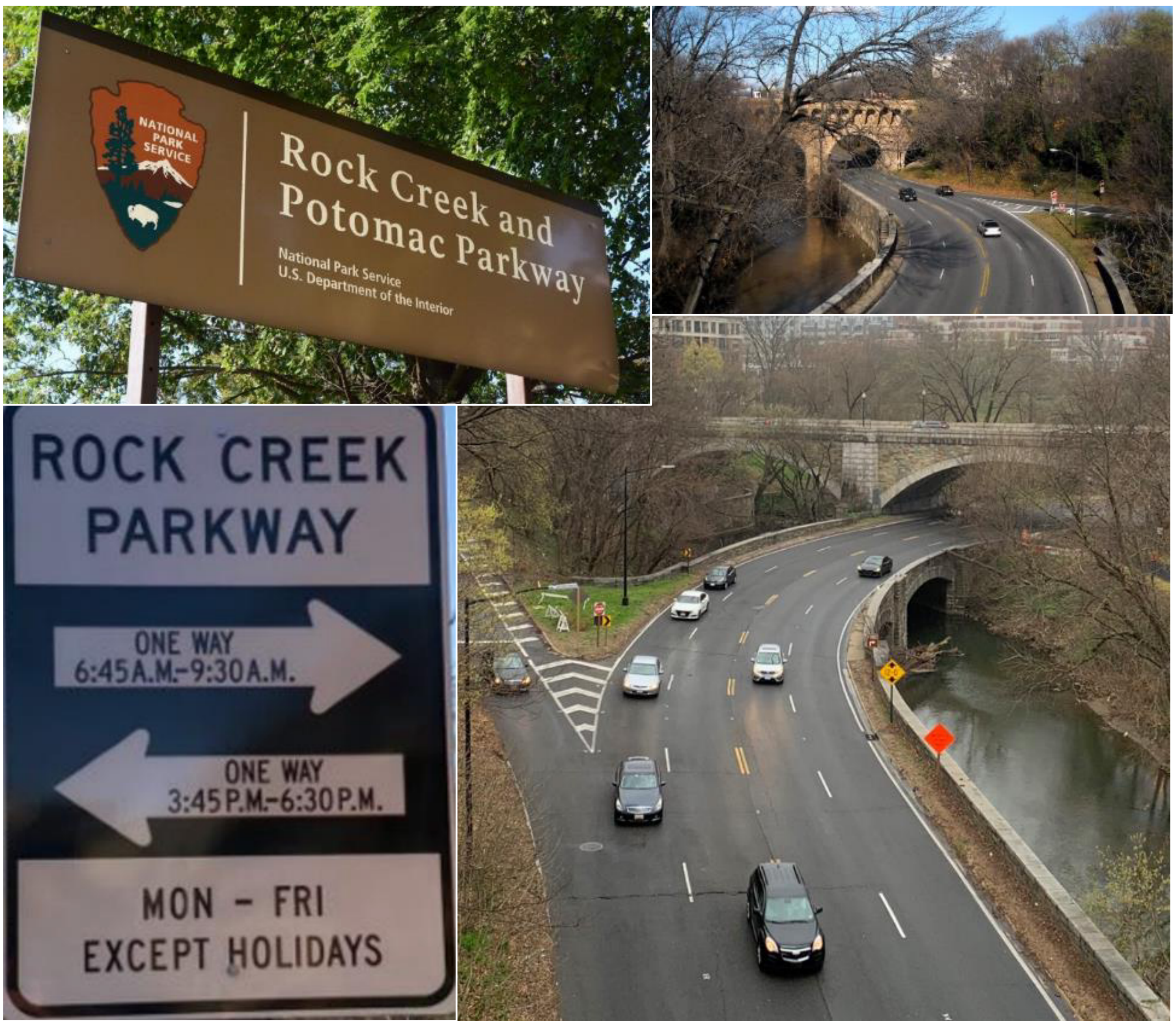
Elimination of Reversible Operations Along Rock Creek & Potomac Parkway: *Transportation Impact Assessment*



Source; RCPP Sign: WTOP. RCPP from P Street Bridge: Wikimedia Commons, User APK. One-way hours sign: Volpe. RCPP from Q Street Bridge: Volpe

U.S. Department of Transportation
Volpe Center

January 2024

Report notes

The U.S. Department of Transportation John A. Volpe National Transportation Systems Center (Volpe Center) in Cambridge, Massachusetts prepared this report. Michael Littman, of the Transportation Planning Division, led the project team, which included Sean Laffey, David Lamb, Vijaeth Hiraesave, Sean Pierce, Annisha Borah, and Anna Solow-Collins from the Transportation Planning Division, the Program Development and Capacity Building Division, the Policy Analysis and Strategic Planning Division, and the Economic Analysis Division. This effort is part of the Interagency Agreements between the National Park Service (NPS) and the Volpe Center (NPS agreements VXBHA121 and VXP4A100).

Acknowledgments

The authors want to thank the numerous organizations and individuals, who graciously provided their time, knowledge, and guidance in the development of this report, including:

National Capital Region (NCR)

Wayne Emington, *Transportation Program Manager*
David Daddio, f*ormer Transportation Program Manager*
Ryan Yowell, *Active Transportation and Transit Program Manager*
Julie Fetzer, *Transportation Project Manager*
John Ceglarek, *Transportation Project Manager*

Rock Creek Park (ROCR)

Julia Washburn, *former Superintendent*
Brian Joyner, *Deputy Superintendent*
Nick Bartolomeo, *Resources Manager*
Michael Ransome, *acting Facility Operations Services Manager*
Donald Kirk, *former Facility Operations Services Manager*

National Mall and Memorial Parks (NAMA)

Jeffrey P. Reinbold, *Superintendent*
Yue Li, *Community Planner*

NPS Washington Area Support Office (WASO)

Wayne Emington, *former Transportation Safety Program Manager*

United States Park Police (USPP)

Captain Jonathan D. Hofflinger, *Commander, West District*

District Department of Transportation (DDOT)

Yi Zhao, *Traffic Engineering Branch Manager, Traffic Engineering & Safety Division*
Edward Stollof, *Manager, Planning and Sustainability Division*
Wasim Raja, *Associate Director, Traffic Engineering & Safety Division*
Jonathan D. Rogers, N*eighborhood Planning Manager*

Metropolitan Washington Council of Governments (MWCOG)

Dusan Vuksan, *Transportation Engineer/Program Manager*
Nicole McCall Manager, *Planning Research and Assistance*

Executive Summary

Background

Rock Creek and Potomac Parkway is a 180-acre area of linear parkland in Washington, D.C. administered by Rock Creek Park (ROCR) and the National Mall and Memorial Parks (NAMA), two units of the National Park Service (NPS). The parkway runs in a generally north-south direction along Rock Creek and the Potomac River waterfront, between the area south of the National Zoological Park tunnel and Calvert Street NW, and West Potomac Park at the Lincoln Memorial.

The roadway within Rock Creek and Potomac Parkway (RCPP) is a primary thoroughfare between downtown and the northwest quadrant of Washington, D.C. Construction of the roadway was completed in 1936, and reversible one-way operations were established the following year to offer a measure of relief from commuter congestion. The traffic policy allowed the bidirectional four-lane roadway to become a one-way throughfare during peak commuting hours operating in the predominant direction of commuter travel.

Today, RCPP reversible one-way operations are still in effect on weekdays, except on federal holidays and weekends. The policy permits southbound (inbound) traffic entering D.C. to use all four lanes during the peak morning commute (6:45 – 9:30 a.m.), and northbound (outbound) traffic leaving D.C. to use all four lanes during the peak afternoon commute (3:45 – 6:30 p.m.). At all other times, the roadway is bidirectional, open to both inbound and outbound traffic. The corridor serves about 7,500 vehicles during each reversible period and nearly 50,000 vehicles each weekday.

Study Purpose

This study explores the safety and operational impacts of the reversible one-way operations on RCPP. The findings of this study will help inform the design process for an upcoming project to rehabilitate RCPP. This process will include further coordination with partner agencies, completion of the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) compliance processes, and public outreach.

Key Findings

Safety

- The existing one-way reversible operations do not conform to modern federal traffic standards and present unusual challenges for drivers to safely navigate.
- Enacting and enforcing one-way reversible operations requires United States Park Police (USPP) staff time and places officers in vulnerable positions on the roadway.
- The rate of crashes that occur during one-way reversible operations is disproportionately higher than the rate of crashes that occur during bidirectional travel.

Operations

- The highest hourly bidirectional volumes on the roadway occur in the middle of the day, outside of the one-way reversible operations. The highest bidirectional traffic volume occurs in the morning just after the reversible operations ends around 9:30 – 10:30 a.m., and in the afternoon, just before the reversible operations begin around 2:30 – 3:30 p.m.
- Should NPS eliminate one-way reversible operations, some users travelling in the predominant direction of commuter travel would shift to parallel corridors while reverse commuters would

shift to using RCPP. More vehicular traffic is expected to divert to the RCPP corridor than divert away from the RCPP corridor.

- Most of the traffic delays caused by the elimination of the one-way reversible operations could be largely mitigated through geometric and operational changes along the RCPP corridor. The mitigation would also improve safety through all times of day in addition to the peak periods.
- Eliminating the reversible operations along the RCPP corridor is expected to align with the adjacent Connecticut Avenue project which ended reversible operations in 2020. Commuters that often took advantage of the reversible operations along Connecticut Avenue continued onto RCPP. By eliminating reversible operations along both routes, those commuters will likely choose alternate modes of transportation or rely on the regional highway network instead of cutting through neighborhoods.

Table of Contents

Figures

Tables

1. Introduction

1.1. Project Background

Managing commuter traffic along the reversible Rock Creek and Potomac Parkway (RCPP) and Ohio Drive through Rock Creek Park (ROCR) and the National Mall and Memorial Parks (NAMA) is an ongoing challenge for National Park Service (NPS). Nested in the southern area of the Northwest quadrant of Washington D.C., the approximately 3.1-mile corridor with reversible operations starts at Shoreham Drive, NW, travels adjacent to Rock Creek and the Potomac River, and ends at Lincoln Memorial Circle near the signalized intersection of Ohio Drive/23rd Street/Independence Avenue. For the purpose of this study, RCPP will generally refer to the corridor in which reversible operations occur. The roadway is generally a four-lane arterial with two lanes in each direction, divided by a double-yellow center line or a physical median between the two travel directions. The corridor consists of three signalized intersections; at Virginia Avenue, at F Street (which primarily provides access to the Kennedy Center), and at Independence Avenue/23rd Street.. Several uncontrolled intersections with yield or stop control onto RCPP provide access to additional surface arterial roadways.

During the commuting peak period, RCPP transforms into a one-way roadway with all four lanes inbound (southbound) in the morning, generally from 6:45 – 9:30 a.m., and outbound (northbound) in the afternoon, generally from 3:45 – 6:30 p.m., every weekday, excluding holidays. This operational change makes RCPP an attractive commuter route. Data shows that RCPP has an average daily traffic (ADT) of approximately 50,000 vehicles. Excessive speed and high crash rates detract from park resources and the visitor experience. These conditions may be exacerbated by the reversible operations, which are a costly and labor-intensive process. To set up the reversible operations, four to five U.S. Park Police (USPP) officers manually place wooden sawhorses and traffic cones to close entrance ramps, and flip and/or hang directional signs. The operations restrict the reverse commute movement, which can be confusing to visitors that are unfamiliar with the reversible operations.

1.2. Study Purpose/Identifying the Problem

Reversible operations are a safety concern for both motorists and USPP personnel. A 2013 Road Safety Audit, provided in Appendix A, conducted by the Federal Highway Administration (FHWA) documented an average of 130 crashes annually on RCPP, 36 percent of which occurred during the reversal periods. The audit also identified a lack of consistency between signs alerting motorists of the reversible operations. Additional news articles have documented motorists ignoring the one-way operations, physically moving barricades, or attempting to drive the wrong way outside of the designated time period, which have led to dangerous situations.

The reversible operations began in the 1930s, when traffic and commuting patterns in the D.C. region were dramatically different. In the 1960s, the completion of the Zoo Tunnel further exacerbated congestion across ROCR and the RCPP. The District Department of Transportation (DDOT) owns, operates, and maintains all traffic signals along the Parkway, although the signals are on NPS property.

Eliminating the reversible operations and accommodating traffic demand through other means and methods could improve safety and reduce operating costs. This report measures the impacts of eliminating the reversible operations and identifies several preliminary mitigation measures to improve safety and better accommodate commuter traffic through the corridor.

1.3. Impacts of the COVID-19 Pandemic

The impacts of the Covid-19 pandemic cannot be understated. Traffic studies, such as this study, rely heavily on historic data and trends to make future assumptions regarding the future projections. The pandemic has had far-reaching and deep impacts related to how the urban population lives, travels, and behaves, that has never been seen before. The expectations of commuting and the demonstrated ability for people to work from home has been established as a major change for commuting behavior, which has a direct impact on traffic through the RCPP corridor. A large proportion of the population either work from home a majority of the time or have established a permanent work from home schedule. Transit ridership immediately fell significantly but has slowly grown as recovery efforts increased. While this traffic study identifies short-term and long-term strategies to improve safety and better accommodate commuter traffic through the corridor, the future habits of commuters are difficult to predict and should be continuously monitored to implement the best possible solutions.

1.4. Study Area

Two study areas have been created to measure the impact of the Project, a primary study area and a secondary study area. The primary and secondary study area intersections are listed below and shown in Figure 1.

1.4.1. Primary Study Area Intersections

The primary study area will measure the direct impacts of the RCPP corridor, including those using the corridor today and potential people that will use the corridor in the future.

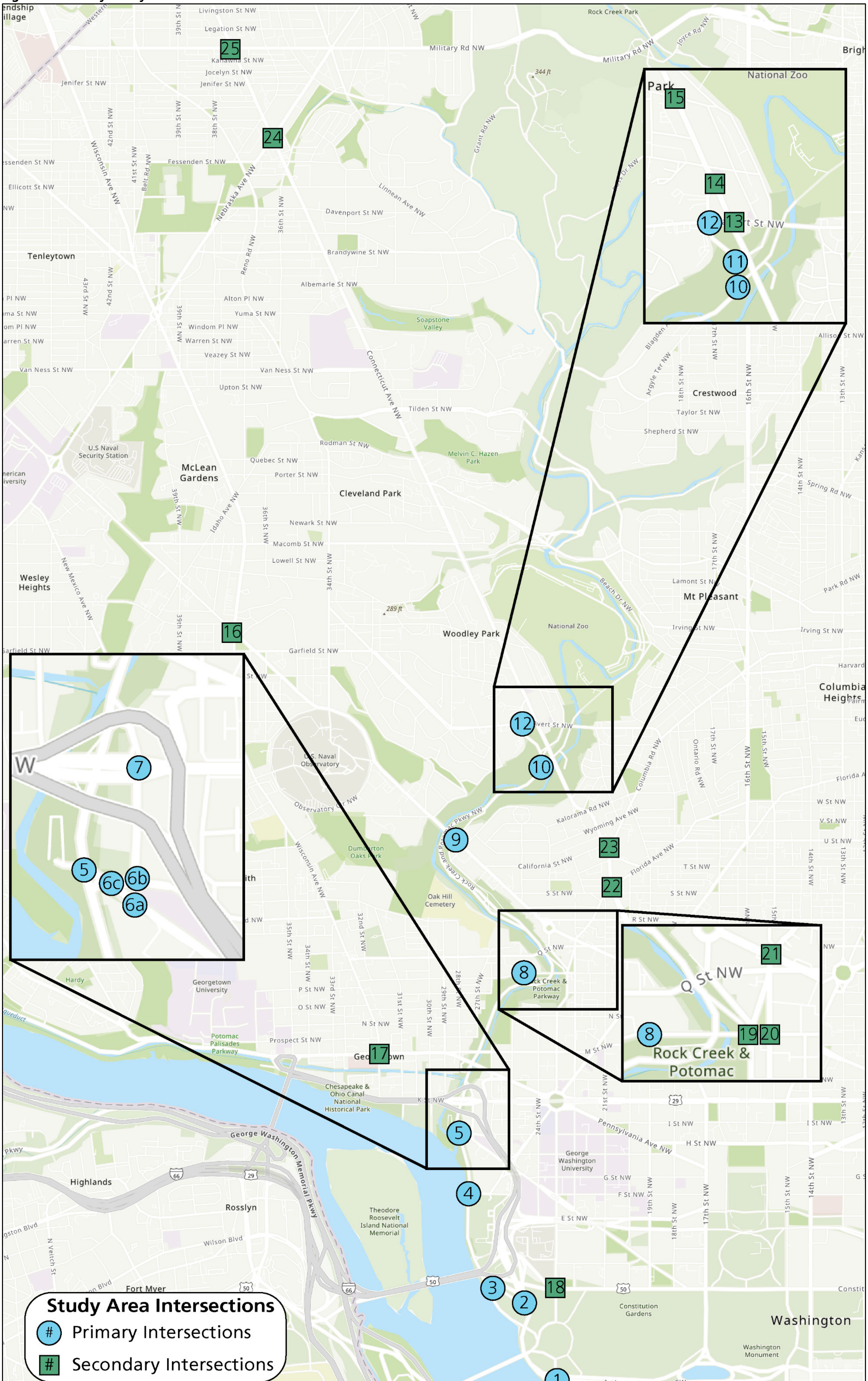
1. Independence Avenue SW/Ohio Drive SW at 23rd Street SW (signalized);
2. Rock Creek & Potomac Parkway NW at E Street Extension (unsignalized);
3. Rock Creek & Potomac Parkway NW at Parkway Drive NW (unsignalized);
4. Rock Creek & Potomac Parkway NW at F Street NW (signalized);
5. Rock Creek & Potomac Parkway NW at Virginia Avenue NW (signalized);
6. Virginia Avenue NW at 27th Street NW/I Street NW;
    - 6a. Virginia Avenue NW at 27th Street NW (signalized)
    - 6b. 27th Street NW/I Street NW (signalized);
    - 6c. Virginia Avenue NW at I Street NW (unsignalized);
7. K Street NW/Whitehurst Freeway NW at 27th Street NW/RCPP Ramps (signalized);
8. P Street NW at RCPP Ramps (unsignalized);
9. Massachusetts Avenue NW at Waterside Drive NW (signalized);
10. Rock Creek & Potomac Parkway NW at Beach Drive NW/Shoreham Drive NW (unsignalized);
11. Shoreham Drive NW at Cathedral Avenue NW (unsignalized); and
12. Calvert Street NW at 24th Street NW/Shoreham Drive NW (signalized);

1.4.2. Secondary Study Area Intersections

The secondary study area will measure the impact to potential alternate routes and consist of signalized intersections along parallel corridors.

13. Connecticut Avenue NW at Calvert Street NW (signalized);
14. Connecticut Avenue NW at 24th Street NW (signalized);
15. Connecticut Avenue NW at Cathedral Avenue NW (signalized);
16. Wisconsin Avenue NW at Massachusetts Avenue NW (signalized);
17. Wisconsin Avenue NW at M Street NW (signalized);
18. Constitution Avenue NW at 23rd Street NW (signalized);
19. P Street NW at 23rd Street NW (signalized);
20. P Street NW at 22nd Street NW (signalized);
21. Massachusetts Avenue NW at Florida Avenue NW/22nd Street NW (signalized);
22. Connecticut Avenue NW at Florida Avenue NW (signalized);
23. Connecticut Avenue NW at Columbia Road NW/Leroy Pl/T St NW (signalized);
24. Connecticut Avenue NW at Nebraska Avenue NW (signalized); and
25. Connecticut Avenue NW at Military Avenue NW (signalized).

Figure 1: Primary Study Area Intersections



1.5. Study Scenarios

The Project will use the following five study scenarios to evaluate the elimination of the reversible operations:

1. Existing Scenario
2. Short-Term (2025) Horizon, Baseline Scenario
3. Short-Term (2025) Horizon, Elimination of Reversible Operations Scenario
4. Short-Term (2025) Horizon, Elimination of Reversible Operations with Preliminary Mitigation Recommendations Scenario
5. Long-Term (2045) Horizon, Baseline Scenario
6. Long-Term (2045) Horizon, Elimination of Reversible Operations Scenario
7. Long-Term (2045) Horizon, Elimination of Reversible Operations with Preliminary Mitigation Recommendations Scenario

The short-term horizon is for the year 2025 to align with the most recent MWCOG planning analysis model. The purpose for the short-term scenarios is to analyze the elimination of the reversible operations as if they were removed immediately. The long-term horizon is set for the year 2045 to align with the long-range planning documents being conducted throughout D.C. Move DC[1] is the District of Columbia long-range multimodal transportation plan conducted by DDOT. Visualize2045[2] is the long-range transportation plan for the metropolitan area conducted by MWCOG. Both plans identify long-range goals, projects, programs, and policies that will meet the needs of D.C.

The elimination of the reversible operations scenario includes traffic diversion related to the reversible operations including diversions away from the RCPP corridor in the commuting direction and diversions to the RCPP corridor in the reverse commuting direction. The elimination of the reversible operations with preliminary mitigation recommendations includes the impact of the preliminary mitigation at several selected intersections. The same mitigation measures were applied to both the short-term (2025) horizon and the long-term (2045) horizon. While the corridor can function as two-way, as it does for a majority of the time today, the mitigation measures will identify additional safety and capacity improvements to help reduce the impact of eliminating the reversible operations.

[1] https://movedc-dcgis.hub.arcgis.com/

[2] https://visualize2045.org/

2. Existing Condition

2.1. Rock Creek & Potomac Parkway Existing Roadway Characteristics

RCPP is an approximately 3.1-mile parkway between the intersection of Shoreham Drive/Beach Drive, to the north and Parkway Drive, to the south where it turns into Ohio Drive until the intersection of Independence Avenue/23rd Street. RCPP and Ohio Drive generally consist of a four-lane cross section consisting of two northbound travel lanes and two southbound travel lanes. Through several sections of the corridor, a median separates the northbound and southbound travel lanes, consisting of either a wooden guardrail or a vertical curb with vegetation, concrete, or asphalt. When a median is not present, a dashed double yellow line is provided to indicate that crossing the line is allowed during the reversible period. Approximately half the corridor includes a median and the other half includes a dashed yellow line. The posted speed limit along the corridor is 35 mph north of Virginia Avenue and 25 mph south of Virginia Avenue. RCPP includes nine points to enter and eight points to exit in the northbound direction and seven points to enter and six points to exit in the southbound direction. Three intersections along RCPP are signalized, including at Virginia Avenue, at F Street, and at Independence Avenue/23rd Street. Additionally, the signalized intersection of Shoreham Drive/Calvert Street/24th Street provides access to the corridor. A continuous shared-use path is provided along the west side of RCPP, and crosswalks and pedestrian curb ramps are provided at all crossings. Grade separated pedestrian crossings (via bridges that are part of the regular D.C. roadway network) are provided at ten locations including Connecticut Avenue (over Beach Drive and Cathedral Avenue), Massachusetts Avenue, Q Street, P Street, M Street, Pennsylvania Avenue, K Street, Theodore Roosevelt Bridge, Parkway Drive (over Ohio Drive), and Arlington Memorial Bridge (over Ohio Drive). One pedestrian bridge is provided at the south side of the Kennedy Center, and at-grade pedestrian crossings are provided at the three signalized intersection at Virginia Avenue, F Street, and Independence Avenue.

The reversible operations occur two times per day, every weekday, not including holidays. In the morning, RCPP is converted into a one-way, four-lane roadway with all lanes allowing inbound, southbound travel only. The signage indicates the reversible operations begin at 6:45 a.m. and last until 9:30 a.m., when the roadway is returned back to regular two-way operations for the middle of the day. In the afternoon, RCPP is converted into a one-way, four-lane roadway with all lanes allowing outbound, northbound travel only. The signage indicates the reversible operations begin at 3:45 p.m. and last until 6:30 p.m., when the roadway is returned back to regular two-way operations for the rest of the day and throughout the night. USPP is responsible for closing down the reverse commute direction by placing barricades and temporary signage to restrict the flow onto RCPP and confirm that all remaining reverse commuting vehicles are off the roadway. According to USPP, these changeover periods cause confusion for drivers, particularly for those unfamiliar with the roadway. Both the morning period and the afternoon period have a unique operating procedure, which is detailed below.

2.1.1. Morning Reversible Operations Process

The changeover to the reversible operation in the morning requires four USPP staff and approximately 30 minutes. The changeover begins around 6:30 a.m. at the southern end of the Parkway at Ohio Drive and is complete by 7:00 a.m. with the closure at Waterside Drive. The changeover back to regular operation, begins around 9:00 a.m. and is complete by 9:30 a.m. The reversible operation is in full effect along RCPP from 7:00 a.m. to 9:00 a.m. During this time, all four lanes of traffic are southbound.

At the northernmost end of the corridor, vehicles are able to enter Shoreham Drive and travel in both the northbound and southbound travel lanes. Vehicles driving along Shoreham Drive are joined by vehicles from Cathedral Avenue and then enter RCPP via a free movement without yielding or stopping for any crossing traffic. Additional vehicles enter RCPP via Beach Drive via the northbound lanes also with a free movement. Shortly after this intersection the median drops and vehicles can change lanes. A median divides RCPP just north of Massachusetts Avenue, and at this point, all traffic is required to divert into the southbound lanes. Vehicles can enter RCPP via Waterside Drive from the Waterside Drive northbound off-ramp. Shortly after vehicles enter via Waterside Drive, the median ends and all vehicles are free to use all four lanes. At this point, vehicles begin to choose a lane based on the destination. Vehicles can exit RCPP onto P Street using the right-most southbound lane and enter RCPP from the P Street southbound on-ramp. Vehicles can exit RCPP onto Pennsylvania Avenue via the Pennsylvania Avenue southbound off-ramp. Vehicles can exit RCPP onto K Street using the right-most southbound lane and enter RCPP from the K Street southbound on-ramp.

A median starts on RCPP just north of K Street and continues to Virginia Avenue. This is the final opportunity for vehicles to select a lane based on the destination. Vehicles destined for Virginia Avenue or I-66 must be in the northbound lanes. Vehicles destined for RCPP south or the Thompson Boat Center must be in the southbound lanes. After the intersection of RCPP and Virginia Avenue, all vehicles are travelling in the southbound lanes. Vehicles can exit RCPP onto Parkway Drive destined for the Arlington Memorial Bridge and enter RCPP southbound from Parkway Drive. After Parkway Drive, RCPP turns into Ohio Drive. At the I-66 ramps, vehicles continuing on Ohio Drive southbound merge into the right-most southbound lane and vehicles entering Ohio Drive southbound from E Street Extension have a free movement and merge into the left-most southbound lane. All northbound traffic is forced to exit Ohio Drive onto the E Street Extension.

The Waterside Drive northbound on-ramp, the P Street northbound on-ramp, the K Street northbound on-ramp, the K Street northbound off-ramp, and the E Street Extension southbound channelized right turn lane are all closed during the morning reversible operation period.

2.1.2. Afternoon Reversible Operations Process

The changeover to the reversible operation in the afternoon requires five USPP staff and approximately 30 minutes. The changeover begins around 3:30 p.m. at the northern end of the Parkway at Waterside Drive and is complete by 4:00 p.m. with the closure at Ohio Drive. The changeover back to regular operations begins around 6:00 p.m. and is completed by 6:30 p.m. The reversible operation is in full effect along RCPP from approximately 4:00 PM to 6:00 PM. During this time, all four lanes of traffic are northbound.

At the southernmost end of the corridor, vehicles are able to enter via the signalized intersection of Ohio Drive/23rd St/Independence Avenue. After vehicles travel through the signalized intersection some choose to drive to the southbound travel lanes which are open to northbound traffic. Vehicles travelling in the northbound travel way must merge into the left-most southbound lane to allow vehicles entering Ohio Drive via the ramp from Lincoln Memorial Circle to merge into the rightmost lane. Vehicles can also enter Ohio Drive via E Street Extension. Shortly after Ohio Drive turns into RCPP at the Parkway Drive intersection, vehicles can enter RCPP via Parkway Drive by taking a left onto RCPP. Just after Parkway Drive, a median separates the northbound and the southbound travel ways and vehicles destined for RCPP north must be in the southbound lanes while vehicles destined for the Kennedy Center, Virginia Avenue, or I-66 must be in the northbound lanes. At the Virginia Avenue intersection cones divide the northbound and southbound directions through the intersection. Vehicles in the northbound lanes must turn right on Virginia Avenue. Vehicles in the southbound lanes continue north on RCPP or can access the Thompson Boat Center. A heavy volume of vehicles enters the RCPP northbound travel way via Virginia Avenue. Additionally, a clear example of driver confusion is the large volume of vehicles (23 vehicles per hour) that u-turn along Virginia Avenue at 27th Street. This is most likely due to drivers that pass the Kennedy Center using the northbound lanes but who intend to continue traveling north on RCPP. These vehicles turn right off, RCPP onto Virginia Avenue, u-turn at 27th Street and then turn right from Virginia Avenue back onto RCPP northbound.

The median continues just beyond K Street. Vehicles can exit RCPP onto K Street using the right-most northbound lane and enter RCPP from the K Street northbound on-ramp. After K Street, the median ends and vehicles are free to change lanes. Vehicles can exit RCPP via the P Street ramp from the leftmost lane using the wrong-way P Street on-ramp. Before Waterside Drive, a median separates the northbound and southbound travel ways again and vehicles exiting RCPP via Waterside Drive must use the northbound travel way. Waterside Drive operates as one-way northbound and a left-turn only lane is provided at the intersection with Massachusetts Avenue for extra capacity. North of Massachusetts Avenue, vehicles can enter RCPP via Waterside Drive. After this merge, the median ends and vehicles are free to change lanes. Vehicles destined for Beach Drive must use the right northbound lane and vehicles destined for Shoreham Drive or Cathedral Avenue can use all other lanes and the intersection operates as free movements for all vehicles. Shoreham Drive remains one-way northbound, and vehicles are restricted from entering Shoreham Drive from Calvert Street or 24th Street.

The ramp from southbound I-66 to southbound RCPP, the southbound lane on Parkway Drive, the right-turn from Parkway Drive onto southbound RCPP, the ramps to and from K Street to southbound RCPP, the ramp from RCPP to P Street, and the ramps from Waterside Drive to southbound RCPP are closed.

