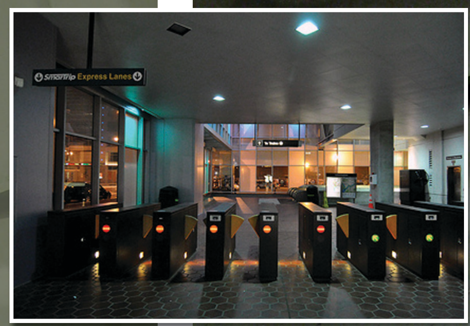
Metrorail Station Access Alternatives Study



Final Report

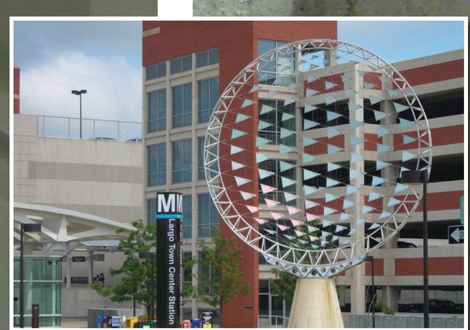
Submitted to:

National Capital Region Transportation Planning Board

Submitted by:

PARSONS BRINCKERHOFF

FOURSQUARE INTEGRATED TRANSPORTATION PLANNING



July, 2012

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Prepared by:

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Executive Summary

Metrorail ridership is projected to continue to grow over the next two decades, reaching nearly a million daily rail riders by 2040. A key aspect of accommodating this growth will be simply getting the passengers to the stations and onto the trains. In an atmosphere of competing priorities, state-of-good-repair investments will receive the bulk of funding, making the estimated 30,000 spaces required if the current Park & Ride arrival mode of 30% remains constant all the more difficult to fund. In addition, WMATA has a strategic objective in using its station areas for transit-oriented development, rather than for additional parking resources.

Study Methodology

The Metrorail Station Access Alternatives Study seeks to evaluate strategies for maximizing passenger access at Metrorail stations that have existing parking facilities by evaluating the costs and benefits of several possible scenarios of future station access. To do so, five case study stations have been chosen. Each of these case-study stations represent one of the types identified in Metro's 2010 Bicycle and Pedestrian Access Improvements Study.   By measuring the actual costs and benefits of additional riders by each access mode, WMATA can form a future access strategy that prioritizes improvements that provide the most 'bang for the buck' in terms of increased station access and enhanced livability for the region and for the immediate station environs.

The five case study stations are:

- **Fort Totten**
- **Vienna-Fairfax/GMU**
- **Naylor Road**
- **Huntington**
- **Shady Grove**

Access during the AM Peak period has been selected as the focus of this analysis as it is the time when the availability of parking resources are a potential limiting factor on ridership. While overall access numbers in the PM Peak period may be symmetrical to the AM Peak, a much larger percentage of passengers access the system as pedestrians at stations in the region's core.

The Station Access Alternatives Study consisted of a peer review of like transit agencies with similar operating profiles to Metrorail, followed by the development of multiple station access scenarios for each of the five stations listed above. Sixteen preliminary scenarios were pared down to ten scenarios (two per station) to be included in the benefit-cost analysis (BCA). Scenarios were selected for the BCA based upon feasibility of concepts, input from stakeholders, and degree of contrast to other scenarios to be analyzed.

Peer Review Findings

The study team carefully selected several peer systems for this review that share some key general characteristics and specific station access challenges with WMATA, including geographic reach, overall system size, suburban stations with parking, and high projected ridership growth. The final list of peer agencies included:

- **Bay Area Rapid Transit (BART)** – San Francisco, California
- **Chicago Transit Authority (CTA)** – Chicago, Illinois
- **Metropolitan Atlanta Rapid Transit Authority (MARTA)** – Atlanta, Georgia
- **Massachusetts Bay Transit Authority (MBTA)** – Boston, Massachusetts
- **Metra** – Chicago, Illinois
- **Orange County Transit Authority (OCTA)** – Orange County, California (Suburban Los Angeles)
- **Sound Transit** – Seattle, Washington
- **TriMet** – Portland, Oregon

This peer review uncovered no truly cutting-edge station access strategies such as dynamic parking pricing, neighborhood ridesharing or non-fixed route demand response service, that have been implemented. The majority of WMATA's peers have a wide variety of station types ranging from urban, urban residential, to suburban residential; and the primary access modes and challenges consequently varies significantly as well. Many agencies are experiencing parking capacity issues at urban and suburban residential stations that they are addressing with parking management approaches, while only OCTA is increasing parking capacity in response to demand.

How each agency is meeting these access challenges or is planning to meet them varied significantly, but several recurring strategies and themes that rose to the top in terms of frequency of application, including:

- **Single Occupancy Vehicle (SOV) Access is the Lowest Priority in Most Cases.** Systems are generally looking to maximize access to their stations by non-motorized modes in general, and are not adding significant amounts of new parking (with the exception of OCTA).
- **Remote/Satellite Parking Lots Can Work.** Several peer systems have successfully implemented shared parking agreements or remote parking lots with dedicated feeder bus or shuttle service
- **Increased Facilities for Bicycle Access are Popular.** The peer review documented several bicycle parking initiatives being undertaken by agencies, including TriMet, MBTA, and Metra.
- **Few Systems Have Ridesharing Accommodations.** Only OCTA and Metra had accommodations targeted at carpoolers.
- **Feeder Bus Connections and Frequency are Critical to Attracting Riders.** The agencies interviewed have found that these connections must be far reaching (many routes), be frequent (short headways), and be convenient (dropping passengers at or very close to rail station entrances).
- **Targeted Reverse Commute Shuttles Are Feasible.** BART, Metra and OCTA have all implemented successful reverse commute shuttles with local partners that focus on improving station egress by improving connections between stations and user destinations.
- **Land Use Policies Are Often Seen as a Solution for Improving Station Access.** Many agencies are working cooperatively with local municipalities to increase density around their stations, including working with private developers and converting surface parking lots into TOD.

- **Bicycle and Pedestrian Access Improvements Extend Beyond the Station Site.** Sound Transit has found that missing bicycle and pedestrian linkages between its stations and the surrounding communities impede the growth of bicycle and pedestrian access mode shares.

Station Access Scenarios

The study team first collected a toolbox of strategies that could potentially be employed as part of station access scenarios for one or more of the case study stations (for details, see page 23). Multiple scenarios were then developed for each case study station by combining sets of these strategies that were felt to be mutually supportive. The ten scenarios that were evaluated through the BCA are summarized in Table 1. Not every strategy in the toolbox was included in each of the station scenarios.

Table 1: Component Strategies of the BCA Scenarios

Strategies	Fort Totten		Huntington		Naylor Road		Shady Grove		Vienna	
	F1	F2	H1	H3	N1	N3	S2	S4	V2	V3
Real-Time Parking Information	X	X	X	X	X	X	X	X	X	X
Shared Parking with Joint or Adjacent Development							X			
Preferred Carpool Spaces and Discounts	X	X	X	X	X	X	X	X		
Dynamic Pricing	X	X	X	X		X	X	X	X	
Add Satellite Parking			X			X				
Improved Connections from Satellite Parking			X			X				
Increased Frequency of Feeder Bus Service					X	X			X	
Neighborhood-Focused Bus Service	X			X	X	X		X	X	
Coordinate with Private Shuttles		X						X		
Redesign Kiss and Ride							X	X	X	
Convert Surface Lot to Structured Parking										X

The strategies focus on increasing the utilization of existing parking facilities and providing alternative modes of access. However, in order to provide analysis for a comprehensive list of options, constructing a new parking garage was included in scenario V3.

Benefits-Cost Analysis Findings

The following two common benefit-cost evaluation measures are included in the benefit-cost analysis, each tailored to compare benefits and costs from different perspectives.

Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.

Benefit Cost (B/C) Ratio: The evaluation also estimates the benefit-cost ratio; where the present value of incremental benefits divided by the present value of incremental costs yields the benefit-cost ratio. The B/C Ratio expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs.

The BCA shows that the anticipated quantifiable benefits from the WMATA Station Access Study projects exceed their anticipated costs. The two shady grove alternatives (S2 and S4) exhibit the highest B/C ratios, largely due to the long travel distances exhibited by Shady Grove passengers.

Table 2: Benefit-Cost Analysis Summary, All Alternatives

Alternative	B/C Ratio	Net Present Value (2011 $)
Fort Totten, F1	1.53	4,165,418
Fort Totten, F2	2.75	7,639,494
Huntington, H1	1.26	6,799,579
Huntington, H2	1.90	15,367,672
Naylor Road, N1	1.49	3,906,216
Naylor Road, N3	1.13	1,377,042
Shady Grove, S2	10.21	99,770,868
Shady Grove, S4	9.87	109,061,998
Vienna, V2	2.49	24,267,451
Vienna, V3	2.45	43,658,088

Recommendations

Possibilities for Pilot Programs

A key objective of this study is to identify specific recommendations and explain how these recommendations might be implemented. The benefit-cost analysis showed that the anticipated quantifiable benefits exceed the anticipated costs for each scenario. Implementation of the strategies would initially take place via a pilot program model, where strategies would be implemented in a systematic and gradual manner and subsequently evaluated. Implementing strategies via pilot programs will allow WMATA to better understand the impact of individual strategies in shifting modes of access to WMATA stations, and thus further invest in the most effective toolbox strategies. Some strategies that are already in use at certain stations may still be considered for pilot programs if they could be implemented on a broader scale (e.g. real-time parking information) or in a more comprehensive manner (e.g. improving pedestrian links). Table 32 delineates the toolbox strategies by those that could work at individual stations.

Table 3: Potential for Pilot Strategies

Strategies	Already in Use	Potential Pilot Program
Real-Time Parking Information	■	■[1]
Parking Districts		■
Shared Satellite Parking		■
Shared Parking with Joint or Adjacent Development		■
Dynamic Ridesharing		■[2]
Preferred Carpool Spaces and Discounts		■
Dynamic Pricing		■
Enhanced Real-Time Parking Information[3]	■	
Add Satellite Parking	■	
Improved Connections from Satellite Parking		■
Increased Frequency of Feeder Bus Service	■	
Neighborhood-Focused Bus Service	■	■
Shuttle Management		■
Improve Pedestrian Links	■	■
Kiss & Ride Redesign	■	

The study team selected seven strategies for additional study as potential pilot programs or policies: 1.) Real-Time Parking Information, 2.) Shared Satellite Parking, 3.) Shared Parking with Joint or Adjacent Development, 4.) Neighborhood-Focused Bus Service, 5.) Shuttle Management, 6.) Preferred Carpool Spaces and Discounts, and 7.) Dynamic Ridesharing. Though some elements of the strategies have a longer-term focus, such as the use of specialized technology in enforcing carpooling rules, each pilot program could be implemented in the near-term.

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[1] Real-time parking information has been implemented for the metered parking spaces at Ft. Totten Station, yet could still be considered a pilot program if implemented for <u>all spaces</u> at a station.

[2] Scale of pilot program would be greater than a single station.

[3] "Enhanced Real-time Parking Information" refers to a system that not only informs potential users of the number of available spaces, but also guides users to the spaces which are open. Examples of such systems in practice can primarily be found at airport parking facilities, including within the region at Dulles International Airport and BWI Thurgood Marshall Airport.

Recommendations by Station Type

Another key objective of this study is to identify those strategies most suitable to each of the five station types. While each station in the Metrorail system possesses unique characteristics, they do share certain common characteristics, and thus are likely to benefit from the same approaches by and large.

Urban Residential Area with a Bus/Automobile Orientation

The Urban Residential Area with a Bus/Automobile Orientation station type is the most urban of the station types that include Park & Ride lots. This type of station consists of predominately single-use development with lower to moderate densities in an urban context, typically with vehicle orientation and lower shares of bicycle and pedestrian utilization. In this report, the case study station was the Fort Totten station.

Table 4: Potential Strategies for Urban Residential Area with Bus/Automobile Orientation Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Pedestrian Links	■		
Real-Time Parking Information	■		
Preferred Carpool Spaces and Discounts		■	
Neighborhood-Focused Bus Service		■	
Coordinate with Private Shuttles		■	

Mixed Use in a Pod Layout

The Mixed Use in a Pod Layout station type is characterized by surrounding pods of single-use activity with little connection between them or the station. These stations are typically auto-oriented, with significant parking lots and difficult street crossings for cyclists and pedestrians. In this report, the case study station was Vienna-Fairfax, which is currently experiencing redevelopment adjacent to the station.

Table 5: Potential Strategies for Mixed Use in a Pod Layout Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Increased Frequency of Feeder Bus Service	■		
Real-Time Parking Information		■	
Neighborhood-Focused Bus Service		■	
Kiss & Ride Redesign			■

The strategies recommended for Mixed Use in a Pod Layout stations aim to capitalize on the nodes of development close to these stations. In many of these stations, there is significant residential or commercial density near the station. In addition, many of these stations do have strong bus service already.

Long-Term Potential for High Density TOD or PUD

The Long-Term Potential for High Density Transit Orientated Development (TOD) or Planned Unit Development (PUD) station types are generally surrounded by underutilized property, but these stations have the potential to change significantly in the future. Today, these stations are typically auto-oriented, with large surface parking lots and proximity to major arterials. The station of this type studied in this report was Naylor Road.

Table 6: Potential Strategies for Long-Term Potential for High Density TOD or PUD Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Shared Parking with Feeder Bus Service	■		
Increased Frequency of Feeder Bus Service	■		
Preferred Carpool Spaces and Discounts		■	
Real-Time Parking Information		■	
Neighborhood-Focused Bus Service			■

Long-Term Potential for High Density TOD or PUD stations can benefit from short-term improvements in feeder bus service. These stations typically have strong bus access shares already, so targeted improvements to bus service can help grow those numbers.

Suburban Residential Area

Suburban Residential Area stations are characterized by low- to medium-density residential land use in the surrounding area. The stations themselves are typically auto-oriented, sited near major arterials, with large amounts of car parking. While some of these stations have shared-use paths proximate to the station, there is typically limited wayfinding and signage, with missing links in the bicycle and pedestrian infrastructure. In this report, Huntington was the case study station examined for the Suburban Residential Area typology.

Table 7: Potential Strategies for Suburban Residential Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Satellite Parking with Connector Service	■		
Preferred Carpool Spaces and Discounts	■		
Improve Bike and Pedestrian Links	■		
Neighborhood-Focused Bus Service		■	
Real-Time Parking Information			■
Dynamic Pricing			■

The strategies that are recommended for Suburban Residential stations aim to expand parking supply though more efficient use of existing parking resources and connecting other satellite parking lots to the station. Many of these stations are at or over parking capacity, so encouraging carpools through preferred spaces or discounts could make better use of the existing constrained parking spaces.

Auto Collector/Suburban Freeway

Auto Collector/Suburban Freeway stations are located in suburban areas, typically adjacent to interstates and major collectors. A single land use, typically low-density residential development, tends to dominate these areas under current conditions. However, these stations also have a great opportunity for High Density TOD or PUD in the future. The stations themselves are quite large and accommodate large numbers of parked cars, as they are typically at the end of a Metrorail line. The Auto Collector/Suburban Freeway station studied for this report was Shady Grove.

Table 8: Potential Strategies for Auto Collector/Suburban Freeway Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Coordinate Private Shuttles	■		
Preferred Carpool Spaces and Discounts	■		
Neighborhood-Focused Bus Service	■		
Shared Parking Facilities			■
Redesign Kiss & Ride			■

As Auto Collector/Suburban Freeway stations are the most auto-oriented typology, strategies to improve station access focus on making more efficient use of existing parking and encouraging bus and shuttle access.

Introduction and Background

Metrorail ridership is projected to continue to grow over the next two decades, reaching nearly a million daily rail riders by 2040. A key aspect of accommodating this growth will be simply getting the passengers to the stations and onto the trains, since passengers will not be able to access Metrorail in the same proportions they do today.   If the current market shares of access modes were to continue, WMATA would need an estimated 30,000 additional parking spaces. In an atmosphere of competing priorities, state-of-good-repair investments will receive the lion's share of funding, making the estimated 30,000 spaces required if the current arrival mode of 30% remains constant all the more difficult to fund. In addition, WMATA has a strategic objective in using its station areas for transit-oriented development, rather than for additional parking resources.

The Metrorail Station Access Alternatives Study seeks to evaluate strategies for maximizing passenger access at Metrorail stations that have existing parking facilities by evaluating the costs and benefits of several possible scenarios of future station access. To do so, five case study stations have been chosen. Each of these case-study stations represent one of the types identified in the 2010 Bicycle and Pedestrian Access Improvements Study.   By measuring the actual costs and benefits of additional riders by each access mode, WMATA can form a future access strategy that prioritizes improvements that provide the most 'bang for the buck' in terms of increased station access and enhanced livability for the region and for the immediate station environs. This study judges station access alternatives based on their weighted benefits to Metrorail riders and to the region, and will form the foundation of WMATA's future access strategies.

The study is solely focused on Metrorail passengers and the ways in which they access the Metrorail system during the AM Peak period (i.e. "access mode shares"). The AM Peak period has been selected as this is the time when the availability of parking resources are a limiting factor on ridership. While overall access numbers in the PM Peak period may be symmetrical to the AM Peak, a much larger percentage of passengers access the system as pedestrians, and parking resources are generally emptying out rather than filling up.

Literature Review of Previous Studies

Nationwide and agency-specific studies were identified to understand WMATA's challenges and policies in the context of its transit agency peers and national experience. The studies reviewed are summarized in Table 9.

Table 9: Document Review Matrix

Study/ Sponsoring Agency/Date	Summary of Access Management Findings and Strategies
Tri-Rail Parking Management Study/South Florida Regional Transportation Authority, August 2010	• The parking fee/ridership elasticity model found that the implementation of a parking fee would result in substantial decrease in Tri-Rail ridership and farebox revenue. As a result of this finding, the study concluded that implementing a parking fee would need to be deferred to the long-term. • The study identified two mid-term strategies to better manage capacity at its parking facilities, including: better parking enforcement to prevent non-riders from using Tri-Rail lots and preferred parking strategies for carpool/vanpools, low emission vehicles, and monthly users.
MacArthur BART Station Access Feasibility Study/ San Francisco Rapid Transit District (BART), May 2008	Four levels of access strategies were outlined in this study, from enforcing nothing beyond current policies, to policies that were groups as those that are more difficult or less cost-effective to implement). A number of strategies were selected as cost-effective and easy to implement to improve access management at the MacArthur BART station in the near-term. Strategies suggested as cost-effective and easy to implement range from hiring a TDM manager to implementing satellite parking.
Access BART/ San Francisco Bay Area Rapid Transit District (BART), December 2006	• This study identified five station types in the BART system (urban, urban with parking, balanced multimodal, auto reliant, auto dependent). • The study created a Direct Ridership Model (DRM) which estimates effects on ridership as a result of varying the land use and access characteristics. • Access BART found that for auto-reliant stations feeder bus and shuttles hold the potential to redistribute access mode shares as demonstrated by the DRM results – particularly when accompanied by office TOD. • Access BART found that for auto-dependent stations, access improvements are not effective in encouraging much mode share shift in the short term. For some of these stations, future development within the station area could strengthen the possibilities long-term mode share shifts.
Multi-modal Public Transportation Station Access Within and Near Highways and Expressways/TRB 2009 Annual Meeting	• Kiss & Ride facilities can optimize station access at auto-dominated stations by providing direct and convenient access for passengers/pedestrians. • Good transportation feeder services (which include bus and shuttle feeder and taxi services) are dependent both on system services (shuttle service, pricing, information systems) and physical design qualities at the station (for example: location of shuttle stop, visibility of waiting area.).
Sound Transit Parking Pricing Study / Sound Transit, June 2010	• Paid parking would be a tool to manage parking supply, generate revenue to fund station improvements, and encourage alternative access modes. • Parking pricing is just one element of successful parking management, and should be considered alongside improved transit options, improved station amenities, enhanced user information, and improved enforcement.
Rail Station Access: An Assessment of Options/ Australian Transport Research Forum 2010	The cost of land for parking is a huge expense, leading parking to be by far the most expensive access mode from the agency's point of view on a per rider basis. For feeder transit service, service frequency is the most significant predictor of feeder bus usage, but other important factors include competing auto travel time, parking cost and availability, and employer subsidies. Elements of successful bicycle parking facilities include shelter from weather, secure locking facilities or lockers, highly visible locations, and cost effectiveness. The quality of the walk is more important than the distance in determining pedestrian access. Urban design, pedestrian facilities, crime and safety perceptions, and demographics are the factors that influence a decision to walk.

