and inform pricing algorithms with fewer deployed assets

To meet these goals, parkDC sought to develop a system that uses an asset-lite approach and benefits all transportation modes. These two elements are described in the subsequent section.

1.4 WHAT MAKES PARKDC UNIQUE?

Municipalities like the cities of San Francisco and Indianapolis have successfully used occupancy detection to make demand-based price adjustments and provide real-time information to customers about parking availability and related topics. While the state of the practice for occupancy detection involves using assets such as sensors and cameras for every parking space, the parkDC Pilot tested a unique, new approach at a fraction of the cost. The pilot also tested the application of demand-based pricing principles other curbside uses such as loading zones. With this multimodal, asset-lite approach, DDOT aims to develop a sustainable, cost-efficient model for occupancy detection.

1.4.1 The asset-lite approach and multimodal

DDOT's goal of cost-effectively estimating real-time parking occupancy precluded the typical practice of providing full sensor or camera coverage in the pilot area. Because the expense of installing and maintaining full sensor coverage outweighs the benefits offered by better pricing policies (Table 1-1), DDOT sought on an optimal mix of assets and coverage to develop a sustainable solution and leverage existing data and assets.

Table 1-1. Approximate year 2014 cost to implement the parkDC pilot using full sensor coverage[6]

	Cameras	Sensors
Example Capital Cost	$2.5 Million	$4.5 Million
Example Annual Operation Cost	$1 Million	$2 Million

DDOT's asset-lite approach develops reliable occupancy data using information from all parts of the parking ecosystem, including networked meters, enforcement data, and pay-by-cell transactions. Combined with a mix of periodic occupancy data collected from portable and fixed closed circuit television (CCTV) cameras and permanent occupancy data collected from strategically placed in-ground sensors, these data allow DDOT to generate accurate parking occupancy information using less equipment (Figure 1-11). The success of the process depended not only on the physical assets associated with DDOT's unique approach, but on the cooperation of other District agencies and partners for the installation, operation, and maintenance of the system.

Effectively implemented, the asset-lite approach provides a minimum viable product that allows DDOT and other jurisdictions to measure real-time occupancy, share real-time information with the public, and inform a pricing engine for parking spaces. Detailed information on DDOT's approach to developing, testing, and implementing its asset-lite approach can be found in Section 3.1.

[6] Soumya Dey PE, P. M. P. (2014). "Asset Lite" Payment Options and Occupancy Detection for Metered Curbside Parking. Institute of Transportation Engineers. ITE Journal, 84(6), 29.

1.4.2 Benefiting all transportation modes

The District's dynamic, multifaceted transportation system warranted project goals that address parking experiences for multimodal users (Figure 1-12). Goals and objectives for the pilot considered infrastructure for commercial vehicles, transit (bus and heavy rail), motorcoaches, bicycles, and pedestrians.