2.1.3. General Observations

During the site visit, the study team observed the RCPP corridor during the morning and afternoon periods, as well as throughout the middle of the day, to understand how the reversible operations process was completed, and potential challenges. The study team also met with USPP to discuss the reversible operations. Observations occurred on March 21-24, 2022, which overlapped with the National Cherry Blossom Festival. The festival may have slightly impacted some travel patterns towards the southern end of the study, but the reversible operations were not impacted. The section of Ohio Drive south of Independence Avenue was closed.

In general, the mixture of drivers that are familiar with the reversible operations combined with drivers that are unfamiliar causes safety conflicts. Familiar drivers may cut-off other drivers and speed through the unusual roadway set-ups, while drivers unfamiliar with the roadway have been observed to stop or even reverse to adjust their position along the roadway.

At the signalized intersection of Independence Avenue/Ohio Drive/23rd Street, during the afternoon period, some vehicles queue in the westbound left-turn lane and travel across the intersection to the southbound travel way. Many vehicles conduct this maneuver at high speed to avoid the merge and congestion just after the signal.

During the reversible operations, several yield or stop merge movements are converted into free movements where vehicles enter their own designated travel lane. However; some vehicles are confused and yield or stop regardless of the signage telling drivers to “Keep Moving”. This can lead to excess delays, driver frustration, or even collisions.

The curve in the RCPP corridor near the P Street ramps causes vehicles to slow significantly, especially when a vehicle is exiting RCPP southbound to P Street. Sight lines are limited due to the horizontal curve in the roadway and the Lauzun’s Legion (P Street) Bridge abutment. Official field measurements were not conducted due to the high level of traffic volumes along RCPP; however, it is estimated that vehicles traveling southbound have approximately 190 feet of sight distance. The stopping sight distance requirement for vehicle traveling at 30 mph is 200 feet.

The USPP officers travel on motorcycles to set-up and break-down the reversible operations while also managing traffic flow. The officers do an excellent job communicating with each other as well as notifying drivers where to queue, when to stop, and when to proceed. If a lapse in communication, or other human error occurs, it could lead to drivers driving in the wrong lanes and potential serious crashes. Backup communication or safety procedures are not in place if something goes wrong.

Drivers were not observed driving in the wrong lanes, however USPP officers stated that it is typical for some drivers to manually move barricades and proceed along RCPP in the wrong direction. It is also typical for some drivers to drive in the oncoming lane too early, before the reversible operations have officially been activated, or exit the oncoming lane too late, after the reversible operations have officially been deactivated.

USPP officers were seen repairing barricades that have been damaged, most likely due to the barricade being struck by a vehicle. USPP officers discussed repairing barricades as a regular task and they spend additional time and funds to repair all equipment, including signage, as are able. Some equipment may stay broken for days or weeks before being fixed.

2.1.4. USPP Labor Obligations

For the reversible operations on RCPP, USPP deploys officers to set up and break down barricades, change signs, and direct traffic. This operation requires four officers for the morning period and five officers in the afternoon. The officers remain at this location for approximately three hours between set-up and breakdown. By eliminating the reversible operations, USPP could re-deploy the officers to other areas of the park to assist park visitors and carry out other duties. The value of the services that the officers would provide – if reallocated from the lane reversals– reflects the economic opportunity cost and can be quantified using the labor cost of the officers' time.

For this analysis, the opportunity cost of the officers' time is estimated from generic USPP wages and fringe benefit costs. According to the USPP Traffic Change Guideline Manual, the estimated hourly wage rate per officer is $85, which is similar to the industry average. In addition to wages, labor costs include fringe benefit costs (e.g., paid leave, insurance, and retirement). The estimated fringe benefit factor for USPP is 1.45, resulting in the total hourly cost of $123 per officer. The annual opportunity cost savings are estimated from the hourly cost per officer ($123). The required staffing time for nine officers spending three-hours each for approximately 250 non-holiday weekdays is 6,750 hours annually. The estimated annual UPSS staff benefit is $830,250.

2.2. Safety Data

The study includes a robust safety analysis that has compiled a repository of historical crash data associated with RCPP as well as crashes that occurred during or related to the reversible operations. The historical crash data contains reported and documented crashes but is only one aspect of the many safety challenges that occur along RCPP. Near misses, unfamiliar parkway users, dangerous behavior, users intentionally disregarding the reversible operations, and the risk associated with USPP staff are some of the many challenges. Some of the challenges have been expressed by area residents, commuters, NPS staff, news agencies, and other stakeholders and documented in the 2013 Road Safety Audit. While some NPS crash data is documented, the crashes from year-to-year can vary significantly, leading to the possibility that many crashes that occur are not documented. To attempt to understand all safety challenges, and especially the safety challenges outside of direct crash data, the study also includes moving violation data and recommendations from the DDOT Vision Zero website.

2.2.1. Historic Crash Data

Crash data associated with the RCPP corridor as well as adjacent intersections and ramps was collected for a 31-year period from 1990 through 2020. Crash records were collected from the following sources:

- Department of Interior (DOI) Incident Management Analysis Reporting System (IMARS): This data set was obtained from the NPS Safety Division and contains crashes that were responded to by the NPS rangers and USPP.
- Open Data DC "Crashes in DC:" This data set was obtained from the City's open data portal and contains the crash locations associated along the DDOT centerline network within the District of Columbia.
- Howard University Transportation and Data Center- Transportation Safety Data Center: This data was obtained online from the City's Midwestern Software Solutions (MS2) Traffic Crash

Location System (TCLS) Crash Data portal. The TCLS aggregates data regarding crash events that took place in D.C.

- DDOT Vision Zero: This data was collected from the City's open data portal. It contains data from a web-based application developed to allow the public to communicate the real and perceived dangers along the roadway from the perspective of either a pedestrian, bicyclist, or motorist.

The datasets were aggregated, and duplicate entries were deleted based on unique crash identification codes, and crash locations and timestamps. The full crash data set included a total of 5,999 crashes over the 31-year period for an average of about 194 crashes per year. Table 1 and Table 2 show the crash severity (by year and time period), and crash types that occurred on RCPP and at adjacent intersections.

Table 1. Crash Severity by Year

Crash Year	Injury Fatality *	Property Damage Only (PDO)	Total
1990	89 [1]	330	420
1991	---	391	391
1992	---	440	440
1993	2	399	401
1994	79 [1]	305	385
1995	53	314	367
1996	7	387	394
1997	7	346	353
1998	8	28	36
1999	4	19	23
2000	10	13	23
2001	4	298	302
2002	5	9	14
2003	3	252	255
2004	13 [1]	25	39
2005	73	210	283
2006	61 [1]	191	253
2007	47	118	165
2008	40	132	172
2009	39 [2]	122	163
2010	44 [1]	135	180
2011	39	150	189
2012	43	167	210
2013	37	75	112
2014	31	84	115
2015	1	7	8
2016	15 [1]	21	37
2017	19	38	57
2018	34	69	103
2019	15	53	68
2020	12	29	41
Total	834 [8]	5,157	5,999

** The superscript number indicates the number of fatal crashes that year.*

Table 2. Crash Type and Severity by Time of Day from 1990 to 2020

Crash Type and Severity	Weekday Morning (6:15 - 10:00 a.m.) *	Weekday Midday (10:00 a.m. - 3:15 p.m.)	Weekday Afternoon (3:15 - 7:00 p.m.) *	Weekday Night (7:00 p.m. - 6:15 a.m.)	Weekend	Total
Crash Type						
Rear End	357	636	608	381	579	2,561
Angle	92	238	165	210	302	1,007
Sideswipe-same direction	72	107	138	122	151	590
Head On	30	81	46	87	111	355
Sideswipe-opposing direction	25	44	39	43	76	227
Other/Unknown	121	264	145	315	416	1,259
Crash Severity						
Fatal	---	2	---	2	4	8
Injury	82	185	135	189	243	834
PD Only	615	1,183	1,006	965	1,388	5,157
Total Crashes	697	1,370	1,141	1,156	1,635	5,999

* *Crashes that are time stamped within 30-minutes of reversible period are considered during reversible operations.*

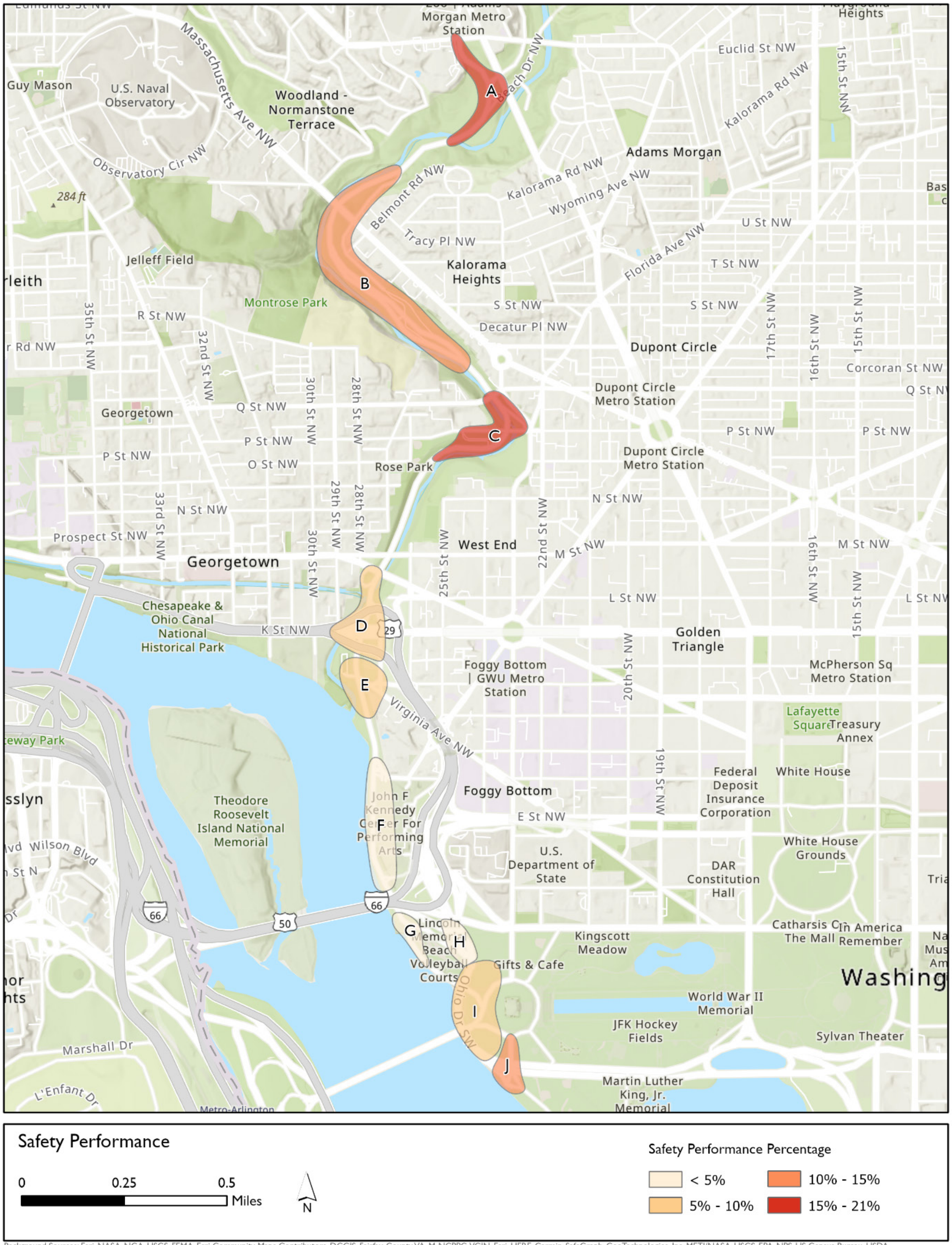
As seen in Table 1 and Table 2, 5,999 documented crashes occurred along RCPP and at adjacent intersections over the past 31 years, between 1990 and 2020. Averaging the crashes into a typical week, approximately 31% of the crashes occurred during the reversible period, including 12% during the morning period and 19% during the afternoon period. To normalize this crash percentage, RCPP operates as reversible for about 22% of the of the week (which includes the 30-minutes before and after, as shown in the tables), and about 19% of the traffic volume along RCPP occurs during the reversible operations.

Over the 31-year period, about 86% (5,157 crashes) resulted in property damage only, about 14% (843 crashes) resulted in injuries, and 8 crashes resulted in 1 or more fatalities. Rear-end (2,561 crashes) and angle crashes (1,007) crashes were the most common crash types, which accounted for 59% of the crashes. The third, fourth, and fifth most common crash types were sideswipe-same direction (10%), head-on (6%), and sideswipe-opposite direction (4%), respectively. The crash type for about 21% (1,257 crashes) were either not documented, listed as unknown, or fell into another crash category.

The study team geospatially analyzed the data to find areas with potentially mitigatable safety concerns, relative to the other study corridor areas. As shown in **Figure 2,** the crashes were grouped into ten areas (Areas A through J) based on their approximate location to an intersection, ramp, or segment. The crashes were then weighted by their severity, time-period, and crash type to identify an overall safety performance so the areas could be compared.

The safety performance of the ten areas is shown relatively to the total safety performance of the study area with Areas A and C (the darkest red colors) being of the highest concern. Area A contains the intersections of RCPP with Calvert Street, Cathedral Avenue, and Shoreham Drive/Beach Drive. Area A had 149 documented head-on and sideswipe, opposite direction crashes, which consisted of 18% of the crashes at this location. Both the total number and the percentage are the highest along the corridor. Area C contains the curved segment of RCPP that intersects with the P Street ramps. There were 154 injury and fatality crashes in Area C, which consisted of 20% of the crashes at this location. Both the total number and the percentage are the highest along the corridor. This location also included the only documented head-on fatal crash. Other areas of concern that contain major merge and diverge points include Area E (with RCPP at Virginia Avenue) and Area H (with Ohio Drive at E Street Extension).

Figure 2: Safety Performance



Background Sources: Esri, NASA, NGA, USGS, FEMA, Esri Community Maps Contributors, DCGIS, Fairfax County, VA, M-NCPPC, VGIN, Esri, HERE, Garmin, SafeGraph, GeoTechnologies, Inc, METI/NASA, USGS, EPA, NPS, US Census Bureau, USDA

2.2.2. Moving Violations

The Metropolitan Police Department (MPDC) maintains a monthly log of moving violations throughout D.C. The dataset contains moving violations from multiple agencies including the USPP, who are typically responsible for enforcement along RCPP. Since RCPP has narrow lanes, and limited places to pull over, USPP often do not observe the busy commuter corridor for violations. However, data is available all along RCPP. Over a two-year period, a total of 532 citations were issues along the RCPP corridor, which included 363 moving violations. The moving violations include 40% (145 citations) related to speeding; 33% (119 citations) related to inappropriate driver behavior such as failing to yield, making an inappropriate turn, or another driver error; and 19% (69 citations) related to distracted driving (including 3 drunk driving incidents). An additional 8% (30 citations) were related to operating a truck or other restricted vehicle and 3% (10 citations) were related to driving on the wrong side of the road, driving through a barricade, or driving the wrong way. The remaining 169 citations are related to vehicle deficiencies such as driving without license plates, expired registration, broken windshields and lights, or other similar infractions.

While these moving violations were not used in any analysis or compared to other city-wide challenges, the violations support the narrative that speeding is an ongoing challenge and some vehicles violate the reversible operations, whether intentionally or unintentionally.

2.2.3. Vision Zero Recommendations

The Vision Zero initiative developed a web-based application[3] to allow the public to communicate real and perceived dangers along D.C. roadways. Pedestrians, bicyclists, and motorists generated comments. Some of the issues identified were related to speeding vehicles, a lack of yielding to pedestrians and bicyclists at ramps, red light running at Virginia Avenue and F Street, vehicles cutting in line when there are queues (especially at the Shoreham Drive/Beach Drive intersection), and accessibility issues. Many of the comments are dated from 2015 but many still remain relevant today.

2.3. Vehicular Traffic Data

Vehicular traffic data forms the basis of the traffic study. The traffic volume data is used primarily to develop the traffic analysis model and perform the traffic operations analysis summary, shown in Chapter 6: Capacity Operations Analysis. Traffic volume data also includes vehicular speeds, which can identify times and location of congestion as well as safety concerns. The detailed vehicle traffic data is provided in Appendix B.

2.3.1. Historical Data

Historical traffic data was gathered at most primary and secondary study area intersections through a variety of methods. DDOT provided two existing condition synchro files, the city-wide Downtown synchro file, and the Connecticut Avenue synchro file. These synchro files included the peak hour turning movement counts (TMC) for the weekday a.m. and p.m. peak hours, as well as the peak hour factor, the heavy vehicle percentage, and the pedestrian and bicycle conflicts. If an intersection was included in the provided synchro files, the TMC data was used as the existing traffic volumes. Several intersections were not included in the synchro files and therefore needed new TMCs collected, or data provided from additional sources. Most of the intersections included a turning movement count that was collected in 2018 or 2019.

[3] https://opendata.dc.gov/datasets/DCGIS::vision-zero-safety/explore?location=38.909009%2C-77.046854%2C14.00

2.3.2. Turning Movement Counts

New TMC data was collected at the intersections of RCPP/I-66 Ramps during both the weekday a.m. and p.m. peak periods and at the intersection of RCPP/Parkway Drive during only the weekday p.m. peak period. TMC data was collected, concurrently with the site visit, on March 23, 2022. TMC data included passenger vehicles, heavy vehicles, bicycles, and pedestrians during the weekday morning peak period (7:30 a.m. – 9:30 a.m.) and afternoon peak period (4:30 p.m. – 6:30 p.m.). The peak hour was identified and incorporated into the existing traffic volume network developed through the existing synchro files and historical traffic data provided by DDOT and MWCOG.

The existing scenario weekday a.m. and p.m. peak hour traffic volumes for the primary and secondary intersections are shown in Figure 3, Figure 4, Figure 5, and Figure 6, respectively.

2.3.3. Average Daily Traffic

Automated Traffic Recorder (ATR) data was collected for 48-hours along RCPP on March 23-24, 2022. The ATR data included directional traffic volume, speed, and class. Since traffic drives in the wrong travel lanes during the reversible periods, the traffic volumes data was recorded separately in the northbound lanes and the southbound lanes. ATR data was collected at the following two locations to capture traffic volumes north of Virginia Avenue and south of Virginia Avenue:

- Rock Creek & Potomac Parkway NW, north of Parkway Drive; and
- Rock Creek & Potomac Parkway NW, south of P Street.

Additional historic ATR traffic volume data was provided from MWCOG at RCPP, south of P Street on June 6-8, 2017, and May 25-27, 2021. The historic data also include northbound and southbound traffic and has been corrected to account for the reversible traffic in the opposite lane. The hourly traffic volumes for all three data periods are shown in Figure 7. Total daily traffic volume was highest in 2017 with a total daily traffic of approximately 62,736 vehicles. The other two years are after the pandemic and show lower daily traffic at approximately 52,993 vehicles in 2021 and 38,342 vehicles in 2022.

The busiest hour throughout the day typically occurred just before the afternoon reversible period at the 2:00 – 3:00 p.m. and/or the 3:00-4:00 p.m. period. The total volume along the roadway decreases during the afternoon reversible period as the southbound traffic is restricted from entering and the additional northbound traffic does not make up the difference. After the reversible operations concludes, demand for southbound traffic increases again. This may indicate that demand for reverse commuting is present, and many regular users are planning their trip to drive through before the reversible operations go into effect or wait until after the reversible operations are removed.

2.3.4. MWCOG Data

MWCOG provided traffic volume (flows on links) data from the TPB production-use travel demand forecasting model (version 2.3.78). The flow on links data includes traffic volumes during the morning (6:00-9:00 a.m., 3 hours), midday (9:00 a.m.-3:00 p.m., 6 hours), afternoon (3:00-7:00 p.m., 4 hours), and night (7:00 p.m.-6:00 a.m., 11 hours). The data also included three analysis years that correspond to the study periods (2019, 2025, and 2045). The traffic volumes during the morning and afternoon periods are shown in Figure 8 and Figure 9.

Figure 3: Existing Scenario Traffic Volumes, Weekday a.m. Peak Hour, Primary Intersections

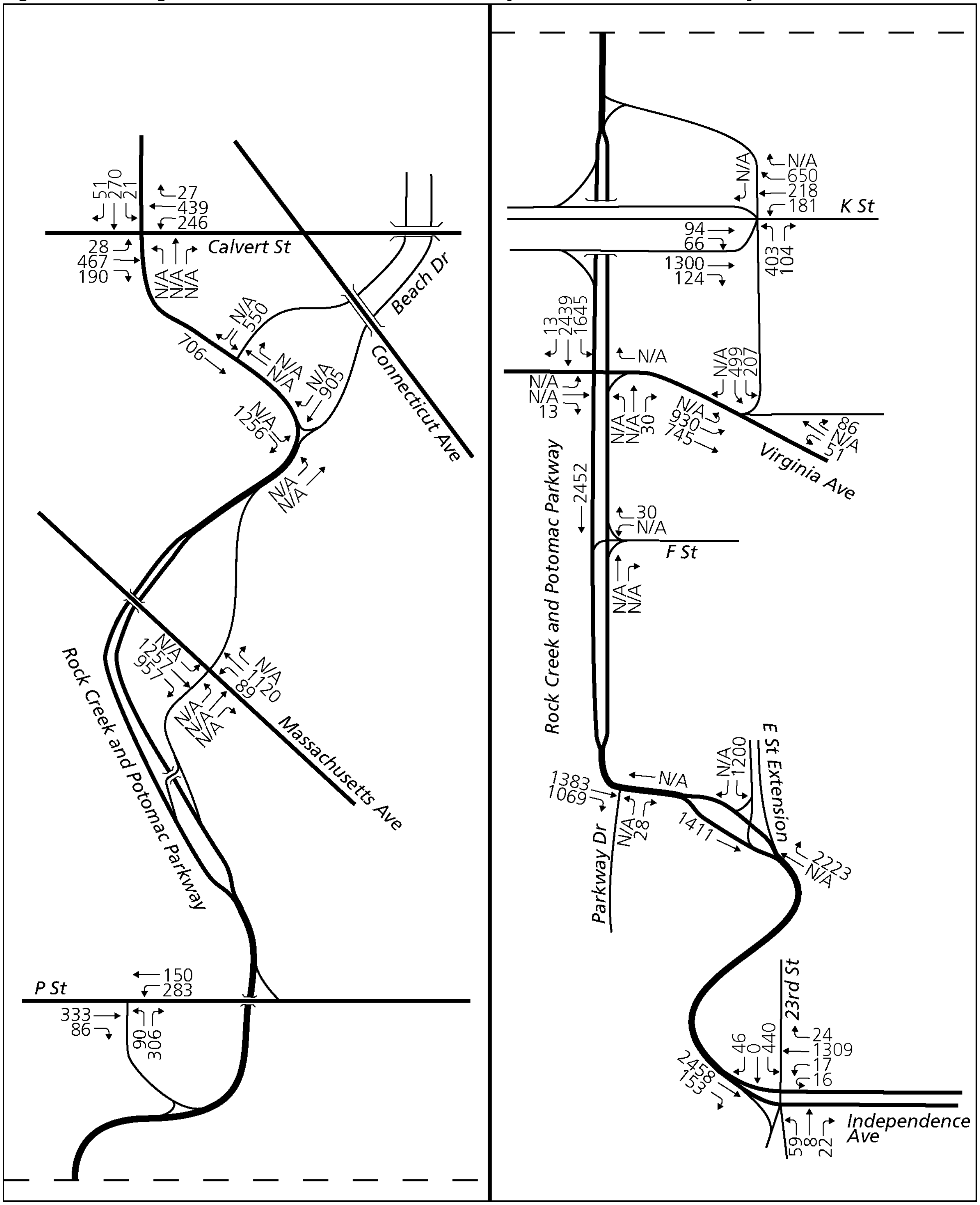


Figure 4: Existing Scenario Traffic Volumes, Weekday a.m. Peak Hour, Secondary Intersections

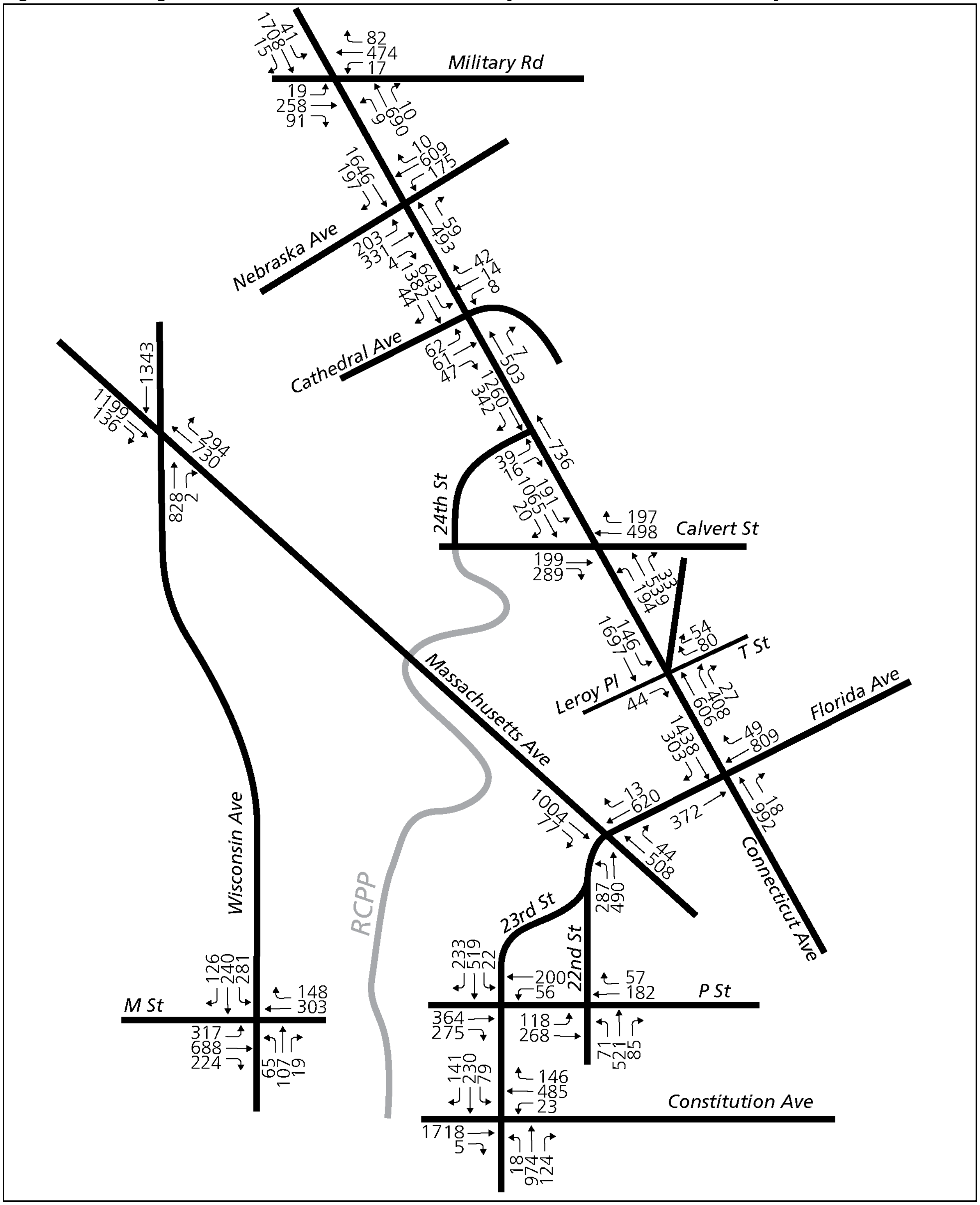


Figure 5: Existing Scenario Traffic Volumes, Weekday p.m. Peak Hour, Primary Intersections

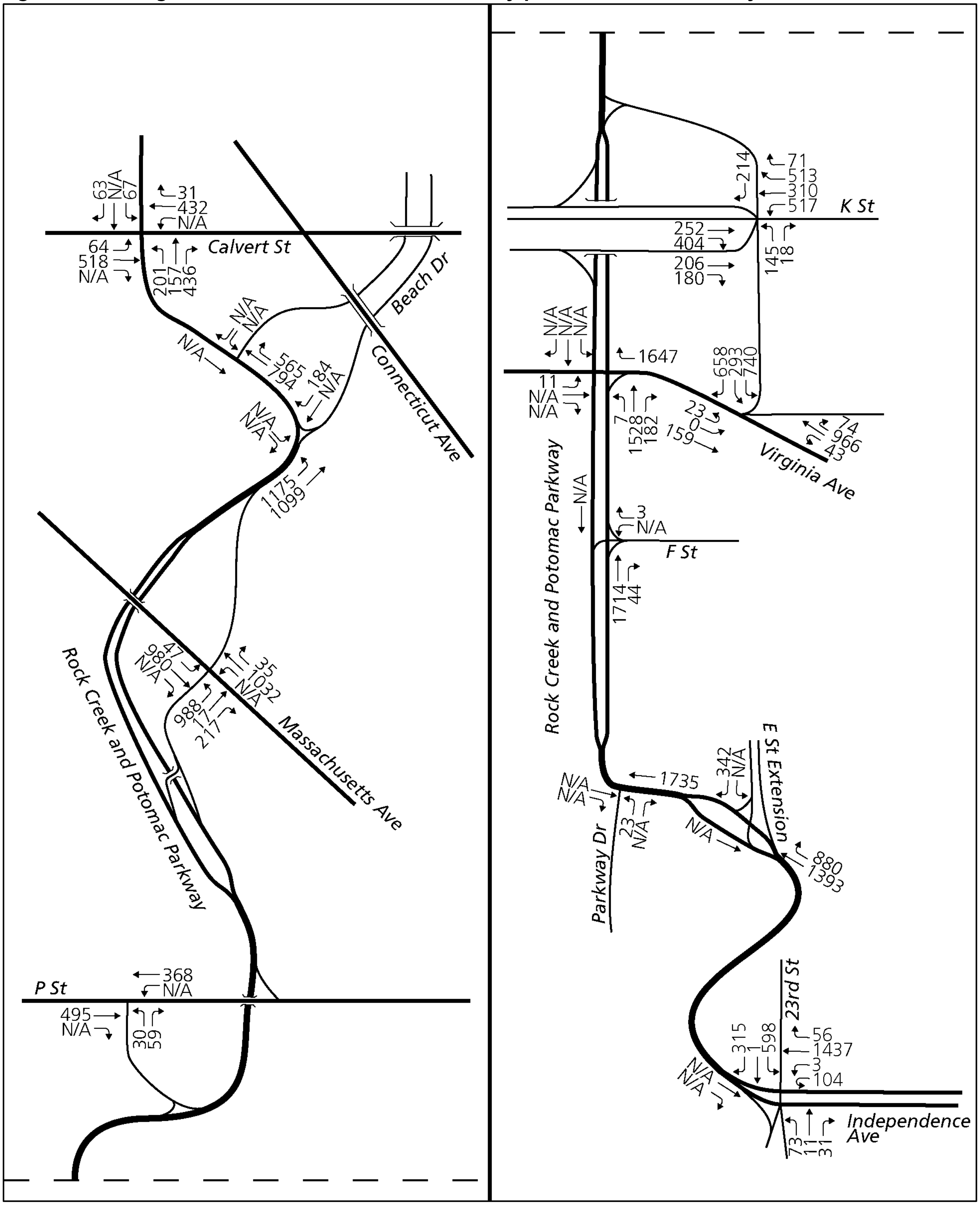


Figure 6: Existing Scenario Traffic Volumes, Weekday p.m. Peak Hour, Secondary Intersections