Peer Review

The need to increase access to transit stations by all modes of transportation is a challenge not unique to WMATA. A number of large transit agencies across the nation have explored or are currently working toward optimizing their station access by a variety of means, including increasing designated ridesharing parking spaces, improving bicycle and pedestrian access infrastructure, revising parking policies, and seeking new efficiencies in feeder bus services. This study reviewed station access management studies and strategies currently in place at peer transit systems across the country to help identify a set of effective strategies appropriate for WMATA.

Peer systems with similar station access issues to WMATA as well as other systems that share some key general characteristics and specific station access challenges with WMATA, including geographic reach, overall system size, suburban stations with parking, and high projected ridership growth were selected for this study.

These agencies are:

- **Bay Area Rapid Transit (BART)** – San Francisco, California
- **Chicago Transit Authority (CTA)** – Chicago, Illinois
- **Metropolitan Atlanta Rapid Transit Authority (MARTA)** – Atlanta, Georgia
- **Massachusetts Bay Transit Authority (MBTA)** – Boston, Massachusetts
- **Metra** – Chicago, Illinois
- **Orange County Transit Authority (OCTA)** – Orange County, California (Suburban Los Angeles)
- **Sound Transit** – Seattle, Washington
- **TriMet** – Portland, Oregon

While every attempt was made to select agencies that are similar to WMATA, in many respects WMATA is at the forefront of station access and station area development issues. None of the peers interviewed currently experience or anticipate experiencing station access challenges at the same level magnitude as WMATA. WMATA's joint development program is also more advanced than many of its peers. WMATA also has a system profile that is qualitatively different from all of the peers interviewed. WMATA serves both dense urban areas, and more disbursed, lower density inner suburban centers across the District of Columbia, Maryland, and Virginia with heavy rail service. BART and MARTA are perhaps the most similar peers to the WMATA, but both of these systems carry far fewer riders (WMATA's weekday average rail ridership is 737,196 versus BART's 350,000 and MARTA's 259,000), and operate within a single state.

The project team conducted hour-long interviews with contacts at each of these peer agencies, and also reviewed other relevant documentation provided by the peer agencies, such as mode of access survey results and station typologies. Overall, most agencies reported facing similar forecasted ridership growth, as well as challenges in providing additional station access due to physical and financial barriers. Many agencies are actively seeking ways to shift mode share from single occupancy vehicles to bus, bicycle, and pedestrian while concurrently beginning to manage parking through pricing and/or other programs, such as shared, satellite, or carpool parking.

None of the systems interviewed are currently experiencing station access challenges on the scale that WMATA is ; most of the systems interviewed were experiencing station access issues at a handful of stations, if any, and have an excess of inexpensive or free parking available in their systems overall. Even so, several successful strategies for facilitating multimodal station access emerged from th is peer review. Additionally, all of the systems interviewed, with the exception of MBTA, utilize their own station typologies, but few of these systems found close relationships between WMATA's station types and their own.

Table 10 shows a qualitative summary assessment of how important each mode of access is to each peer agency plus WMATA, the level of investment the agency has made in the various modes, and the usage level of the access modes. "Significant" auto access is defined as more than 30% arriving by car to park at the station. Table 11 provides an overview of station access characteristics for each of the peer agencies.

Table 10: Cross-Agency Comparison

	Agency								
Topical Area	WMATA	BART	CTA	MARTA	MBTA	Metra	OCTA	Sound Transit	TriMet
Significance of Auto Access	High	High	Low	Medium	Low (T) High (CR)	High	High	High (CR) Low (LRT)	Low
Significance of Feeder Bus Service	Medium	Medium	Medium	Medium	High (T) None (CR)	Low	Low	Medium (CR)	Medium
Ridesharing Benefits or Initiatives	None	None	None	Low	None	Medium	Low	None	None
Bicycle and Pedestrian Facility Investments	High	Low	High	Medium	High (T) Low (CR)	Medium	Low	High (CR)	Medium
Bicycle and Pedestrian Facility Usage	High	Low	High	Medium	Medium (T) Low (CR)	Low	Low	Medium (CR)	High
Significance of Kiss and Ride, Taxi and Other Modes	Medium	Low	Low	Medium	Low (T) Low (CR)	Low	Low	Low (CR)	Low

None Low Medium High

(T) Applies to Heavy Rail only

(CR) Applies to Commuter Rail only

(LRT) Applies to Light Rail only

Table 11: Peer Agencies Station Access Characteristics

	WMATA	BART	CTA	MARTA	MBTA	Metra	OCTA	Sound Transit	TriMet
Service Type (Heavy Rail, Light Rail, Commuter Rail)	Heavy Rail	Heavy Rail	Heavy Rail	Heavy Rail	Heavy Rail and Light Rail (T) and Commuter Rail	Commuter Rail	Commuter Rail	Commuter Rail (primary) and Light Rail	Light Rail (primary) and Commuter Rail
Number of Stations	86	44	144 (17 Park & Ride)	38	146 (T) 133 (CR)	240	11	9 (Commuter Rail)	85 LRT
Service Area Geography and Land Use Type(s)	Four counties and several independent cities, as well as the District of Columbia (Metrorail system only). Urban downtown to suburban residential	Four counties, urban and suburban residential	High to medium density urban	Downtown urban core with pockets of TOD and suburban residential	High density urban (Heavy rail and LRT); Low to Medium density suburban (CR)	Low to medium density suburban	Nearly 800 square miles of primarily urban and suburban residential	Medium density suburban downtowns (CR); High density urban (LRT)	Nearly 500 square miles of primarily urban and suburban residential
Number of Stations with Parking	35 with park & ride + kiss & ride, 8 with metered only	33 of 44	17 of 144	23 (Daily Parking), 9 (Long-Term) of 38	19 T, 43 CR	Nearly all except the few terminal downtown stations	All	10 CR, 1 LRT station	23 of 85
Number of Parking Spaces	58,584 park & ride, 3,515 metered	46,442	6,642	26,000	40,396	88,000	No Data	5,982	9,600
Parking Fees	$3.25-$4.75	$1 at 90% of stations (up to $5 at others)	Varies by station, at 15 stations it is $4 for 12 to 24 hrs	Daily parking is free, $5 or $8 Long-Term	$5-$7 at T Stations, $4 at MBTA CR Lots	System average is $1.37	At 2 of 11 stations	No	No
Monthly or Reserved Parking Fee	$65 monthly in addition to daily parking fare	Yes, $30-$115.50	Available at 5 stations for $43 per month; Available at 2 stations for $80 per month	No	Available at some municipally-operated CR lots	Average is $350/year	No	No	No

	WMATA	BART	CTA	MARTA	MBTA	Metra	OCTA	Sound Transit	TriMet
Shared Use Parking Arrangements?	No	No	No	No	No	Yes	Yes	No	Yes
Feeder Bus Service Providers	Metrobus, Ride On, Fairfax Connector, ART, DASH, The Bus, plus regional commuter bus services	MUNI, AC Transit, several counties and local cities (28 total)	CTA, PACE	MARTA, Local County Transit Agencies	MBTA	PACE	OCTA fixed route service	Local County Transit Agencies	TriMet fixed route service
Bus Service Offered from Remote Lots?	Yes (primarily in Montgomery & Fairfax Counties)	NA	No	Yes	No data	Yes	Yes	Yes	NA
Kiss and Ride Facilities Available	Yes	No, typical turn around pick-up/drop-off	Yes, at peripheral stations, but they are not congested.	Yes, but available kiss and ride slots cannot meet demand at some stations	Yes, on "T" they are busy but not overly congested in the peak	Yes, some stations have kiss and ride, others limited term parking but they are not well used.	No, typical turn around pick-up/drop-off	Yes, anecdotally they've heard Kiss and Ride usage has increased in recent years	Yes, two stations (14 spaces total)
Bicycle Infrastructure Available (Type and Number)	2,000 bike racks & 635 lockers (each with space for two bikes)	974 bike lockers, some on-demand lockers, Bike Link system (on-demand bikes)	Sheltered bike parking at 90 stations, 2,400 bike parking spaces systemwide, bike racks on all CTA buses	Bicycle parking is available at many stations, and bicycles are allowed on MARTA trains at all times	On the "T" - Bicycle Cages at some stations (incl. Alewife), Bike Cage Smart Card, Hubway Bikeshare	Bike racks	Bike racks, lockers, and one bike station	Bike storage available at all stations, but not well utilized	Yes, 503 lockers, 803 rack spaces, cages, electronic bike locker pilot program
Designated Preferential Carpool or Vanpool Parking?	No	Yes, 1,068 carpool spaces	No	No	No	Yes, vanpool only	No	No	Yes, carpool/ vanpool at two stations

Agency Interview Summaries

Bay Area Rapid Transit (San Francisco, CA) – Heavy Rail

Bay Area Rapid Transit (BART) is a heavy-rail rapid transit system serving the San Francisco Bay Area in California. BART's primary station access modes vary substantially by station depending on surrounding land use, availability of parking and, because San Francisco is very hilly, the surrounding topography. Overall, 49% of users access stations by car (34% drive alone, 5% carpool, and 10% are dropped off), 31% walk, 15% use transit, and 4% bicycle. Most of BART's stations (33 out of 44) offer parking, and the system maintains a mix of surface and structured parking. Most stations charge $1 per day for parking, although a few stations with higher parking demand charge $2-$5 a day to park. BART also offers a reserved parking system at nearly all of its stations, with monthly fees ranging from $30 to $116 per month. BART has achieved recent increases in its bicycle and walk mode shares; between 1998 and 2008 the system realized a 5 percent increase in walk mode share and a 1 percent increase in bicycling mode share. Most BART stations have bicycle lockers (there are 974 systemwide), with on-demand, fully-enclosed, secure bike lockers available at several stations.

Chicago Transit Authority (Chicago, IL) – Heavy Rail

The Chicago Transit Authority (CTA) provides heavy rail and bus service throughout the City of Chicago and 40 inner suburban jurisdictions. CTA's service area includes dense urban centers, urban neighborhoods and some inner suburban neighborhoods. CTA does not have any access mode goals, but they do have a general, inexplicit goal of increasing bicycle and pedestrian trips to transit. There are few stations within the CTA system for which park and ride is the main mode of access. Overall system access by mode is 60% walk, 19% local bus, 8% commuter rail, 6% drive and 4% kiss and ride, 1.4% other and 0.5% bicycle. Out of CTA's 144 stations, 17 have park and ride lots, and most of these are the outer ends of the Blue Line or the Orange Line. Only one station currently operates at its parking capacity, the Midway Airport Station on the Orange Line. Parking rates vary by station: at 15 of the stations the parking fee is $4 for 12 *or* 24 hours; monthly reserved parking is available at 5 stations for $40 per month and at two other stations for $80 per month. Sheltered bicycle parking is available at 90 CTA stations, with 2,400 bicycle parking spaces available system wide. Bicycle parking tends to be fairly well utilized, depending on the station. The CTA is currently working on improving pedestrian access to stations, adding additional entrances to a number of "block long" stations.

Metra (Chicago, IL) – Commuter Rail

Metra, the Commuter Rail Division of the Chicago Regional Transportation Authority (RTA), operates service on 11 lines that extend between 30 and 60 miles in every direction from the City of Chicago. Metra's service area is much larger and more geographically dispersed than WMATA's, and it covers areas ranging from exurbs with very low population and development densities to the dense core of the City of Chicago. Auto is the primary mode of access to the majority of their stations (72% overall, of which 54% are SOV commuters, 4% carpoolers and 14% dropped off), as is consistent with the medium-to-low density land uses surrounding many Metra stations outside of their downtown Chicago terminal stations. There are stations that are experiencing constrained parking and auto access on some Metra lines. Metra has a total of 88,000 parking spaces, of which 90% are surface spaces. The municipalities own and operate most of the Metra parking facilities, and each municipality sets its own park and ride policies and fee structure. The average daily parking fee throughout the system is $1.37, but can be as high as $5. Parking prices vary significantly by Metra line. Metra's all-day access modes are 21% walk, 4% bus, 1% bike, 1% rapid transit, and 1% other Metra line. Metra offers discount passes for CTA bus and for PACE suburban bus, and has found that the traditional feeder routes that have been successful are the ones that serve stations with high parking demand and low parking supply. Metra provides bike racks at all of their new stations and is working to get them in place at all of their existing stations.

While feeder bus has a very low access mode share for Metra system wide, the agency does support feeder bus services in a number of ways. To succeed in the Chicago region feeder bus must operate in an area with a relatively stressed parking situation to attract riders. The traditional feeder routes that have been successful are the ones that serve stations with high parking demand and low parking supply, as well as provide a well-designed service. At the Naperville Downtown station, Metra has coordinated with suburban bus provider PACE to provide more robust feeder bus service and to ensure that the service design is targeted and meeting the needs of patrons that are taking that service. Riders are willing to use feeder bus if it meets their needs.

Massachusetts Bay Transit Authority (Boston, MA) - Heavy Rail, Light Rail and Commuter Rail

The Massachusetts Bay Transportation Authority (MBTA) operates a heavy rail (Orange, Red and Blue Lines), a light rail (Green Line and Red-Mattapan High Speed Line), and bus rapid transit (Silver Line) system known as the "T" in Boston and its surrounding inner suburbs, as well as an extensive commuter rail service that extends out of Boston to suburbs to the north, to the south as far as Rhode Island, and into Central Massachusetts to the west. Most of the stations in the MBTA system are urban, and the dominant mode of access is by foot. Overall mode of access shares for the T (Excluding Silver Line BRT) are walk: 61%, drive/park: 11%, drop-off: 4%, taxi: 0.1%, shuttle/van: 1%, bicycle: 1%, other: 0.2%, MBTA bus: 15%, other bus: 1%, commuter rail: 6%, boat: 0.2%, other transit: 0.1%. The terminal stations and some other end of the line stations have parking, but these parking garages have differing rates of usage. Only one rapid transit station (Alewife, one of the terminal stations on the Red Line) is at capacity for parking. The Alewife parking garage is usually full by 7:30 a.m. The T raised parking prices in 2009, and they now charge $5 to $7 at their stations. In contrast with the urban stations, most MBTA commuter rail stations experience very high rates of parking usage. Overall modes of access for MBTA Commuter Rail are walk: 27%, drive/park: 53%, drop-off: 12%, taxi: 0.3%, shuttle/van: 0.4%, bicycle: 1%, other: 0.1%, MBTA bus: 1%, other bus: 1%, rapid transit: 4%. Some commuter rail parking facilities are owned and operated by MBTA, but most are owned and operated by the jurisdiction that the station is located in, and charge $4 per day. Most of the commuter rail stations that have the highest parking usage rates are located in smaller municipalities removed from the immediate Boston suburbs.

Metropolitan Atlanta Rapid Transit Authority (Atlanta, GA) – Heavy Rail

The Metropolitan Atlanta Rapid Transit Authority (MARTA) operates a 48-mile heavy rail system in the Atlanta Region serving DeKalb and Fulton Counties and the Hartsfield-Jackson Atlanta International Airport in Clayton County. The MARTA rail system has 38 stations with four major branches of service that in some places share track. The primary mode of access to MARTA stations overall is walking (70%), but stations outside of the urban core are typically accessed by the automobile. Other mode of access shares for the system are: 13% drive alone, 1% carpool/vanpool, 15% drop off (Kiss and Ride and feeder bus), 0.3% bicycle, 0.5% ride and walk or bicycle. Systemwide, MARTA has 26,000 parking spaces and excess parking capacity. Most of the stations outside of the downtown Atlanta core, 23 in total, have free daily parking. As downtown Atlanta daily parking rates are only $3 to $5 per day, any MARTA parking charge would make the total cost of using the system greater than driving and parking and thus discourage transit use. Only one of MARTA's stations, College Park, currently has a parking garage that is consistently at capacity on weekdays. To a lesser extent, several of MARTA's end-of-the-line stations also have parking capacity issues. At other stations, particularly those where joint development has occurred or that are in the urban core, there are parking and/or other access challenges such as insufficient kiss and ride facilities or pedestrian access barriers.

Orange County Transportation Authority (Orange County, CA) – Commuter Rail and Bus

OCTA is Orange County's primary provider of public transportation, operating in a 798 square-mile area serving more than 3 million residents in 34 cities and unincorporated areas. County wide, several dense but geographically disperse commercial and retail centers are surrounded by low density urban and suburban residential land uses. OCTA provides a variety of public transportation options such as local bus, rail feeder, express and paratransit services. OCTA also funds and supervises Metrolink commuter rail service in Orange County, which is a regional rail system linking commuters to employment and activity centers. While private vehicle is the predominant access mode to the Metrolink system (68% SOV share), a significant number of users utilize the bus system to travel from rail to work, particularly the Station Link service which provides a series of "last mile" circulators to major employers and destinations near the rail stations. All the stations have city owned/operated large surface lots and/or parking structures. Overall, parking is readily available at all stations and OCTA does not pursue strategies that would force or incentivize users to find another mode of access outside of personal auto. A few stations are having capacity issues that OCTA is addressing by funding new parking structures. Other OCTA mode of access shares include 13% drop off, 7% bus, 5% carpool, 5% walk, and 2% bicycle.

Sound Transit (Seattle, WA) - Commuter Rail and Light Rail

Sound Transit was created in 1996 to provide regional transit service in the Greater Seattle area. The agency has a 76 square mile service area spanning three counties: Snohomish, King and Pierce. Sound Transit currently operates long-distance express commuter bus, ferries, commuter rail, and light rail service, and has several major intermodal transfer centers. Sound Transit's Sounder Commuter Rail, which began service in 2000, has two lines and 10 stations. The agency's Link light rail service is also very new – the Tacoma Link line opened in 2003 and the Central Link line opened in 2008. In the Link light rail system, the only station with parking is SeaTac, which serves an airport and was an interim terminus prior to system expansion. In the Sounder system only the downtown stations were built without parking. All other Sounder stations have free parking provided by Sound Transit adjacent to the station platform. A couple of the stations have structured parking, but most of them have surface lots. Parking is currently free, although Sound Transit is interested in starting to charge for parking. Sounder parking utilization data is compiled every month, and there are currently two Sounder stations that are at or near parking capacity. Most Sounder station parking facilities have a utilization rate around 80%. Overall mode of access shares for the Sounder system are SOV 61%, walk 21%, other auto 8%, bus 8%, and bicycle 2%. Sounder stations have bicycle parking currently, but it is not well used. Sound Transit is now funding "last mile" bicycle and pedestrian improvements *outside* of their station property to improve alternative modes of access shares.

TriMet (Portland, OR) – Light Rail and Commuter Rail

TriMet is a municipal corporation providing public transportation for much of the three counties in the Portland, Oregon metro area (500 square miles). The metro area land use is primarily urban and suburban residential. TriMet operates a comprehensive transit network including a 52-mile light rail system (the MAX), 79 bus lines, and the 14.7-mile commuter rail, the WES. As a policy, TriMet does not own, operate, or support park and rides within five miles of the downtown core, and overall park and rider users constitute only 8% access mode share systemwide. In terms of access priority, they feel auto should be last. Even so, TriMet owns 9,600 park and ride spaces across their four MAX lines primarily in surface parking lots. All parking is free, but high usage stations often have a 24-hour limit and several of the most crowded stations have designated short-term parking spaces. Only a few stations experience parking capacity constraints. The overall mode of access for the TriMet system is: 74% walk, 8% drive alone, 9% bus to LRT, 3% LRT to bus, 3% drop-off, 1% bicycle, and 2% other. TriMet provides 503 keyed bike locker parking spaces and 803 short-term (bike rack) parking spaces at rail stations and transit centers. TriMet has increased bike parking and provided high capacity bike cages at stations both with and without park and rides.