Figure 1-11. parkDC System Overview

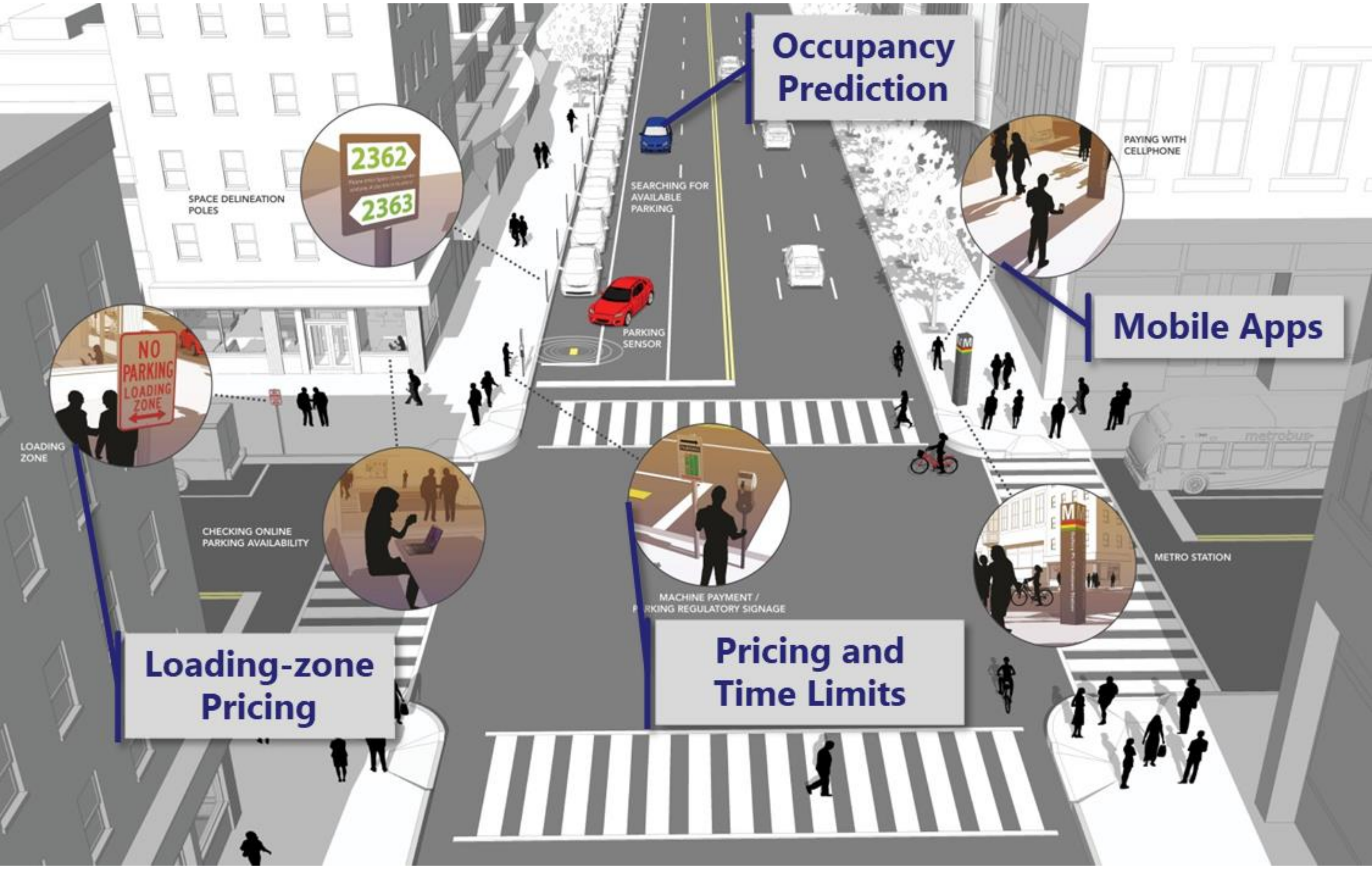
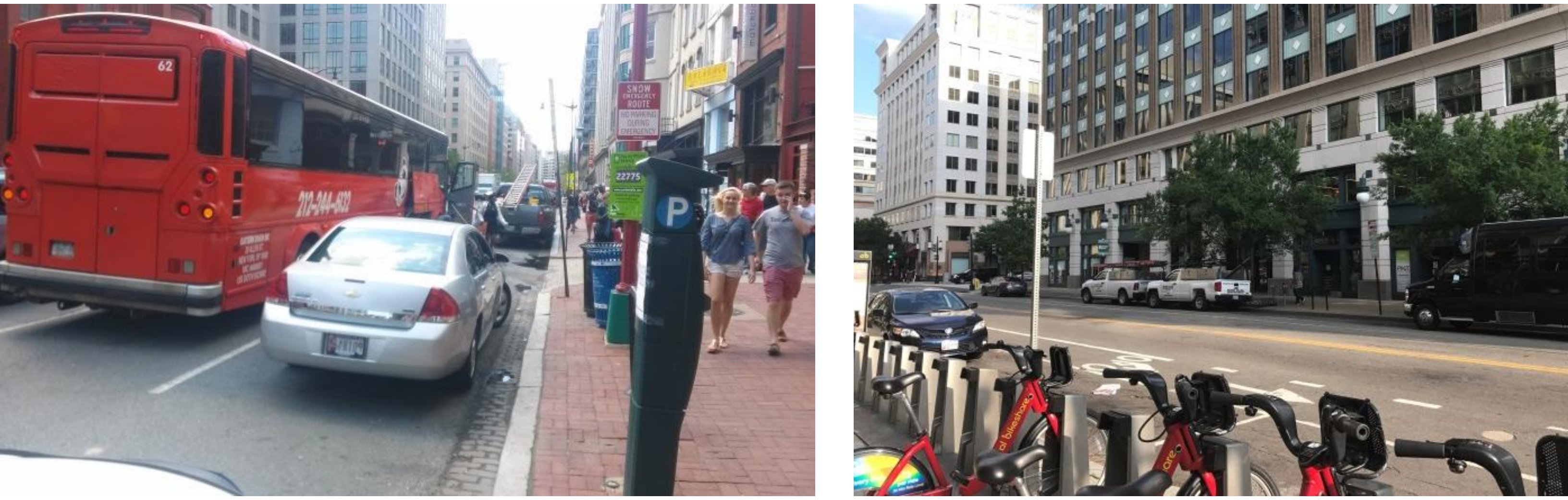