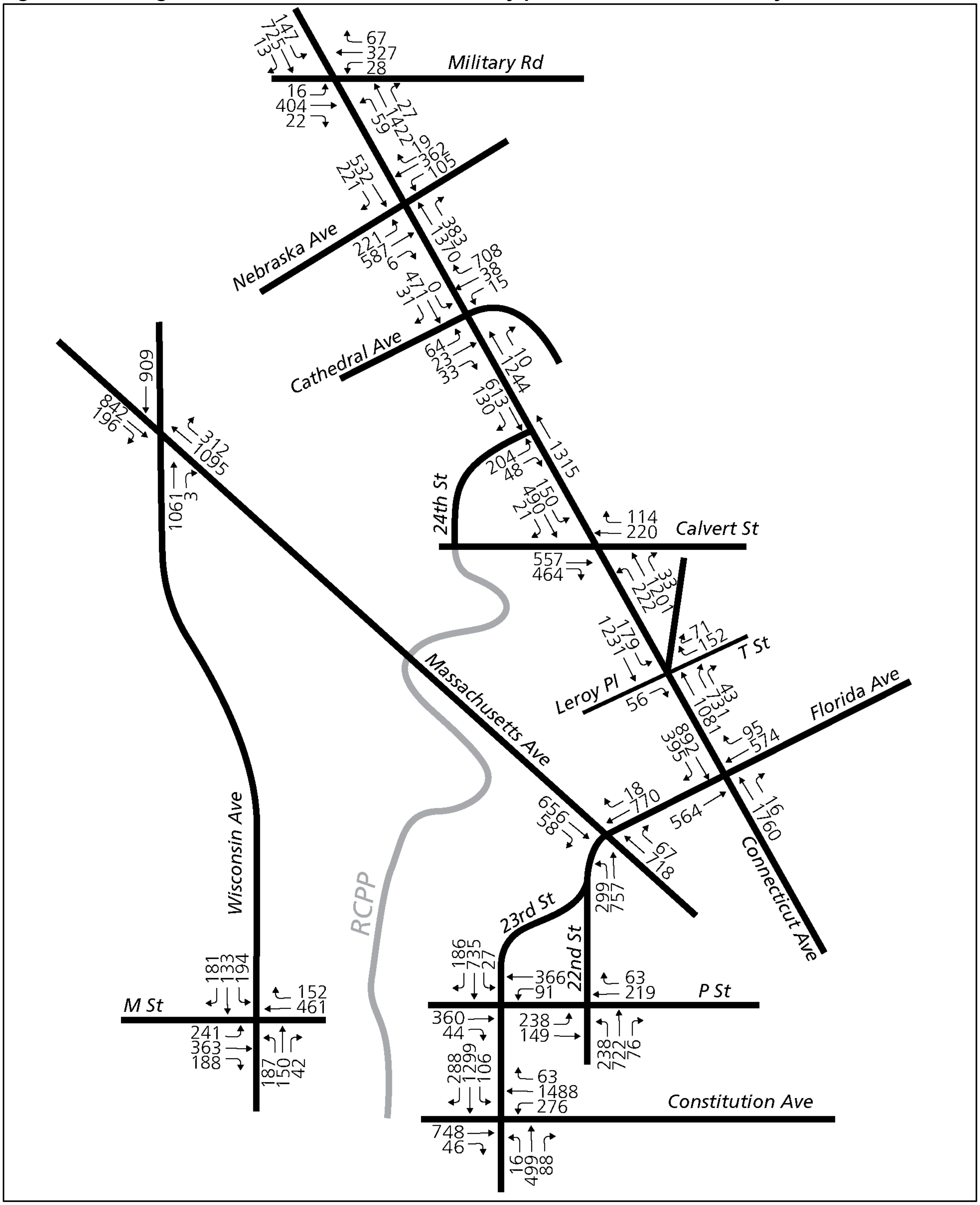


Figure 7: Hourly Traffic Volume, RCPP south of P Street, June 2017, May 2021, and March 2022

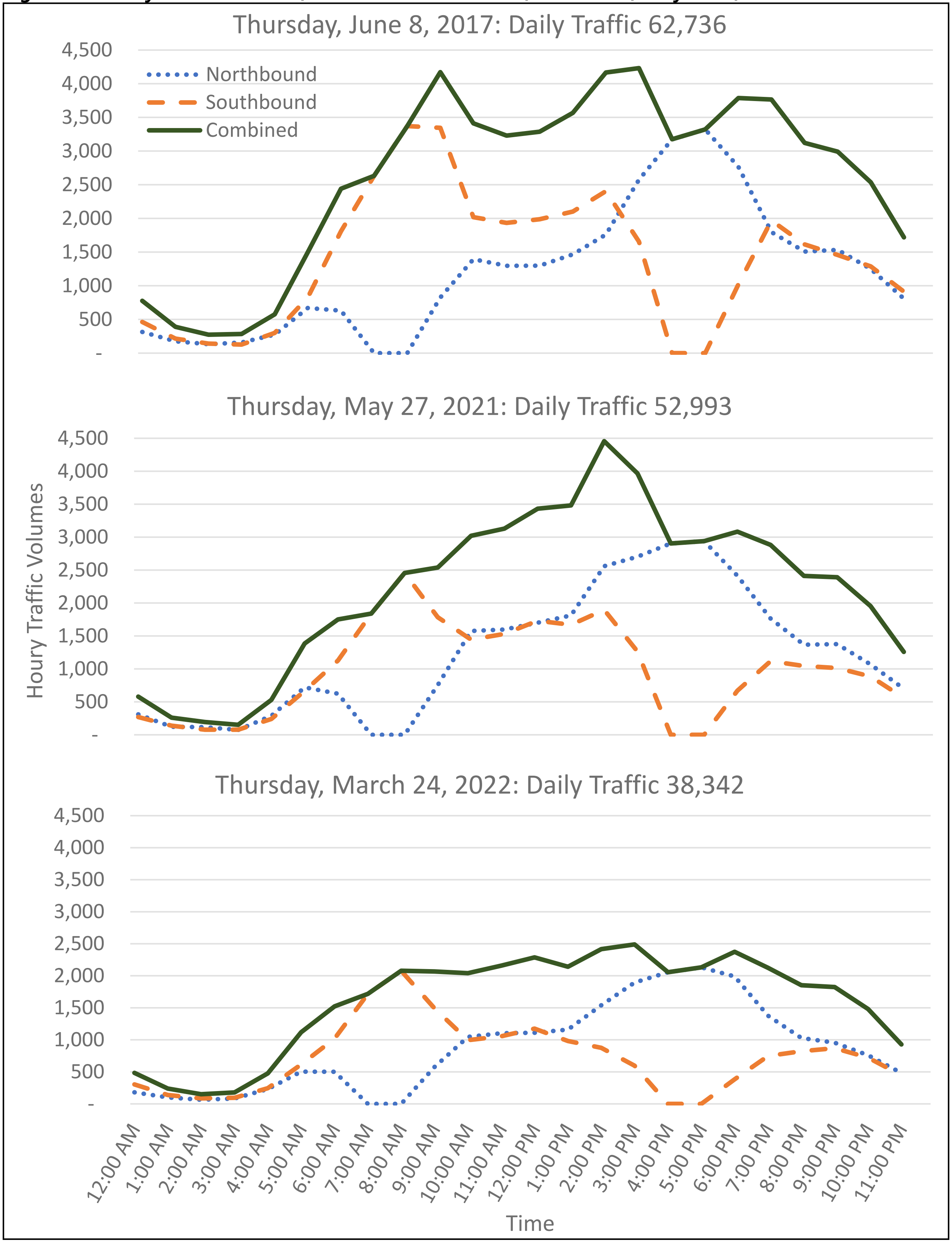


Figure 8: MWCOG Link Volumes, a.m. Peak Period, 6:00 – 9:00 a.m.

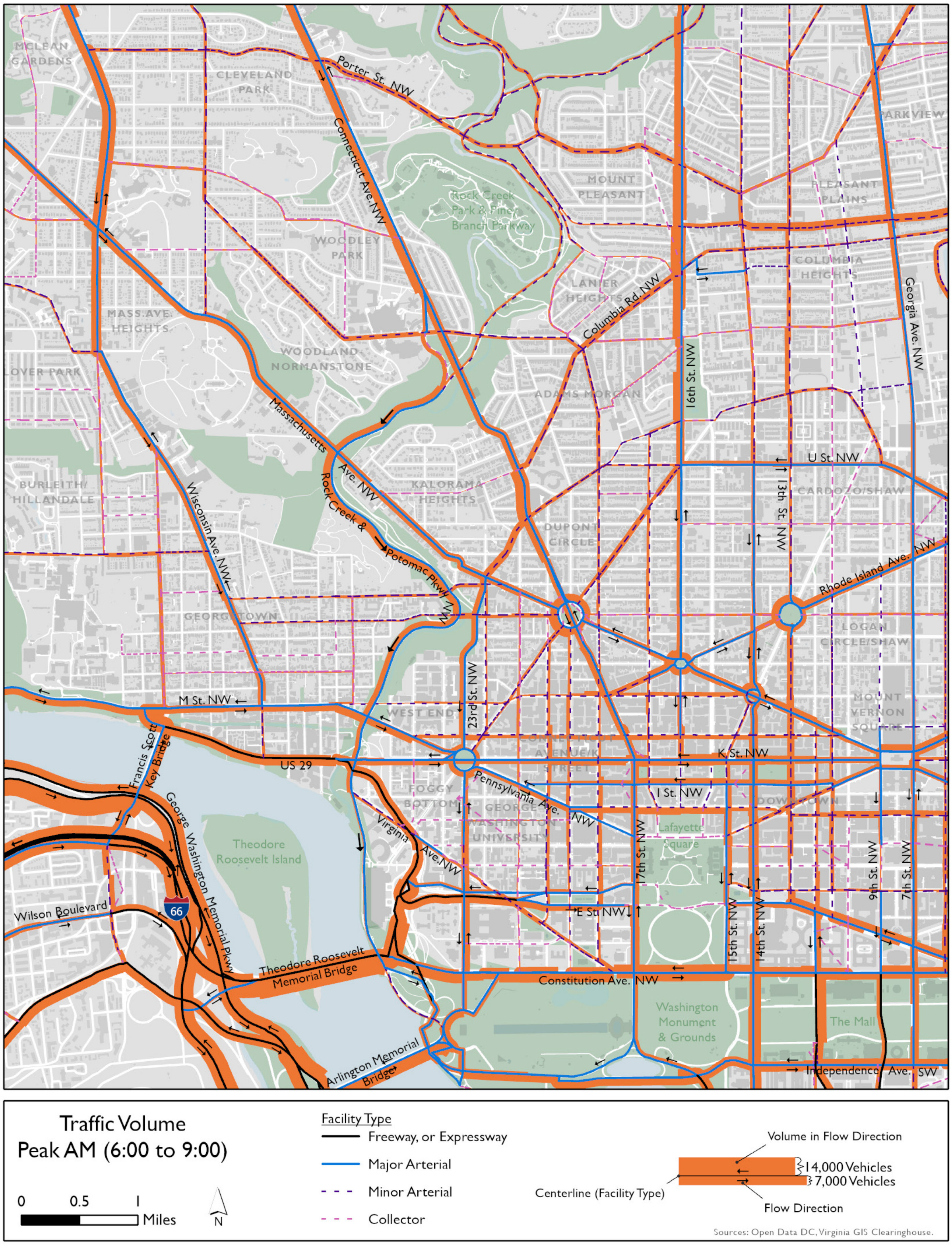
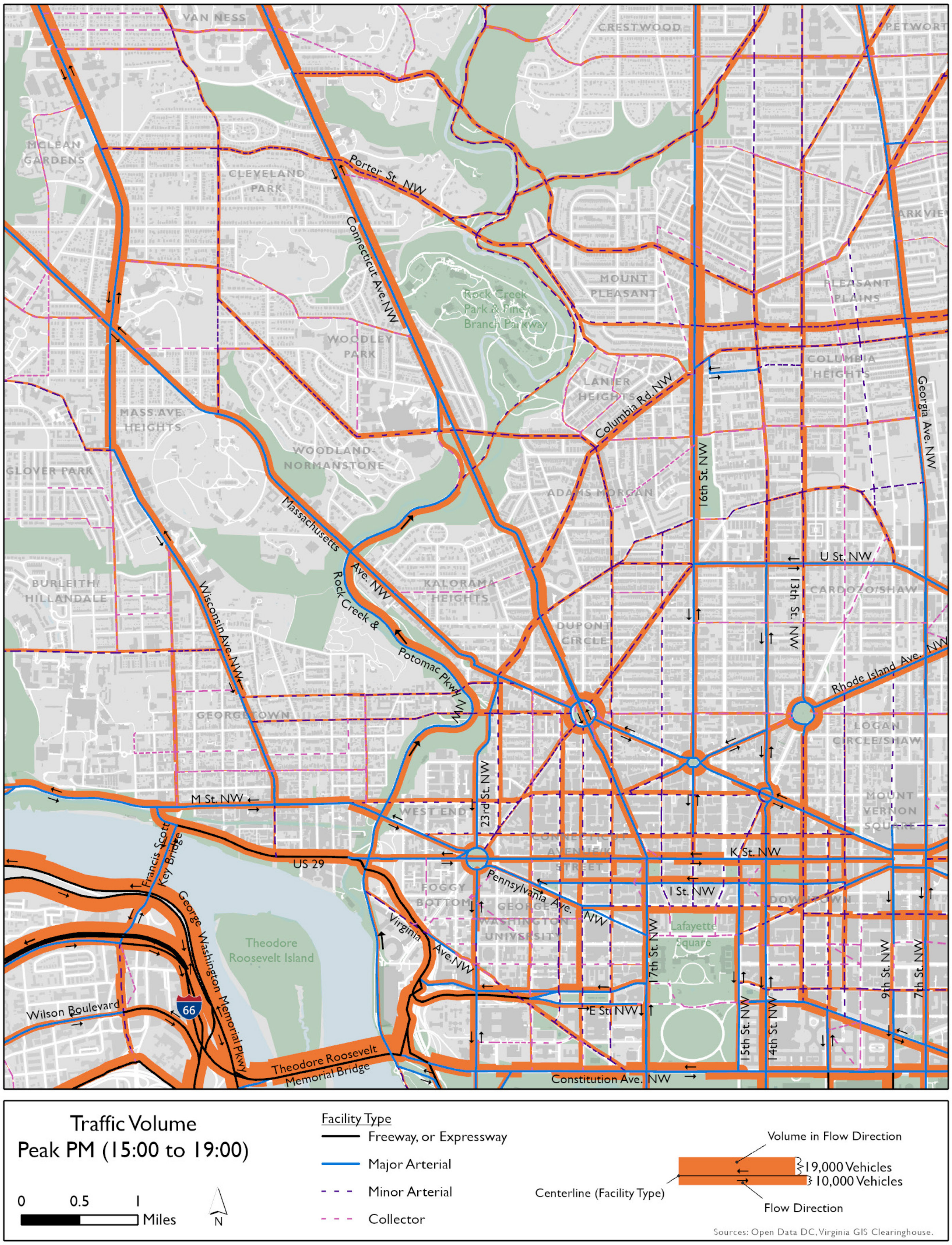


Figure 9: MWCOG Link Volumes, p.m. Peak Period, 3:00 – 7:00 p.m.



2.3.5. Vehicle Speeds

National Performance Management Research Data Set (NPMRDS) contains data from a fleet of anonymous probe vehicles that generate speed and travel time data aggregated in 5-minute, 15-minute, and hourly increments. The data is available across the National Highway System (NHS), and the primary study corridor is within the NHS. NPMRDS data was collected along RCPP and Ohio Drive between Independence Avenue, to the south and Beach Drive, to the north.

The NPMRDS data reflects vehicle speeds for every typical Tuesday, Wednesday, and Thursday in the year 2019 to capture typical commuting hour congestion. Figure 10 and Figure 11 present the typical travel speeds along RCPP from 6:00 a.m. to 12:00 noon in the southbound direction and from 2:00 p.m. to 8:00 p.m. in the northbound direction to capture the vehicle speeds before, during, and after the morning and afternoon reversible operations period. Figure 12 and Figure 13 present the average, 25th percentile and 75th percentile northbound and southbound travel times.

As seen in Figure 10, the inbound bottleneck during the morning commuting period generally coincides with the end of the reversible operation when the northbound traffic is opened back up to traffic and all southbound traffic is forced into the two southbound travel lanes. The queue originates at the signalized intersection of Virginia Avenue. The southbound queue length extends to P Street with traffic generally traveling slow (at or below 10 mph). Additional slowdowns are common south of Virginia Avenue and only extend to the Shoreham Drive/Beach Drive merge for a short period of time. As seen in Figure 11, the outbound bottleneck during the afternoon commuting periods is not as concentrated and generally originates at two locations, in the south at the signalized intersection of Virginia Avenue and again where RCPP diverges to Beach Drive/Shoreham Drive. Queueing a slow traffic is generally expected at signalized intersections or at key intersections. The slowdown at Beach Drive/Shoreham Drive is likely due to vehicles changing lanes by cutting the queue at the last moment. Additional queueing, not shown, is observed along Waterside Drive, due to the signalized intersection with Massachusetts Avenue.

Figure 12 and Figure 13 show the travel times across the corridor during select times of day. The average travel times are represented by the blue line. The orange shading represents the 25th to 75th percentile travel times. During the morning commute period in the southbound direction, the average travel time before the reversible lane operations start (at 6:00 a.m.) is approximately 5.5 minutes. The average and 75th percentile travel time increases slightly throughout the morning to 7 minutes and 8.5 minutes, respectively, when the reversible operations are in effect. The travel time peaks to approximately 12 minutes just after the reversible operations are removed between 9:30 and 9:45.

During the afternoon commute period in the northbound direction, the travel time after the reversible lane operations end (around 8:00 p.m.) is similar to the morning travel time. When the reversible operation is in effect, the average travel time experiences a noticeable reduction and takes about 8 minutes on average and approximately 9 minutes at the 75th percentile. In the 15 minutes just prior and just after the reversible operation is put into effect, the northbound travel times increase, demonstrating that the one-way traffic operations help reduce peak travel time.

The ATR data, mentioned above, also contains vehicular speed data. The ATR vehicular speed data differs from the NPMRDS speed data as it tracks all vehicles that pass a point along the roadway instead of relying on data from probe vehicles which may make up only a percentage of vehicles. The ATR data was collected along RCPP south of P Street and north of Parkway Drive. Figure 14 and Figure 15 show the hourly vehicles traveling above the speed limit as well as the percentage of vehicles traveling above the speed limit. The speed limit north of Virginia Avenue is 35mph and the speed limit south of Virginia Avenue is 25mph. South of P Street during both reversible operation periods, the total number of vehicles traveling over 35 mph increase and the percentage of vehicles traveling over 35 mph indicating that the reversable operations encourages vehicles to travel at higher speeds. The traffic north of Parkway Drive does not show as drastic a change in vehicle speeds. However, a noticeable increase in the percentage of vehicles traveling above the speed limit occurs during the afternoon reversible period.

Figure 10: NPMRDS Data, RCPP Southbound Travel Speeds, 6:00 a.m. – 12:00 noon

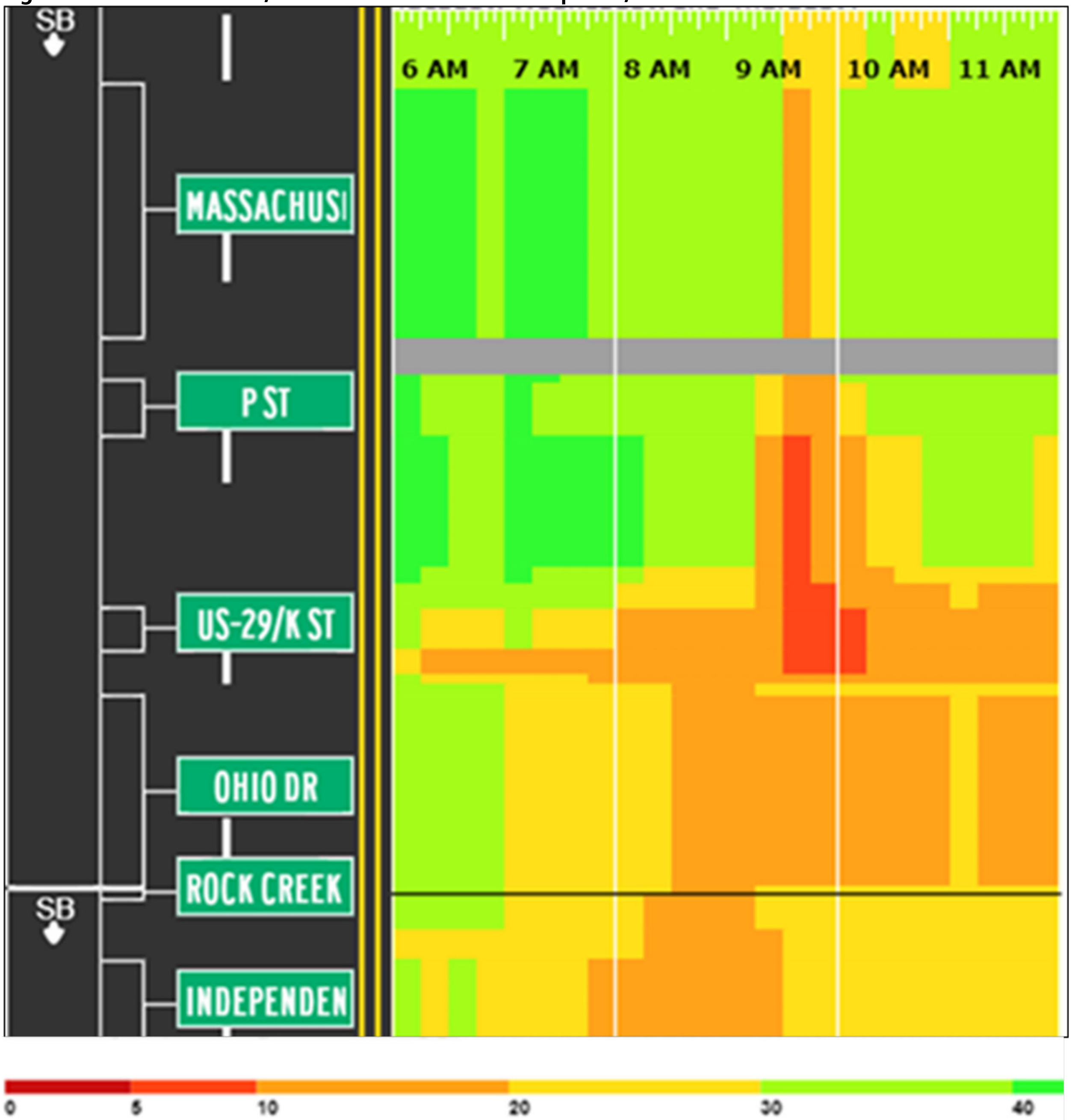


Figure 11: NPMRDS Data, RCPP Northbound Travel Speeds, 2:00 – 8:00 p.m.

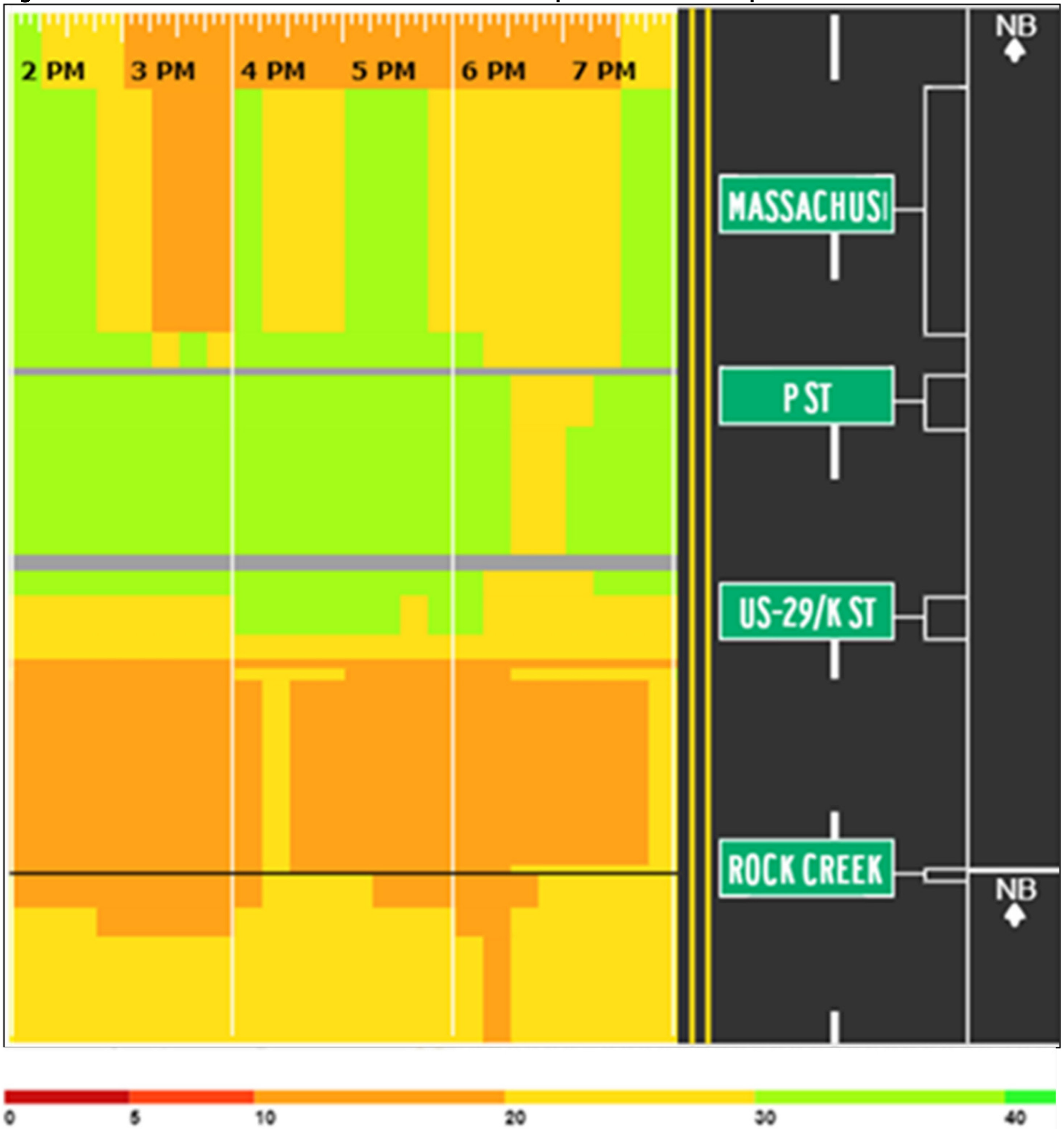


Figure 12: NPMRDS Data, RCPP Southbound Travel Times, 6:00 a.m. – 12:00 noon

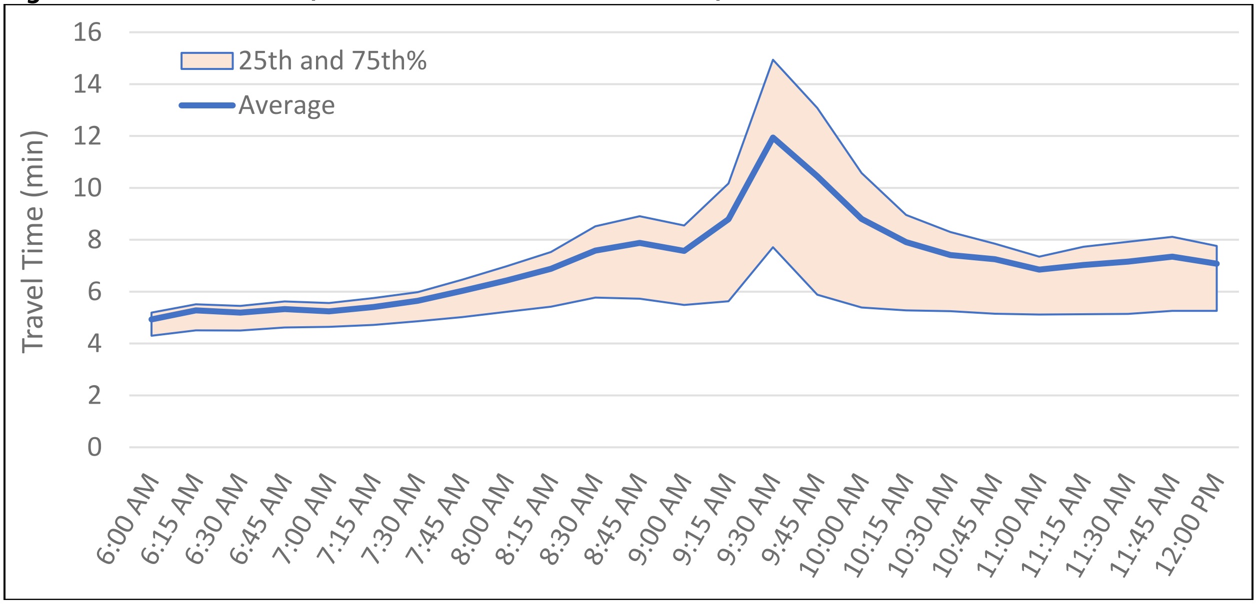


Figure 13: NPMRDS Data, RCPP Northbound Travel Times, 2:00 – 8:00 p.m.