Contrasts and Issues

This peer review uncovered no truly cutting-edge station access strategies such as dynamic parking pricing, neighborhood ridesharing or non-fixed route demand response service, that have been implemented. The majority of WMATA's peers have a wide variety of station types ranging from urban, urban residential, to suburban residential; and the primary access modes and challenges consequently varies significantly as well. Many agencies are experiencing parking capacity issues at urban and suburban residential stations that they are addressing with parking management approaches, while only OCTA is increasing parking capacity in response to demand.

While all the agencies profess a desire or outright policy to increase non-motorized mode share to stations, the results of the efforts to achieve this undertaken to date have been minimal except at stations where parking is severely constrained and feeder bus service extensive (for example, the Alewife Station on the T's Red Line or the Metra's Naperville Downtown Station). Long term, many agencies are adopting policies and working with local cities to affect land use strategies around the stations that will impact access mode share. This cooperation is viewed as a critical step in the overall strategy of meeting the demand of projected increases in ridership while balancing the needs of all users system wide.

In general, the commuter rail systems interviewed had much higher overall rates of auto access and were more likely to be experiencing broad station access challenges. How each agency is meeting these access challenges or is planning to meet them varied significantly, but several recurring strategies and themes (reviewed below) that rose to the top in terms of frequency of application.

Single Occupancy Vehicle (SOV) Access is the Lowest Priority in Most Cases

With the exception of OCTA, WMATA's peer transit agencies are not building significant amounts of new parking. In fact, several peer agencies emphasized that auto access, particularly by SOV, is their lowest priority access mode. There are a variety of reasons why transit agencies are not building new parking facilities; one of the primary reasons may be that at most systems only small minorities of parking facilities are experiencing capacity constraints. Systems are also generally looking to maximize access to their stations by non-motorized modes in general.

Remote/Satellite Parking Lots Can Work

Several of the systems studied, including Metra, OCTA, and Sound Transit, had successfully implemented shared parking agreements or remote parking lots with dedicated feeder bus or shuttle service to their stations. These lots were typically at churches or municipal parking garages. Remote parking lots work well when they serve stations with an overwhelming demand for parking coupled with well-designed quality feeder bus services.

Increased Facilities for Bicycle Access are Popular

Most agencies are Increasing bicycle facilities. An outstanding issue across most, if not all, systems is the lack of capacity for bike storage on the trains themselves. Agencies feel this has limited the potential for bicycle access mode share. This peer review documented several bicycle parking initiatives being undertaken by agencies including TriMet, MBTA, and Metra, among others.

Few Systems Have Ridesharing Accommodations

While a handful of the systems interviewed have designated carpool or vanpool parking, these spaces were generally not well used. Conventional ridesharing to stations among park and ride users was not significant arrival mode among any of the systems interviewed. Nevertheless, as described in the next section, dynamic carpooling models have potential for Metro.

Feeder Bus Connections and Frequency are Critical to Attracting Riders

A number of the agencies have stations that have a high number of feeder bus connections and experience a very high bus access mode share. While some of the stations also have parking, the majority have limited parking capacity but still enjoy a high level of access through connecting fixed-route service. The agencies have found that these connections must be far reaching (many routes), be frequent (short headways), and be convenient (dropping passengers at or very close to rail station entrances).

Targeted Reverse Commute Shuttles Are Feasible

BART, Metra and OCTA have all implemented successful reverse commute shuttles with local partners that focus on improving station egress by improving connections between stations and user destinations, typically employment and education centers. These shuttles are limited in their frequency and are typically timed to correspond with train arrivals and departures.

Land Use Policies Are Often Seen as a Solution for Improving Station Access

Many agencies are working cooperatively with local municipalities to increase density around their stations, including working with private developers and converting surface parking lots into TOD.

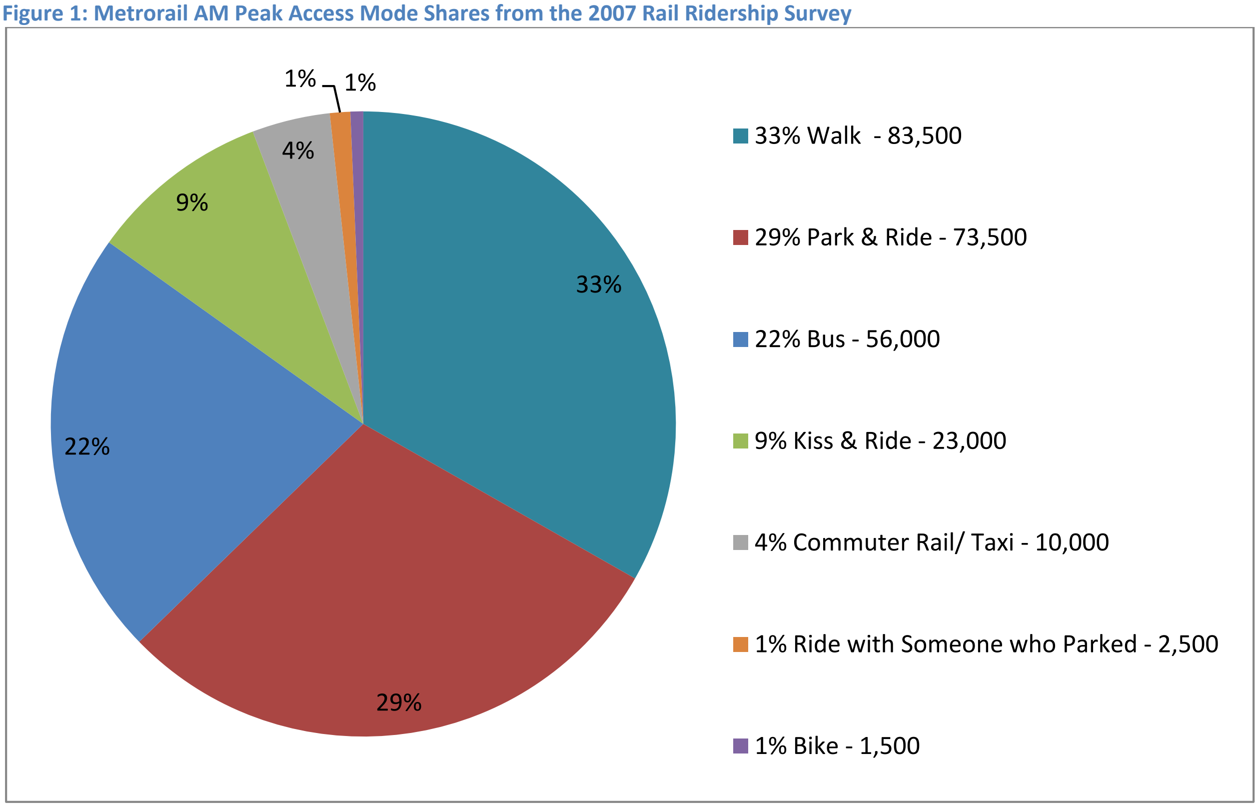
Bicycle and Pedestrian Access Improvements Extend Beyond the Station Site

Sound Transit has found that missing bicycle and pedestrian linkages between its stations and the surrounding communities impede the growth of bicycle and pedestrian access mode shares. The agency is now in the process of identifying bicycle and pedestrian access improvements up to ½ mile outside of their stations that they can fund and construct.

Metrorail Station Access

Metrorail serves an average weekday ridership of 250,000 customers during the morning peak (from 5:30 AM to 9:30 AM). Of these boardings, the largest share (33 percent) walk to their origin Metrorail station, followed by those who drive to a station (30 percent, including one percent riding with someone who parked) and those who ride a bus to a station (22 percent). Other modes of access include Kiss & Ride drop-offs (nine percent), commuter rail or taxi transfers (four percent), and bicycle access (one percent).

Figure 1: Metrorail AM Peak Access Mode Shares from the 2007 Rail Ridership Survey



Morning peak systemwide ridership is projected to increase significantly in the coming decades; an estimated 350,000 boardings are expected in 2040. This translates to a need for 30,000 additional parking spaces if current station access trends continue. However, many of Metro's parking lots are currently reaching capacity and cannot accommodate additional growth. The additional 100,000 customers arriving at Metrorail stations in the morning peak will need to be accommodated primarily through increased walking, bicycle, carpool, and transit access to stations.

This study aims to identify strategies that can accommodate access to Metrorail stations by shifting mode of arrival. This is not a one-size-fits-all approach, however. The 86 Metrorail stations vary greatly in context, from suburban stations in highway right of way with acres of parking spaces to underground stations in Washington D.C.'s dense downtown with no parking spaces. In 2010, WMATA released its Bicycle and Pedestrian Access Improvements Study, which identified nine separate station types based on land use and transportation characteristics. The nine station types and their AM peak ridership :

- **High Density Mixed-Use in a Grid Network:** stations with high-density, mixed-use residential development and large shares of bicycle, pedestrian, and transit access (67,000 riders at 22 stations).
- **Urban Residential Center:** predominately medium- to high-density residential land uses with some mix of uses, medium to large shares of bicycle and pedestrian access (22,500 riders, 11 stations).
- **Urban Residential Area with a Bus/Automobile Orientation:** predominately single-use development with lower to moderate densities in an urban context, typically with vehicle orientation and lower shares of bicycle and pedestrian utilization (12,700 riders, 5 stations).
- **Campus:** college campuses and research centers with pockets of dense residential development nearby, high levels of bicycle and pedestrian activity with a focus on connection between the Metrorail station and the campus (10,400 riders, 5 stations).
- **Mixed-Use in a Pod Layout:** pods of commercial activity separated by surface parking lots and other barriers, focus on vehicular access with limited bicycle and pedestrian access (39,400 riders, 13 stations).
- **Long-Term Potential for High Density Transit-Oriented Development (TOD) or Planned Unit Development (PUD):** stations with underutilized nearby property and potential for large-scale redevelopment, current bicycle and pedestrian access is low but future redevelopment could change that (5,800 riders, 4 stations).
- **Suburban Residential Area:** low-density suburban residential development with minimal mix of uses, focus on vehicular access with limited bicycle and pedestrian access (32,200 riders, 9 stations).
- **Auto Collector/Suburban Freeway:** low-density suburban development in the vicinity with major barriers to station access like interstate highways and surface parking lots, lowest bicycle and pedestrian utilization (28,600 riders, 5 stations).
- **Employment Center/Downtown/Urban Core:** typical downtown stations with commercial and office uses in an urban context, high bicycle and pedestrian utilization (22,700 riders, 12 stations).

Using 2007 Metrorail Ridership Survey data and these station types, general trends in station access by type can also be found. For example, the Auto Collector/Suburban Freeway type is associated with the highest share of Park & Ride access to a station, while High-Density Urban Mixed Use type is associated with the highest rates of pedestrian station access. Employment Center/Downtown/Urban Core stations are associated with high rates of 'other' station access because in the morning peak, many riders transfer from commuter rail to Metrorail at the Union Station and L'Enfant Plaza stations, driving up the average 'other' access share for the entire type. See Table 12 for morning peak access shares by station type.

Table 12: Access Mode Shares by Station Type

Station Type	Bus	Park & Ride	Kiss & Ride	Walk	Bike	Other
High-Density Urban Mixed Use	17.5%	7.6%	7.5%	64.7%	0.9%	1.9%
Urban Residential	18.4%	8.7%	7.1%	64.2%	0.8%	0.9%
Urban Residential - Bus/Auto	49.9%	23.5%	10.0%	15.5%	0.1%	1.1%
Campus and Institutional	19.0%	37.9%	13.3%	18.3%	2.6%	9.0%
Mixed Use "Pod" Layout	19.2%	52.2%	11.4%	15.2%	0.7%	1.4%
Long Term TOD or PUD	9.7%	50.3%	11.6%	25.2%	1.1%	2.1%
Suburban Residential	19.7%	43.2%	9.9%	16.6%	0.8%	9.8%
Auto Collector/Suburban Freeway	18.0%	65.9%	10.2%	3.3%	0.3%	2.4%
Employment Center/ Downtown/ Urban Core	16.7%	4.6%	6.3%	34.1%	0.2%	38.1%

Of the nine types, only five types have existing Park & Ride lots: 3.) Urban Residential Area with a Bus/Automobile Orientation, 5.) Mixed-Use in a Pod Layout, 6.) Long-Term Potential for High Density TOD or PUD, 7.) Suburban Residential Area, and 8.) Auto Collector/Suburban Freeway. Because this study examines strategies to shift station access from Park & Ride to other modes, these station types were selected for analysis in this study. For each of these five station types, a case study station was chosen. While these case study stations were not meant to be entirely representative of the extent of stations in the types, they are strong examples of the characteristics of each type. These stations provide concrete figures and characteristics to base assumptions upon, and they provide a context in which to test strategies. The five case study stations are:

- **Fort Totten for Type 3: Urban Residential Area with a Bus/Automobile Orientation**. The Fort Totten station is located in an urban residential context but has significant bus station access and bus transfer activity.
- **Vienna-Fairfax/GMU for Type 5: Mixed Use in a Pod Layout.** The Vienna station is currently undergoing significant residential development adjacent to the station and is primarily an auto-oriented station.
- **Naylor Road for Type 6: Long-Term Potential for High Density TOD or PUD.** Several long-term redevelopment plans for the Naylor Road station have been proposed, and the station is poised to change in the future.
- **Huntington for Type 7: Suburban Residential Area.** The Huntington station is close to significant suburban residential development that lacks clear connections to the station itself.
- **Shady Grove for Type 8: Auto Collector/Suburban Freeway.** The Shady Grove station is heavily auto-oriented as the end of the Red line, and major roads in the area act as barriers to pedestrian and bicycle access.

See the Station Access Scenarios section for a discussion of these case study stations, their representative types, and the strategies that may be most applicable to them in encouraging additional station access.

Toolbox of Station Access Strategies

To provide WMATA with new methods or incentives to facilitate station access, a set of "toolbox strategies" were developed. As discussed later in the Recommendations Section, WMATA may further evaluate each of these strategies individually to assess the feasibility of piloting or implementing them within the system. The selection of the toolbox strategies was based on extensive research of strategies that have been employed to-date by other agencies, including at the peer review agencies, as well as policies that have been applied in other transportation contexts, but that to-date have not been employed by transit agencies.

To understand how the application of the toolbox strategies could impact the modes of access shares, and how differing sets of toolbox strategies created unique associated costs and benefits, a set of station access alternative scenarios were developed for each case study station These scenarios are presented later in this study, in the Station Access Alternatives Scenarios section.

Table 13 presents an overview of all of the toolbox strategies. There are three broad types of strategies:

- **Parking Strategies** that seek to moderate the demand for parking, incentivize carpooling to Metrorail stations, provide additional parking outside of the station property, and provide real-time parking availability information.
- **Bus Strategies** that strategically focus and increase bus service.
- **Other Strategies** that include establishing new pedestrian linkages to station sites and the redesign of Kiss & Ride facilities.

Table 13: Toolbox Strategies Overview

Type	Toolbox Strategy	Description
Parking Strategies	Real-Time Parking Information	Provide real-time information to parking patrons indicating the availability of spaces at a particular station.
	Enhanced Real-Time Parking Information	Provide guidance to open spaces, minimizing "wandering" behavior by customers and ensuring full use of facilities. Similar to systems in use at regional airports.
	Parking Districts	Designated areas where parking prices are or where parking is restricted to those that have a displayed parking permit on their vehicle. Typically used to limit parking by non-residents on residential streets.
	Shared Satellite Parking	Create agreements with existing land uses whose private parking resources are utilized at a low rate during weekdays from peak to peak to allow Metrorail parking in their lots. Examples include houses of worship, large-lot retail, or apartment complexes. Ideally, shared parking locations should be within walking distance of a station or an existing bus route that serves the station.
	Shared Parking with Future	Negotiate with developers to include designated Metrorail

Type	Toolbox Strategy	Description
	Adjacent Development	parking areas in new developments. Coordinate rates for parking to ensure that they are attractive as alternatives. Work with jurisdictional staff to include TDM site plan requirements.
	Dynamic Ridesharing	Computer applications utilizing mobile web platforms applications and SMS text match drivers with potential riders on a trip-by-trip basis in real-time.
	Preferred Carpool Spaces and Discounts	Designate preferred parking spaces for carpools and/or discounting parking fees for carpoolers.
	Dynamic Pricing	Vary the price of parking by the level of demand. This can be done using an automated, electronic technology
	Add Satellite Parking	Provide off-site designated satellite parking for WMATA patrons served by a feeder bus route.
Bus Strategies	Improved Connections from Satellite Parking	Implement increased or dedicated feeder bus service from satellite parking.
	Increased Frequency of Feeder Bus Service	Increase the frequency of existing feeder bus service, particularly for services that have experienced service cuts in recent years, but that serve major residential areas.
	Neighborhood-Focused Bus Service	Implement new, Neighborhood-Focused feeder bus service.
	Coordinate with Private Shuttles	Work with jurisdictional staff to coordinate with private residential property managers and commercial building managers to better coordinate shuttles serving Metrorail stations in areas where they are complementary to existing Metrobus service. Private shuttles could also accommodate reverse commute trips.
Other Strategies	Pedestrian and Bicycle Links	Fix broken pedestrian and bicycle links both within and outside of the station footprint.
	Kiss & Ride Redesign	Improve Kiss & Ride design to eliminate queuing patterns that interfere with bus operations, create unsafe conditions for pedestrians, and generally allow for the potential of the Kiss & Ride lot to be fully realized. Could include a remote waiting area (i.e. “cell phone lot”).

Preferred Carpool Spaces and Discounts

Designated preferred parking spaces for carpools and/or parking fee discounts for carpools are in place at many transit agency owned (such as BART and TriMet) or municipally owned parking facilities across the nation. In the Washington D.C. region, Montgomery County owned structured parking facilities offer designated preferred parking and parking fee discounts for carpools.

At Montgomery County parking garages in the Silver Spring Parking District a regular monthly parking pass costs $95, but for a 2-person carpool the cost is $80, for a 3-4 person carpool it is $45 and for a 5 or more person carpool it is $10. In the Silver Spring Parking District there are a total of 10,577 garage parking spaces across eight garages; one of the garages is located directly adjacent to the Silver Spring Metrorail Station. The number of designated carpool spaces was not available, but as of October 2011 there are 114 registered carpools of two or more people operating in the parking district. All carpools must have at least two or more members that commute a minimum of three days per week. Designated carpool spaces are reserved for carpools only until 9:30am. After 9:30am any patron can park in a carpool space. All carpool members must work in the parking district, but may not live within it.

The principal driver of a carpool wishing to obtain a carpool parking pass must submit a carpool application packet that includes a copy of their driver's license and a work verification form signed by their employer to Montgomery County Commuter Services. All members of the carpool must submit a rideshare application, an acceptable form of home address verification and an employer signed work verification form.

Like WMATA, in the 1990s Montgomery County had challenges with carpool parking pass fraud. By requiring written employer verification and periodically checking in with all of the members of registered carpools, Montgomery County believes that it has significantly reduced carpool parking pass fraud. It is now not possible for "phantom" commuters to be registered with a carpool. Montgomery County Commuter Services staff members spend a not insignificant amount of time each month following up with registered carpools to confirm that they are still operational and have maintained their ridership. Typically staff will send a "check-in" email out to a carpool group, and if an email address bounces they begin calling members of the carpool to confirm that they still all ride in the carpool, are still with the same employer, etc. Montgomery County does not attempt to confirm carpools through field enforcement/on-site checks at parking facilities. All members of carpool groups are also periodically called and asked to confirm their ongoing participation in the carpool. This process will occasionally uncover a carpool in which the registered members of the carpool no longer participate, but the principal driver of the carpool is still receiving the carpool monthly pass.