Figure 1-12. Multimodal Users in the Pilot Area



The strategies for benefiting multimodal users of the Penn Quarter and Chinatown transportation system were intertwined with those for balancing curbside parking demand and supply. An increase in on-street parking availability would reduce unsanctioned use of loading zones, bus zones, motorcoach parking, or bike lanes for parking or stopping by private vehicles. The availability of public roadway and curbside space for all multimodal users would further reduce disruptions to traffic flow by allowing multimodal users to efficiently access their designated spaces without blocking motorized travel lanes.

In addition to supporting multimodal travel by reducing double parking and circling for parking, DDOT sought to encourage higher transit use, particularly during high demand periods, through the provision of better information about parking availability. DDOT also endeavored to increase loading zone availability through demand-based pricing. DDOT aimed to more effectively balance the supply and demand of parking by acknowledging and seeking to influence these multimodal aspects of the parking ecosystem.

1.5 FROM LEGISLATION TO PILOT: THE PROJECT TIMELINE

The District Council approved the legislation that permitted the parkDC: Penn Quarter/Chinatown Pilot in October 2012. The FHWA grant funding that enabled the pilot was awarded to DDOT in August 2012, and DDOT officially kicked off the project in late 2014. The pilot project lasted four years and encompassed a pre-pilot phase and five price changes. DDOT developed a project management plan, concept of operations plan, system requirements plan, communication plan, and data collection plan during the pre-pilot phase to ensure that the pilot progressed on schedule and met all goals and objectives. **Error! Reference source not found.** outlines the project timeline for the parkDC Pilot, along with major District events that likely impacted pilot results.

Table 1-2. Pilot Timeline (2014 – 2017)

Time Period	Pilot Activities	Districtwide Events
Q3 2014	▪ Project kickoff	
Q1 2015	▪ Prepared project management documentation ▪ Developed new signage	
Q2 & Q3 2015	▪ Used portable and fixed CCTV cameras to collect baseline data and inform asset-lite sensor deployment ▪ Tested in-ground sensors ▪ Transitioned to pay-by-space to collect accurate occupancy information from payment data	
Q4 2015	▪ Collected data and performed baseline conditions assessment	
Q1 2016	▪ Installed parking occupancy sensor equipment throughout pilot area	
Q2 2016	▪ Developed and tested pricing algorithm	▪ WMATA SafeTrack Program: segments of MetroRail lines were shut down or continuously single tracked for extended periods
Q3 2016	▪ Installed new signage ▪ Implemented first (round 1) demand-based price change (October) ▪ Provided real-time parking availability information through parkDC and VoicePark mobile applications	▪ WMATA SafeTrack Program continued
Q4 2016		▪ WMATA SafeTrack Program continued
Q1 & Q2 2017	▪ Round 2 price change (February) ▪ Round 3 price change (May)	▪ Presidential Inauguration (January) ▪ Implementation of Red Top Meter Program in District's Central Business District, reserving and pricing accessible on-street spaces for people with disabilities
Q3 2017	▪ Round 4 price change (August) ▪ Tested time limit adjustments (September) ▪ Implemented first loading zone price change (September) ▪ Performed after conditions assessment	
Q4 2017	▪ Round 5 price change (November) ▪ Completed comprehensive impact assessment	
2018	▪ Synthesized results of comprehensive impact assessment in pilot report, executive summary and data book ▪ Transitioned pilot to regular operations	