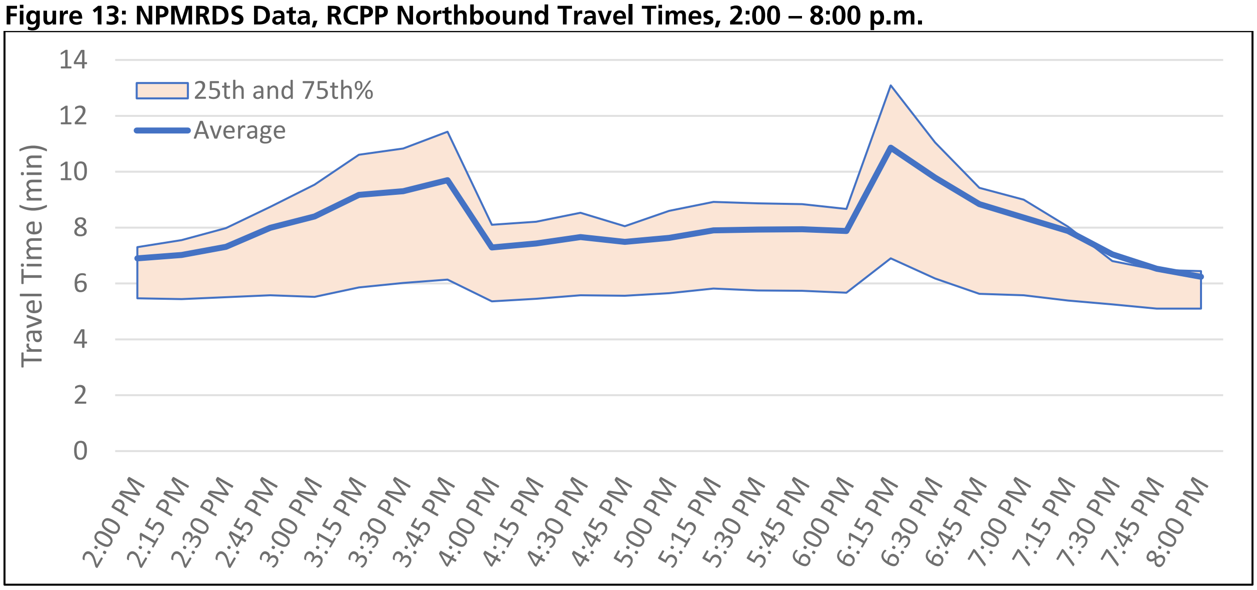


Figure 14: Speed Data, RCPP South of P Street, Vehicles Traveling Over 35mph Speed Limit

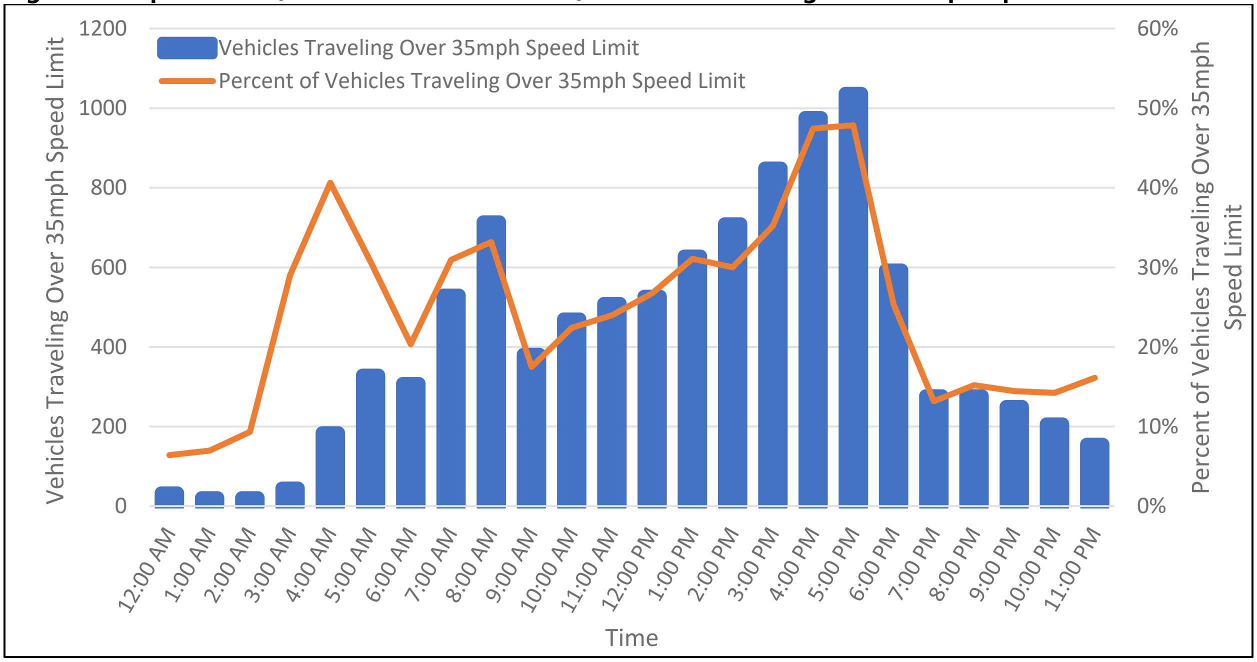
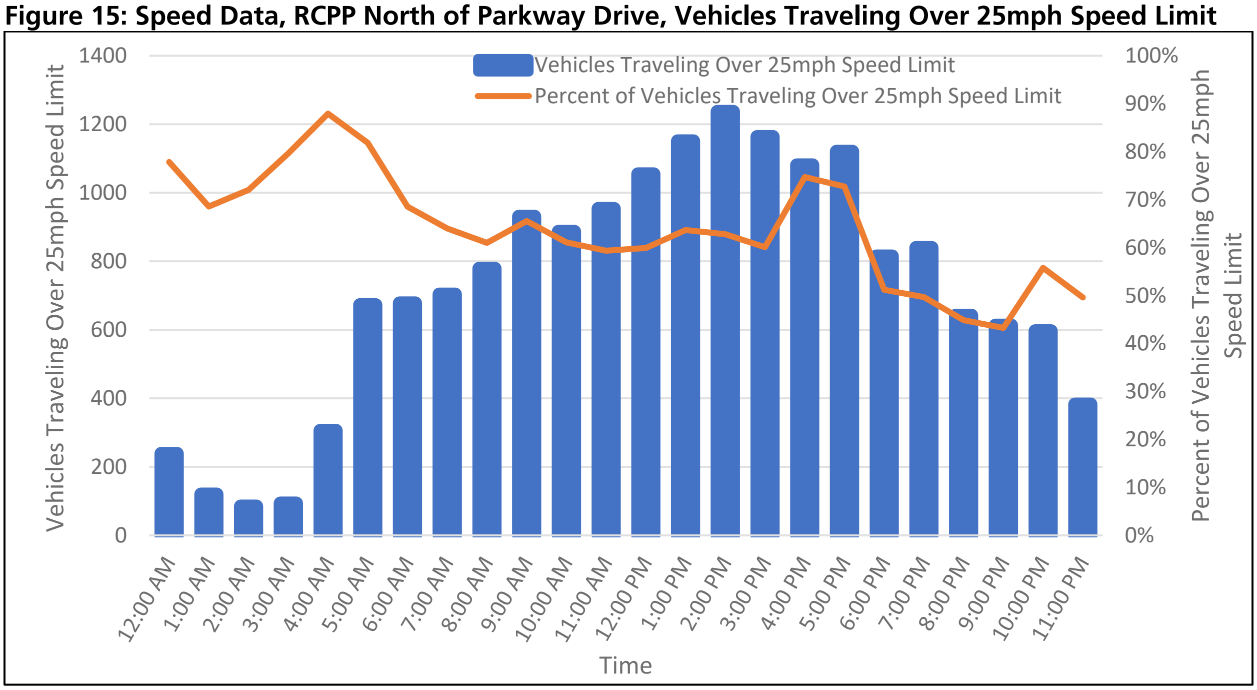


Figure 15: Speed Data, RCPP North of Parkway Drive, Vehicles Traveling Over 25mph Speed Limit



2.4. Origin-Destination Data

O-D data forms the basis of this traffic study. O-D data is used to predict the existing travel patterns for vehicles that may use RCPP today as well as the possible alternate routes adjacent and parallel to RCPP. The O-D data comes from three data sources.

2.4.1. Journey to Work Data

The Longitudinal Employer Household Dynamics (LEHD) program provides Longitudinal Origin-Destination Employer Statistics (LODES) data from the US census. This data shows the residential-employment pairs based on geographical areas. Data is compiled through the OnTheMap[4] web-based mapping and reporting application. RCPPs reversible operations are most beneficial for commuters, therefore the journey to work data set, which connects employment locations to residential addresses, is an excellent data source. The commuters that take advantage of the RCPP reversible operations most commonly live to the north of D.C. and work in the downtown core of D.C.

The employment data showed fourteen census tracts in the downtown core of D.C. made up 63% of the total employment in D.C. This group of census tracts, as well as parts of Arlington and Alexandria, was identified as the primary employment zone. The residential zones included a variety of geographic layers depending on how far they were from the employment zone, and included 24 zip codes, 22 County Subdivision in Montgomery County and Prince Georges County, and six additional counties in Maryland. The O-D pairs were adjusted by a mode share to include just vehicle trips, and then distributed to RCPP as well as other adjacent and parallel routes to determine the total number of commuters that would commute along RCPP during the reversible time period.

2.4.2. MWCOG Model

Similar to the MWCOG Flows on links data, MWCOG provided O-D data. The O-D data included vehicle trips between the 3,722 traffic analysis zones (TAZs). The data included vehicle trip tables for four time periods including morning (6:00-9:00 a.m., 3 hours), midday (9:00 a.m.-3:00 p.m., 6 hours), afternoon (3:00-7:00 p.m., 4 hours), and night (7:00 p.m.-6:00 a.m., 11 hours). The data also included three analysis years that correspond to the study periods (2019, 2025, and 2045). The vehicle trip tables included single occupant vehicles, high occupant vehicles, commercial vehicles, trucks, airport passenger vehicles, and a total. This data source was used to further understand origin-destination patterns other than home-work pairs that may not have been identified in the Journey to Work dataset.

2.4.3. StreetLight

StreetLight is an on-demand dataset that collects, aggregates, and anonymizes location data from location tracking smartphone applications. The StreetLight data is accessed through a cloud-based platform to perform mobility analyses and identify mobility metrics. The study team used StreetLight data to further understand O-D travel patterns through the study area. The study team developed a series of zones to understand the origin and destination for vehicles that use RCPP and how these vehicles moved through the corridor, including which intersection a driver entered and exited RCPP and how they passed through the critical intersection of RCPP at Virginia Avenue. The study team used the data in conjunction with the Journey to Work data, and the MWCOG data, to develop the Existing Origin-Destination Patterns.

2.4.4. Existing Origin-Destination Patterns

The three data sources were combined to show the existing O-D travel patterns for vehicles that use RCPP for the typical morning inbound commuter period and/or the afternoon outbound commuter

[4] https://onthemap.ces.census.gov/

period. The origins and destination geographies were combined into 21 unique TAZs that were grouped to have similar travel patterns along RCPP and along parallel and adjacent corridors. The 21 groups are shown in Figure 16.

The existing origin-destination patterns for the morning and afternoon peak periods are shown in Figure 16 and Figure 18, respectively. The blue represents the origin zone of vehicles that enter RCPP, and the green represents the destination zone of vehicles that exit RCPP. In the bottom right corner of the figure, a traffic volume and direction key are displayed that shows the directionality and magnitude of all users.

In the morning about 90% of trips originate from the northern zones, including about 54% from zones 11 and 12, which represents most of Montgomery County including Bethesda and Silver Spring, Maryland. About 29% of trips originate from zone 4, 6, and 8 in northern D.C. Drivers are destined for zones to the south including about 71% of vehicles to zones 1 and 2, which downtown D.C., but also about 7% to zone 9 and 10, in southeast D.C. about 6%, and 2% to zones 13 and 14, which represent Alexandria and Arlington, Virginia.

In the afternoon, many of the same origin destination pairs remain including about 86% of trips destined to the northern zones. About 65% of trips originate in zones 1 and 2 from downtown D.C., 5% from zone 3 from Georgetown, 9% from zone 9 and 10 from southwest DC, and 9% from zones 13 and 14 from Alexandria and Arlington. About 49% of trips are destined for zones 11 and 12, to Montgomery County, and 29% are destined to zones 4, 6, and 8, to northern D.C.

Figure 16: TAZ Groups

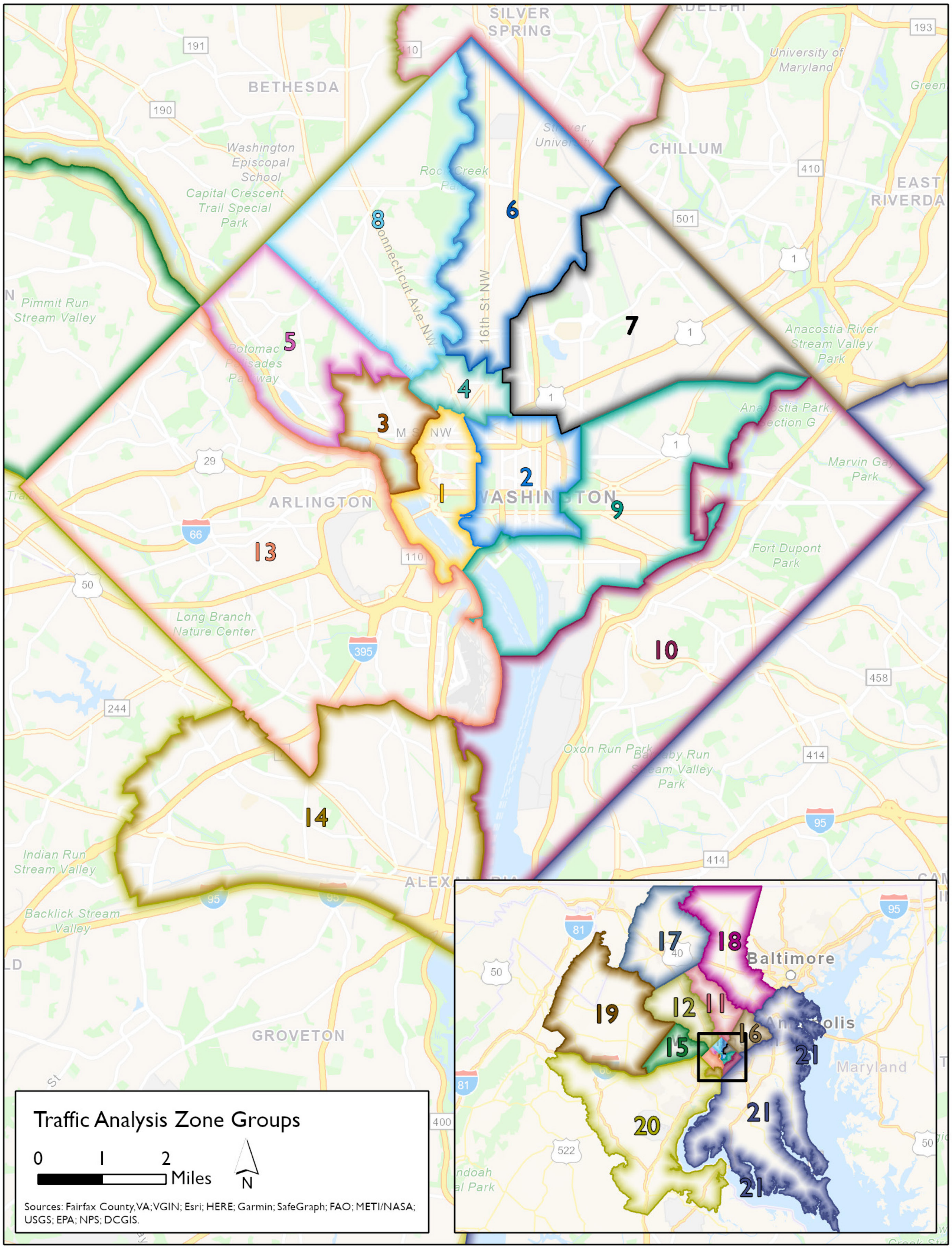


Figure 17: RCPP O-D Links, Morning Inbound Commuter Period

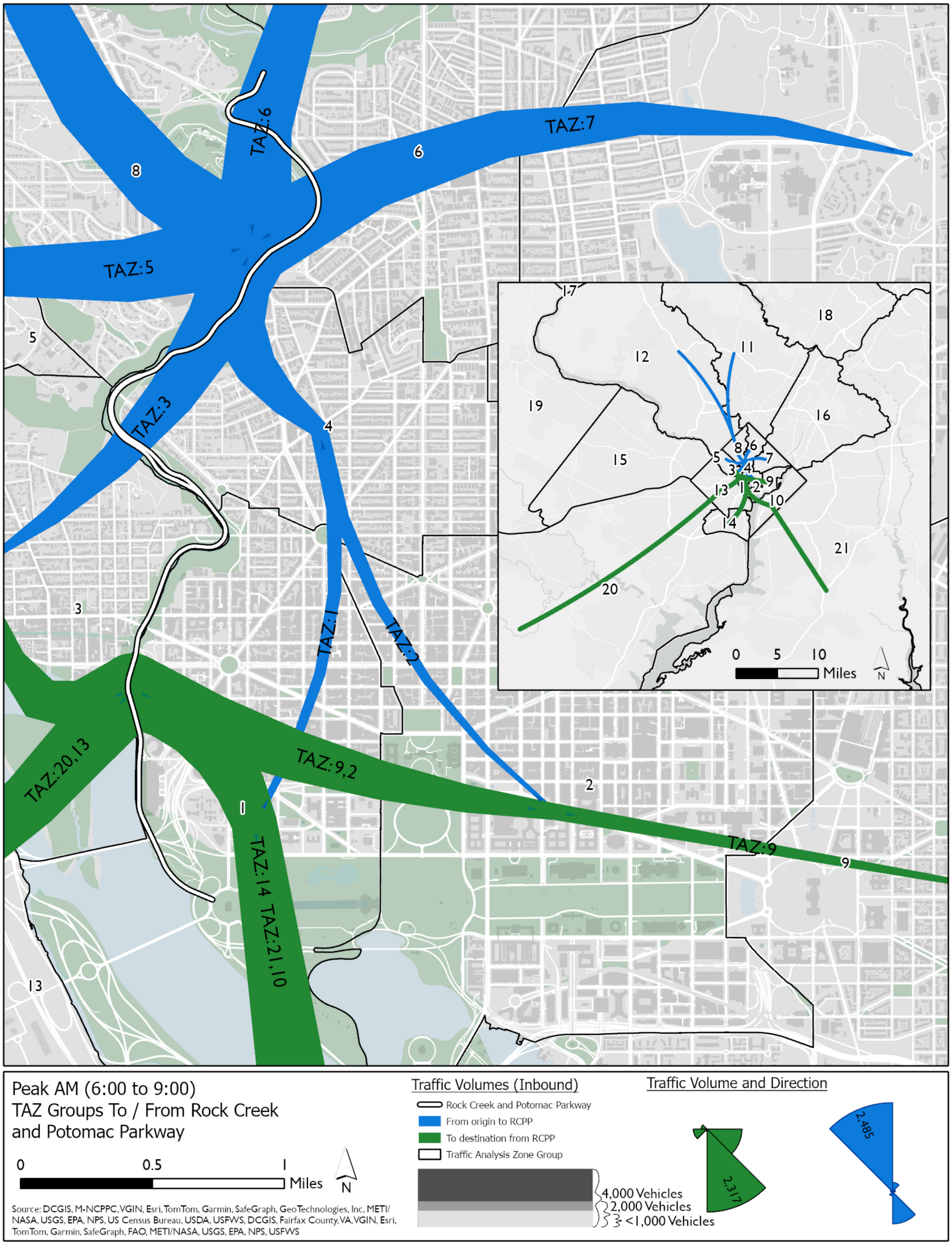
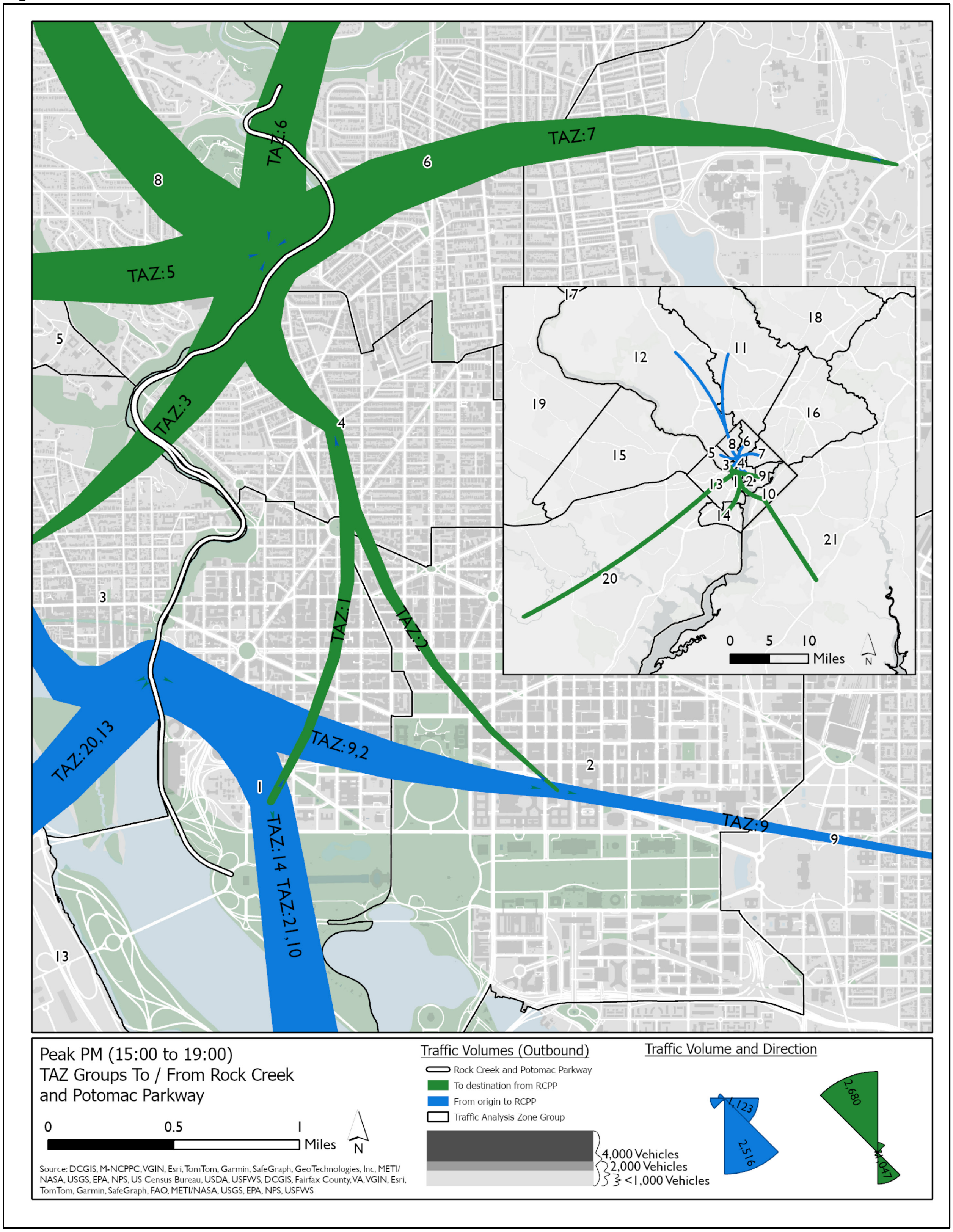


Figure 18: RCPP O-D Links, Afternoon Outbound Commuter Period



2.5. Existing Pedestrian and Bicycle Facilities

The pedestrian and bicycle facilities throughout Rock Creek Park provide excellent transportation commuting opportunities parallel to RCPP. Rock Creek Trail is an approximately 5.4 mile continuous shared-use path through ROCR between Broad Branch Road to the north and the Lincoln Memorial to the south. Trail counts indicate that the path serves over 2,000 daily users. ROCR recently completed a full rehabilitation of about 2.8 miles of the Rock Creek Trail between P Street, to the south, and Broad Branch Road, to the north. The rehabilitation included a new 110-foot pedestrian/bicycle bridge just south of the Beach Drive tunnel near the Smithsonian National Zoo. Lastly the Rock Creek trail connects to the re-opened Zoo Loop Trail that previously collapsed. Crossing treatments such as high visibility crosswalks, median refuge islands, and curb ramps that meet ADA requirements are present in locations where the multiuse trail crosses the roadway (e.g., Shoreham Drive and Cathedral Avenue).

The Capital Bikeshare system includes approximately 5,000 bicycles at over 600 stations consisting of both classic bicycles and electric bicycles. In July 2022, members and visitors took approximately 400,000 trips. According to DDOT's Pedestrian Master Plan (2009), the majority of sections along RCPP were determined to have moderate to high pedestrian activity. In an online survey available from December 2006 to February 2007, Rock Creek Park was one of the most frequently cited destinations in the District in need of improvements to make walking safer and more comfortable. In 2022, the NPS decided to make the pandemic-era closures of sections of northern Beach Drive to through vehicular traffic permanent.

These initiatives through DDOT, NPS, and other local agencies continue to build on the idea that safety, equity, and mobility for all users is of critical importance. The pedestrian and bicycle network continues to expand and improve. While this project does not provide any major improvements to bicycle or pedestrian facilities, the goals of the project do not decrease safety or mobility for bicyclists or pedestrians. Pedestrian and bicycle safety has been strongly considered when identifying any possible mitigation measures or traffic impacts at intersections.

2.6. Existing Public Transportation Services

The Project area is served by several public transportation services, including the Washington Metropolitan Area Transit Authority (WMATA) bus and rail system, the DC Circulator, the Maryland Area Regional Commuter (MARC) system, and the Virginia Railway Express (VRE). The Project will not directly impact any public transportation routes as public transportation is not provided along RCPP. However, a small proportion of drivers may switch to public transportation for their primary commute mode, which will impact the nearby and parallel public transportation services. Similarly, existing commuters using transit for reverse commuting may switch to a vehicle due to the new desirable driving option becoming available. The existing public transportation routes for WAMATA and the DC Circulator are shown in Figure 19.

Figure 20 shows the average weekday ridership each month since January 2019. Like most transit agencies, the Covid-19 pandemic had a major impact on ridership. Initially ridership fell by approximately 92% during the first three months of the pandemic. Ridership has slowly increased at a rate of approximately 10% per month, but the current ridership levels remain at approximately 70% compared to pre-pandemic levels.