The right set of conditions must be in place in order for Metrorail customers to chose to carpool in significant numbers. Once commuters have made the choice to carpool for financial, time, or other reasons, in many cases a shared trip to their final destination will be more attractive than a shared trip to a Metrorail station, which carries extra time to park and transfer. In the Washington D.C. region, experience shows that the ability to utilize HOV lanes is a primary consideration for those who carpool, and the presence of HOV routes that extend to the region's core (particularly I-66 and I-395) is a limiting factor on the number of commuters who may choose to carpool to Metrorail.

Dynamic Ridesharing

Dynamic, or real-time, ridesharing utilizes online, mobile web platform applications and text to match drivers with potential riders on a trip-by-trip basis in real-time. Individuals interested in sharing a ride must register with an individual dynamic ridesharing service. Dynamic ridesharing services, operated by private vendors, typically only require the individuals to provide their bank account information both to verify their identity and to enable automatic trip cost sharing between the driver and the riders. No other background or driving record checks are required for interested individuals to sign up for private dynamic ridesharing services.

Vendors

An ever-increasing number of vendors are competing for users in the dynamic ridesharing market. A ridesharing application must reach a critical mass of users to be successful. If a user is unable to consistently find a ride they will not continue to use the ridesharing application. Several jurisdictions in the region are interested in partnering with dynamic ridesharing vendors to pilot their technology in this region, and WMATA may wish to coordinate with these efforts.

Among the vendors currently offering products that exhibit some or all of the characteristics of dynamic ridesharing are:

- Avego - http://www.avego.com/
- Carticipate – http://www.carticipate.com/
- Flinc – https://www.flinc.org/world
- Go Loco - https://www.goloco.org/
- Green Riders – http://www.greenriders.com/
- Pickup Pal - http://www.pickuppal.com/
- Ridaroo - http://ridaroo.com/
- Ride Amgios - http://www.rideamigos.com/
- Zebigo - https://zebigo.com/landing.php
- Zimride - http://public.zimride.com/

This list does not include all of the vendors currently working in the dynamic ridesharing market. Some vendors are only focused on particular types of trips (i.e. airport trips, or special events), and new vendors continue to enter the dynamic ridesharing market. During the research process for this report, the study team interviewed Avego staff. Avego has been involved in a number of dynamic ridesharing pilots programs with U.S. and European transportation agencies.

Avego's dynamic carpooling application has been used in several pilot programs in the United States and Europe. While Avego's product has reached a critical mass of users in some of its European pilots, it has yet to do so in a United States pilot. Currently, the firm is collecting metrics on real-time carsharing, i.e. how many riders, how many drivers are needed to sustain this service, what is the amount of required incentive to get drivers and riders to carpool, etc. The firm has learned based on its experiences with both European and U.S. pilot programs that there is a need to be flexible with incentives offered by program sponsors. For example, NuRide offers coupons and some employers offer benefits. Monetary incentives do not tend to motivate dynamic ridesharing drivers since these individuals will reduce their trip cost by sharing a ride and will have access to a car during the day or for a return trip. However, monetary and other incentives are very important to inducing rider participation. Avego has found that a value (or savings) of around $50 per month sufficiently motivates riders to participate in dynamic ridesharing.

Overall however, Avego has found that monetary incentives are not the most important motivators or indicators of where dynamic ridesharing will be successful. Avego has found that the ability to achieve travel time saving (via HOV access) is the most significant indicator of whether an individual will be attracted to dynamic ridesharing, followed by the "right" demographic (younger, more price sensitive to fuel and travel costs), and the third motivator is the ability save or make money or take advantage of other incentives.

In the Washington, D.C. region, Avego currently has two dynamic ridesharing pilot projects underway First, the Full Access Solutions for Transportation (FAST)[4] TMA in Arlington's Potomac Yard has launched a pilot of Avego's ridesharing application that offers employees and residents rewards for participating. All FAST participants that register with Avego's application receive $10 in free Avego credits. The first 100 users that sign up will receive a free $25 gas card for three months if they complete five rides in the first month, 10 rides in the second month, and 15 rides in the third month. Second, the Northern Virginia Regional Commission is currently conducting a dynamic rideshare pilot program using Avego technology that includes driver and rider incentives, aimed at Department of Defense employees impacted by the Base Realignment and Closure activities in Northern Virginia.

In Avego's experience, other factors that influence the success of a dynamic ridesharing pilot include the presence of strong local partners and exposure. On the other hand, they have found that requiring background checks for program participants, though a good idea in theory, is difficult in practice. For example, in one project in Washington State, out of its 300 applicants, only 20 individuals completed all of the required background checks and provided the required information, making the whole pilot project unviable.

Add New Satellite Parking

Satellite parking (off-site parking designated for WMATA patrons) allows WMATA to provide additional parking without additional property at its stations. Satellite parking is served by frequent peak-period and low cost or free connector bus service. Satellite parking works best in areas where station parking is constrained, but demand for additional parking is high enough to support a frequent connector bus service between a satellite lot and Metrorail stations. It also works well where traffic congestion is high and there are few alternative routes, as is the case in the I-66 corridor between Fairfax County and the District of Columbia. Fairfax Connector currently successfully operates service between several satellite parking facilities that serve Metrorail along this corridor.

While adding satellite parking facilities has been shown to work in the Washington, D.C. region, it represents a significant capital expense. It may also be challenging to find land areas large and close enough to existing WMATA stations. It may be best to pursue the addition of satellite parking facilities in conjunction with the jurisdictions, both to lower the expense and to capitalize on their experience with satellite parking and park and ride lot operation.

Shared Parking with Future Adjacent Development

With new developments within walking distance of many Metrorail stations anticipated, there may be opportunities to negotiate shared parking agreements with developers, where they could agree to allow a set number of parking spaces that may otherwise be unused during the day to be designated for WMATA commuters, priced at a competitive rate. Shared parking with future adjacent development works best in station areas where high density development is anticipated, but parking demand from patrons outside of the station area remains high. In the MacArthur Station BART Station Access

[4] For more information on the FAST TMA, go to: http://www.fastpotomacyard.com/.

Feasibility Study, unbundled, shared parking with future transit oriented development was explored as a possibility. This study estimated that for 94 spaces of shared parking with future adjacent development, the ten-year cost to BART to provide associated TDM services would be $110,000.

Shared Satellite Parking with Existing Land Uses

Negotiating shared parking agreements with those uses that have low rates of parking utilization during the work day such as theaters, churches and apartment complexes, or those with an excess of parking on a daily basis, such as large-lot retail, can provide additional parking for WMATA patrons without creating an additional cost for the agency. Key to making these shared parking facilities work well is that they either need to be within walking distance of a station, or be connect with a high frequency peak period bus or shuttle service.

WMATA has a shared parking arrangement at the Franconia-Springfield station. The Transportation Association of Greater Springfield (TAGS) shuttle connects the station to a mall and office park to the east. Metro customers can park in these areas when the station's lots are full. The shuttle is free when going to the station and costs $0.25 on the return trip.

Improved Connections from Existing Satellite Parking Facilities

Improved connections from existing satellite parking, specifically increasing the frequency of service or implementing dedicated feeder service, can have a significant impact on use of satellite parking facilities. Fairfax Connector's Route 980 serves the Herndon-Monroe Park and Ride, providing non-stop trips to West Falls Church station every 6 minutes during the peak. Parking is free at the Herndon-Monroe Park and Ride, while parking at West Falls Church Station costs $4.50 daily. The Herndon-Monroe Park and Ride has 1,745 spaces, and the lot is currently at capacity. Weekday daily ridership on Route 980 is 2,690, with 32 average boardings per trip. A quarter of patrons using Route 980 have household incomes of greater than $70,000.[5] As the West Falls Church parking lots and deck do not typically fill up until 9:00 AM or later, these passengers are largely riders of choice. In addition to saving the cost of parking at West Falls Church, 980 riders also save several minutes since the bus can travel in the Dulles Toll Road HOV and airport access lanes, and alights passengers much closer to the station than the parking deck.

Increased Frequency of Feeder Bus Service

Increasing the frequency of existing feeder bus service may attract new patrons that otherwise might have driven to a Metrorail station. According to the research[6], Montgomery County Ride-On exhibited a service elasticity of +1.07 over a 20-year period in which the system experienced extensive growth, and a service elasticity of +1.14 during a shorter peak growth period. Service on existing feeder bus lines provided by local transit agencies has been cut as a result of decreased transit agency funding in recent years as a result of the recession. As budgets allow, transit agencies may be replacing the service that was cut in recent years, and examining service levels on important feeder bus routes.

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[5] Fairfax County Transit Development Plan, http://www.fairfaxcounty.gov/fcdot/tdp.htm
[6] Transit Cooperative Research Program Report 95, Chapter 10, Bus Routing and Coverage.

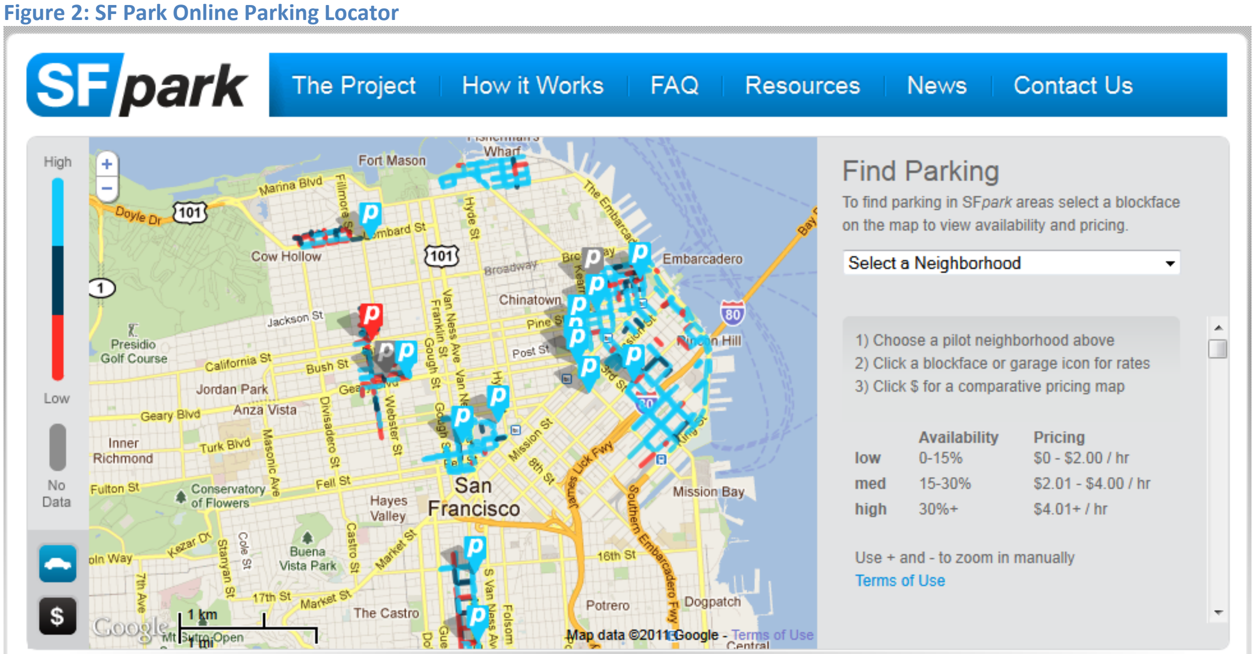
Dynamic/Performance Parking Pricing

Dynamic or performance pricing, varying price according to the level of demand, has several applications in transportation. To-date, it has been used most widely in variable price lanes on toll roads, but it is also increasingly being used to manage parking demand. Dynamic or performance parking pricing pilot projects are currently in use by transportation agencies in Washington, D.C., New York City and San Francisco, and are planned for Los Angeles and several other major cities across the country.

Dynamic pricing can be implemented using a variety of technologies, from something as simple as peak and off-peak period parking prices determined by quantitative methodologies used by staff on a periodic basis (monthly, quarterly, annually), to an automated system that monitors parking demand and incrementally increases or decreases parking rates by time of day on a month-to-month basis. New York City's neighborhood based PARK Smart pilot projects varied the price of on-street parking by the time of day at a set rate, charging up to $3.75 per hour during peak parking demand hours during the day. Two of the three neighborhood-based PARK Smart pilots transitioned to permanent programs after they proved successful at decreasing traffic volumes and parking durations while increasing parking space availability and the number of unique vehicles parked throughout the day. The third neighborhood pilot is still ongoing.

San Francisco's SF *park* pilot project is currently in place at 7,000 of the city's metered spaces, and at 12,250 parking spaces in 15 municipally-owned parking garages. Sensors installed at each SF *park* parking space detect whether the spaces are occupied or free, and this information is uploaded to the City's data feed and distributed to the public in real-time via an Internet site and a Smartphone application. Parking space usage information is aggregated and used to adjust the price of parking based on demand on a monthly basis, but parking prices are never dramatically changed on a month-to-month basis. At the parking garages, parking rates are varied by the time of day but rates are only changed on a quarterly basis.

Figure 2: SF Park Online Parking Locator



SF Park modifies parking prices in an area until they reach a rate at which at least one space is available at any given time. In areas with a high demand for parking this generally means that rates increase, but the converse is also true.

Real-Time Parking Information

Real-time parking information guides vehicles already in a parking facility to open spaces, and/or allows patrons to assess whether a particular facility is full before they begin their trip or during their trip via smart phone technology. Information about the availability of parking at a station may influence a patron's decision to use a given Park & Ride facility, continue on to another facility with available spaces, or an alternative mode. This technology would be similar to systems in use at regional airports and is a prerequisite to dynamic pricing.

A pilot of Real-time parking information is currently underway at the Fort Totten station's Kiss & Ride lot. Battery-powered sensors installed in the pavement within parking spaces capture parking space usage data, and communicate information on space availability in real-time. If this pilot succeeds, the technology may be applied to other types of parking spaces available at Metrorail stations, and information on parking availability will be provided over the web and in a mobile web-compatible format. WMATA also installed additional sensors inside of the Kiss & Ride parking space meters, which facilitate payment and will soon allow patrons to add time to meters using a cell phone.

Coordinate Private Shuttles

Working with jurisdictional staff to coordinate with private residential property managers and commercial building managers could increase the number of private shuttles serving Metrorail stations where this would be appropriate. Shuttles can also be used to accommodate reverse commute trips, such as Metrorail's TAGS shuttle that serves the Franconia-Springfield Station and Springfield area employers. This strategy is a low cost alternative to providing additional feeder bus service, but should be pursued ***only*** at stations where the capacity to accommodate this service exists. In fact, in some cases, there are too many shuttles trying to access a given station during peak periods, due in part to a duplication of efforts among some shuttle operations. The Recommendations section of this report addresses this issue in more detail.

Pedestrian and Bicycle Links

Providing assistance or funding to identify gaps in the pedestrian networks that lead to stations, but are beyond the station property, is a strategy that has been pursued by Seattle's Sound Transit to increase pedestrian mode of access shares on their Sounder Commuter Rail system. WMATA is proceeding with efforts to improve pedestrian and bicycle access as part of its 2012-2017 Capital Improvement Program.

Kiss & Ride Redesign

Some Kiss & Rides within the WMATA system are currently experiencing capacity issues. At these facilities, a redesign that incorporates remote vehicle waiting areas "cell phone lots" for pick up, additional Kiss & Ride spaces or new designs that facilitate more effective vehicle throughput may increase the number of patrons utilizing the facilities.

This strategy may require WMATA to acquire additional land in order to accommodate larger Kiss & Ride facilities or new remote “cell phone lots.” This may prove to be cost prohibitive at many stations, but at others the existing space may be re-designed (for example, converting waiting parking spaces to a queuing Kiss & Ride lane(s), or adding a queuing Kiss & Ride lane(s) to Kiss & Rides that are designed with pull-in parking spaces).

Station Access Scenarios

To understand how the application of the toolbox strategies could impact the mode of access shares, and how differing sets of toolbox strategies created unique associated costs and benefits, a set of station access alternative scenarios were developed for each case study station. Initially, a *base case scenario* of access mode share in 2040, that is, demand estimates in the absence of any improvements, was determined for all case study stations. The 2040 access mode share estimates were determined by applying the most recent Metrorail mode of access shares from the 2007 Metrorail Passenger Survey to WMATA's 2040 Metrorail ridership estimates for each case study station. These figures were then adjusted based on several factors described below, and a final "revised 2040 base case scenario" was derived.

Known changes in land use (i.e. planned transit oriented development (TOD)) or the introduction of new transit connections (such as the Corridor Cities Transitway in Maryland) were included in the revised base case scenarios as appropriate on an individual station basis. While the effects of new TODs and transit lines are implicit in the 2040 ridership projections, these changes will impact the way customers access Metrorail station relative to current access modes. For example, residents of a TOD are more likely to arrive at the station by walking than the station's current access patterns would suggest. It was assumed that all new Metrorail riders generated by TODs within a quarter mile of a station would walk to the stations. An estimate of additional Metrorail riders generated from currently planned TODs within a quarter mile of the station area was calculated using the number of additional dwelling units to generate the number residents per unit, and then converting this number into additional Metrorail riders expected based on data from the 2005 Metrorail Development Related Ridership Survey. The size and number of planned TODs within each station area was determined by obtaining planned development information directly from the District of Columbia Economic Partnership, Fairfax County's Planning Division, and Montgomery County.

In addition to including TOD and additional transit arrival estimates, the revised base case also made several adjustments to the mode of access shares based on existing policies or other research. In February 2011, the WMATA Board of Directors passed a resolution recommending that the system seek to quintuple bicycle mode of access shares system wide to 3.5 percent by 2030. The individual station bicycle mode of access goals required to meet this goal as compiled in the Metrorail Bicycle and Pedestrian Access Improvements Study were used as the base case scenario bicycle mode of access share. An auto occupancy of 1.04 persons per vehicle was assumed, as this was the average occupancy per vehicle recorded in recent survey data. In all of the revised base cases, it was assumed that parking facilities will be utilized to capacity. An "other" mode of access share of 1 percent was assumed in all of the base cases except Naylor Road. Naylor Road's current "other" mode of access share of zero percent was maintained in its base case scenario.

Once the revised base case scenario for each case study station was complete, the unmet station access needs in 2040 were determined by comparing the base case mode of access figures with the existing station capacity for each mode of access. This calculation resulted in a deficiency of Park & Ride spaces at all of the case study stations, ranging from 326 to 695 parking spaces. One case study station, Shady Grove, also had a Kiss & Ride space deficiency.

Following the development of the base case scenarios, the project team developed three to four potential station access alternative scenarios that demonstrate mode of access shifts generated by the implementation of toolbox strategies. The individual strategies selected for each station were typically focused around a set of complementary improvements (such as neighborhood circulator bus service or satellite parking), and selected based on their applicability to the individual station context. These draft alternatives scenarios were then further assessed, and two final alternative scenarios determined for each station. The assumptions for the level of mode shift induced by each of the toolbox strategies is covered in the following overview of each alternative scenario. Each assumption represents a high-level, theoretical level of demand for each mode at each station. In practice, the change in mode split gained by each scenario would have to be tested under actual conditions. The Recommendations section discusses possible pilot programs based on the findings from the benefit/cost analysis.

Fort Totten

Base Case Scenario

The revised base case for Fort Totten (station type: *Urban Residential with Bus/Auto Orientation*) demonstrates an unmet need for nearly three quarters more parking (326 spaces) than is currently available at the station. The overall park and ride mode of access share is 18 percent in the base case scenario, a figure that is already much lower than stations with parking in other station types with more suburban surrounding land uses.