1.6 EVALUATING THE PILOT

DDOT used data gathered before, during, and after the parkDC: Penn Quarter/Chinatown Pilot to evaluate how effectively it met its stated goals and objectives. Data sources for the pilot covered multiple modes and ranged in granularity from location-specific, quantitative data points to area-wide, qualitative feedback. The data informed the before- and after-conditions evaluations detailed in Chapter 5. In addition to reporting on the success of the pilot in meeting its goals and objectives, DDOT used the data to evaluate the sustainability and replicability of the pilot beyond the Penn Quarter and Chinatown neighborhoods. **Error! Reference source not found.** outlines the pilot's different metrics of success and associated data sources.

Table 1-3. Pilot evaluation metrics and data

Pilot Goal	Pilot Metrics	Data Source	Sample Data Sets
Reduce time to find an available parking space	Increased parking availability; increased use of low-demand parking spaces, decreased use of high-demand parking spaces	Parking sensors	Sensor "heartbeat" (parking session start/stop) data, uptime data, cost data, installation anecdotes
		Portable and fixed cameras	Parking session start/stop data
		Parking payment data (meters, pay by cell)	Payment session time, type and amount
	Increased clarity of regulatory signage	Customer surveys	Qualitative feedback collected through surveys distributed on meter receipts and DDOT social media accounts
	Increased dissemination of parking availability information	Mobile applications	Users, sessions, app crashes, average sessions per user, user devices, system performance statistics
Reduce congestion and pollution, improve safety, and encourage use of other modes	Reduced double parking	Parking citations	Citation type, location, and time
		Manual surveys	Surveys of double parking
		Portable and fixed cameras	Observations of double parking in loading zones
	Reduced circling for parking	Pole-mounted Bluetooth sensors	Cruising characteristics data collected via 59 Bluetooth sensors
		Manual surveys	Surveys of parking search time
		Probe vehicle archive	Congestion (travel time index) and reliability (planning time index) data from INRIX
	Encourage travel by other modes	Public transit operations (rail and bus)	Transit speed and ridership data from WMATA
		Bicycle	Bikeshare ridership data from Capital Bikeshare
		Census	Automobile ownership, single-occupant-vehicle (SOV) drivers, transit users, and bikers/walkers
	Improve operations of commercial loading zones	Portable and fixed cameras	Observations of activity in loading zones

Pilot Goal	Pilot Metrics	Data Source	Sample Data Sets
Develop parking management solutions through a cost-effective asset-lite approach	Test different parking occupancy detection solutions	Parking sensors	Sensor "heartbeat" (parking session start/stop) data, uptime data, cost data, installation anecdotes
		Portable and fixed cameras	Parking session data, installation anecdotes
	Explore effectiveness of fusing data from various sources to provide accurate real-time availability information and inform pricing algorithms with fewer assets in the field	Parking sensors	Sensor "heartbeat" (parking session start/stop) data, uptime data, cost data, installation anecdotes
		Asset-lite system outputs	System performance statistics (accuracy of occupancy data reported by asset-lite system)
		Parking payment data (meters, pay by cell)	Payment session time, type and amount

1.7 DOCUMENT ROADMAP

This report is divided into six chapters and an executive summary. This chapter—chapter 1—provides an overview of the project and background information on how and why DDOT sought to implement the parkDC pilot. Chapter 2 provides a summary of the planning and policy needed to enact the project, and chapter 3 describes how DDOT implemented the project. DDOT's efforts to coordinate with stakeholders and customers is presented in chapter 4. The impacts and results from the study are shown in chapter 5, with the conclusions, lessons learned, and next steps provided in chapter 6.