Figure 19: Existing Public Transportation Facilities

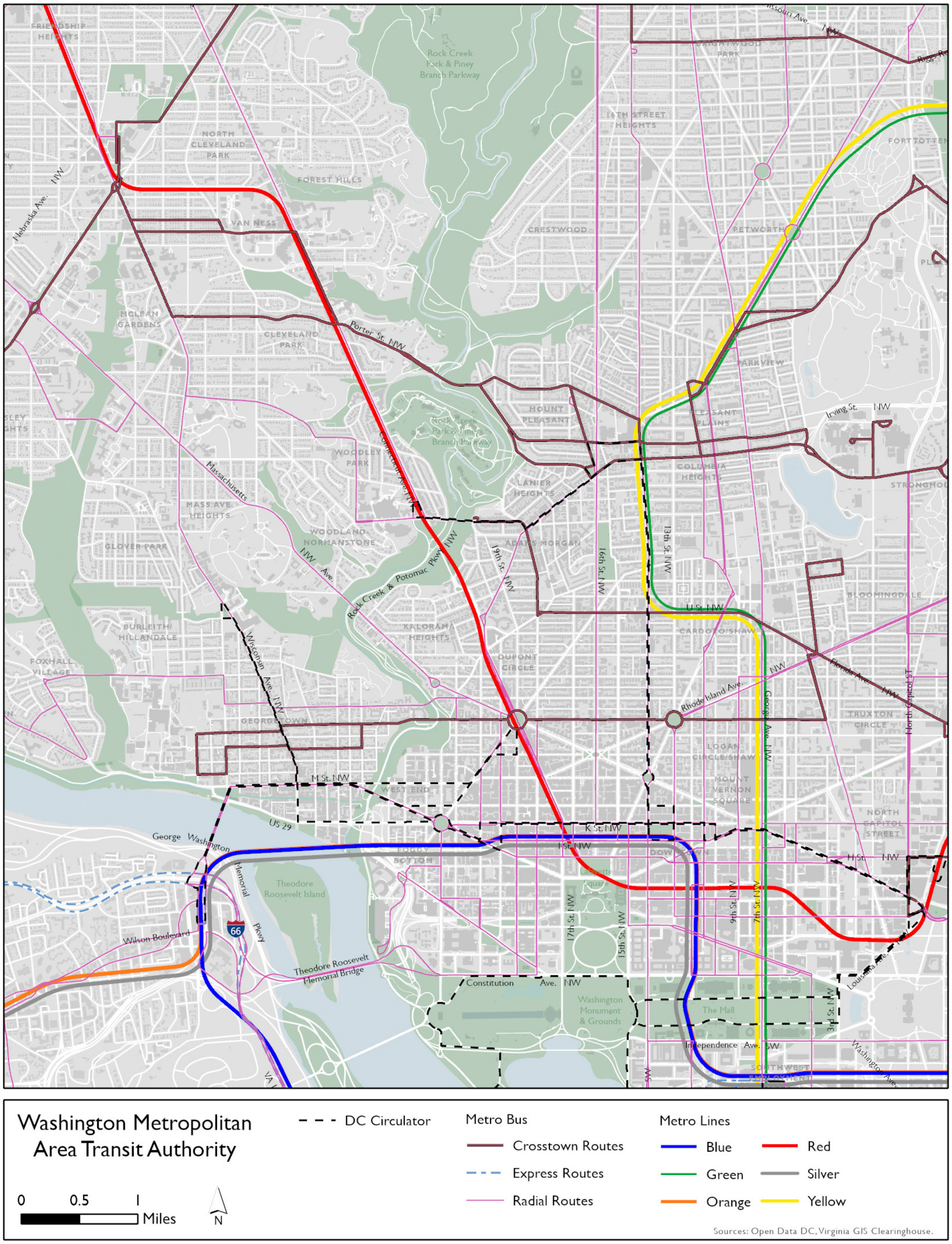
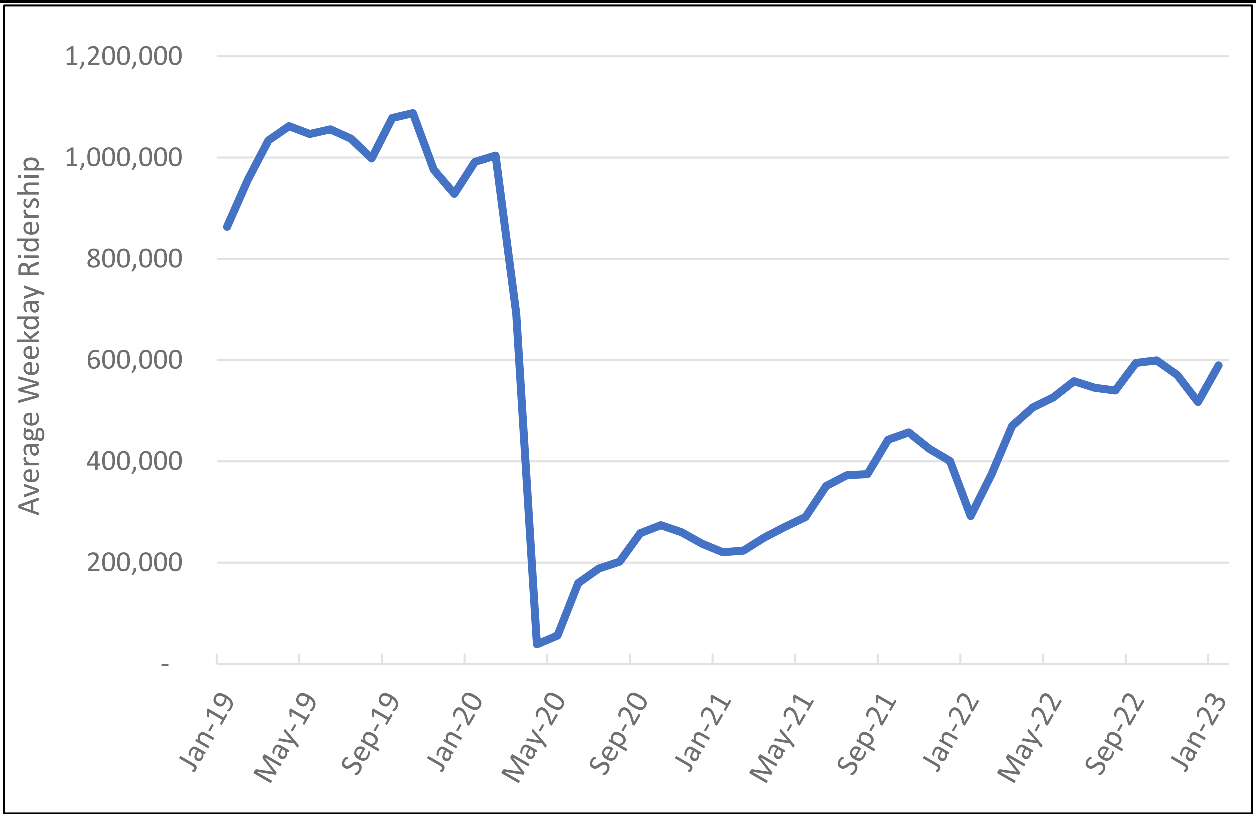


Figure 20: Average Weekday Ridership by Month
Source WMATA Ridership Data Portal



2.6.1. WMATA Metrorail

The Metrorail is the rapid transit system for WMATA. The Metrorail includes six lines, 98 stations, and 128 track miles. The Metrorail serves D.C. as well as Maryland and Virginia. The service generally operates between 5:00 a.m. to midnight Monday through Thursday, 5:00 a.m. to 1:00 a.m. on Friday, 7:00 a.m. to 1:00 a.m. on Saturday, and 7:00 a.m. to midnight on Sunday. The Red Line, Yellow Line, and Green Line all offer potential parallel routes for residents that live to the north and commute into the downtown core. Additional up-to-date information regarding timetables and service routes can be found on the WAMATA website[5].

WMATA Red Line

The WMATA Red Line operates between Shady Grove Station in Rockville, Maryland to the northwest travels through the downtown core of D.C. and Glenmont Station in Glenmont, Maryland to the northeast. Transfer to other lines is provided at Metro Center to the Blue, Orange, and Silver Lines, at Gallery Place to the Green and Yellow Line or Fort Totten to the Green Line. At the time of this publication, the Red Line operates at 5-minute headways during the peak periods, 6-minute headways during the off-peak periods, and 10-minute headways late night, and 6- to 8-minute headways on weekends.

[5] https://www.wmata.com/

WMATA Yellow Line

The WMATA Yellow Line operates between Huntington Station in Alexandra, Virginia to the southwest and Greenbelt Station in Greenbelt, Maryland to the northeast. Transfer to other lines is provided at L'Enfant Plaza to the Blue, Orange, and Green Line, at Gallery Place or Fort Totten to the Red Line. The Yellow Line and the Blue Line operate along the same route between King Street-Old Town and Pentagon. The Yellow Line and Green Line operate along the same route north of L'Enfant Plaza. At the time of this publication, the Yellow Line operates at 6-minute headways during the peak periods, with 8-minute headways during the off-peak, and with 8-minute headways late nights and weekends.

WMATA Green Line

The WMATA Green Line operates between Branch Avenue Station in Suitland-Silver Hill, Maryland to the southeast and Greenbelt Station in Greenbelt, Maryland to the northeast. Transfer to other lines is provided at L'Enfant Plaza to the Blue, Orange, and Yellow Line, at Gallery Place or Fort Totten to the Red Line. The Green Line and Yellow Line operate along the same route north of L'Enfant Plaza. At the time of this publication, the Green Line operates at 6-minute headways during the peak periods, with 8-minute headways during the off-peak, and with 8-minute headways late nights and weekends.

2.6.2. WMATA Metrobus

The Metrobus system serves D.C. metropolitan area with 269 bus routes. The buses are broken into frequent service and other routes. The RCPP corridor does not provide any bus service however the parallel routes provide bus service, including along Connecticut Avenue, Wisconsin Avenue, Massachusetts Avenue, and 16th Street as well as cross-town services along Pennsylvania Avenue, P Street, and M Street.

2.6.3. DC Circulator

The DC Circulator primarily runs between the city's main attractions and popular neighborhoods for visitors and tourists for the cost of $1. The system is a product of a unique partnership between DDOT, WAMATA, DC Surface Transit (DCST, and NPS. The system consists of six routes and has 10-minute headways during all hours of operation. Hours of operation range for each route but service is generally provided every day as early as 6:00 a.m. and some as late as 3:30 a.m. Information on the operating hours is shown online on the schedule[6]. According to the webpage[7], the circulator "provides close to five million trips a year".

2.6.4. Other Regional Transit Service

Two other regional transit providers operate within the area that commuters may take advantage of. The MARC and the VRE. The MARC is the commuter rail system with three lines that all terminate at D.C.'s Union Station. The Brunswick Line serves residents that will be most impacted by the Project. The Brunswick Line operates between D.C.'s Union Station to the south and Frederick, Maryland, or Martinsburg West Virginia to the north. The VRE operates between Spotsylvania, to the south and Union Station, to the north. Both services may provide existing RCPP users with regional transportation alternatives to driving.

---

[6] https://dccirculator.com/ride/rider-tools/schedule/

[7] https://dccirculator.com/connect/about-us/

3. Future Baseline Scenarios

The future baseline scenario incorporates anticipated transportation changes associated with planned infrastructure improvements, expected traffic growth independent of any specific project, and traffic associated with planned major land development projects that will affect travel patterns throughout the study area. The two future baseline years, including the Short-term Horizon for year 2025, and the Long-term Horizon for the year 2045, are consistent with the MWCOG traffic model and the long-range planning efforts Visualize2045, for MWCOG, and MoveDC, for the District of Columbia.

3.1. Planned Infrastructure Projects

Infrastructure projects have the potential to impact traffic patterns, mode choice, and traffic operations. The study team, in coordination with DDOT, has identified several nearby infrastructure projects that may impact traffic throughout the area.

Connecticut Avenue Reversible Lanes[8]:

This project includes the elimination of the reversible lanes along Connecticut Avenue between Calvert Street to the south and the Maryland State Line to the north. At the start of the Covid-19 pandemic, the reversible lanes were deactivated. On December 15, 2021, the Mayor and DDOT officially approved Concept C of the Connecticut Avenue Multimodal Safety Improvement Project. Concept C includes a protected bicycle lane along both sides of the roadway with four general travel lanes and turning lanes or on-street parking, where necessary. This traffic impact study includes the vehicle diversions projected from the Connecticut Avenue NW Reversible Lane Safety & Operations Study: Traffic Analysis Report, published December 2020.

Beach Drive Closure[9]:

This project includes the closure of traffic through several sections of Beach Drive NW in Rock Creek Park, between Broad Branch Road NW and the Maryland State Line. The project maintains local traffic access along Beach Drive between Joyce Road NW and Picnic Grove 10, to allow for access to picnic recreation areas. Wise Road NW, along with Beach Drive NW between Wise Road NW and West Beach Drive NW, remains open to vehicles, in order to maintain an east-west connection across the northern section of the park. Since the start of the Covid-19 pandemic, the roadway has been closed to vehicles. In November 2022, NPS announced that this roadway closure will remain in effect permanently.

K Street Transitway[10]:

The K Street Transitway project includes the reconfiguration of K Street between 12th Street NW and 21st Street NW. The project proposes a two-way bus-only lane through the middle of K Street and two general travel lanes in each direction. While the project proposes to eliminate the existing bicycle lane along K Street, the parallel bicycle infrastructure along L Street will be enhanced. This traffic impact study includes the traffic volume diversions projected from the K Street NW Traffic Analysis FINAL traffic Analysis Memorandum, dated November 2020.

[8] https://ddot.dc.gov/page/connecticut-avenue-nw-reversible-lane-safety-and-operations-study
[9] https://parkplanning.nps.gov/document.cfm?parkID=198&projectID=102800&documentID=124589
[10] https://kst-transitway.ddot.dc.gov/

16th Street BRT[11]:

DDOT implemented Bus Rapid Transit lanes along a 2.7-mile section of 16th Street between H Street, to the south, and Arkansas Avenue to the north. Construction was completed in Spring 2022. The bus lanes will impact more than 20,000 daily riders (according to pre-pandemic ridership levels) and make up approximately half of the daily users along the corridor. The bus lanes will be in effect during peak periods from 7:00 – 9:30 a.m. and 3:30 – 7:00 p.m. The bus lanes are expected to save bus passengers approximately 2-3 minutes per trip and allow the buses to better stay on schedule.

3.2. Background Traffic Growth

Background traffic growth is related to changes in demographics, regional job and population growth, and changes in commuting behavior. According to Visualize 2045, the region's population is expected to increase by 23% with the largest increases expected in D.C. and Fairfax County (including the City of Fairfax and the City of Falls Church). While the single occupancy vehicle (SOV) auto mode is expected to decrease, the carpool/high occupancy vehicle (HOV) mode share is expected to increase. Combined with the population growth throughout the region and based on a review of historic traffic data provided by MWCOG, a one-half percent per year annual traffic growth rate was used.

3.3. Mode Shift Expectations

Visualize 2045 developed high-level aspirational initiatives that emphasize alternative transportation, to expand bus rapid transit, increase usage of the Metrorail, and improve walking and biking access to transit. While Visualize 2045 did not set defined goals for the region, it projected the future mode share and population changes for the Core (District of Columbia, Arlington, and Alexandria), the Inner Suburbs (Montgomery, Prince George's, and Fairfax counties) and Outer Suburbs (Charles, Frederick, Loudoun, and Prince William Counties). Table 3 shows the existing mode share, as well as the expectations for the year 2025, and 2045, to align with the short-term and long-term horizon years.

Table 3. Mode Shift Expectations

Geographic Area	Mode	Existing (2022)	2025 Mode Share	2045 Mode Share
Core	Drive Alone	34.1%	32.8%	23.5%
	Carpool	4.6%	4.8%	6.2%
Annual Population Growth	Transit	42.3%	43.6%	52.6%
1.29%	Walk/Bike	19.0%	18.8%	17.7%
Inner Suburbs	Drive Alone	69.4%	68.3%	61.0%
	Carpool	8.0%	8.4%	11.1%
Annual Population Growth	Transit	18.9%	19.6%	24.0%
0.63%	Walk/Bike	3.6%	3.7%	3.9%
Outer Suburbs	Drive Alone	81.4%	80.4%	73.9%
	Carpool	12.1%	12.8%	18.1%
Annual Population Growth	Transit	5.5%	5.6%	6.3%
1.12%	Walk/Bike	1.0%	1.1%	1.7%
Total Region	Drive Alone	64.6%	63.5%	56.3%
	Carpool	8.2%	8.6%	11.9%
Annual Population Growth	Transit	20.9%	21.5%	25.5%
0.89%	Walk/Bike	6.4%	6.4%	6.3%

[11] https://ddot-cp-16-st-nw-bus-dcgis.hub.arcgis.com/

While the mode share is expected to move towards transit usage, walking and biking, and carpool, and away from driving alone, the driving population is expected to continue to grow in the four defined geographic areas. Any improvements in mode shift away from automobile usage will be offset by the population growth, resulting in traffic growth. As shown in the Chapter 2.4: Origin-Destination Data, 51% of commuters along RCPP originate from outside of the Core region and 89% of commuters along RCPP are destined for locations inside the Core region, meaning most users begin their trip from outside of the Core and are destined for locations inside the Core, which is typical for commuting behavior.

Other mode shift resources include the Sustainable DC 2.0 Plan[12], which does identify clear mode shift goals for the District of Columbia to be reached by the year 2032. The goal included a 9.5% increase in the transit from 37% to 50%, an 8.2% increase in walking and biking from 19.65 to 25%, and a 17.7% decrease in driving from 43.4% to 25%. Additionally, one of the established policies (Policy P) in Move D.C. repeats this goal to "promote partnerships and programs such as travel demand management to achieve 75 percent non-auto mode commute trips by 2032." The District of Columbia developed both documents, which do not account for additional regional changes or predictions in Maryland or Virginia. These mode shift goals generally align with the mode shift expectations for the Core geographic area, which also includes Arlington and Alexandria, published in the Visualize 2045 MWCOG resource.

3.4. Future Baseline Traffic Volumes

The Existing Scenario traffic volumes have been adjusted to account for the planned infrastructure projects, the background traffic growth, and the land development projects to develop the Short-Term (2025) Horizon Baseline Scenario.

Similar to the Short-Term (2025) Horizon Baseline Traffic Volumes, the Long-Term (20245) Horizon Scenario, Baseline Traffic Volumes account for the planned infrastructure projects, the background traffic growth, and the land development projects. The primary difference is the growth rate accounts for an additional 20-years of traffic growth, which increases all traffic volumes by an additional 10.5%.

The Short-Term (2025) Horizon Baseline Traffic Volumes during the weekday a.m. and p.m. peak hours at the primary and secondary intersections are shown in Figure 21, Figure 22, Figure 23, and Figure 24, respectively. The Long-Term (2045) Horizon Baseline Traffic Volumes during the weekday a.m. and p.m. peak hours at the primary and secondary intersections are shown in Figure 25, Figure 26, Figure 27, and Figure 28, respectively.

[12] https://sustainable.dc.gov/sdc2

Figure 21: Short-Term (2025) Horizon, Baseline Scenario Traffic Volumes, Weekday a.m. Peak Hour, Primary Intersections

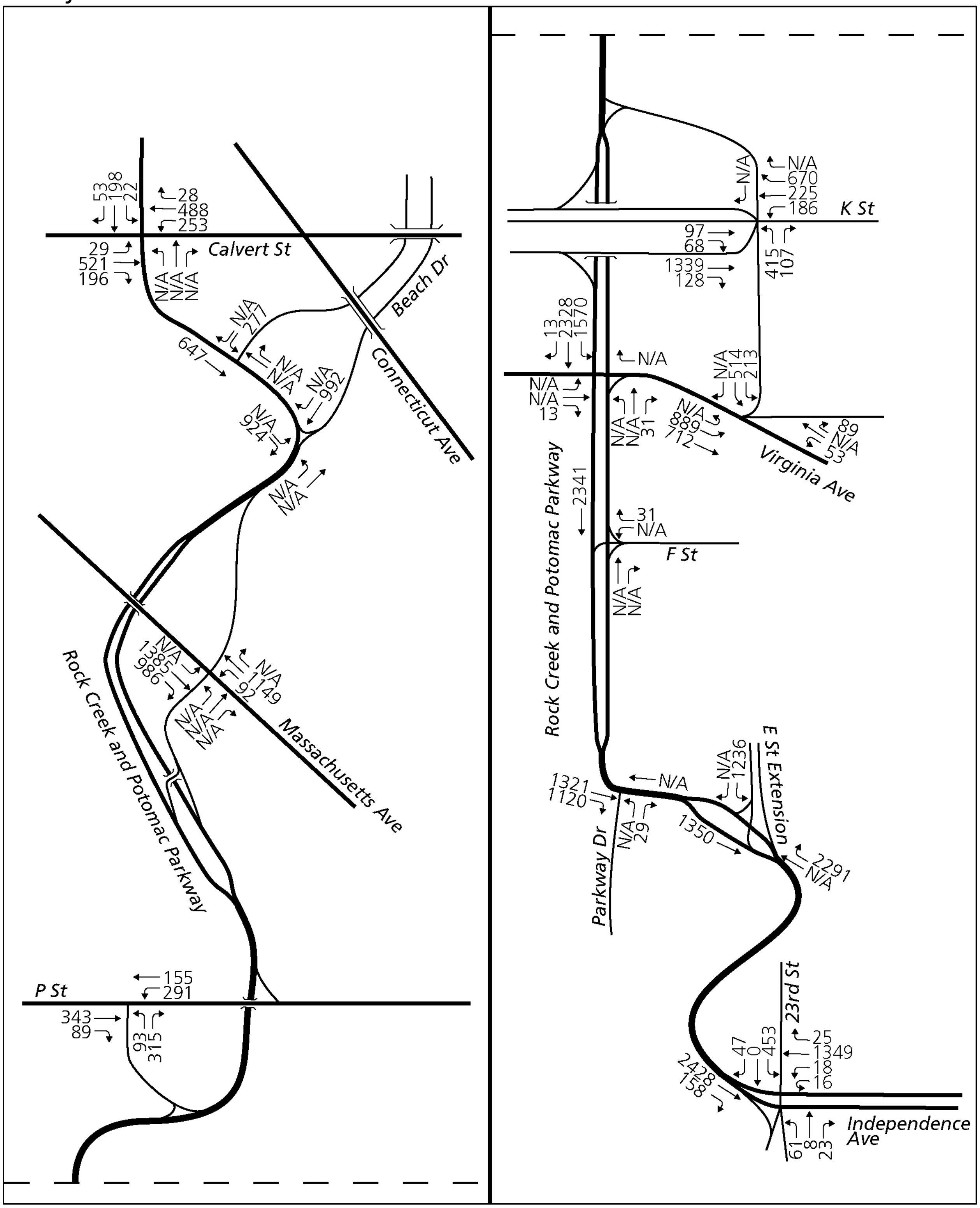


Figure 22: Short-Term (2025) Horizon, Baseline Scenario Traffic Volumes, Weekday a.m. Peak Hour, Secondary Intersections

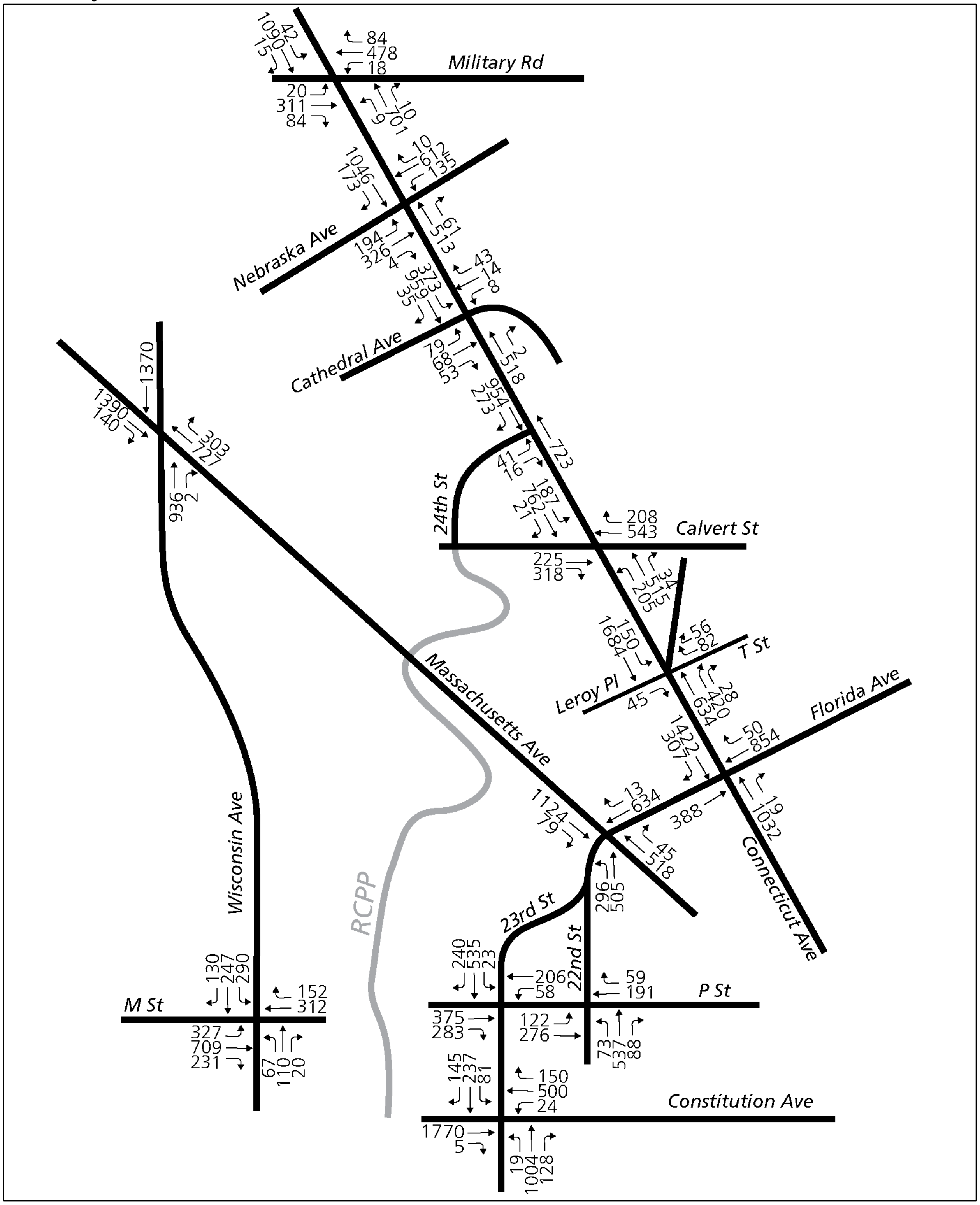


Figure 23: Short-Term (2025) Horizon, Baseline Scenario Traffic Volumes, Weekday p.m. Peak Hour, Primary Intersections

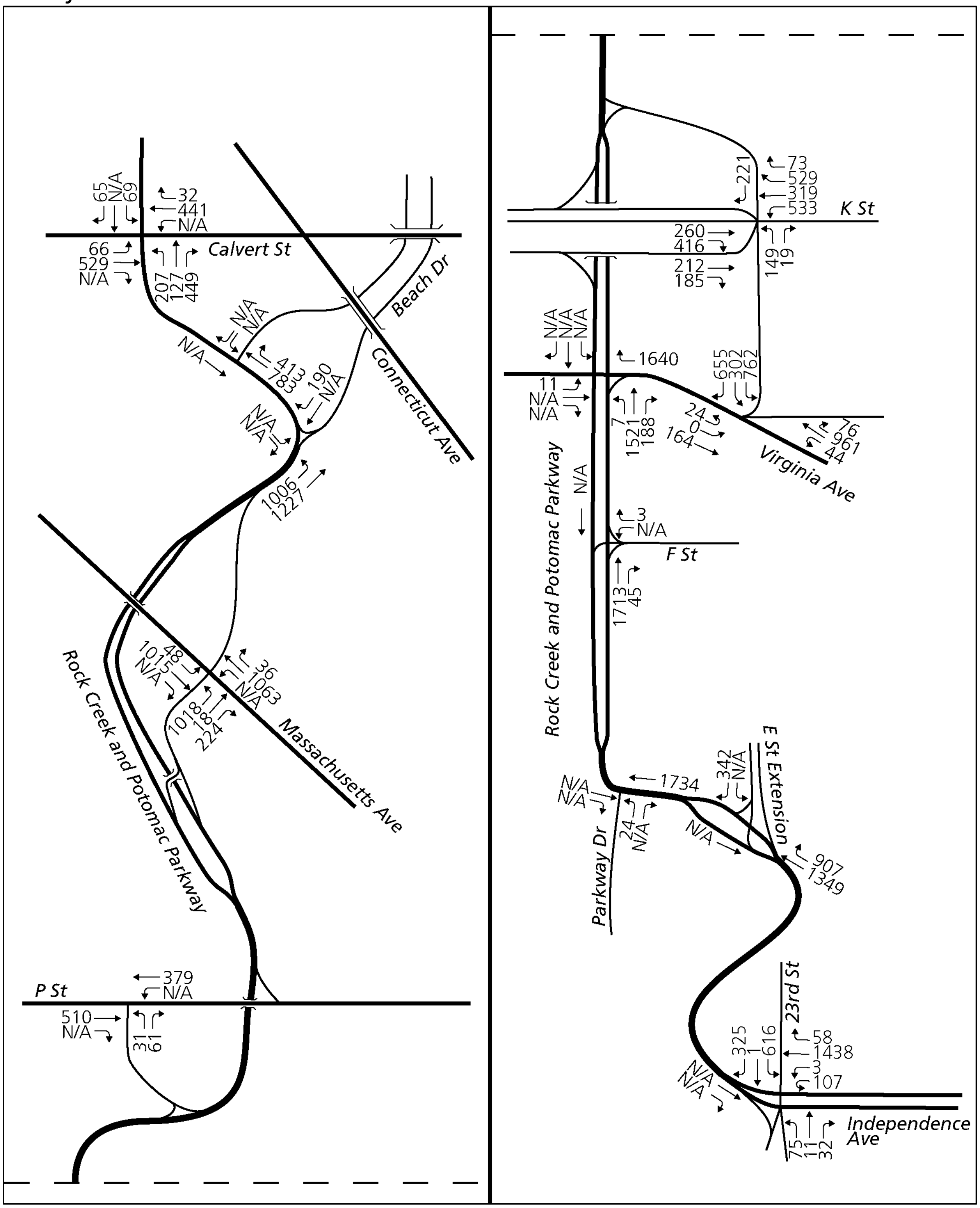


Figure 24: Short-Term (2025) Horizon, Baseline Scenario Traffic Volumes, Weekday p.m. Peak Hour, Secondary Intersections

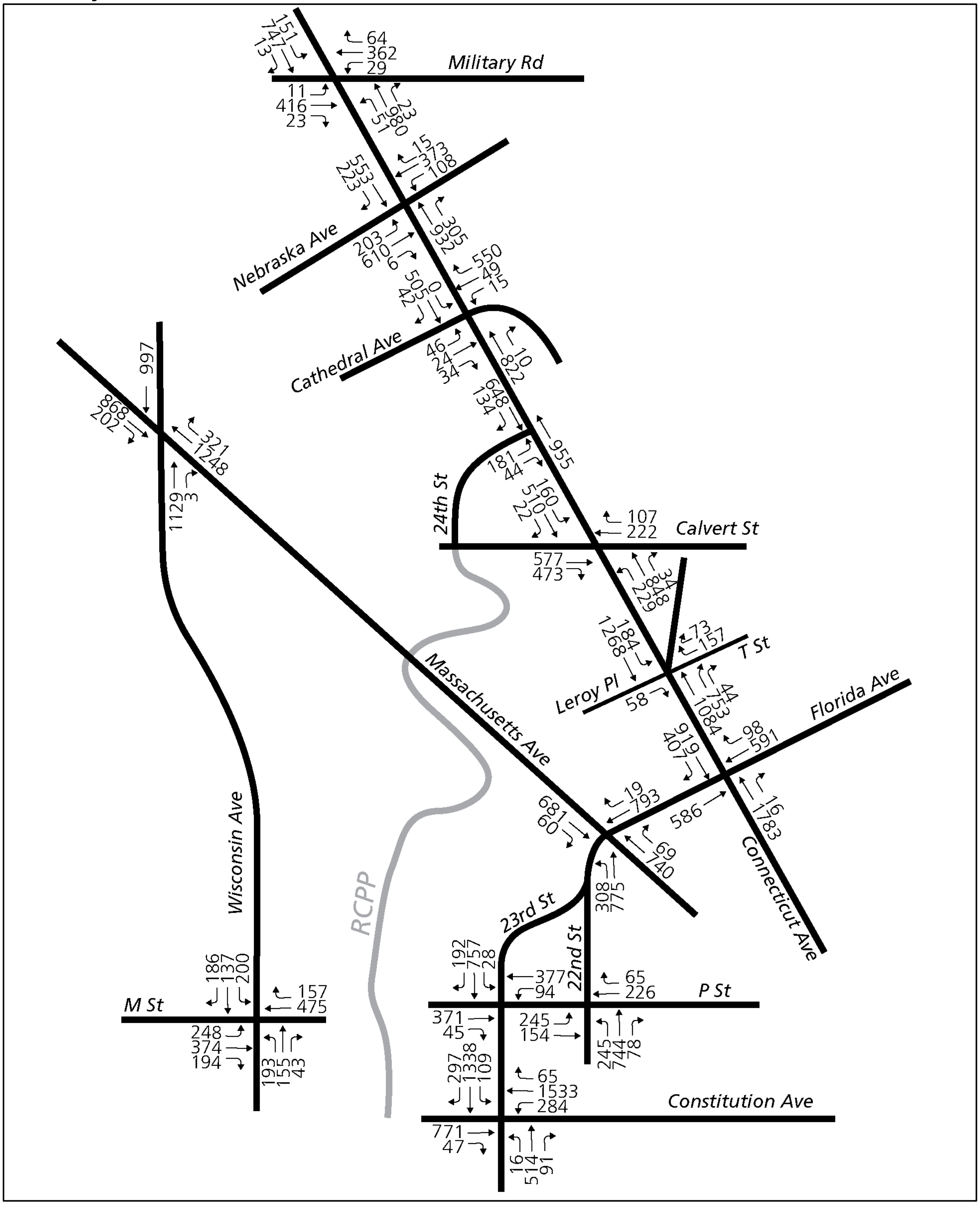


Figure 25: Long-Term (2045) Horizon, Baseline Scenario Traffic Volumes, Weekday a.m. Peak Hour, Primary Intersections