Mode of AM Peak Access	2010 Ridership[7]	Mode Share	Revised 2040 Base Case	Mode Share	Station Capacity	Unmet Need
Park & Ride	679	17.9%	750	17.9%	424[8]	326
Kiss & Ride	446	11.7%	445	10.6%	1,173[9]	
Bus	1,953	51.4%	1,953	46.6%	11,568[10]	
Walk	658	17.3%	935	22.3%	n/a	
Bike	0	0.0%	69	1.6%	103	
Other	63	1.7%	42	1.0%	n/a	
Total	3,799	100%	4,194	100.0%		

A transit oriented development with more than 1,300 dwelling units and 2,700 residents is planned for Fort Totten. Using information from WMATA's Development Related Ridership Survey, it is anticipated that about half of these residents will access the Metrorail system on a daily basis for commute purposes. Accordingly, an increase in the walk mode of access share from 17 percent today to 22 percent is assumed. Today, the majority of Fort Totten riders access the station via bus (51 percent), but this figure is expected to decrease slightly to account for the increase in the walk share. The share of kiss and ride patrons was also decreased slightly to account for the increase in walk share due to the planned TOD, but it is anticipated that the overall number of Kiss & Ride patrons will remain stable. The

[7] Derived from applying the mode of access shares from the 2007 Metrorail Passenger Survey.
[8] Capacity reflects 408 Park & Ride spaces filled, with an assumed vehicle occupancy rate of 1.04.
[9] Based on a field observation of the dwell time of vehicles applied to the number of waiting spaces available.
[10] Capacity reflects 241 peak period bus trips at 48 seats per bus. 241 peak bus trips.

bike access mode share may increase as well due to completion of the Metropolitan Branch Trail by 2040 and additional bicycle infrastructure in the station area

Alternative Scenarios

Scenario F1: Focus on Neighborhood Bus Service

In this scenario, WMATA could accommodate increased ridership at Fort Totten by encouraging greater bus ridership through providing increased neighborhood circulator service. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Neighborhood Circulator Service

The analysis of the mode of access for Fort Totten's Park & Ride shed showed that over 80 percent of riders that access the station through park and ride live within a five mile radius. Given the proximity of these patrons to the station, it was reasoned that the addition of frequent, targeted bus service in the immediate neighborhood, accompanied with effective parking pricing and real-time parking information, could facilitate a shift of a portion of patrons. The increase in the bus mode of access share equates to 11 new morning peak period bus trips, with an average ridership of 28 riders per bus trip.

Table 14 Scenario F1: Focus on Neighborhood Bus Service

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	440	10.5%	-310
Kiss & Ride	445	10.6%	
Bus	2,263	54.0%	310
Walk	935	22.3%	
Bike	4669	1.6%	
Other	42	1.0%	
Total	4,194	100.0%	

In addition to meeting increased station access needs through enhanced neighborhood circulator service, preferred carpool spaces and discounts could potentially shift the average occupancy of vehicles that access the Park & Ride garage; in this scenario it was estimated that the average vehicle occupancy would shift from 1.04 to 1.08. To facilitate this average vehicle occupancy shift the designation of 16 parking spaces as preferred carpool spaces was assumed. Enforcement of preferred carpool spaces and discounts would be required, as discussed in the Toolbox Scenarios section.

The costs calculated for Scenario F1 are shown in Table 15.

Table 15: Scenario F1 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$26,889 ($660 / space)
	Operating	$2,689/year (at 10% capital cost per year)
Real-Time parking information	Capital	$268,886 ($660 / space)
	Operating	$26,889/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Neighborhood circulator service	Capital	$3,450,000
	Operating	$632,352 / year

Scenario F2: Focus on Private Shuttles

Scenario F2 is essentially the same as scenario F1, except private shuttles are envisioned as meeting the need for additional non-auto modes of access to the station rather than neighborhood circulator bus. It was selected because it represents a lower cost alternative than adding neighborhood circulator bus service, while serving essentially the same population (those living within 5 miles of Fort Totten and using the Park and Ride). The benefit of having shuttles provide additional station access trips, rather than Metrobus or another local bus service, would be a lower operating cost. However, it should be noted that as the 2011 Shuttle Services at Metro Facilities study documented, many WMATA stations face space constraints that make accommodating private shuttles difficult. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Coordinate Private Shuttles

Thirty-one new morning peak period shuttle trips (each carrying on average 10 passengers per trip) would be required, as opposed to 11 new morning peak period bus trips, to accommodate the shift of 310 Fort Totten passengers from Park & Ride access.

Table 16 Scenario F2: Focus on Private Shuttles

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	440	10.5%	-310
Kiss & Ride	445	10.6%	
Bus	1,953	46.6%	
Shuttles	310	7.4%	310
Walk	935	22.3%	
Bike	69	1.6%	
Other	42	1.0%	
Total	4,194	100.0%	

The costs calculated for Scenario F2 are shown in Table 17.

Table 17: Scenario F2 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$26,889 ($660 / space)
	Operating	$2,689/year (at 10% capital cost per year)
Real-Time parking information	Capital	$268,886 ($660 / space)
	Operating	$26,889/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Coordinate Private Shuttles	Capital	$550,000 (Redesign station footprint to accommodate private shuttle access)
	Operating	$256,913/ year

Huntington

Base Case Scenario

Demand for parking at Huntington, (station type: *Suburban Residential*) is expected to decrease slightly as a proportion of overall modes of access to Huntington, but the overall number of customers expected to access the station via Park & Ride will increase and result in an unmet need for 695 parking spaces.

Over 2,100 new dwelling units located within a quarter mile of the Huntington Station are expected to be in place in 2040, resulting in nearly 5,000 new station area residents. Of these new residents, 31 percent are expected to use Metrorail on a daily basis for their commutes, according to WMATA's Development Related Ridership Survey, or around 1,500 passengers. The base case scenario assumed that all of these new TOD residents will walk to the station, but only 854 new TOD riders were included in the base case scenario, to incorporate a more conservative estimate of the impact of the development.

Table 18 Huntington, 2040 Access Mode Share Base Case Scenario

Mode of AM Peak Access	2010 Ridership[11]	Mode Share	Revised 2040 Base Case	Mode Share	Station Capacity	Unmet Need
Park & Ride	3,322	52.5%	4,456	50.0%	3,761[12]	695
Kiss & Ride	527	8.3%	525	5.9%	925[13]	
Bus	1,321	20.9%	1,790	20.1%	5,136[14]	
Walk	1,043	16.5%	1,897	21.3%	n/a	
Bike	43	0.7%	148	1.7%	221	
Other	73	1.2%	89	1.0%	n/a	
Total	6,329	100.0%	8,905	100.0%		

The *raw number* of Huntington passengers accessing the station through Kiss & Ride facilities on the north and south ends of the station was assumed to essentially remain constant in 2040 to reflect the higher number of those accessing the station on foot, while the *percentage* of patrons accessing the station via bus was assumed to essentially remain constant as there are few alternatives for those accessing the station via bus service on US-1.

Alternative Scenarios

Scenario H1: Satellite Parking

Scenario H1 emphasizes the provision of off-site, satellite parking with a direct bus or shuttle connector service that with a low fare or possibly free. The scenario was selected as the land uses near Huntington, particularly underutilized, large lot retail parking lots in the US-1 corridor, are conducive to conversion for satellite parking; moderating demand for parking at Huntington Station is also a key component of Scenario H1. The toolbox strategies selected for this scenario include:

- Satellite Parking with Connector Service
- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts

An increase of the average occupancy of vehicles parking at Huntington from 1.04 to 1.08 is assumed as a result of the introduction of preferred carpool spaces and discounts. To achieve this higher per vehicle occupancy, this study assumed that 252 designated preferred carpool spaces would be needed at Huntington. Dynamic pricing and real-time parking information are featured in this scenario to moderate the demand for parking to match the remaining parking facility capacity at the station.

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[11] Derived from applying the mode of access shares from the 2007 Metrorail Passenger Survey.
[12] Capacity reflects 3,716 Park & Ride spaces filled, with an assumed vehicle occupancy rate of 1.04.
[13] Based on a field observation of the dwell time of vehicles applied to the number of waiting spaces available.
[14] Capacity reflects 107 peak period bus trips at 48 seats per bus.

Fairfax County Department of Transportation has identified several potential sites for future satellite parking facilities on the US-1 corridor south of the Huntington Station. The provision of free or reduced rate parking at a satellite parking facility, coupled with the free or inexpensive frequent connector bus access to the station could potentially serve 443 of the patrons accessing the station by bus.

Table 19 Scenario H1: Satellite Parking

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	4,013	45.1%	-443
Kiss & Ride	525	5.9%	
Bus	2,233	25.1%	443
Walk	1,897	21.3%	
Bike	148	1.7%	
Other	89	1.0%	
Total	8,905	100.0%	

The costs calculated for Scenario H1 are shown in Table 20.

Table 20: Scenario H1 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$245,239 ($660 / space)
	Operating	$24,524/year (at 10% capital cost per year)
Real-Time parking information	Capital	$2,415,231 ($660 / space)
	Operating	$245,239/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Satellite parking connector bus service	Capital	$8,280,000
	Operating	$876,884/ year
Satellite parking, extra parking spaces (annualized costs, includes capital and operating):	Combined	$227,258/year (@ $480 / surface space / year)

Scenario H2: Neighborhood Circulator Service

Scenario H2 is similar to Scenario H1, with the difference being the provision of new neighborhood circulator services rather than additional satellite parking with a connector service. Neighborhood circulator service provided by Fairfax Connector on the US-1 corridor and in its surrounding neighborhoods has proven successful to-date, and this scenario was selected to build upon that success. WMATA would still need to conduct some analysis on where the circulators would be most efficient. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Neighborhood Circulator Service

The addition of neighborhood circulator service in lieu of a satellite lot facility is another possibility for serving the demand and would obviate the need for WMATA to secure a satellite parking facility. During the morning peak period 23 additional neighborhood circulator bus trips would be required to offset the unmet parking need identified in the base case scenario.

Table 21 Scenario H2: Neighborhood Circulator Service

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	4,013	45.1%	-443
Kiss & Ride	525	5.9%	
Bus	2,233	25.1%	443
Walk	1,897	21.3%	
Bike	148	1.7%	
Other	89	1.0%	
Total	8,905	100.0%	

The costs calculated for Scenario H2 are shown in Table 22.

Table 22: Scenario H2 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$245,239 ($660 / space)
	Operating	$24,524/year (at 10% capital cost per year)
Real-Time parking information	Capital	$2,415,231 ($660 / space)
	Operating	$245,239/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Neighborhood Circulator Service	Capital	$6,900,000
	Operating	$378,264/ year

Naylor Road

Base Case Scenario

The Park & Ride mode of access share at Naylor Road (station type: *Long-Term Potential for TOD or PUD*) is currently constrained by a limited parking supply. According to analysis of Park & Ride patron commute sheds for adjacent Green Line stations, it is believed that patrons that use Park & Ride facilities at these stations actually live closer to Naylor Road. Field observations have also documented the use of non-WMATA parking facilities adjacent to the station by Naylor Road patrons.

In Naylor Road's 2040 base case scenario, the proportion of passengers parking at the station was increased to match that currently experienced by two other Green Line stations with similar land use profiles (Southern Avenue and Suitland). The bus mode of access share was maintained near its current proportion, which is midway between the Southern Avenue and Suitland comparison stations. The number of Kiss & Ride patrons was also lowered in the 2040 base case scenario, reflecting the fact that many of these access trips may be the result of the constrained parking situation at Naylor Road.

The raw number of those currently accessing the station on foot, 307, was left unchanged in the 2040 base case scenario, as there are no transit oriented developments currently planned in the vicinity of Naylor Road.

Table 23 Naylor Road, 2040 Access Modes Shares Base Case Scenario

Mode of AM Peak Access	2010 Ridership	Mode Share	Revised 2040 Base Case	Mode Share	Station Capacity	Unmet Need
Park & Ride	635	33.9%	726	40.0%	382[15]	344
Kiss & Ride	285	15.2%	187	10.3%	1,120[16]	
Bus	647	34.5%	573	31.6%	6,432[17]	
Walk	307	16.4%	307	16.9%	n/a	
Bike	0	0.0%	21	1.2%	31	
Other	0	0.0%	0	0.0%	n/a	
Total	1,874	100.0%	1,814	100.0%		

Alternative Scenarios

Scenario N1: Enhanced Feeder and Neighborhood Bus Service

Scenario N1 focuses on increasing the frequency of existing bus service and adding new Neighborhood-Focused bus services to offset the unmet parking demand. The intention of the focus on bus services in this scenario is to capture those patrons that reside physically closest to Naylor Road, but that are

[15] Capacity reflects 368 Park & Ride spaces filled, with an assumed vehicle occupancy rate of 1.04.
[16] Based on a field observation of the dwell time of vehicles applied to the number of waiting spaces available.
[17] Capacity reflects 134 peak period bus trips at 48 seats per bus.

driving to other Green Line stations to use Park & Ride facilities. The toolbox strategies selected for this scenario include:

- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Increased Frequency of Feeder Bus Service
- Neighborhood Circulator Service

Increasing the frequency of feeder bus service would require five new morning peak period bus trips, while adding neighborhood circulator service to meet the unmet demand would require eight new morning peak period bus trips.

Preferred carpool spaces and discounts are employed to increase the auto occupancy rate from 1.04 to 1.08. Fifteen parking spaces would need to be designated for carpools to reach this increase of the auto occupancy rate.

Table 24 Scenario N1: Enhanced Feeder and Neighborhood Bus Service

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	397	21.9%	-329
Kiss & Ride	187	10.3%	
Bus	902	49.7%	329
Walk	307	16.9%	
Bike	21	1.2%	
Other	0	0.0%	
Total	1,814	100.0%	

The costs calculated for Scenario N1 are shown in Table 25.

Table 25: Scenario N1 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Real-Time parking information	Capital	$242,611 ($660 / space)
	Operating	$24,261/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Increased feeder bus service and Neighborhood Circulator Service	Capital	$3,450,000
	Operating	$378,264/ year
Satellite parking, extra parking spaces (annualized costs, include capital and operating):	Combined	$158,596/year (@ $480 / surface space / year)

Scenario N3: Satellite Parking and Neighborhood Circulators

Scenario N3 is different from Scenario N1, only by the addition of dynamic pricing to moderate parking demand and satellite parking connected by an inexpensive, frequent, and dedicated feeder bus service. The intention of Scenario N3 is identical to that of N1 - capture those patrons that reside physically closest to Naylor Road, but that are driving to other Green Line stations to use Park & Ride facilities. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Increased Frequency of Feeder Bus Service
- Neighborhood Circulator Service
- Satellite parking connected by feeder service

The bus mode of access share in Scenario N3 assumes 200 satellite spaces filled at an auto occupancy rate of 1.04, meaning 208 passengers would connect to Naylor Road using a dedicated and free or reduced fare bus service. Operating this service between the satellite lot and Naylor Road Station would require six new morning peak period bus trips. Eight new morning peak period neighborhood circulator bus trips would be required to meet the remaining station access demand through bus service.

As with the previous scenario, Scenario N3 uses preferred carpool spaces and discounts to increase the auto occupancy rate from 1.04 to 1.08.

Table 26 Scenario N3: Satellite Parking

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	397	21.9%	-329
Kiss & Ride	187	10.3%	
Bus	902	49.7%	329
Walk	307	16.9%	
Bike	21	1.2%	
Other	0	0.0%	
Total	1,814	100.0%	

The costs calculated for Scenario N3 are shown in Table 27 on the next page.

Table 27: Scenario N3 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$24,261 ($66 / space)
	Operating	$2,426/year (at 10% capital cost per year)
Real-Time parking information	Capital	$242,611 ($660 / space)
	Operating	$24,261/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Increased feeder bus service and Neighborhood Circulator Service	Capital	$3,450,000
	Operating	$412,651/ year
Satellite parking, extra parking spaces (annualized costs, include capital and operating):	Combined	$158,596/year (@ $480 / surface space / year)

Shady Grove

Base Case Scenario

Shady Grove, the *Auto Collector/Suburban Freeway* type station, will experience a number of changes that will impact its mode of access shares by 2040. The Corridor Cities Transitway (CCT), a 14 mile dedicated transitway, will provide a new transit connection to the Shady Grove Station for residential neighborhoods across Montgomery County. The base case scenario uses a *conservative* estimate (per CCT model runs) of passengers transferring from CCT to Metrorail at Shady Grove of 4,187. As a result of the introduction of the CCT, the number of Metrorail passengers accessing the system via other bus operators at Shady Grove is expected to decline by nearly 2,000.

Table 28 Shady Grove, 2040 Access Mode Shares Base Case Scenario

Mode of AM Peak Access	2010 Ridership[18]	Mode Share	Revised 2040 Base Case	Mode Share	Station Capacity	Unmet Need
Park & Ride	5,735	57.4%	6,342	39.4%	5,974[19]	368
Kiss & Ride	1,075	10.8%	1,075	6.7%	760[20]	315
Bus	2,725	27.3%	2,399	14.9%	9,264[21]	
CCT	0	0.0%	4,187	26.0%	n/a	
Walk	325	3.3%	1,735	10.8%	n/a	
Bike	42	0.4%	206	1.3%	308	
Other	83	0.8%	161	1.0%	n/a	
Total	9,985	100.0%	16,105	100%		

A large transit oriented development, with more than 6,400 dwelling units and 18,000 residents, is planned for Shady Grove. When completely built out, this development could be expected to generate more than 5,600 peak period morning commuters access the station daily, when factors from the WMATA Development Related Ridership Study are applied. However, for the purposes of this base case scenario a very conservative estimate of 1,735 new riders from the Shady Grove TOD was assumed.

The raw number of Kiss & Ride passengers was maintained from 2010 to 2040, as it is believed to be unlikely that this number would be greatly impacted by the changes impacting Shady Grove. As a result of the planned TOD and the introduction of the CCT, Park & Ride access mode share at Shady Grove is expected to fall. Auto access to Shady Grove will become less dominant, although an unmet need of 436 parking spaces and capacity for 315 additional Kiss & Ride trips would still remain.

Alternatives Scenarios

Scenario S2: Shared Parking Facility

Shared parking with future development is the primary strategy used to meet the station access needs in 2040 in Scenario S2. Shared parking could potentially fit well with the new development anticipated at Shady Grove. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Shared Parking with Future Development
- Redesign Kiss & Ride

[18] Derived from applying the mode of access shares from the 2007 Metrorail Passenger Survey.
[19] Capacity reflects 5,745 Park & Ride spaces filled, with an assumed vehicle occupancy rate of 1.04.
[20] Based on a field observation of the dwell time of vehicles applied to the number of waiting spaces available.
[21] Capacity reflects 193 peak period bus trips at 48 seats per bus.

A shared parking agreement with future development at the Shady Grove Station should allow WMATA access to additional parking facilities within walking distance of the station, without building any additional parking. The negotiation of a shared parking agreement is contingent upon the new development type being compatible with accommodating Metrorail riders. For example, the addition of a venue such as a large theater or sports complex at the site would add parking capacity in the station area that would likely not be well used during the normal work hours. A shared parking agreement would be difficult to negotiate with a less compatible use, such as an office building, where parking will be in use during the work day. At an auto occupancy rate of 1.04, 289 shared parking spaces would be needed to allow access for 300 patrons via a shared parking facility.

Given the capacity issues expected at the Shady Grove Kiss & Ride facility, a redesign that adds 28 new Kiss & Ride waiting spaces is needed to meet demand. This redesign may also include new features, such as a remote "cell phone" waiting lot or new vehicle pick up/drop off locations as the planned development at Shady Grove transforms the land use profile around the station.

Dynamic pricing will match demand with the supply of parking at Shady Grove, while real-time parking information and preferred carpool spaces and discounts will aid in the optimization of parking capacity. Scenario S2 assumes an increase in average auto occupancy from a rate of 1.04 to 1.08, which would require 230 designated preferred carpool parking spaces.

Table 29 Scenario S2: Shared Parking Facility

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	6,204	38.5%	-138
Shared Parking Facility	300	1.9%	300
Kiss & Ride	1,075	6.7%	
Bus	2,237	13.9%	-162
CCT	4,187	26.0%	
Walk	1,735	10.8%	
Bike	206	1.3%	
Other	161	1.0%	
Total	16,105	100.0%	

The costs calculated for Scenario S2 are shown in Table 30.

Table 30: Scenario S2 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$397,467 ($66 / space)
	Operating	$39,747/year (at 10% capital cost per year)
Real-Time parking information	Capital	$3,974,667 ($660 / space)
	Operating	$397,467/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Shared parking (annualized costs, include capital and operating):	Combined	$138,853/year (@ $480 / surface space / year)
Redesigned kiss and ride (annualized costs, include capital and operating)	Combined	$13,453/year (@ $480 / surface space / year)

Scenario S4: Enhanced Bus and Shuttle Service

Scenario S4 replaces the shared parking facility used to meet unmet station access needs with the addition of neighborhood circulator and private shuttle strategies. In the event that the development at Shady Grove is not suitable for shared parking, the unmet demand could likely be met through enhanced bus services. The raw bus mode access number in this scenario remains lower than the 2010 bus mode access number due to the presence of the CCT. Much of the existing feeder bus service delivers riders from portions of Montgomery County north and west of Shady Grove. All of the other strategies that are employed in Scenario S2 are used in Scenario S4. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Preferred Carpool Spaces & Discounts
- Neighborhood Circulator Service
- Coordinate Private Shuttles
- Redesign Kiss & Ride

In addition to the required improvements related to all of the other strategies covered in Scenario S2, eight new morning peak period neighborhood circulator bus trips are needed to replace unmet Park & Ride trips in 2040.

Table 31 Scenario S4: Enhanced Bus and Shuttle Service

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	6,204	38.5%	-138
Kiss & Ride	1,075	6.7%	
Bus	2,537	15.8%	138
CCT	4,187	26.0%	
Walk	1,735	10.8%	
Bike	206	1.3%	
Other	161	1.0%	
Total	16,105	100.0%	

The costs calculated for Scenario S4 are shown in Table 32.

Table 32: Scenario S4 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$379,133 ($66 / space)
	Operating	$37,913/year (at 10% capital cost per year)
Real-Time parking information	Capital	$3,791,333 ($660 / space)
	Operating	$379,133/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Circulator service	Capital	$1,380,000
	Operating	$206,326 / year
Redesigned kiss and ride (annualized costs, include capital and operating)	Combined	$13,453/year (@ $480 / surface space / year)

Vienna

Base Case Scenario

The 2040 base case scenario for Vienna (station type: *Mixed Use in a Pod Layout*) indicates an unmet need for 585 park and ride spaces in 2040. A planned transit oriented development at Vienna will result in more than 2,200 new dwelling units and more than 5,700 new residents by 2040. Based on data from the WMATA Development Related Ridership Survey, it is expected that nearly a third of these residents (31 percent) or 1,775 residents will use Metrorail on a daily basis to commute to work. It is assumed that these new TOD generated riders will walk to the station. In the 2040 base case scenario, this figure was decreased to 1,474 walkers, to reflect a more conservative estimate.

The base case assumes that the Park & Ride access mode share will decrease organically from today's share of 60 percent to 55 percent in 2040, due to growth in the bike and walk patron share as the planned TOD at Vienna is completed. Station access by bus would also be impacted by the increased bike and walk shares at Vienna, as the bus access share would decline from 20 percent to 17 percent while decreasing in raw numbers by only 57 passengers. The Kiss & Ride access mode share to the Vienna station is also expected to decrease slightly as a percentage, but remain stable in terms of overall volume due to the increase in patrons accessing the station by bicycle or foot.

Table 33 Vienna, 2040 Access Mode Share Base Case Scenario

Mode of AM Peak Access	2010 Ridership[22]	Mode Share	Revised 2040 Base Case	Mode Share	Station Capacity	Unmet Need
Park & Ride	5,866	59.9%	5,960	55.0%	5,375[23]	585
Kiss & Ride	1,034	10.6%	1,047	9.7%	1,725[24]	
Bus	1,916	19.6%	1,859	17.2%	6,336[25]	
Walk	873	8.9%	1,474	13.6%	n/a	
Bike	48	0.5%	389	3.6%	580	
Other	57	0.6%	108	1.0%	n/a	
Total	9,794	100.0%	10,837	100.0%		

Alternative Scenarios

Scenario V2: Increased Bus with Kiss & Ride Improvements

Scenario V2 is focused on bringing more morning peak period passengers to Vienna via enhanced reconfigured and enhanced bus services (including increased feeder bus frequencies, more direct bus service, and neighborhood circulator service), as well as a redesign of the existing Kiss & Ride facility to increase its capacity. This scenario reflects a strategy of accommodating more patrons residing in neighborhoods within short drives of the station via bus. The toolbox strategies selected for this scenario include:

- Dynamic Pricing
- Real-time parking information
- Increased frequency of feeder bus service
- Redesign Kiss & Ride
- Neighborhood Circulator Service

Dynamic pricing and real-time parking information would play a significant role in the Scenario V2, shifting 585 Park & Ride patrons to other modes. Most of these passengers, 470, could be served through new and expanded bus services, including not only increased feeder bus frequencies and new

[22] Derived from applying the mode of access shares from the 2007 Metrorail Passenger Survey.
[23] Capacity reflects 5,169 Park & Ride spaces filled, with an assumed vehicle occupancy rate of 1.04.
[24] Based on a field observation of the dwell time of vehicles applied to the number of waiting spaces available.
[25] Capacity reflects 132 peak period bus trips at 48 seats per bus.

Neighborhood-Focused services, but also direct, and possibly free, bus connections from existing satellite parking facilities. It would take 14 new morning peak period bus trips to increase frequencies on existing feeder bus routes, and eight new neighborhood circulator bus trips in the morning peak period, to facilitate the needed shift of patrons from Park & Ride to bus modes of access.

Table 34 Scenario V2: Increased Bus with Kiss & Ride Redesign

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	5,375	49.6%	-585
Kiss & Ride	1,162	10.7%	115
Bus	2,329	21.5%	470
Walk	1,474	13.6%	
Bike	389	3.6%	
Other	108	1.0%	
Total	10,837	100.0%	

The Kiss & Ride at the Vienna station is currently subject to long queues of vehicles, likely deterring some would-be Kiss & Ride passengers. A facility redesign that included features such as a remote "cell phone waiting area" or other alternative waiting areas, could be constructed to reduce the queues currently experienced and attract new Kiss & Ride patrons. However, additional space is not currently available at the station site for expansion of this facility.

Even with the increase in Kiss & Ride, bus, walk and bike access to Vienna expected to result from the application of Scenario V2 strategies, the majority of Vienna patrons (50 percent) would continue to access the station via Park & Ride.

The costs calculated for Scenario V2 are shown in Table 35.

Table 35: Scenario V2 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Dynamic Pricing	Capital	$328,472 ($66 / space)
	Operating	$32,847/year (at 10% capital cost per year)
Real-Time parking information	Capital	$3,284,722 ($660 / space)
	Operating	$328,472/year (at 10% capital cost per year)
Preferred carpool spaces and discounts, enforcement	Operating	$4,665 / year (equal to 2 FTE over 35 stations)
Neighborhood circulator service and improved feeder bus service	Capital	$5,520,000
	Operating	$386,681 / year
Redesigned kiss and ride (annualized costs, include capital and operating)	Combined	$2,833/year (@ $480 / surface space / year)

Scenario V3: Construct Additional Parking

Scenario V3 explores the impact of constructing an additional structured parking facility at Vienna. The two strategies selected for this scenario include:

- Convert one existing surface lot to multi-level Park & Ride
- Real-time parking information

Table 36 Scenario V3: Construct Additional Parking

Mode of AM Peak Access	2040 Access Mode Share	2040 Access Mode Share	Change from the Base Case
Park & Ride	6,135	56.6%	175
Kiss & Ride	972	9.0%	-75
Bus	1,759	16.2%	-100
Walk	1,474	13.6%	
Bike	389	3.6%	
Other	108	1.0%	
Total	10,837	100.0%	

The conversion of the existing surface parking North lot to a multi-level, structured parking facility would result in the addition of 1,545 Park & Ride spaces at Vienna. Assuming that the average vehicle occupancy of 1.04 remained constant, these additional spaces would generate enough Park & Ride capacity to accommodate 6,982 passengers. This increased parking capacity would more than provide for the anticipated number of Park & Ride patrons in 2040, and would in fact generate a “surplus” of 814 unused parking spaces daily based on the assumptions of this scenario. In order to maintain a conservative estimate for the purpose of the benefit/cost analysis, this scenario did not attribute any induced parking demand based on increased supply. This surplus of parking spaces is the result of the fact that should WMATA build additional parking, it would likely build a multi-level garage similar in profile to the existing parking garages at Vienna, The capacity of the envisioned garage is based on the assumption that WMATA would replace an entire surface lot (the North lot), and realize a quadrupling of capacity through that conversion.

Real-Time parking information technologies would be employed to assist patrons in locating available parking spaces across all of the Vienna station parking facilities.

The costs calculated for Scenario V3 are shown in Table 37.

Table 37: Scenario V3 Costs

Strategy	Cost Type	Cost used in Benefit-Cost Analysis
Real-Time parking information	Capital	$4,580,278 ($660 / space)
	Operating	$328,472/year (at 10% capital cost per year)
Convert surface lot to garage of 2,080 spaces (annualized costs, include capital and operating):	Combined	$1,633,539/year (@ $793 / structured space / year

Benefit-Cost Analysis

Analysis of Benefits to WMATA and the Region

The benefit-cost analysis (BCA) conducted as part of the WMATA Station Access Alternatives Study (SAAS) estimated the benefits and costs for two potential alternatives for each of the five case study stations. This BCA is conducted in accordance with the benefit-cost methodology as recommended by the US DOT in the Federal Register.[26] This analysis focused on peak-period performance, where station access capacity becomes a constraint. Accordingly, all benefits incurred are assumed to be incurred during the AM and PM peak periods.

Benefits and costs are typically evaluated for a period that includes the construction period and an operations period ranging from 20-50 years after the initial project investments are completed. Given the permanence and relatively extended design life of capital infrastructure investments in transit stations, longer operating periods, and thus, evaluation periods are often used.

For the WMATA SAAS projects, the evaluation period includes 30 years of operations beyond project completion, within which benefits accrue. All access improvements were assumed to be completed in 2020 for the purpose of this analysis, and benefits are assumed to begin accruing in the same year. Capital costs of all alternatives were applied as a one-year expenditure occurring in the year prior to opening for operations, i.e. 2019.

As a simplifying assumption, all benefits and costs are assumed to occur at the end of each year, and all benefits begin in the year immediately following the final construction year.

The project region for this study is assumed to be the WMATA service area, which consists of the District of Columbia; Arlington County, VA; City of Alexandria, VA; Fairfax County, VA; Falls Church, VA; Fairfax City, VA; Montgomery County, MD; and Prince Georges County, MD. All benefits and costs are assumed to be incurred within this region.

The costs utilized in the BCA have been outlined for each scenario in the preceding section. The term 'cost' refers to the additional resource costs or expenditures required to implement, perpetuate, and maintain the investments associated with the scenario. All costs were expressed in 2011 dollars.

Benefits were calculated for each scenario in the areas of state of good repair, economic competitiveness, livability, environmental sustainability, and safety. Table 38 below includes a complete list of the benefits sub-categories that were analyzed for each scenario. For greater detail on these benefits and how they are calculated, se the separate Metrorail Station Access Benefit-Cost Analysis Technical Memorandum.

[26] 75 Federal Register 30460

Table 38: Benefits Categories Used in the BCA

Benefits Category	Sub-category
State of Good Repair	Reduced Pavement Damage from vehicles
Economic Competitiveness	Travel Time Savings Fuel Savings Reduced non-fuel O&M Costs (non-transit) Reduction in oil imports - societal benefits Reliability Productivity
Livability	Noise reduction
Environmental Sustainability	CO Reductions NOX reductions PM10 reductions SO2 reductions VOC reductions CO2 reductions
Safety Benefits	Fatality reductions Injury reduction Property Damage Only

Benefit-Cost Analysis Results

The following three common benefit-cost evaluation measures are included in this BCA, each tailored to compare benefits and costs from different perspectives.

Net Present Value (NPV): NPV compares the net benefits (benefits minus costs) after being discounted to present values using the real discount rate assumption. The NPV provides a perspective on the overall dollar magnitude of cash flows over time in today's dollar terms.

Benefit Cost (B/C) Ratio: The evaluation also estimates the benefit-cost ratio; where the present value of incremental benefits divided by the present value of incremental costs yields the benefit-cost ratio. The B/C Ratio expresses the relation of discounted benefits to discounted costs as a measure of the extent to which a project's benefits either exceed or fall short of their associated costs.

This analysis shows that the anticipated quantifiable benefits from the WMATA Station Access Study projects exceed their anticipated costs. The two Shady Grove alternatives (S2 and S4) exhibit the highest B/C ratios, largely due to the long travel distances exhibited by Shady Grove passengers. By accommodating these trips, S2 and S4 reduce a high amount of Vehicle Miles Traveled (VMT) relative to other scenarios, thereby resulting in a higher level of benefit per unit of service delivered

Table 39: Benefit-Cost Analysis Summary, All Alternatives

Alternative	B/C Ratio	Net Present Value (2011 $)
Fort Totten, F1	1.53	4,165,418
Fort Totten, F2	2.75	7,639,494
Huntington, H1	1.26	6,799,579
Huntington, H2	1.90	15,367,672
Naylor Road, N1	1.49	3,906,216
Naylor Road, N3	1.13	1,377,042
Shady Grove, S2	10.21	99,770,868
Shady Grove, S3	9.87	109,061,998
Vienna, V2	2.49	24,267,451
Vienna, V4	2.45	43,658,088

Recommendations

Possibilities for Pilot Programs

In the Station Access Alternatives Study, a set of individual strategies was identified for stations within the five WMATA station types that were the focus of this study. The intent of these scenarios was to broadly identify which strategies may be effective with each station type. The benefit-cost analysis showed that the anticipated quantifiable benefits exceed the anticipated costs for each scenario. Therefore, a logical next step would be to begin to identify specific elements from each scenario for possible implementation.

Implementation of the strategies would initially take place via a pilot program model, where strategies would be implemented in a systematic and gradual manner and subsequently evaluated. Implementing strategies via pilot programs will allow WMATA to better understand the impact of individual strategies in shifting modes of access to WMATA stations, and thus further invest in the most effective toolbox strategies. Some strategies that are already in use at certain stations may still be considered for pilot programs if they could be implemented on a broader scale (e.g. real-time parking information) or in a more comprehensive manner (e.g. improving pedestrian links).

Pilot programs would be implemented at a single station in order to test the effectiveness and identify necessary adjustments before implementing elsewhere. Some strategies would require physical station-level improvements and are relevant in certain station access and surrounding land use contexts. For example, a Kiss & Ride redesign may be a greatly needed improvement at one station, but have little to no impact at another.

Table 40 delineates the toolbox strategies by those that could work at individual stations.

Table 40: Potential for Pilot Strategies

Strategies	Already in Use	Potential Pilot Program
Real-Time Parking Information	■	■[27]
Parking Districts		■
Shared Satellite Parking		■
Shared Parking with Joint or Adjacent Development		■
Dynamic Ridesharing		■[28]
Preferred Carpool Spaces and Discounts		■
Dynamic Pricing		■
Enhanced Real-Time Parking Information[29]	■	
Add Satellite Parking	■	
Improved Connections from Satellite Parking		■
Increased Frequency of Feeder Bus Service	■	
Neighborhood-Focused Bus Service	■	■
Create Shuttle Management Policy		■
Improve Pedestrian Links	■	■
Kiss & Ride Redesign	■	

There are two basic approaches through which WMATA could choose to pursue station based pilots, including:

- Individual station pilot(s) of a single strategy
- Piloting multiple strategies (as appropriate) by station

An individual station pilot of a single strategy would allow WMATA to assess the impact of an individual strategy in shifting modes of access prior to making a commitment to employ that strategy at multiple stations. This may be important for strategies that would require a capital investment, such as a Kiss & Ride redesign or the addition of satellite parking. WMATA could pursue the implementation of different strategies at different stations simultaneously, and then evaluate the impact of individual strategies collectively to inform future investments in implementing toolbox strategies.

WMATA may also choose to pilot multiple strategies at an individual station(s) at one time, depending on the resources available. Several of the station access strategies may work well if implemented together as a bundled "package." For example, the addition of enhanced real-time parking information could be coupled with dynamic pricing to maximize the impact of the latter on demand.

[27] Real-time parking information has been implemented for the metered parking spaces at Ft. Totten Station, yet could still be considered a pilot program if implemented for all spaces at a station.

[28] Scale of pilot program would be greater than a single station.

[29] "Enhanced Real-time Parking Information" refers to a system that not only informs potential users of the number of available spaces, but also guides users to the spaces which are open. Examples of such systems in practice can primarily be found at airport parking facilities, including within the region at Dulles International Airport and BWI Thurgood Marshall Airport.

At many of the stations comprehensive station access studies have been completed, and WMATA recently completed a systemwide Bicycle and Pedestrian Access Improvements Study. These studies, along with analyses of local area plans and other relevant planning documents, could be used to develop a comprehensive station-based access improvement implementation plan.

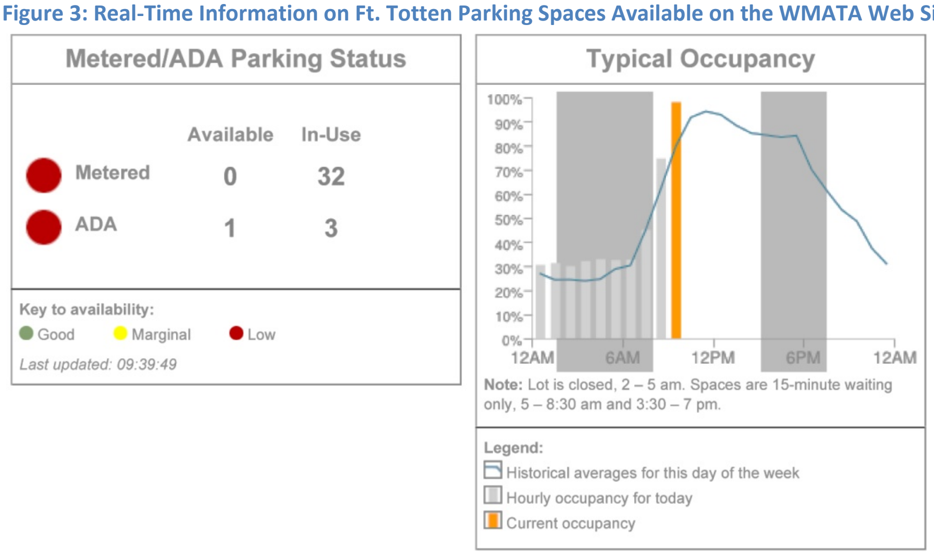
The following sections outline how some of the strategies identified could be implemented as pilot programs. These strategies are considered some of the most conducive to being piloted, but this is by no means a comprehensive list.

Real-Time Parking Information

Real-time parking information can be used as a tool to balance parking supply and demand systemwide. By providing information about parking availability at various stations, WMATA can encourage more utilization at underutilized stations and better manage overflow parking at constrained stations. This would benefit WMATA by maximizing the efficient use of its constrained parking resources. With better information about available parking, Metrorail customers can identify potential parking locations without spending time looking for parking at a Park & Ride facility already at capacity.

Real-time parking information can be implemented at a variety of levels, ranging from signs placed at station entrances that tell whether or not a given lot is full to enhanced approaches that display the exact number of spaces available in real time or even direct drivers to those spots that are available. An example of enhanced real-time parking information has already been implemented within the Metrorail system. In June 2011, WMATA launched a pilot program at Fort Totten station to monitor and communicate information about metered parking spaces at the station. This system is compatible with the Parker Smartphone app, which indicates parking availability, shows a timer for the meter, and helps the user find their car in the parking lot.

Figure 3: Real-Time Information on Ft. Totten Parking Spaces Available on the WMATA Web Site.



WMATA is planning to implement a real-time parking information system in the non-metered parking facilities of the Vienna Station. At Vienna's south surface lot, a loop monitor device will detect vehicles entering and exiting the lot, providing an indication of whether or not the lot is full. The entry and exit sensor will be supplemented by a sampling of individual-space sensors within the reserved portion of the lot in order to provide an estimate of the availability of reserved parking. Later phases of the pilot program will include a sampling of space sensors in the non-reserved spaces. Passengers will be able to access information on parking availability through a mobile application provided by the Streetline Company, WMATA's partner in the project.