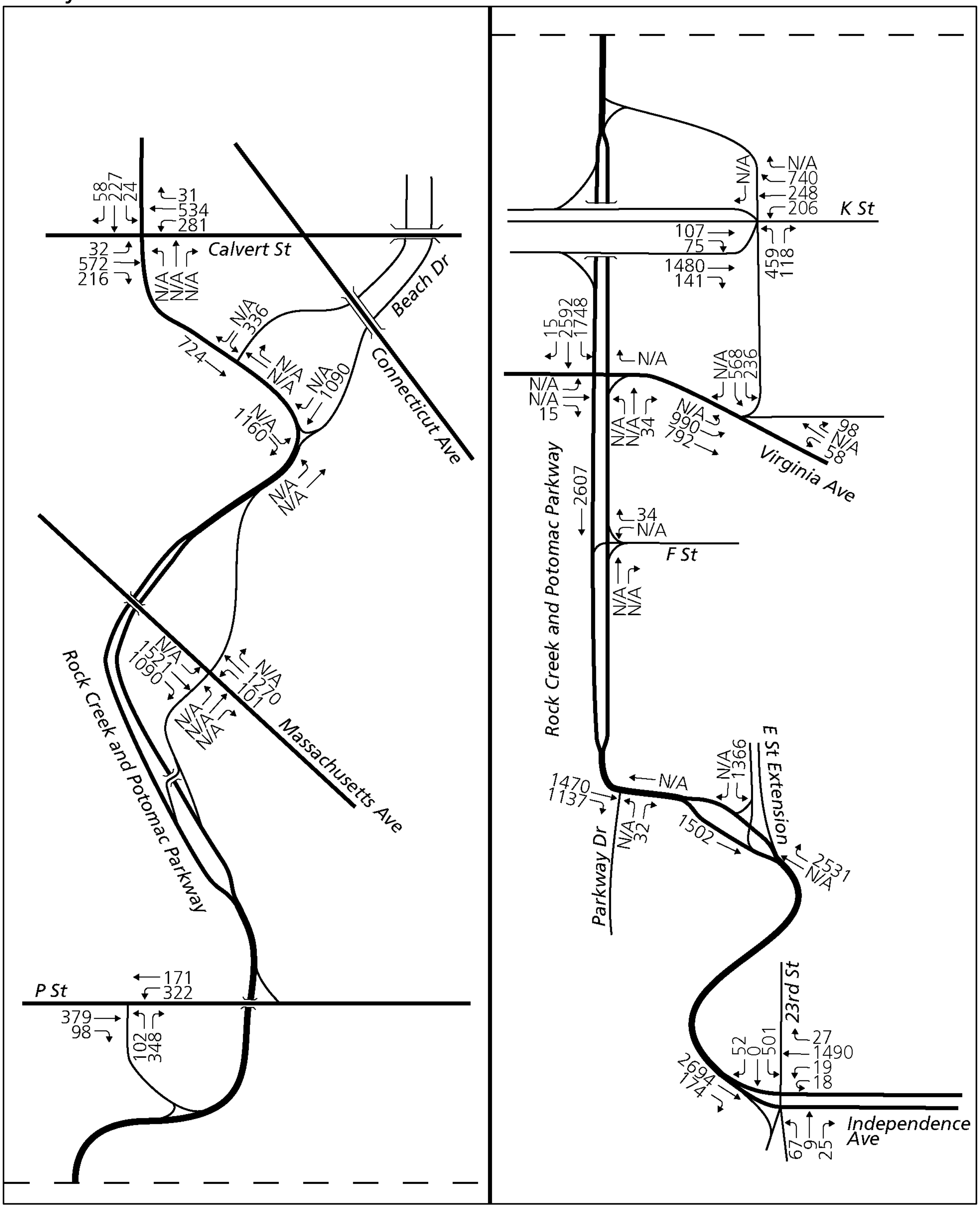


Figure 26: Long-Term (2045) Horizon, Baseline Scenario Traffic Volumes, Weekday a.m. Peak Hour, Secondary Intersections

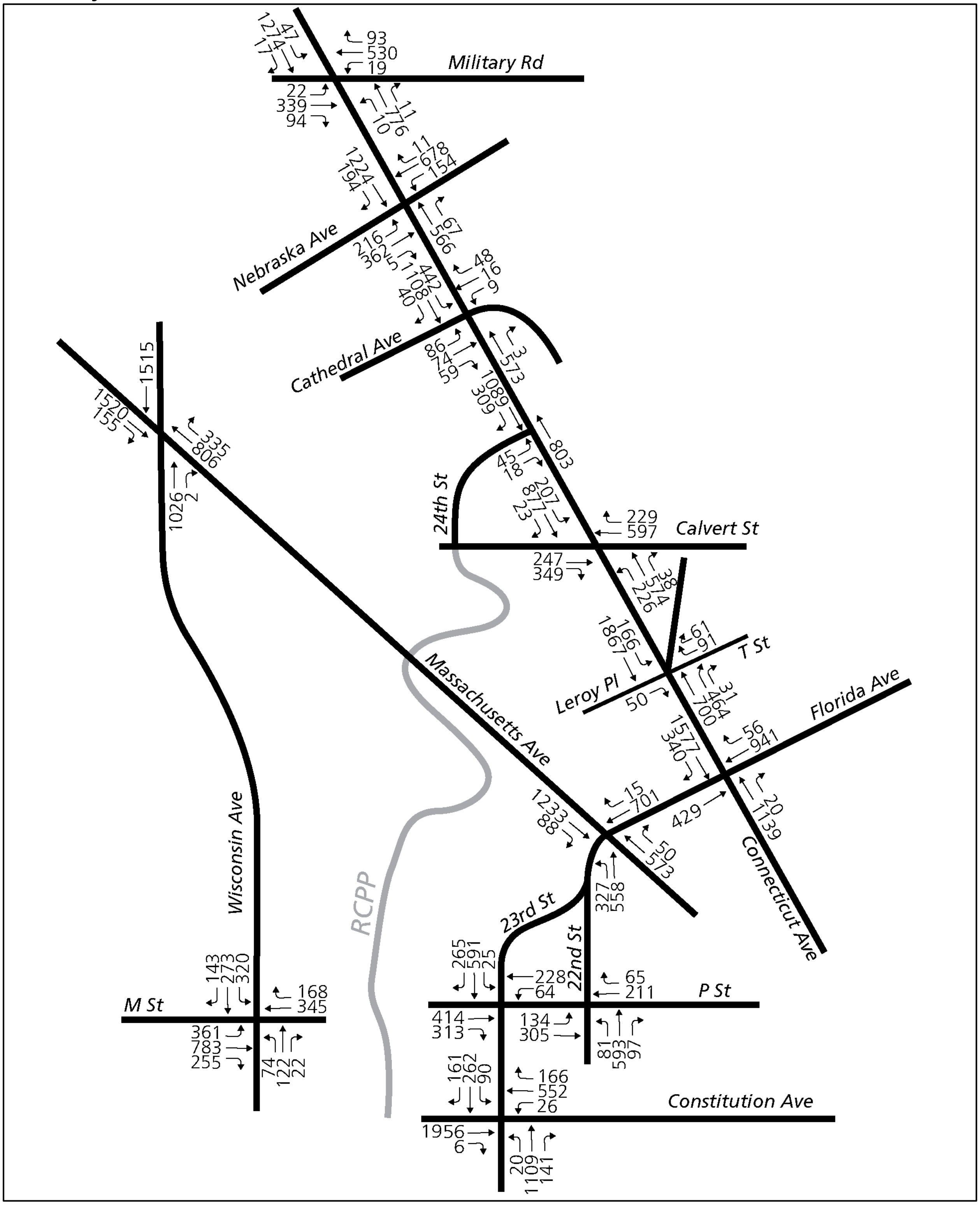


Figure 27: Long-Term (2045) Horizon, Baseline Scenario Traffic Volumes, Weekday p.m. Peak Hour, Primary Intersections

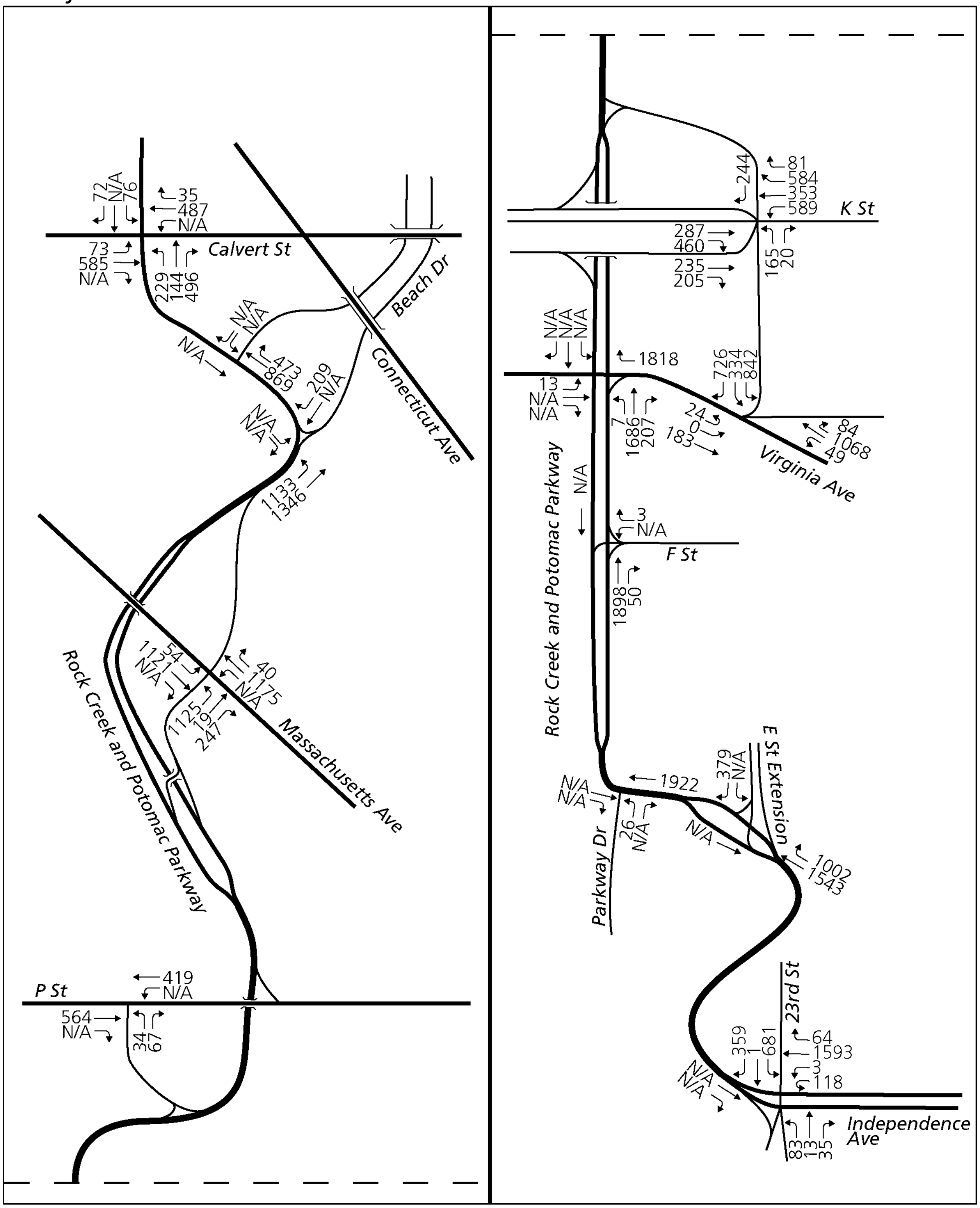
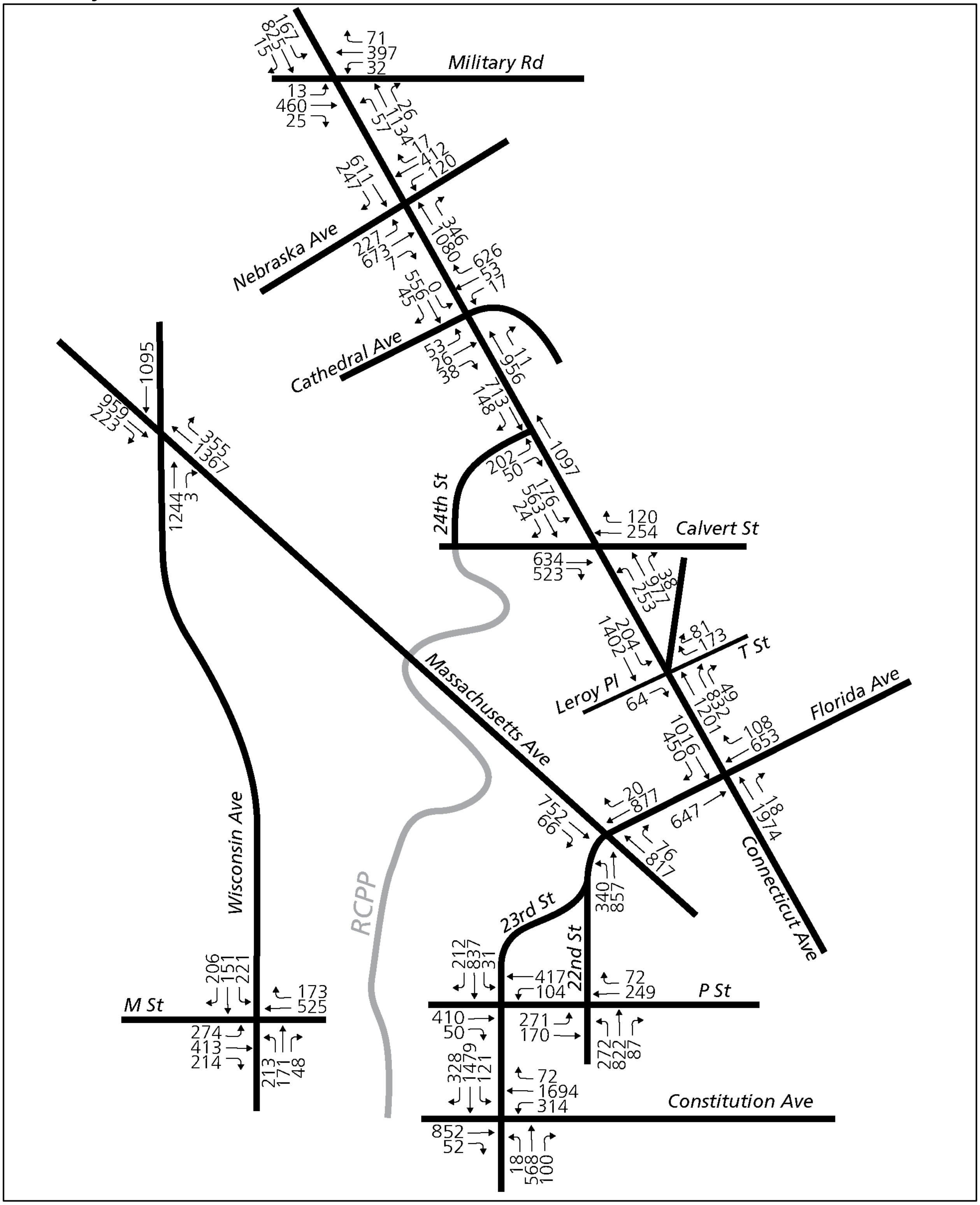


Figure 28: Long-Term (2045) Horizon, Baseline Scenario Traffic Volumes, Weekday p.m. Peak Hour, Secondary Intersections



4. Elimination of the Reversible Operations

Eliminating the reversible operations will impact traffic patterns along the RCPP corridor and will generally impact the parallel arterial corridors within proximity to RCPP during the peak periods including Connecticut Avenue, Wisconsin Avenue, and Massachusetts Avenue, among other. The traffic volumes are expected to decrease along RCPP in the commuting direction and increase along RCPP in the reverse commuting direction. Along parallel routes, the opposite is true, traffic volumes are expected to increase in the commuting direction and decrease in the reverse commuting direction. While the trend is fairly predictable, the magnitude of the diversions is estimated using the available data and knowledge of driver behavior. The estimate is conservative in nature to represent a near worst-case scenario. Additional traffic volume changes along arterial roadways and highways outside the study area and throughout the region are expected to be negligible.

In theory, the USPP could stop setting up the reversible operation tomorrow and the existing roadway infrastructure would be able to function with two-way traffic as it does during weekday off-peak, holidays, and weekends. However, the high vehicular volume during the peak periods could cause potential congestion, confusion, and undesirable safety challenges if the corridor operated with two-way traffic during the peak periods as it exists today. To mitigate those challenges, several preliminary mitigation measures have been recommended with the emphasis to improve safety, minimize congestion, and improve predictability.

4.1. Vehicular Traffic Diversion

While individual commuting or transportation decisions may seem inflexible, collective commuting decisions—such as route choice, mode choice, travel time, and destination—tend to be more flexible. This is especially true in a major city such as D.C. with a redundant roadway network, a robust public transportation system, and a diverse mix of jobs and land-use. Additionally, the rise of GPS-based navigation systems has allowed people to easily change their travel behavior depending on the time of day, the weather, or real-time congestion, among other factors.

When the reversible operations are eliminated, vehicles will divert away from RCPP in the commuting direction (southbound in the morning and northbound in the afternoon) and divert to RCPP in the reverse commuting direction (northbound in the morning and southbound in the afternoon). Drivers that choose to divert from their existing travel patters can generally be categorized into the following four scenarios:

- Route: Take an alternate route;
- Time: Drive at a different time using the same route;
- Location: Work from a different location or work from home; or
- Mode: Travel using a different mode.

The people that choose to take an alternate route are the primary focus when determining the traffic pattern changes during the peak hour. The capacity of RCPP also factored into the traffic volume diversions. The capacity of RCPP is primarily limited by the signalized intersection of RCPP at Virginia Avenue. In the morning, vehicles entering RCPP in the southbound direction have an uninterrupted route until the signal at Virginia Avenue, therefore most of the queuing and delay occur at this intersection. Similarly, in the afternoon, most vehicles using RCPP travel through the intersection at Virginia Avenue and exit at Massachusetts Avenue (via Waterside Drive) or travel to the end of RCPP continuing onto Shoreham Drive, Cathedral Avenue or Beach Drive. Additionally, the origin-destination patterns identified in Chapter 2.4: Origin-Destination Data were used to understand how vehicle traffic patterns would change if the reversible operations were eliminated. Detailed information related to the vehicle diversion methodology is presented in Appendix C.

Table 4 and Table 5 show the vehicular traffic diversions along RCPP, during the weekday a.m. and p.m. peak hour, respectively. Each table shows the existing vehicular traffic entering RCPP in the inbound direction and exiting RCPP in the outbound direction. The tables show the proportional demand of traffic entering or exiting RCPP in the commuting direction. For the reverse commute direction, the proportional demand was estimated based on the origin-destination data presented in the vehicle diversion methodology report provided in Appendix C. The tables also show the future demand along RCPP, the projected net change in traffic volume along RCPP, and the projected net change in traffic volume along secondary routes. Table 6 shows the net change in traffic volumes expected along RCPP and secondary routes with both the inbound and outbound directions added together.

Table 4. Vehicular Traffic Diversions along RCPP, Weekday a.m. Peak Hour

	Existing Traffic	Proportional Demand	Future RCPP Demand	Net Change along RCPP	Net Change along Secondary Routes
Inbound Total	**4,208**	**100%**	**2,735**	**-1,473**	**1,326**
Shoreham Drive*	1,473	35%	957	-516	464
Beach Drive	1052	25%	684	-368	331
Waterside Drive	1,220	29%	793	-427	384
P Street/K Street	463	11%	301	-162	146
Outbound Total	**0**	**100%**	**1,394**	**1,394**	**-1,255**
Shoreham Drive*	0	29%	404	404	-364
Beach Drive	0	21%	293	293	-264
Waterside Drive	0	36%	502	502	-452
P Street/K Street	0	14%	195	195	-176

**Shoreham Drive includes traffic volume along both Shoreham Drive and Cathedral Avenue.*

Table 5. Vehicular Traffic Diversions along RCPP, Weekday p.m. Peak Hour

	Existing Traffic	Proportional Demand	Future RCPP Demand	Net Change along RCPP	Net Change along Secondary Routes
Inbound Total	**0**	**100%**	**1,991**	**1,991**	**-1,792**
Shoreham Drive*	0	34%	677	677	-609
Beach Drive	0	21%	418	418	-376
Waterside Drive	0	26%	518	518	-466
P Street/K Street	0	19%	378	378	-340
Outbound Total	**3,846**	**100%**	**2,126**	**-1,145**	**1,031**
Shoreham Drive*	1,175	31%	659	-355	320
Beach Drive	1,099	29%	617	-332	299
Waterside Drive	1,222	31%	659	-355	320
P Street/K Street	350	9%	191	-103	93

**Shoreham Drive includes traffic volume along both Shoreham Drive and Cathedral Avenue.*

Table 6. Net Change in Traffic Volumes along RCPP and Secondary Routes

Time Period	Net Change along RCPP	Net Change along Secondary Routes
Weekday a.m. Peak Hour	**-79**	**+71**
Weekday p.m. Peak Hour	**+846**	**-761**

The projected change in traffic volume during weekday a.m. peak hour is negligible as the increase of vehicles using the reverse commute almost matches the decrease in vehicles that divert from RCPP. The projected change in traffic volume during weekday p.m. peak hour shows that about 846 additional vehicles will use the RCPP corridor and about 761 vehicles will divert away from the secondary routes. The vehicular traffic diversions along each individual route during the weekday a.m. and p.m. peak hours and are shown in Figure 29 and Figure 30, respectively. Figure 31 shows the percent change along roadways in the study area throughout the day.

4.2. Elimination of Reversible Operations Traffic Volumes

The short-term horizon (2025) and long-term horizon (2045) baseline scenario traffic volumes have been adjusted to account for the traffic diversions related to the elimination of the reversible operation. The Short-Term Horizon (2025), Elimination of Reversible Operations Scenario traffic volumes during the weekday a.m. and p.m. peak hours are shown in Figure 32, Figure 33, Figure 34, and Figure 35, respectively. The Long-Term Horizon (2045), Elimination of Reversible Operations Scenario traffic volumes during the weekday a.m. and p.m. peak hours are shown in Figure 36, Figure 37, Figure 38, and Figure 39, respectively.

Figure 29: Vehicular Traffic Diversions, Weekday a.m. Peak Hour

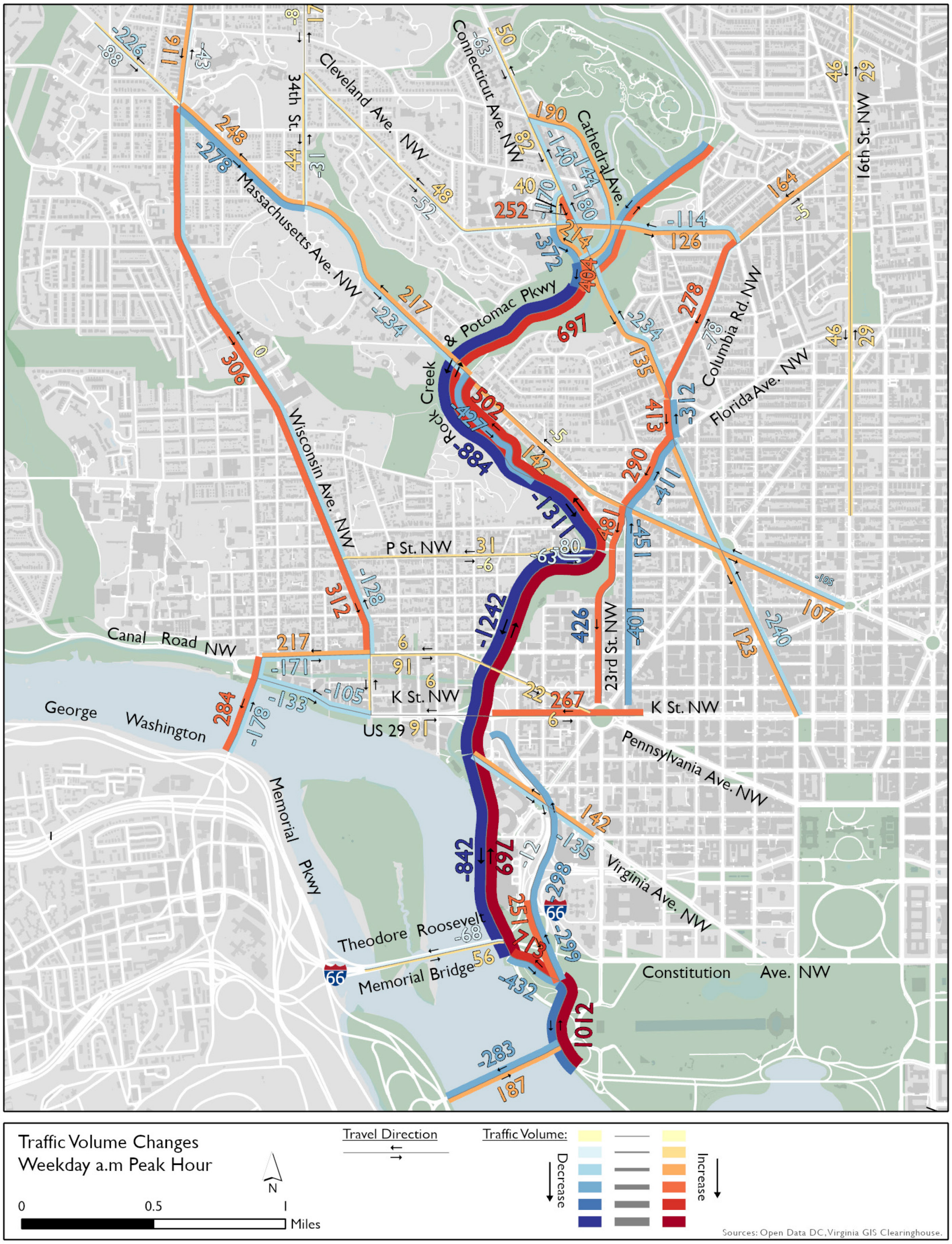


Figure 30: Vehicular Traffic Diversions, Weekday p.m. Peak Hour

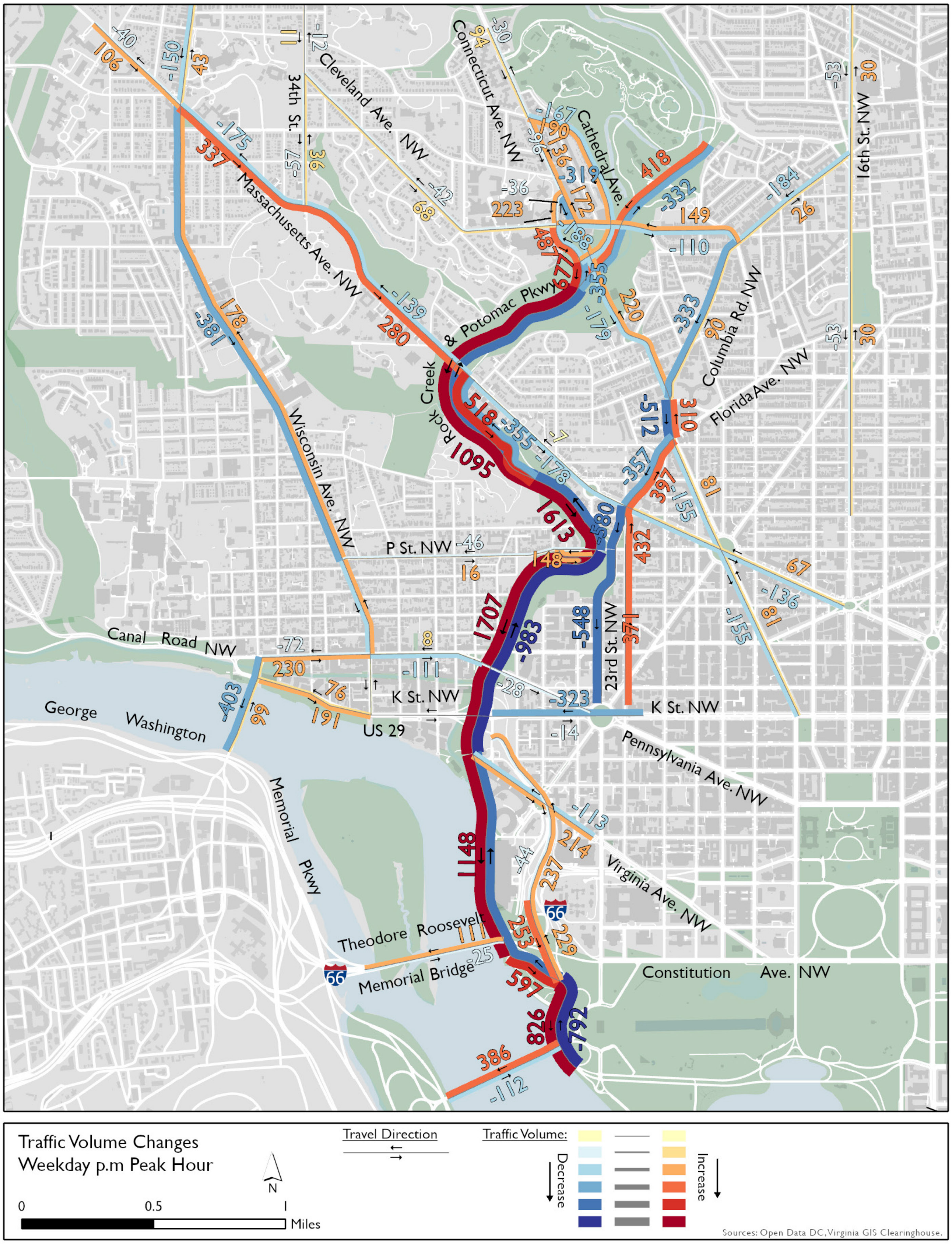


Figure 31: Traffic Volume Percent Change, Daily

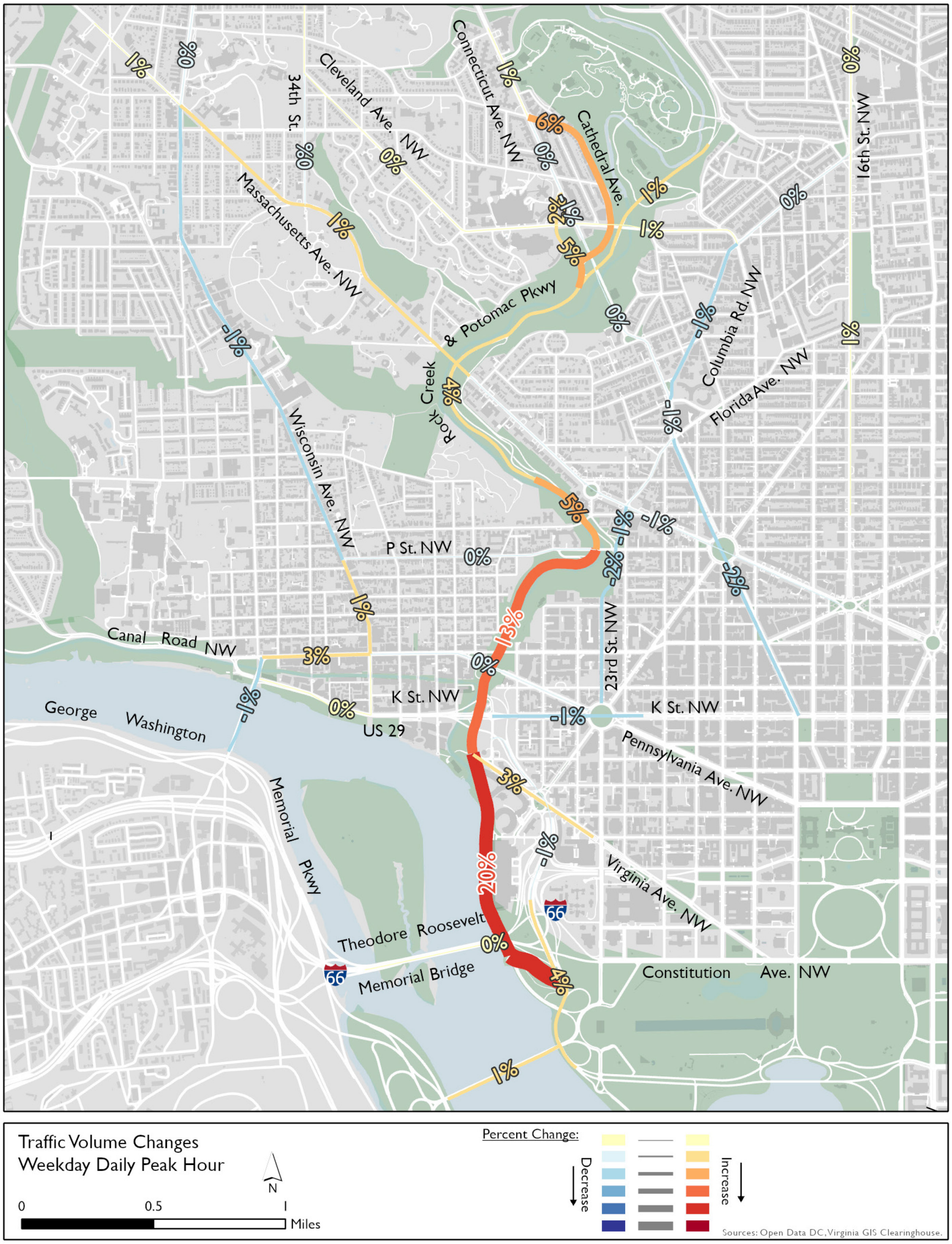


Figure 32: Short-Term (2025) Horizon, Elimination of Reversible Operations Scenario Traffic Volumes, Weekday a.m. Peak Hour, Primary Intersections

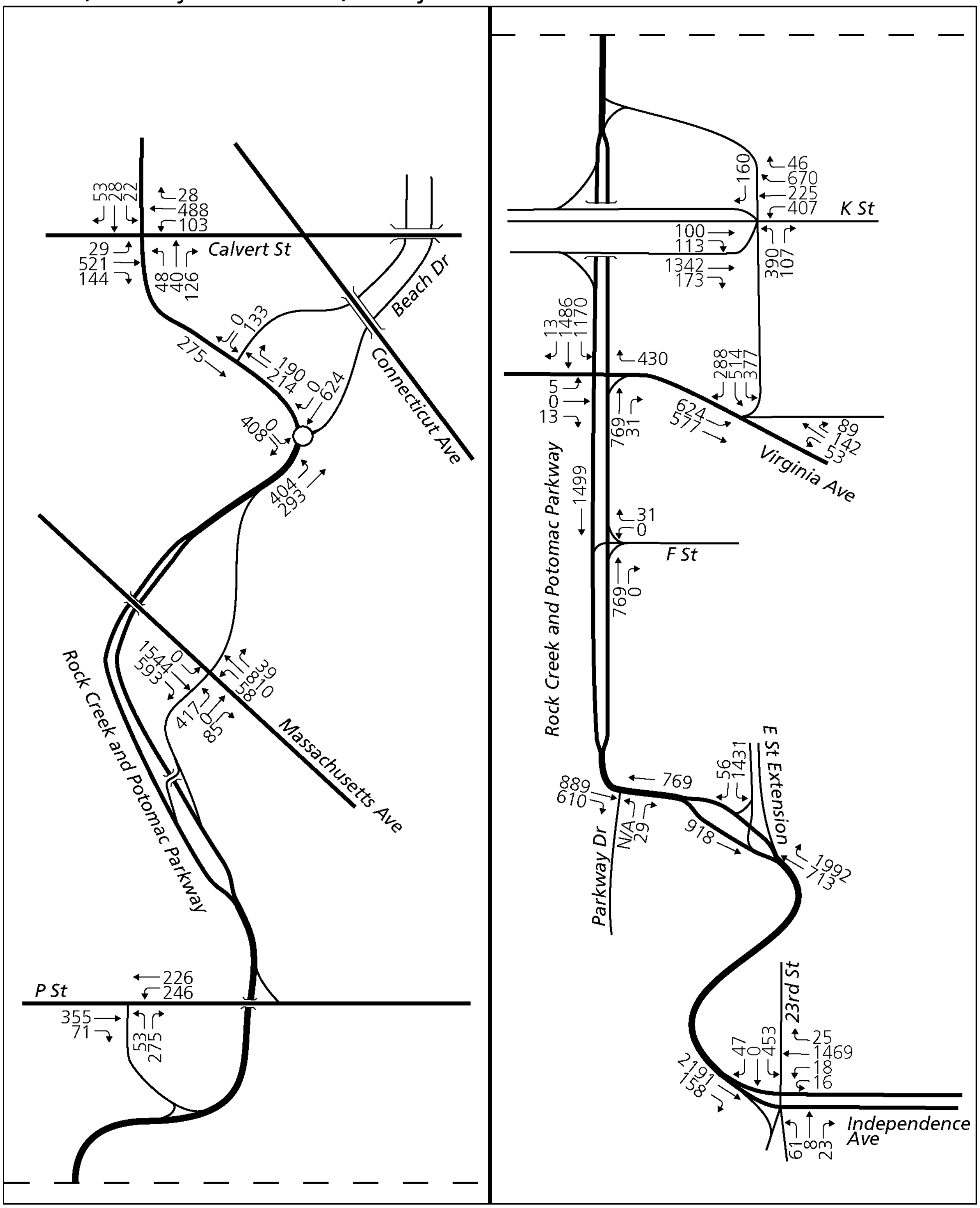


Figure 33: Short-Term (2025) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday a.m. Peak Hour, Secondary Intersections

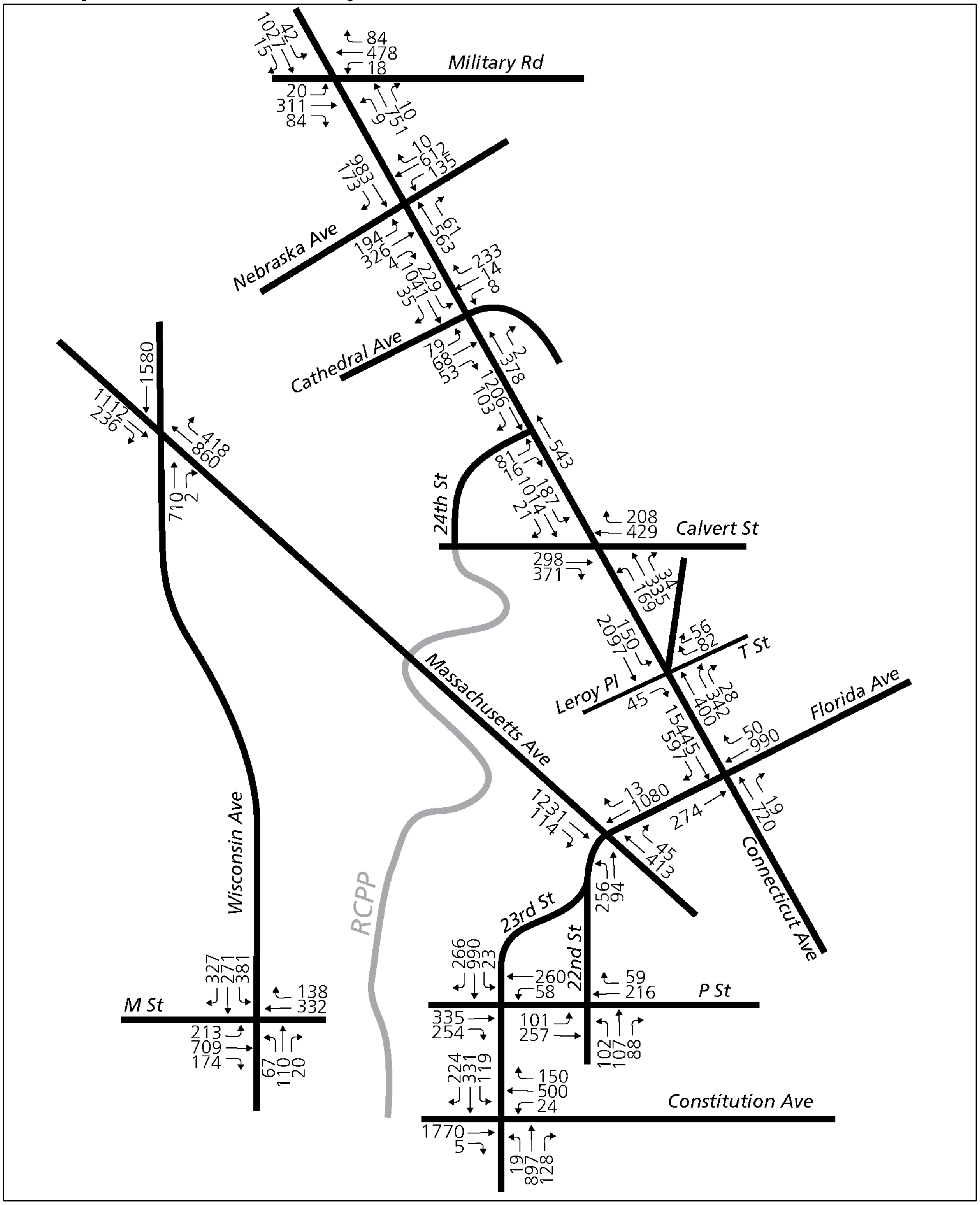


Figure 34: Short-Term (2025) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday p.m. Peak Hour, Primary Intersections

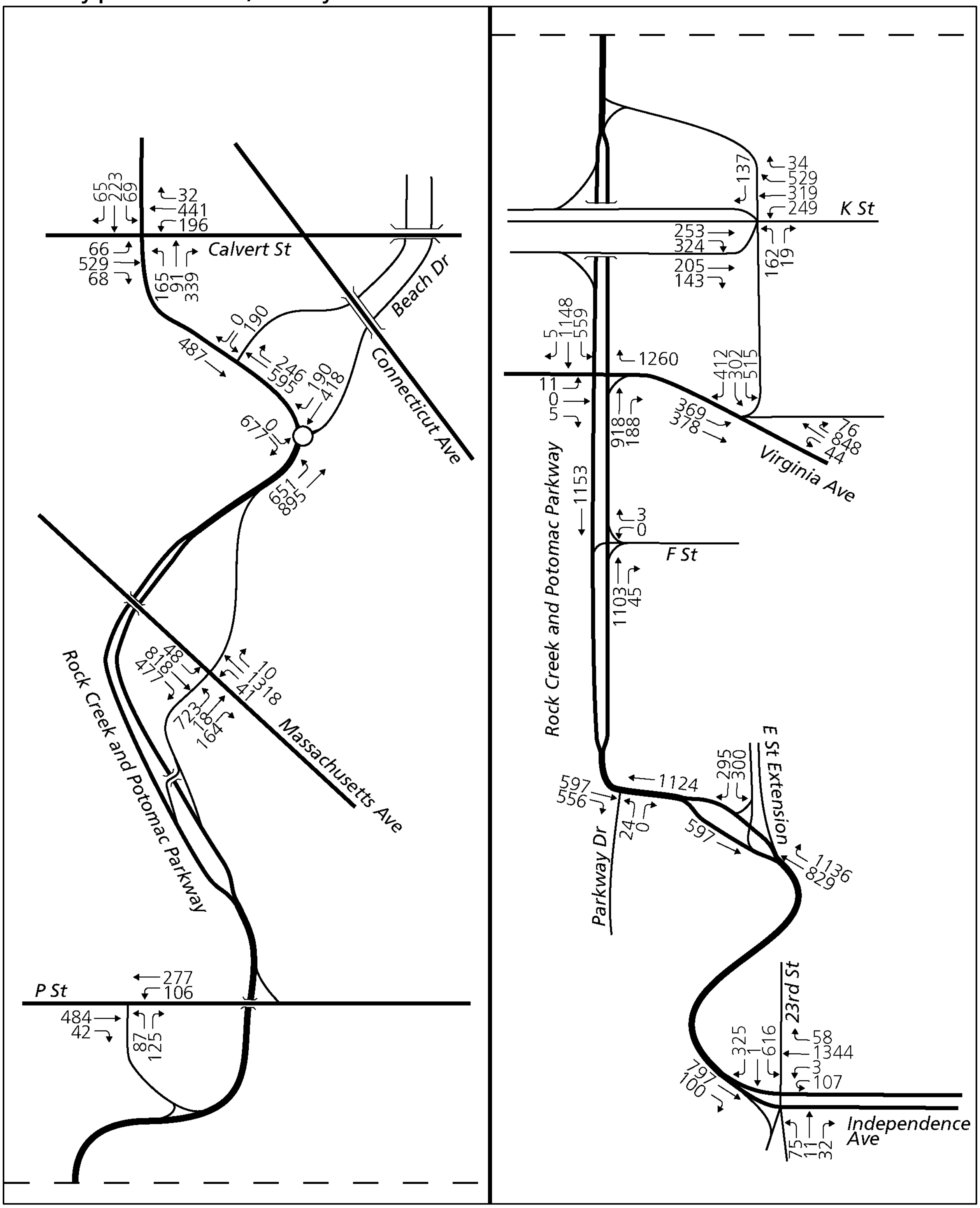


Figure 35: Short-Term (2025) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday p.m. Peak Hour, Secondary Intersections

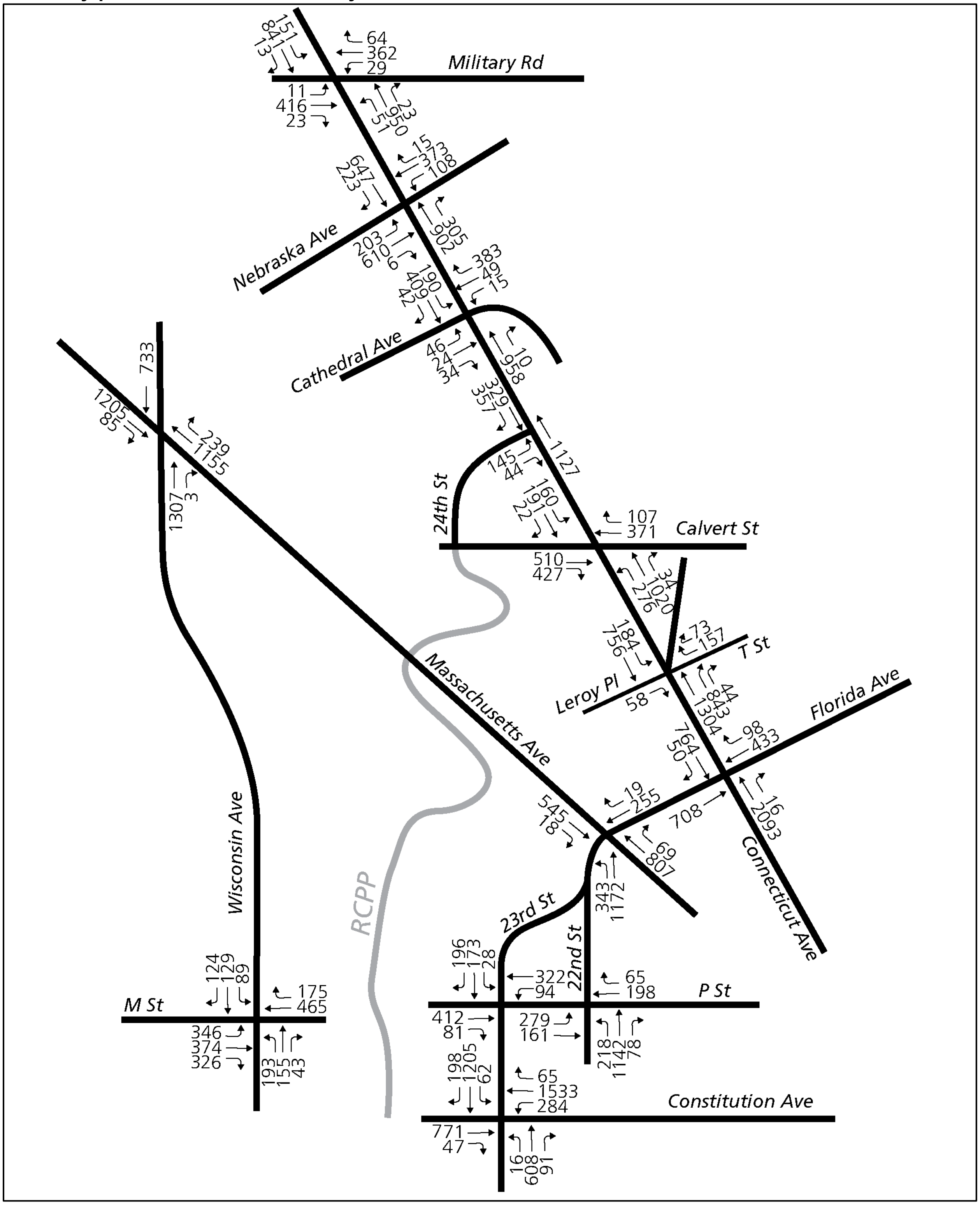


Figure 36: Long-Term (2045) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday a.m. Peak Hour, Primary Intersections

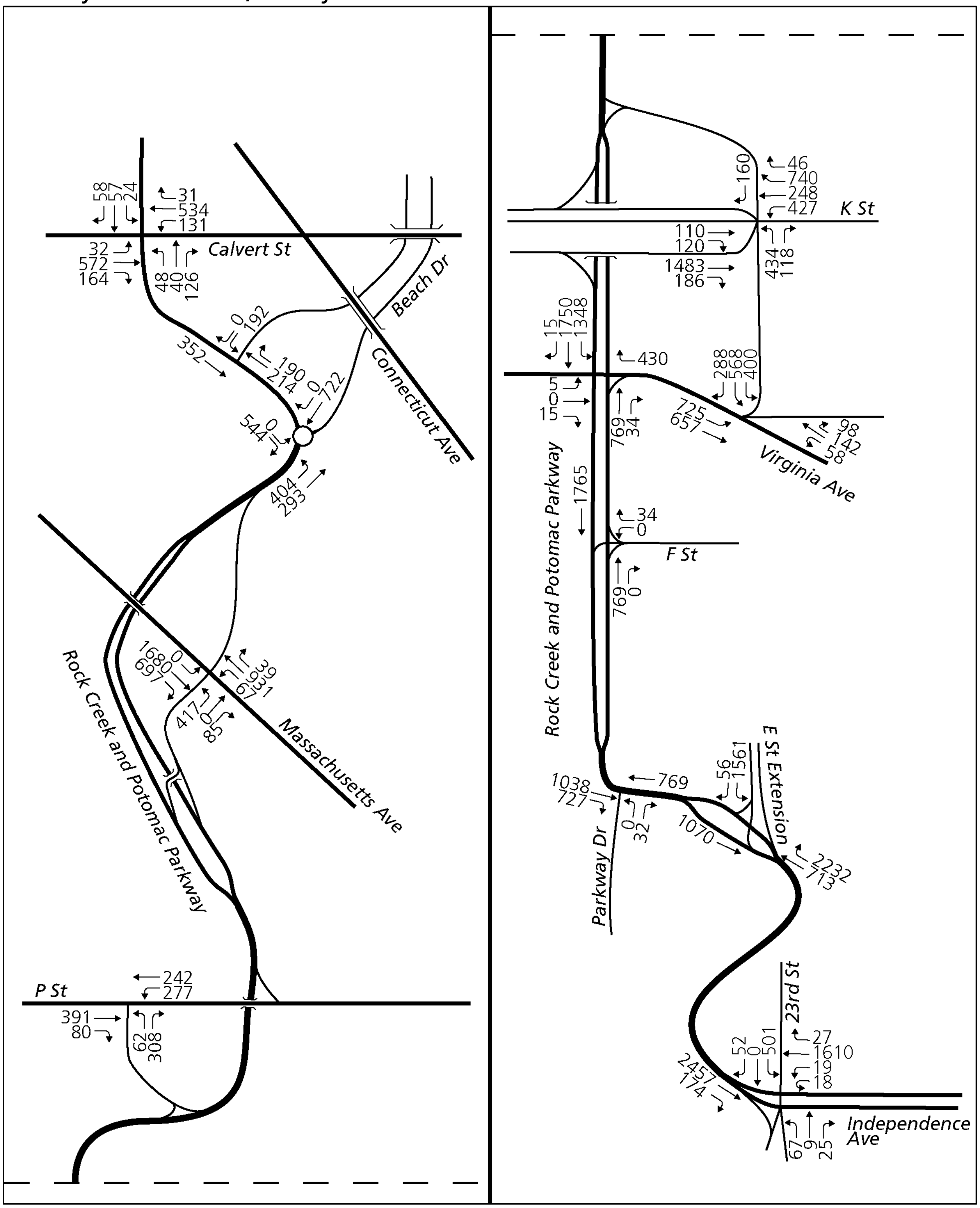


Figure 37: Long-Term (2045) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday a.m. Peak Hour, Secondary Intersections

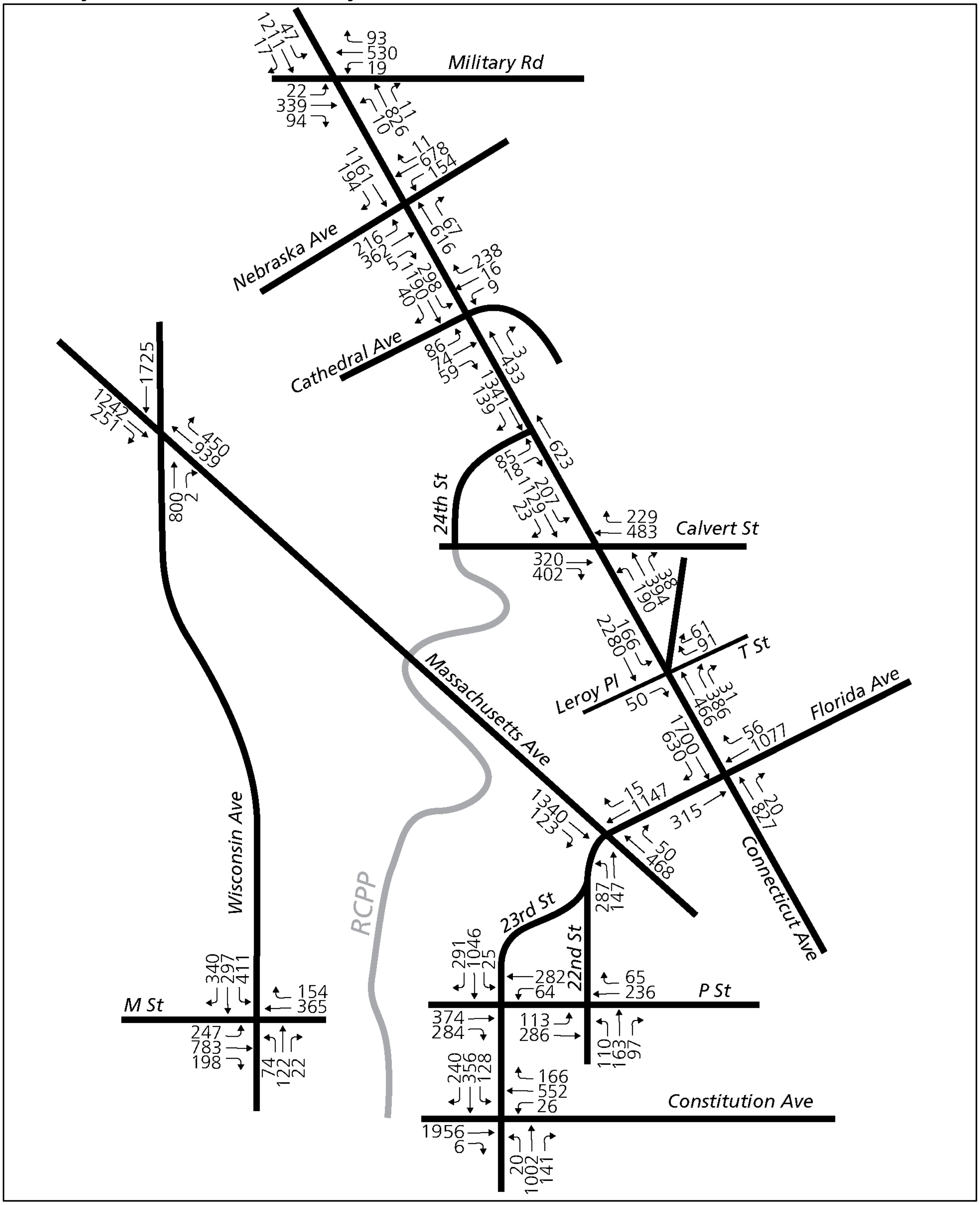


Figure 38: Long-Term (2045) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday p.m. Peak Hour, Primary Intersections