As WMATA continues to advance real-time parking information, implementation will likely need to be spaced over several years on a station-by-station basis, as expansion of the system will have to compete with all other capital programming priorities. The stations that should be prioritized for real-time parking information are those which show the highest utilization rates, especially those that are known to fill up early in the AM peak.

If implemented in conjunction with dynamic parking pricing, real-time parking information would have the benefit of directing passengers to those lots that have greater availability and lower rates. If passengers have access to such information, as well as pricing incentives to choose those stations with more available parking, the anticipated result would be a greater optimization of all parking resources, whereas currently certain lots fill up very early while others are not fully utilized. For example, on the western leg of the Red Line in FY 2010, Grosvenor-Strathmore and Rockville averaged over 100 percent usage while Shady Grove averaged over 90 percent. At the same time, White Flint and Twinbrook averaged only 50 percent and 75 percent, respectively. As satellite navigation systems advance, it is reasonable to assume that such information could be incorporated in much the same way as real-time traffic information is incorporated.

In the benefit-cost analysis, real-time parking information was assumed to have a capital expense of approximately $660 per parking space. This figure is based on WMATA's experience with sensor technology implementation at the Fort Totten station, as well as industry standards. In terms of operating and maintenance costs, real-time parking information technology is assumed to have an expense of ten percent of capital costs per year.

Shared Satellite Parking

Many Metrorail stations have Park & Ride lots that are at or above capacity, and many more will be reaching capacity in the near future. A way to expand parking supply at stations without building additional parking is through developing agreements with others who supply parking for different time periods. This strategy seeks to identify area parking lots with additional weekday capacity (such as large parking lots associated with strip retail and houses of worship) and encourage Metrorail customers to park there and walk or take transit to the nearby Metrorail station. Such off-site shared parking lots would be managed by private landowners, so the WMATA expenditures are considered minimal. The benefits to WMATA are that this strategy allows the expansion of parking capacity at stations without building additional parking facilities. On the other hand, the owners of these lots benefit from capturing revenue from surplus parking spaces. However, it is important to note that parking facilities serving existing uses may face significant limitations in formulating agreements with WMATA, including zoning restrictions and liability issues.

WMATA has experience using a shared parking strategy with a shuttle bus at a Metrorail station with constrained parking. At the Franconia-Springfield station at the southern end of the Blue Line, Metrobus operates the Transportation Association of Greater Springfield (TAGS) shuttle. This shuttle runs every 15 minutes on weekdays from 7 AM to 7 PM between the Springfield Mall, Hilton Springfield, the Metro Park office park complex, and the Metrorail station. This shuttle aims to connect the station (and its constrained parking) to the mall to the west and office park to the east (with their plentiful free parking). The shuttle is free to customers traveling eastbound from the Metrorail station to Metro Park, while a fare of 25 cents is charged to customers traveling westbound to the Springfield Mall or Hilton Springfield.

The Naylor Road Station Access Study identified several potential locations for shared parking in the vicinity of the Naylor Road, Suitland, and Southern Avenue Stations that WMATA could explore. In all, roughly 5,000 spaces were identified at locations on the property of major commercial centers and houses of worship. Each of those locations are within short (<10 minute) bus ride distances to one of the above stations.

Certain station typologies are more likely to be suited to shared parking strategies than others. The two typologies that could do well with shared parking strategies include Long Term Potential for High-Density TOD or PUD and Auto Collector/Suburban Freeway. Certain end of line stations could also adapt to shared parking, particularly with shuttle service. The Vienna station is currently served by several long-haul bus routes that connect to free park & ride lots more than 10 miles away.

If WMATA seeks to expand this practice to additional stations, multiple factors will need to be considered in choosing implementation. Availability of appropriate facilities within walking and/or short bus trip distance is an obvious determinant, but equally important is the availability of good pedestrian infrastructure or frequent and inexpensive transit service that can be utilized to provide users with a quick, low-cost connection to the station.

In the Benefit Cost Analysis, shared parking was assumed to have an annualized cost (inclusive of capital and operating costs) of $480 per surface parking space per year. This figure was developed for the benefit/cost analysis using historic expenditures on WMATA parking assets, annualized over a thirty-year span.

Shared Parking with Joint or Adjacent Development

Many of the stations with surface parking facilities are slated for joint development in the future. Others will see significant development on parcels adjacent to the station. In either case, WMATA may seek to reach agreements with developers to allow one pool of parking to serve both transit customers and customers/residents of the development. Such an arrangement could save capital cost for both WMATA and the developer, making the joint development more viable for both parties. The viability of this approach is based on different peak periods of use (i.e. AM Peak for transit customers, afternoon and evening for retail establishments, entertainment venues or similar land uses).

An example of shared parking arrangement currently in place at a WMATA facility can be found at the Grosvenor-Strathmore station. During evening events at the Strathmore performing arts center, patrons with a valid ticket can park at the WMATA-owned garage. A share of the ticket proceeds is given to WMATA for use of the spaces and to provide a parking attendant to open the gates for Strathmore users.

To ensure that sufficient parking remains available for the businesses in the development, a certain number of spaces could be reserved during the AM Peak, or transit customers could be required to pay on entry and the number of entries allowed could be limited. However, such an arrangement would take a higher level of parking management than currently offered at many facilities.

WMATA could share in the funding of the parking facilities with the developer, and thus share the parking revenue as well. Even if WMATA does not co-fund, developers may be interested in entering into agreements with WMATA to share parking facilities based on the presumption that allowing transit parking may steer some additional customers to their businesses as they go to and from their cars.

Neighborhood-Focused Bus Service

All of the station types that formed the focus of this study are characterized by the proximity of residential neighborhoods, if not immediately adjacent to the station, well within the distance of a short transit trip. Despite the proximity of the station to these neighborhoods, many residents choose to drive to the station because of poor pedestrian and bicycle connections. However, these neighborhoods may have sufficient density to justify neighborhood-focused bus service connecting to the Metrorail station. By using SmarTrip data to identify and analyze potential station ridership within a 15-minute bus radius to a station and crafting bus or shuttle service to match this existing demand, local jurisdictions or Metrobus can maximize transit access to Metrorail stations. These bus services could be extensions of existing bus services or new routes, and should be coordinated regionally by station with area jurisdictions.

Potential stations that could benefit from neighborhood-focused bus service include the Urban Residential with Bus or Auto Orientation and Suburban Residential Area typologies. These station typologies are associated with stations located adjacent to residential neighborhoods. The proximity of these neighborhoods to Metrorail stations could allow short headways, with minimal travel times between the residential neighborhoods and stations. Public transportation has the potential to provide excellent station access while requiring minimal station space per passenger transferred. While the cost and effectiveness of neighborhood-focused bus service will naturally vary based on local conditions for each station, the Benefit Cost Analysis indicated that the cost per new passenger attracted through this strategy is roughly between $2.50 and $5.00. Cost figures were based on the actual rate of transfers from suburban feeder routes to Metrorail (10.1 per trip)[30], which was used to estimate the number of additional trips necessary.

Shuttle Management Policy

A number of public and private employers, property owners and other groups provide additional transit access to Metrorail stations in the form of shuttles or vanpools. At many stations, shuttles constitute a significant portion of station access during peak periods. By allocating space for this mode of arrival, WMATA can encourage viable transit access at little to no cost to the system, as the operating costs for shuttles are typically paid by others.

However, many of WMATA's Kiss & Ride and bus facilities are capacity constrained during peak periods. Therefore, care must be taken when encouraging this mode of access. WMATA should pursue a

[30] WMATA data on bus to rail transfers for the month of May, 2011.

systemwide shuttle policy. This policy should identify the location for shuttles to board and alight their passengers, the terms of use to be followed by shuttle providers and how to coordinate shuttles as a part of local Transportation Demand Management (TDM) policies.

Designing for Shuttles

One of the busiest stations in the Metrorail system in terms of shuttle activity is Van Dorn Street, which was noted in WMATA's 2011 Shuttle Study as exhibiting problems related to private shuttles blocking lanes in the Kiss & Ride lot, as well as laying over in an unsafe location on Eisenhower Avenue. Unregulated shuttle access creates an unsafe environment for shuttle passengers, Kiss & Ride users and pedestrians accessing the station. As such, Van Dorn Street Station provides a good case study to illustrate how a shuttle management policy could be implemented in terms of station design.

The largest shuttle vehicles serving Van Dorn Street Station could be assigned to board and alight passengers in one of the station bus bays instead of either utilizing the Kiss & Ride or stopping on Eisenhower Avenue. WMATA would review the utilization of the station's bus bays and determine which have excess capacity that could be used by private operators. Those operators would be required to tailor their schedules to accommodate published bus schedules.

For smaller shuttle vehicles, WMATA could create a designated shuttle loading zone or zones within the Kiss & Ride lot. The Van Dorn Kiss & Ride has approximately 400 feet of curb frontage for passenger pickups, but shuttles currently crowd into the space closest to the station entrance, often parking two or three deep along a small section of curb while leaving other long stretches unutilized. This creates a dangerous situation for pedestrians, who are forced to walk through a line of idling shuttles, as well as a major bottleneck for any vehicle passing through the Kiss & Ride. During the AM and PM peak periods the central, curved portion of the Kiss & Ride loading area should be reserved for privately-owned vehicles (shown as green-hatch symbol in Figure 4), whereas the portions of the loading area farther from the station entrance should be reserved for shuttles (shown as yellow-hatch symbol in Figure 4). Those areas reserved for shuttles could be broken into several marked "bays," which would further streamline shuttle operations by allowing passengers to wait at the exact location where their shuttle will load.

Figure 4: Van Dorn Street Station Kiss & Ride Lot (source: Google Earth)

Terms of Use

Systemwide, shuttle operators could be required to register with WMATA and agree to follow certain terms of use as spelled-out by WMATA. As part of each shuttle operator's agreement, WMATA would identify the location(s) where the operator is authorized to board and alight passengers at a given station. These locations would be identified by station access studies or as part of the development of the shuttle policy itself. WMATA staff or other party would perform spot observations of shuttles at stations to verify that operators are boarding & alighting passengers at approved locations.

Coordination with Local TDM Efforts

Many shuttle operations are part of local Transportation Demand Management (TDM) policies. However, these policies often do not account for duplicative efforts. For example, two projects right next to each other could both be required to provide a shuttle to the nearest Metrorail station as a mitigation, when in fact one shuttle operation could serve them both. This duplication of efforts can become problematic for WMATA as the number of shuttles serving the station increases the need for space for boarding and alighting.

WMATA's shuttle policy should address this issue by developing guidelines for local jurisdictions to follow when allowing shuttles to Metrorail stations to be used as part of a TDM strategy. The guidelines should explain when consolidation of shuttle routes would be appropriate as well as identify non-WMATA space near stations for boarding and alighting. WMATA may consider partnering with one or two local jurisdictions to develop a set of policies that could be piloted before implementing systemwide.

Preferred carpool spaces and discounts.

Preferred carpool spaces are attractive to WMATA as a potential pilot program due to the low cost threshold of such a program. In addition, such a program would provide the added benefit of flexibility, as the number of carpool spaces could be adjusted based on realized demand at the pilot stations. For customers, the primary benefit would be to share travel costs such as fuel and parking fees. Additional discounts would create an added incentive to carpool if sufficient enough to outweigh lost trip flexibility inherent in choosing to carpool.

A carpool preference program could be implemented either through a low-tech or high-tech approach. If a low-tech approach is chosen, then this strategy is among the lowest-cost options due to its lack of capital investment. In either case, enforcement is the critical factor for success, so that passengers who opt-in to any carpool system feel they are getting a worthwhile benefit that they are not sharing with numerous free riders.

Lower-technology solutions might include:

- Self-registration in a carpool program, in which two or more passengers identify themselves as carpool mates and commit to carpooling a certain percentage of weekdays. If said riders were required to register their smart fare media, travel patterns could be analyzed on a random basis to catch enrollees who are not living up to their carpool commitment
- Simple in-person enforcement by WMATA revenue enforcement personnel who observe carpool parking areas throughout the system on a rotating basis, ticketing those cars whose drivers violate the rules. Enforcement would not need to be omnipresent, but simply frequent (and random) enough that the chance of a ticket outweighs the benefit of parking in the carpool spaces illegally.

As technology develops in the long term, possible automated enforcement mechanisms might include:

- Carpool space “meters” that require touches from multiple fare media cards or QR codes on a Smartphone once the space is recorded as occupied by an embedded sensor. Failure to swipe would trigger enforcement, such as an automated message to Metro Transit Police or revenue enforcement personal.

- Passive camera systems that automatically record the number of occupants getting out of a vehicle, much as camera systems are being developed to detect passengers and thus enforce HOV restrictions on highways.

The benefit/cost analysis focused on in-person enforcement as the most likely method, and the cost of the parking enforcement personnel as the primary operating cost of carpool-preferential programs. Two full time equivalents (FTEs) were assumed to cover the enforcement role in the analysis of the scenarios, but actual staffing rates would need to be determined based on pilot program details prior to implementation.

Dynamic Ridesharing

Dynamic ridesharing utilizes online, mobile web platform applications and SMS text to match drivers with potential riders on a trip-by-trip basis in real-time. A pilot of dynamic ridesharing where WMATA is concerned would involve a partnership with a vendor who would provide the technological infrastructure, while WMATA would encourage use of the system among Metrorail passengers.

Only a few true pilots of dynamic ridesharing have taken place in the nation (including two in Northern Virginia, which are detailed on page 25). Several factors could serve to encourage the adaption of dynamic ridesharing technology in the WMATA service area, including the region’s persistent traffic congestion, the presence of high occupancy vehicle (HOV)/high occupancy toll (HOT) lanes on several major highways, and the established practice of “slugging,” or impromptu carpooling centered on established (but unofficial) pick-up locations.

Although not necessary, a dynamic ridesharing pilot project focused on station access could work in conjunction with preferred carpool spaces and discounts. In the dynamic ridesharing pilots that have occurred to-date, incentives have proven key to garnering participation. Particularly at stations in the “suburban residential area” and “auto collector/suburban freeway” typologies, a discount associated with carpool spaces may be attractive for WMATA patrons. WMATA may wish to work with agencies throughout the region that are currently engaged in dynamic ridesharing pilots or considering pilots, adding an explicit focus on facilitating dynamic ridesharing for station access.

As discussed, dynamic ridesharing is currently being piloted by other transportation agencies in the WMATA Compact region in various forms. Dynamic ridesharing requires a critical mass of users to be successful. It may be difficult to reach the required critical mass of users if transportation agencies in the region all selected varying vendors to operate dynamic ridesharing pilots. WMATA may also look to other transportation agencies implementing these pilots currently to ask them to include a focus on WMATA riders in their current efforts. For the same reasons, any dynamic ridesharing pilot would likely be implemented across several stations, if not system-wide. Potential users would be more likely to commit to signing up for a service if it can be used to arrange rides to numerous places rather than a few (or one). Finally, WMATA should coordinate with transportation agencies in the region and beyond to access and apply the knowledge gained from others' pilot projects.

Recommendations by Station Type

In addition to identifying a handful of potential pilot programs, a key objective of this study is to identify those strategies most suitable to each of the five station types that were studied in depth through case studies. The typologies were developed based on the current land use and transportation characteristics of a given station. While each station in the Metrorail system possesses unique characteristics, they do share certain common characteristics, and thus are likely to benefit from the same approaches by and large. However, it is important to note that over time, each station will evolve as the area around it changes.

Table 41: The Five Station Types Included in the Study

Station Type	Characteristics	Case Study Station
Urban Residential Area with a Bus/Automobile Orientation	• Urban residential context • Significant bus station access and bus transfer activity	Fort Totten
Mixed Use in a Pod Layout	• Pods of commercial activity separated by surface parking lots and other barriers • Existing station facilities are focused on automobile access	Vienna
Long-Term Potential for High Density TOD or PUD	• Underutilized nearby property • Potential for large-scale redevelopment	Naylor Road
Suburban Residential Area	• Close to significant suburban residential development • Minimal mix of uses • Existing station facilities are focused on automobile access	Huntington
Auto Collector/Suburban Freeway	• Heavily auto-oriented • Major roads in the area act as barriers to pedestrian and bicycle access	Shady Grove

Urban Residential Area with a Bus/Automobile Orientation

The Urban Residential Area with a Bus/Automobile Orientation station type is the most urban of the station types that include Park & Ride lots. This type of station consists of predominately single-use development with lower to moderate densities in an urban context, typically with auto and bus orientation and lower shares of bicycle and pedestrian utilization. In this report, the case study station was the Fort Totten station.

Table 42: Potential Strategies for Urban Residential Area with Bus/Automobile Orientation Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Pedestrian Links	■		
Real-Time Parking Information	■		
Preferred Carpool Spaces and Discounts		■	
Neighborhood-Focused Bus Service		■	
Coordinate with Private Shuttles		■	

The strategies that are recommended for Urban Residential stations include those that are more suited to more compact, urban environments. In the short-term, enhancing pedestrian links is a strategy that can be very effective with this type of station, because of the concentration of nearby residential development. Site-specific pedestrian improvements can encourage pedestrian activity at these typically bus- and auto-oriented stations.

The real-time parking information that has seen success at the Fort Totten station's metered parking spaces should also be encouraged at this type of station. Because of their location closer in to the central business district, Urban Residential Area with Bus/Automobile Orientation stations are good backup stations for those who cannot find parking at more suburban Metrorail stations. Information on available parking is essential for this station type to be effective as an option.

In the medium-term time frame, strategies that encourage transit access and make more efficient use of existing parking spaces are also recommended for Urban Residential Area with Bus/Automobile Orientation stations. To use existing parking facilities more efficiently, a carpool incentive program with preferred carpool spaces and/or parking discounts could be very effective. These stations are also well-suited for neighborhood circulators or private shuttles that connect the station with nearby concentrations of residential development. Many of these stations already have significant numbers of bus transfers and high rates of bus access to Metrorail, providing a strong foundation for enhanced transit access to the station.

Mixed Use in a Pod Layout

The Mixed Use in a Pod Layout station type is characterized by surrounding pods of single-use activity with little connection between them or the station. These stations are typically auto-oriented, with significant parking lots and difficult street crossings for cyclists and pedestrians. In this report, the case study station was Vienna-Fairfax, which is currently experiencing redevelopment adjacent to the station.

Table 43: Potential Strategies for Mixed Use in a Pod Layout Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Increased Frequency of Feeder Bus Service	■		
Real-Time Parking Information		■	
Neighborhood-Focused Bus Service		■	
Kiss & Ride Redesign			■

The strategies recommended for Mixed Use in a Pod Layout stations aim to capitalize on the nodes of development close to these stations. In many of these stations, there is significant residential or commercial density near the station. In addition, many of these stations do have strong bus service already. A short-term strategy for Mixed Use in a Pod Layout stations is to capitalize on this existing bus service by improving frequency of service to the station. While this existing bus service is restored or enhanced in the short term, in the medium term neighborhood-focused bus service should be established to better connect these pods of development with the station.

In the medium term, Real-Time parking information should be pursued at these stations. The Mixed Use in a Pod Layout stations include both those with significantly underutilized parking (like the White Flint station) and those with constrained parking (like Vienna). Real-Time parking information, as part of a systemwide implementation strategy, will help to balance supply and demand at these stations.

Many of these stations have higher shares of passenger drop-offs because of their proximity to pods of residential development. In the long term, these stations may be ideally suited for Kiss & Ride redesigns. Cell phone waiting areas and separate waiting and circulation areas could improve traffic flow at many of these stations. However, it is important to note that such facilities would require additional space within the station area.

Long-Term Potential for High Density TOD or PUD

The Long-Term Potential for High Density Transit Orientated Design (TOD) or Planned Unit Development (PUD) station types are generally surrounded by underutilized property, but these stations have the potential to change significantly in the future. Today, these stations are typically auto-oriented, with large surface parking lots and proximity to major arterials. The station of this type studied in this report was Naylor Road.

Table 44: Potential Strategies for Long-Term Potential for High Density TOD or PUD Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Shared Parking with Feeder Bus Service	■		
Increased Frequency of Feeder Bus Service	■		
Preferred Carpool Spaces and Discounts		■	
Real-Time Parking Information		■	
Neighborhood-Focused Bus Service			■

Long-Term Potential for High Density TOD or PUD stations can benefit from short-term improvements in feeder bus service. These stations typically have strong bus access shares already, so targeted improvements to bus service can help grow those numbers. Additionally, a short-term focus on satellite parking with feeder bus service may be effective at these stations. Naylor Road, the case study station in this report, has had informal shared parking near the station in the past, and other stations of this type may see more of this as parking becomes more constrained.

In the medium term, strategies to more effectively utilize existing parking should be considered for these stations. A carpool incentive program with preferred spaces or parking discounts could increase station access capacity without building new parking facilities. Real-time parking information could help to balance supply and demand at these stations, which are generally along a corridor of similar stations. For example, real-time parking information along Suitland Parkway in Prince George's County could help to make more efficient use of the parking at all four Metrorail stations in that corridor: Branch Avenue, Suitland Parkway, Naylor Road, and Southern Avenue.

Finally, in the long-term, these stations are well-suited for neighborhood-focused bus service. Several of the stations in this typology already have good bus access to stations, but many of the routes don't effectively serve the areas surrounding the stations (in the case of Naylor Road, many residents of the surrounding neighborhoods would take a Metrobus to a different Green Line station). This bus service should be planned in coordination with any future TOD or PUD development in the station areas.

Suburban Residential Area

Suburban Residential Area stations are characterized by low- to medium-density residential land use in the surrounding area. The stations themselves are typically auto-oriented, sited near major arterials, with large amounts of car parking. While some of these stations have shared-use paths proximate to the station, there are missing links in the bicycle and pedestrian infrastructure. In this report, Huntington was the case study station examined for the Suburban Residential Area typology.

Table 45: Potential Strategies for Suburban Residential Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Satellite Parking with Connector Service	■		
Preferred Carpool Spaces and Discounts	■		
Improve Bike and Pedestrian Links	■		
Neighborhood-Focused Bus Service		■	
Real-Time Parking Information			■
Dynamic Pricing			■

First, WMATA should aim to address missing links in bicycle and pedestrian infrastructure, as these are relatively low-cost and efficient ways to improve station access. Other short-term strategies that are recommended for Suburban Residential stations focus on expanding parking supply though more efficient use of existing parking resources and connecting other satellite parking lots to the station. Many of these stations are at or over parking capacity, so encouraging carpools through preferred spaces or discounts could make better use of the existing constrained parking spaces.

In the medium term, Suburban Residential Area stations are well-suited for neighborhood circulator bus service as well. Many of these stations are surrounded by medium-density residential developments, and with well-planned schedules and routes, a neighborhood circulator service could connect these residential areas with Metrorail stations. Satellite parking with connector bus service would allow parking for Metrorail customers off-site, thus increasing parking supply without having to construct additional parking.

In the long term, Suburban Residential Area stations should be considered for parking strategies that balance supply and demand more efficiently. Dynamic parking pricing, coupled with real-time parking information, could be very effective in making the best use of constrained parking at these stations.

Auto Collector/Suburban Freeway

Auto Collector/Suburban Freeway stations are located in suburban areas, typically adjacent to interstates and major collectors. A single land use, typically low-density residential development, tends to dominate these areas under current conditions. However, these stations also have a great opportunity for High Density TOD or PUD in the future. The stations themselves are quite large and accommodate large numbers of parked cars, as they are typically at the end of a Metrorail line. The Auto Collector/Suburban Freeway station studied for this report was Shady Grove.

Table 46: Potential Strategies for Auto Collector/Suburban Freeway Stations

Toolbox Strategies	Short-Term	Medium-Term	Long-Term
Coordinate Private Shuttles	■		
Preferred Carpool Spaces and Discounts	■		
Neighborhood-Focused Bus Service	■		
Shared Parking Facilities			■
Redesign Kiss & Ride			■

As Auto Collector/Suburban Freeway stations are the most auto-oriented typology, strategies to improve station access focus on making more efficient use of existing parking and encouraging bus and shuttle access. In the short term, shuttles and neighborhood circulator services can encourage transit access to the station from activity generators and nearby residential areas. Additionally, preferred carpool spaces and discounts can better utilize limited parking spaces at these highly-used stations.

In the long term, Auto Collector/Suburban Freeway stations could benefit from shared parking facilities, either connected with bus or shuttle service from more remote satellite facilities, or from nearby parking lots. Also in the long term, these stations could benefit from redesigned Kiss & Ride facilities given the auto-oriented nature of these stations.

Appendix 1: Per-Passenger Unit Cost Figures

One of the goals of the project was to calculate the current, systemwide cost per passenger of principal arrival modes. **The unit cost figures from this analysis were developed for informative purposes only, and were not used as a basis of calculations in the benefit/cost analysis, as these are tailored to each specific scenario.** These unit costs incorporate capital, operating, and maintenance costs; which are aggregated together to calculate costs on a per-year basis during the AM Peak period for fiscal year 2011. The final costs were expressed on a per-passenger level, both for the 'maximum' passenger capacity level, as well as the 'actual' passenger level. Costs were included for Parking, Kiss and Ride, Bus, and Bicycling. Walking was initially calculated but determined to have a negligible per-passenger cost. Thus, these costs were excluded from this analysis.

The final per-passenger costs of each mode using two capacity definitions are shown below. Note, the cost analysis of parking facilities was based upon a recent analysis conducted by WMATA that compared the current maintenance practices and replacement schedules of parking assets ("Baseline") with a revised approach featuring a greater emphasis on preventive maintenance. In general, this study found that increased preventive maintenance activity could significantly reduce the long-term cost to WMATA of operating its parking facilities by extending their useful lives.

Parking

	Costs	Costs - **less** Revenue
Annualized cost per AM Peak Passenger Served at Maximum Capacity (Baseline Scenario)	$3.96	($0.38)
Annualized cost per AM Peak Passenger in 2010 (Baseline Scenario)	$4.52	$1.17

Annualized cost per AM Peak Passenger Served at Maximum Capacity (Preventive Maintenance Scenario)	$3.35	($0.99)
Annualized cost per AM Peak Passenger in 2010 (Preventive Maintenance Scenario)	$3.83	$0.48

Kiss and Ride

Annualized cost per AM Peak Passenger Served at Maximum Capacity	$0.01	$0.01
Annualized cost per AM Peak Passenger (Actual 2010)	$0.15	$0.15

Bus

Annualized cost per AM Peak Passenger Served at Maximum Capacity	$0.29	($0.87)
Annualized cost per AM Peak Passenger (Actual 2010)	$4.73	$3.57

Appendix 2: Detailed Benefit-Cost Analysis Results

Benefits and Costs by Category, with B/C Results, Fort Totten F1

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	8,139
	Subtotal state of good repair	8,139
Economic Competitiveness		
	Travel Time Savings	3,656,580
	Fuel Savings	884,691
	Reduced non-fuel O&M Costs (non-transit)	644,906
	Reduction in oil imports - societal benefits	840,456
	Reliability	3,458,801
	Productivity	1,319,441
	Subtotal economic competitiveness	10,804,878
Livability		
	Noise reduction	7,513
	Subtotal Livability	7,513
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	2,523
	PM10 reductions	40,878
	SO2 reductions	418.5
	VOC reductions	1,311
	CO2 reductions	82,532
	Subtotal Environmental	127,664
Safety Benefits		
	Fatality reductions	353,258
	injury reduction	618,509
	Property Damage Only	79,393
	Subtotal Safety	1,051,161
Total Benefits		**11,999,357**
Costs	Dynamic Pricing, Capital	19,647
	Real-Time Parking Info, Capital	196,474
	Preferred Parking, Operating	59,953
	Circulator, Capital	2,520,881
	Circulator, Operating	4,656,853
	Dynamic Pricing, Operating	34,558
	Real-Time Parking Info, Operating	345,570
Total Costs		**7,833,939**
B/C Ratio		**1.53**
Net Present Value		**4,165,418**

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Benefits and Costs by Category, with B/C Results, Fort Totten F2

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	8,139
	Subtotal state of good repair	8,139
Economic Competitiveness		
	Travel Time Savings	3,656,580
	Fuel Savings	884,691
	Reduced non-fuel O&M Costs (non-transit)	644,906
	Reduction in oil imports - societal benefits	840,456
	Reliability	3,458,801
	Productivity	1,319,441
	Subtotal economic competitiveness	10,804,878
Livability		
	Noise reduction	7,513
	Subtotal Livability	7,513
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	2,523
	PM10 reductions	40,878
	SO2 reductions	418.5
	VOC reductions	1,311
	CO2 reductions	82,532
	Subtotal Environmental	127,664
Safety Benefits		
	Fatality reductions	353,258
	injury reduction	618,509
	Property Damage Only	79,393
	Subtotal Safety	1,051,161
Total Benefits		**11,999,357**
Costs	Dynamic Pricing, Capital	19,647
	Real-time Parking Info., capital	196,474
	Preferred Parking, operating	59,953
	Private Shuttle, operating	3,301,779
	Shuttle bus loop, capital	401,879
	Dynamic Pricing, Operating	34,558
	Real-Time Parking Info, Operating	345,570
Total Costs		**4,359,862**
B/C Ratio		**2.75**
Net Present Value		**7,639,494**

Benefits and Costs by Category, with B/C Results, Huntington H1

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	29,688
	Subtotal state of good repair	29,688
Economic Competitiveness		
	Travel Time Savings	7,889,533
	Fuel Savings	3,228,015
	Reduced non-fuel O&M Costs (non-transit)	2,352,209
	Reduction in oil imports - societal benefits	3,066,615
	Reliability	8,550,933
	Productivity	3,046,067
	Subtotal economic competitiveness	28,133,376
Livability		
	Noise reduction	27,404
	Subtotal Livability	27,404
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	9,202
	PM10 reductions	149,097
	SO2 reductions	1,526
	VOC reductions	4,784
	CO2 reductions	301,026
	Subtotal Environmental	465,638
Safety Benefits		
	Fatality reductions	1,288,462
	injury reduction	2,255,930
	Property Damage Only	289,577
	Subtotal Safety	3,833,971
Total Benefits		**32,490,077**
Costs	Dynamic Pricing, Capital	179,193
	Real-time Parking Info., capital	1,791,936
	Preferred parking, operating	59,953
	Connector, capital	6,050,114
	Connector, operating	11,269,485
	Satellite parking, capital	2,920,660
	Dynamic Pricing, Operating	315,163
	Real-Time Parking Info, Operating	3,103,990
Total Costs		**25,690,498**
B/C Ratio		**1.26**
Net Present Value		**6,799,579**

Benefits and Costs by Category, with B/C Results, Huntington H2

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	29,688
	Subtotal state of good repair	29,688
Economic Competitiveness		
	Travel Time Savings	7,889,533
	Fuel Savings	3,228,015
	Reduced non-fuel O&M Costs (non-transit)	2,352,209
	Reduction in oil imports - societal benefits	3,066,615
	Reliability	8,550,933
	Productivity	3,046,067
	Subtotal economic competitiveness	28,133,376
Livability		
	Noise reduction	27,404
	Subtotal Livability	27,404
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	9,202
	PM10 reductions	149,097
	SO2 reductions	1,526
	VOC reductions	4,784
	CO2 reductions	301,026
	Subtotal Environmental	465,638
Safety Benefits		
	Fatality reductions	1,288,462
	injury reduction	2,255,930
	Property Damage Only	289,577
	Subtotal Safety	3,833,971
Total Benefits		**32,490,077**
Costs	Dynamic Pricing, capital	179,193
	Real-time Parking Info., capital	1,791,936
	Preferred Parking, operating	59,953
	Circulators, capital	5,041,762
	Circulators, operating	6,629,107
	Dynamic Pricing, Operating	316,461
	Real-Time Parking Info, Operating	3,103,990
Total Costs		**17,122,405**
B/C Ratio		**1.90**
Net Present Value		**15,367,672**

Benefits and Costs by Category, with B/C Results, Naylor Road N1

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	7,991
	Subtotal state of good repair	7,991
Economic Competitiveness		
	Travel Time Savings	2,603,912
	Fuel Savings	867,994
	Reduced non-fuel O&M Costs (non-transit)	633,150
	Reduction in oil imports - societal benefits	824,594
	Reliability	4,201,741
	Productivity	1,533,372
	Subtotal economic competitiveness	10,664,766
Livability		
	Noise reduction	7,376
	Subtotal Livability	7,376
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	2,477
	PM10 reductions	40,132
	SO2 reductions	410.87
	VOC reductions	1,287
	CO2 reductions	81,028
	Subtotal Environmental	125,337
Safety Benefits		
	Fatality reductions	346,818
	injury reduction	607,234
	Property Damage Only	77,946
	Subtotal Safety	1,032,000
Total Benefits		**11,837,471**
Costs	Real-time Parking Information, capital	177,273
	Preferred Parking, operating	59,953
	Bus service, capital	2,520,881
	Bus service, operating	4,861,350
	Real-Time Parking Info, Operating	311,796
Total Costs		**7,931,254**
B/C Ratio		**1.49**
Net Present Value		**3,906,216**

Benefits and Costs by Category, with B/C Results, Naylor Road N3

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	7,991
	Subtotal state of good repair	7,991
Economic Competitiveness		
	Travel Time Savings	2,603,912
	Fuel Savings	867,994
	Reduced non-fuel O&M Costs (non-transit)	633,150
	Reduction in oil imports - societal benefits	824,594
	Productivity	4,201,741
	Reliability	1,533,372
	Subtotal economic competitiveness	10,664,766
Livability		
	Noise reduction	7,376
	Subtotal Livability	7,376
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	2,477
	PM10 reductions	40,132
	SO2 reductions	410.87
	VOC reductions	1,287
	CO2 reductions	81,028
	Subtotal Environmental	125,337
Safety Benefits		
	Fatality reductions	346,818
	injury reduction	607,234
	Property Damage Only	77,946
	Subtotal Safety	1,032,000
Total Benefits		**11,837,471**
Costs	Dynamic Pricing, Capital	17,727
	Real-time parking information, capital	177,310
	Preferred parking, operating	59,953
	Bus service, capital	2,520,881
	Bus service, operating	5,303,283
	Satellite parking, capital	2,038,234
	Dynamic Pricing, Operating	31,178
	Real-Time Parking Info, Operating	311,860
Total Costs		**10,460,428**
B/C Ratio		**1.13**
Net Present Value		**1,377,042**

Benefits and Costs by Category, with B/C Results, Shady Grove S2

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	107,548
	Subtotal state of good repair	107,548
Economic Competitiveness		
	Travel Time Savings	29,755,373
	Fuel Savings	11,777,667
	Reduced non-fuel O&M Costs (non-transit)	8,521,145
	Reduction in oil imports - societal benefits	11,188,784
	Productivity	25,804,066
	Reliability	7,772,173
	Subtotal economic competitiveness	94,819,211
Livability		
	Noise reduction	99,275
	Subtotal Livability	99,275
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	33,338
	PM10 reductions	540,120
	SO2 reductions	5,529
	VOC reductions	17,333
	CO2 reductions	1,090,503
	Subtotal Environmental	1,686,826
Safety Benefits		
	Fatality reductions	4,667,602
	injury reduction	8,172,363
	Property Damage Only	1,049,027
	Subtotal Safety	13,888,993
Total Benefits		**110,601,855**
Costs	Dynamic Pricing, Capital	290,425
	Real-time Parking Info., capital	2,904,250
	Preferred parking, operating	59,953
	Shared parking, capital	1,784,502
	Redesigned kiss and ride, capital	172,894
	Dynamic Pricing, Operating	510,818
	Real-Time Parking Info, Operating	5,108,142
Total Costs		**10,830,986**
B/C Ratio		**10.21**
Net Present Value		**99,770,868**

Benefits and Costs by Category, with B/C Results, Shady Grove S4

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	118,502
	Subtotal state of good repair	118,502
Economic Competitiveness		
	Travel Time Savings	34,743,535
	Fuel Savings	12,968,754
	Reduced non-fuel O&M Costs (non-transit)	9,389,074
	Reduction in oil imports - societal benefits	12,320,317
	Reliability	26,582,766
	Productivity	7,967,285
	Subtotal economic competitiveness	103,971,734
Livability		
	Noise reduction	109,387
	Subtotal Livability	109,387
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	36,734
	PM10 reductions	595,135
	SO2 reductions	6,092
	VOC reductions	19,098
	CO2 reductions	1,201,578
	Subtotal Environmental	1,858,639
Safety Benefits		
	Fatality reductions	5,143,024
	injury reduction	9,004,766
	Property Damage Only	1,155,877
	Subtotal Safety	15,303,668
Total Benefits		**121,361,932**
Costs	Dynamic Pricing, Capital	277,028
	Real-time Parking Info., capital	2,770,289
	Preferred parking, operating	59,953
	Circulator Service, capital	1,008,352
	Circulator Service, operating	2,651,648
	Redesigned kiss and ride, capital	172,894
	Dynamic Pricing, Operating	487,248
	Real-Time Parking Info, Operating	4,872,518
Total Cost		**12,299,933**
B/C Ratio		**9.87**
Net Present Value		**109,061,998**

Benefits and Costs by Category, with B/C Results, Vienna V2

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	26,071
	Subtotal state of good repair	26,071
Economic Competitiveness		
	Travel Time Savings	16,525,003
	Fuel Savings	2,830,584
	Reduced non-fuel O&M Costs (non-transit)	2,065,674
	Reduction in oil imports - societal benefits	2,689,055
	Reliability	9,424,853
	Productivity	3,229,339
	Subtotal economic competitiveness	36,764,510
Livability		
	Noise reduction	24,066
	Subtotal Livability	24,066
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	8,081
	PM10 reductions	130,934
	SO2 reductions	1,340
	VOC reductions	4,201
	CO2 reductions	264,357
	Subtotal Environmental	408,916
Safety Benefits		
	Fatality reductions	1,131,508
	injury reduction	1,981,123
	Property Damage Only	254,302
	Subtotal Safety	3,366,933
Total Benefits		**40,590,497**
Costs	Dynamic Pricing, Capital	240,011
	Real-time Parking Info., capital	2,400,114
	Redesigned kiss and ride, capital	36,408
	Bus service, capital	4,033,409
	Bus service, operating	4,969,523
	Dynamic Pricing, Operating	422,141
	Real-Time Parking Info, Operating	4,221,436
Total Costs		**16,323,045**
B/C Ratio		**2.49**
Net Present Value		**24,267,451**

Benefits and Costs by Category, with B/C Results, Vienna V3

Category	Sub-category	Value (2011 $)
Benefits		
State of Good Repair		
	Reduced Pavement Damage from vehicles	64,512
	Subtotal state of good repair	64,512
Economic Competitiveness		
	Travel Time Savings	23,502,468
	Fuel Savings	7,083,175
	Reduced non-fuel O&M Costs (non-transit)	5,111,402
	Reduction in oil imports - societal benefits	6,729,017
	Reliability	16,037,307
	Productivity	5,814,648
	Subtotal economic competitiveness	64,278,020
Livability		
	Noise reduction	59,550
	Subtotal Livability	59,550
Environmental Sustainability		
	CO Reductions	-
	NOX reductions	19,998
	PM10 reductions	323,991
	SO2 reductions	3,316
	VOC reductions	10,397
	CO2 reductions	654,137
	Subtotal Environmental	1,011,841
Safety Benefits		
	Fatality reductions	2,799,857
	injury reduction	4,902,185
	Property Damage Only	629,258
	Subtotal Safety	8,331,302
Total Benefits		**73,745,227**
Costs	Real-time Parking Info., capital	3,296,055
	Parking garage, capital	20,993,818
	Real-Time Parking Info, Operating	5,797,265
Total Costs		**30,087,139**
B/C Ratio		**2.45**
Net Present Value		**43,658,088**