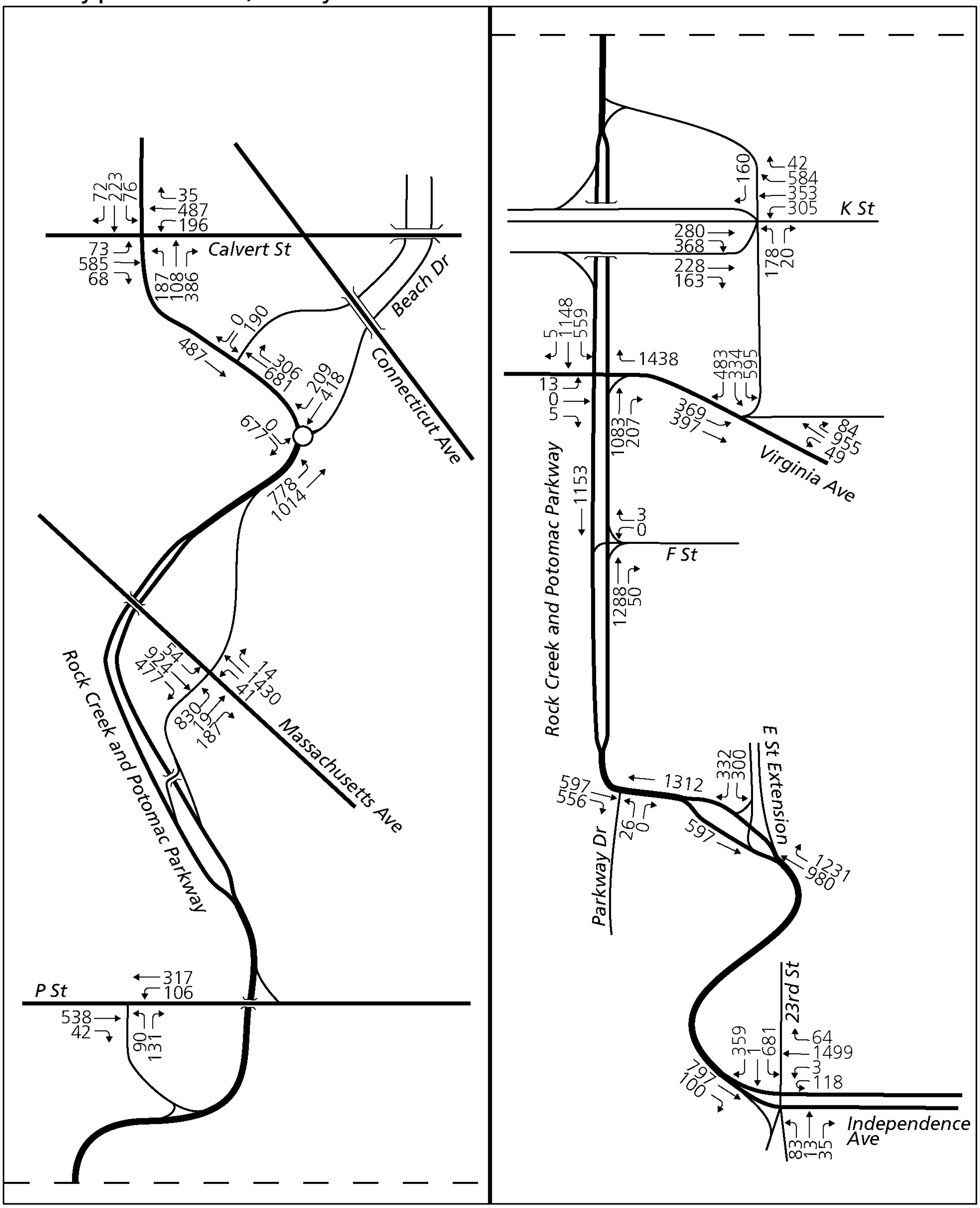
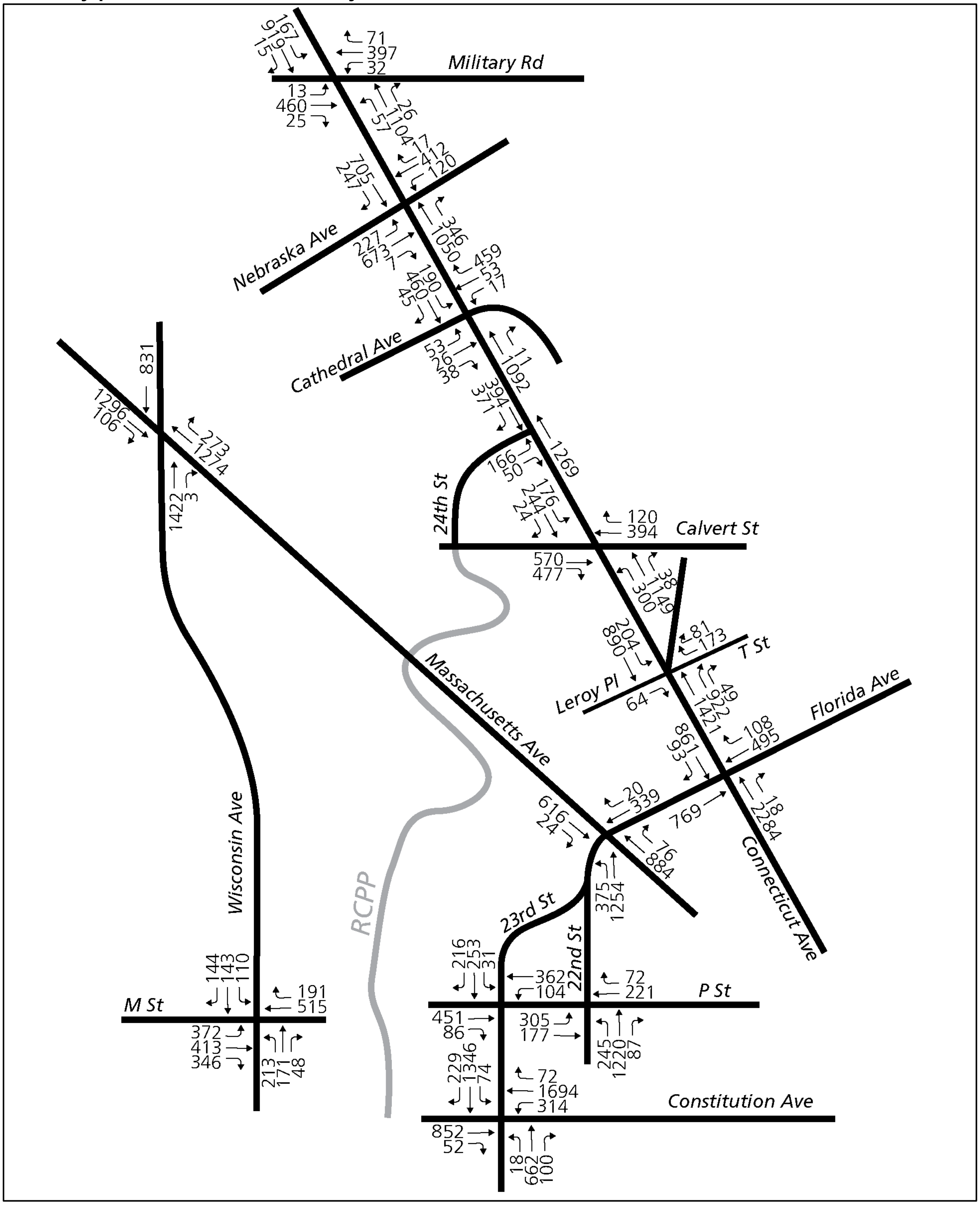


Figure 39: Long-Term (2045) Horizon, Elimination of Reversible Operations Traffic Volumes, Weekday p.m. Peak Hour, Secondary Intersections



4.3. Preliminary Mitigation Measures

Based on the traffic volume projections, existing safety challenges, and identified areas of congestion, the study team has identified preliminary mitigation measures at four key locations. The preliminary mitigation measures will improve safety, minimize congestion, and improve predictability along the RCPP corridor. The preliminary mitigation measures are intended to primarily address safety and congestion challenges amplified by eliminating the reversible operations, while also improving safety and congestion throughout the entire day. The mitigation measures have been developed as a preliminary conceptual level plan with a planning level cost estimate. Coordination with other stakeholders including DDOT, FHWA, local community groups, and others, is critical for the advancement of the design. While additional concepts were considered, they are not presented in this document. NPS will continue to evaluate all feasible concepts through the A/E design phase and the EA phase, as a follow-up to this initial traffic impact assessment. A level of service analysis of the mitigation is provided in Chapter 6: Capacity Operations Analysis

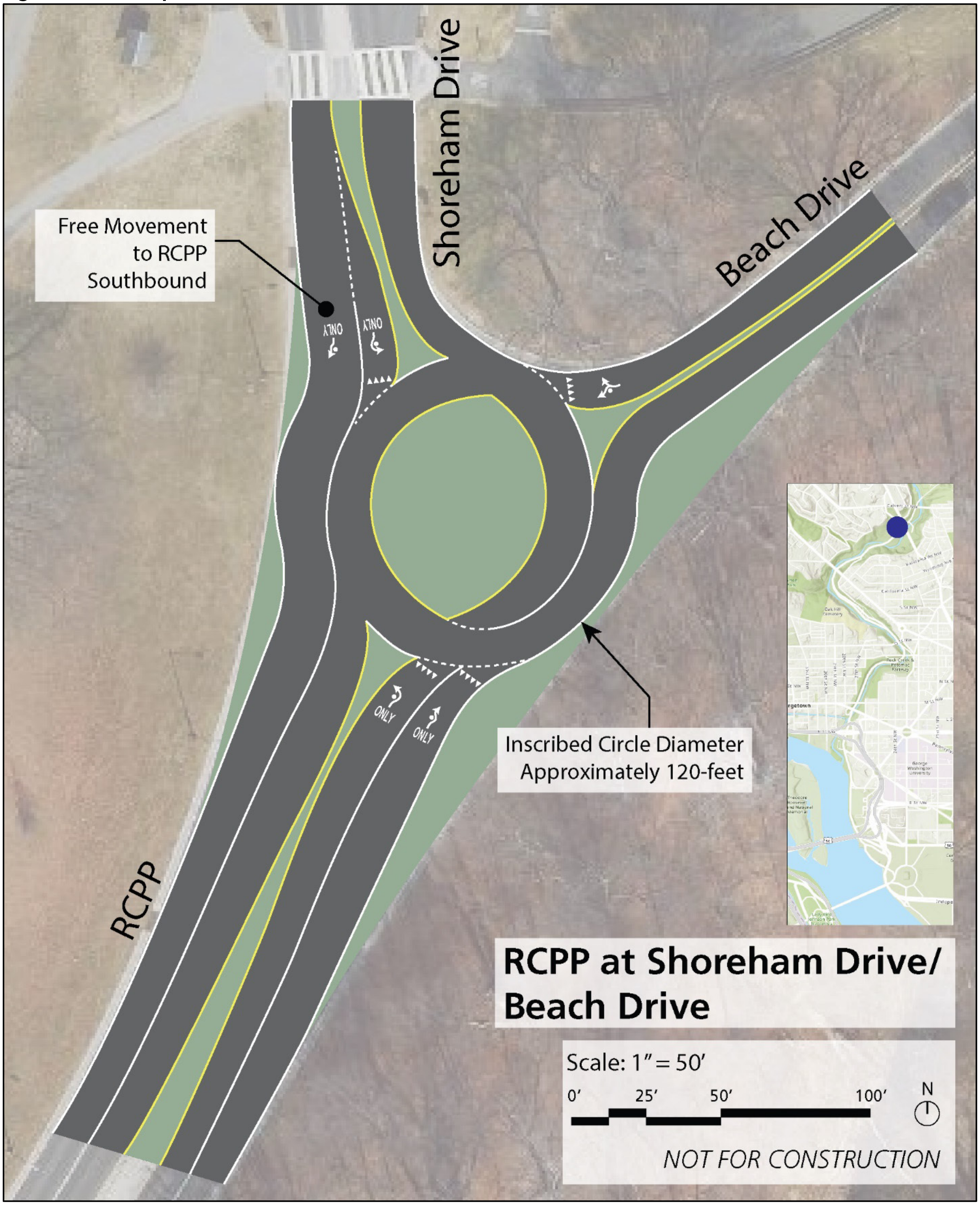
4.3.1. Location A: RCPP at Shoreham Drive/Beach Drive

The existing reversible operations allow this intersection to operate as free flow in both the morning and the afternoon reversible operation periods. In the morning, vehicles approaching from Beach Drive enter RCPP into the northbound lanes and vehicles approaching from Shoreham Drive enter RCPP into the southbound lanes. In the afternoon, vehicles destined for Beach Drive use the northbound lanes and vehicles destined for Shoreham Drive use the southbound lanes. If the reversible operations are eliminated, the largest impact will occur at the southbound Beach Drive approach. Southbound vehicles will have to yield to oncoming traffic along RCPP turning left destined for Shoreham Drive. This conflict occurs throughout the rest of the day when the roadway functions under normal two-way operation, however the higher demand of traffic commuting could lead to excessive delay.

The proposed recommendation is to create a multi-lane spiral roundabout, as shown in Figure 40. The spiral roundabout requires vehicles to choose a lane prior to entering the roundabout and restricts lane changes within the roundabout. The primary benefit of the roundabout is that it requires vehicles to slow down when entering and circulating, which will drastically improve safety. The Shoreham Drive to RCPP southbound movement does not conflict with any other movements and will operate as a free movement. The RCPP northbound movements will also generally operate as a free movement with the only conflicting vehicular movement is the low-volume Shoreham Drive to Beach Drive movement. The primary conflicting movements include the southbound Beach Drive approach conflicting with the northbound RCPP to Shoreham Drive movement. The low-speed circulating traffic in the roundabout will allow the vehicles entering from the southbound Beach Drive approach to find a gap and enter the roundabout better than a high-speed left-turn as it is presented today.

The multilane roundabout is typically discouraged in urban environments as pedestrian crossings can be more dangerous due to the dual threat conflict. The dual threat is when a vehicle on a multi-lane street stops for a pedestrian to cross, then a second vehicle in the second lane coming from the same direction, cannot see the pedestrian and strikes the pedestrian in the crosswalk. In this case, the only crosswalk is across Shoreham Drive for the Rock Creek Trail. The short, left-turn pocket should begin after the crosswalk to eliminate the dual threat risk. Another possible challenge that is identified is the steep slope along Shoreham Drive and the grading variation around the intersection. Roundabouts should be constructed on reasonably level areas to minimize vehicle speed variation for vehicle in the roundabout. The fill to level the terrain was included in the cost estimate. The feasibility of constructing the roundabout will be evaluated during the follow-up A/E design phase.

Figure 40: Conceptual Plan of RCPP at Shoreham Drive/Beach Drive



4.3.2. Location B: RCPP at Virginia Avenue

RCPP at Virginia Avenue is a key intersection for the successful elimination of the reversible operations. It is the first traffic signal when traveling southbound and a key decision point for many people using RCPP to commute into and out of downtown D.C. During the morning commute period, it is an especially critical location. As vehicles enter RCPP, the queue builds from this location and extends to the north. Other than the on-ramp at K Street (located approximately 350 feet to the north), RCPP's queue length can grow to approximately 4,000 feet before impacting another intersection. This is beneficial because potentially long queues will only impact drivers, contributing to the long queue.

The preliminary mitigation shows the southbound RCPP approach will expand to three lanes beginning south of the Whitehurst Freeway Bridge (to avoid impacts to the bridge structure). The southbound approach will include one left-turn only lane and one through only lane, and one shared through/right-turn lane. At this time, modifications are not proposed at the DDOT owned and maintained intersection of Virginia Avenue at 27th Street/I Street. The study team explored expanding the signalization to the intersection of Virginia Avenue at I Street and minor modification in lane use, and signal phasing. Since Virginia Avenue was partially reconstructed in early 2022 to accommodate a two-way cycle track along the south side of Virginia Avenue, the study team did not propose any geometric modifications at the intersections or along 27th Street. Additional analysis and coordination with DDOT and other necessary stakeholders will be considered to address any potential queuing and operations challenges.

A conceptual plan of RCPP at Virginia Avenue is shown in Figure 41 and the proposed signal phasing is shown Figure 42. The intersection is shown to operate with four-phases and provide a concurrent pedestrian phase across the southern and western legs of the intersection, concurrent with the low traffic volume of the Thompson Boathouse Driveway. The Thompson Boathouse Driveway is proposed to operate upon vehicle detection only, therefore if a vehicle is not detected, it will be skipped, allowing additional time to go to the southbound left-turn movement and westbound right-turn overlap movement, while allowing the pedestrian phase across RCPP to operate on full recall without any conflicting traffic.

Figure 41: Conceptual Plan of RCPP at Virginia Avenue

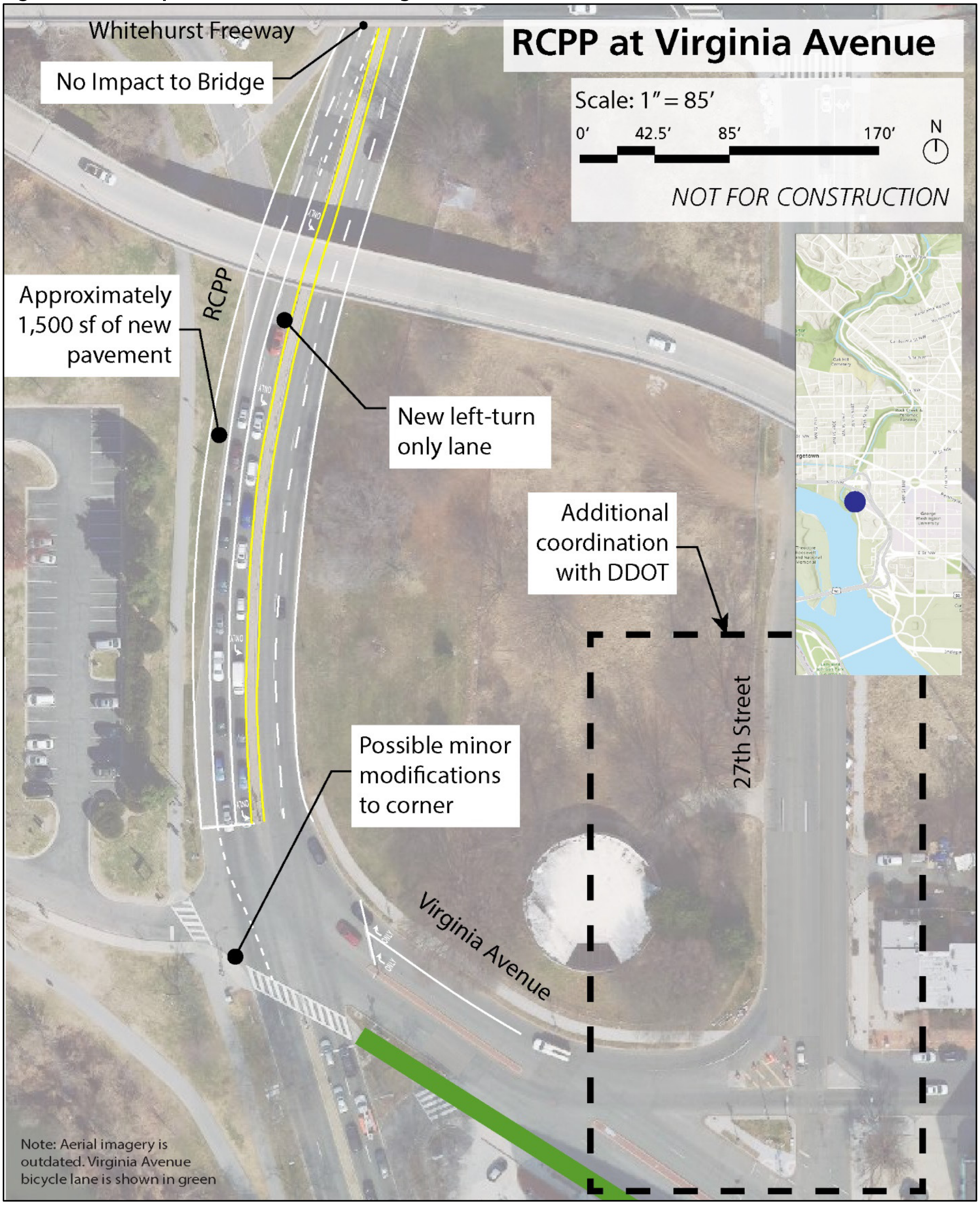
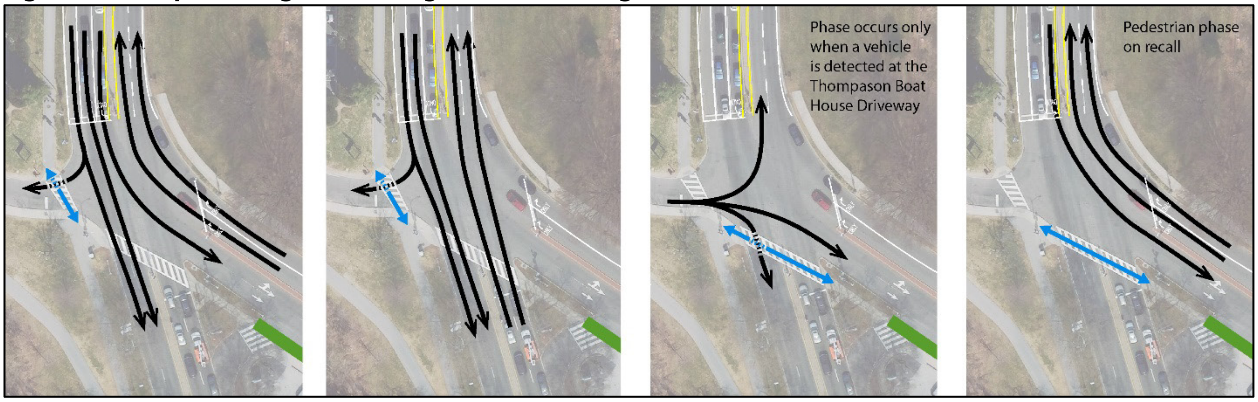


Figure 42: Proposed Signal Phasing of RCPP at Virginia Avenue



4.3.3. Location C: Ohio Drive at E Street Extension

Similar to Location A, the reversible operations set-up at this intersection allows vehicles to operate as free flow during both the morning and afternoon periods. Vehicles do not have to stop or yield to any oncoming traffic. This presents the opportunity for significant congestion during the peak period that does not occur today if the reversible operations were eliminated. Unlike Location A, this intersection accommodates a pedestrian crossing. A pedestrian can cross the northern legs of the intersection, which all currently operate as uncontrolled. Pedestrians have to cross a southbound channelized right lane, a southbound left-turn lane, and northbound section with two travel lanes. The soon to be built Desert Storm Memorial is likely to generate additional pedestrian demand at this location.

As shown in Figure 43, the proposed recommendation is to signalize the intersection and expand the E Street Extension southbound left movement to two lanes. This will improve the capacity for vehicles using the I-66 corridor, parallel to the Kennedy Center and for vehicles using the Theodore Roosevelt Bridge. The proposed phasing is shown in Figure 44. The signal will operate in just two phases which allows the intersection to operate efficiently. Pedestrian movements are protected and can operate concurrently with the vehicle movements without any pedestrian-vehicle turning conflict. The signalized pedestrian movements improve safety for pedestrians. Additionally, the preliminary concept provides a new pedestrian crossing connecting the north and south sides of the intersection, which is a key connection between the Rock Creek Trail and the future Desert Storm Memorial.

An additional concept was initially considered at this intersection, but a drawing or analysis is not included in the report. The concept would also signalize the intersection but would reorient the primary movement as north-south instead of east-west. The concept was initially dismissed as the reorientation of the roadway may impact the parkway's historical alignment. A recent evaluation of this area determined that the alignment was not part of the NPS historical significance. This concept, as well as others, should be considered through the A/E design phase as a follow-up to this study.

Figure 43: Conceptual Plan of Ohio Drive at E Street Extension

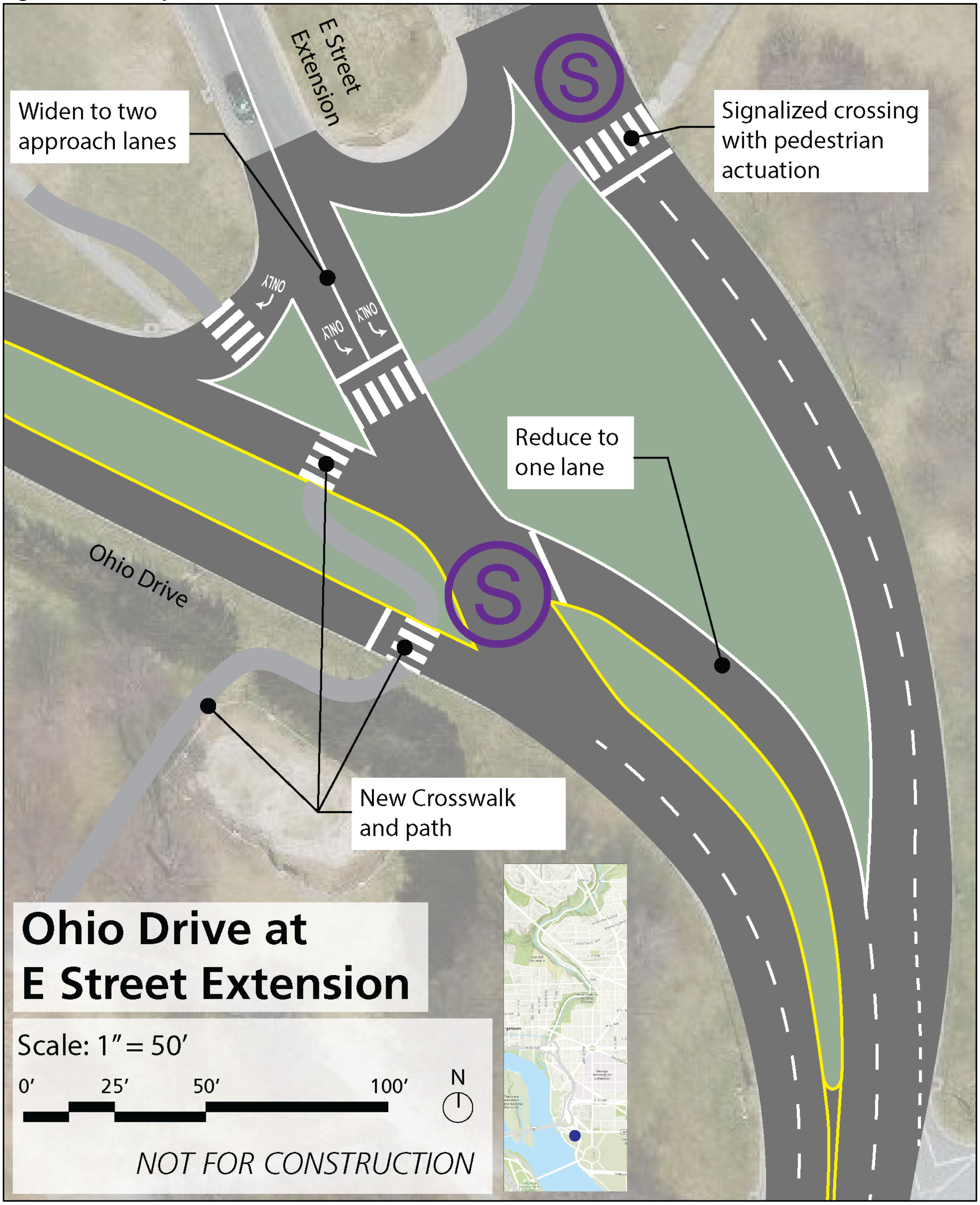
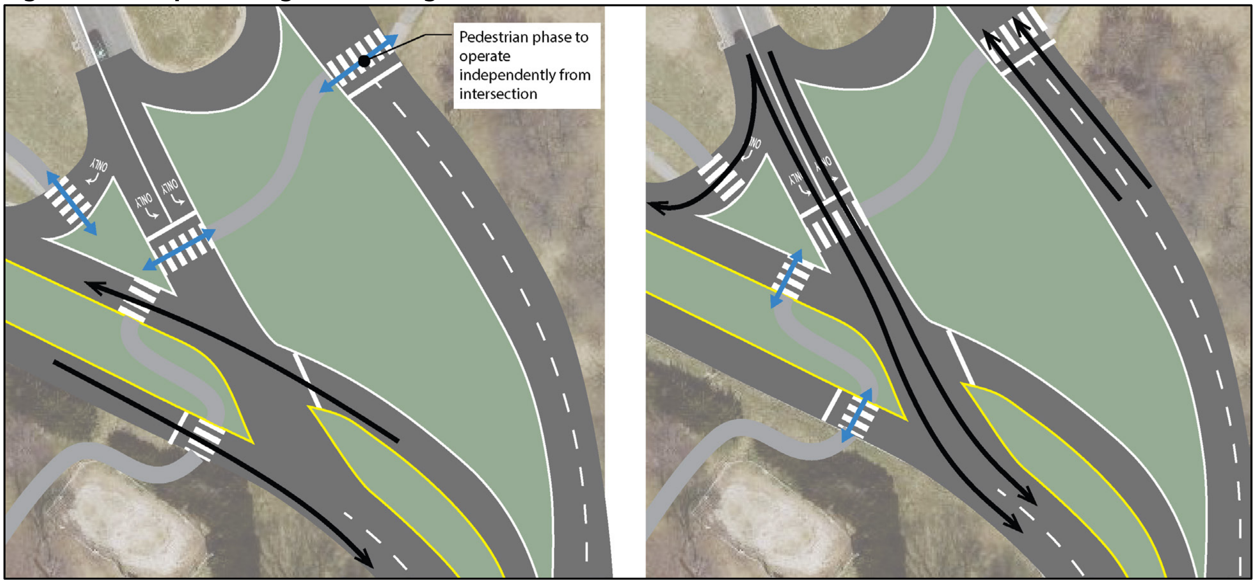


Figure 44: Proposed Signal Phasing at Ohio Drive at E Street Extension



Traffic Signal Warrant Evaluation

The installation of a signalized intersection has been justified using the Manual on Uniform Traffic Control Devices (MUTCD) Signal Warrant evaluation. The MUTCD guidance states that "a traffic control signal should not be installed unless one or more of the factors described in [the MUTCD] are met." This signal meets the three traffic volume warrants including Warrant 1 (Eight-Hour Vehicular Volume) Warrant 2 (Four-Hour Vehicular Volume) and Warrant 3 (Peak Hour). The traffic volumes used for the warrant analysis include a combination of volumes estimated through this traffic study as well as actual traffic volumes recorded throughout the middle of the day. The detailed signal warrant information is provided in Appendix D.

4.3.4. Location D: RCPP at P Street Ramps

A sharp horizontal curve is located along RCPP near P Street. The roadway alignment requires drivers to curve around a bend in one direction and then reverse to the other direction. This is a difficult location to navigate especially when drivers are also driving fast, focused on exiting RCPP to P Street or on other drivers entering RCPP from P Street. At this location a median is not provided and the risk of veering out of the travel lane is higher. Approximately 20% of the crashes at this location resulted in a fatality or injury, which is the highest along the corridor. This location included the only documented head-on fatal crash.

Eliminating the reversible operations has many possible safety benefits, but one risk is introducing two-way traffic during the busiest time of the day, which can lead to an increase in crashes and an increase in the severity of a crash. Providing a median guardrail would largely eliminate the risk of head-on crashes and sideswipe, opposite-direction crashes in this section of the corridor. While additional sections could benefit from a median guardrail installation, this location should be prioritized. The recommendation is to install a median guardrail beginning to the north of the Lauzun's Legion Bridge for approximately 2,100 feet to where RCPP straightens out, as shown in Figure 45. The median would be constructed in steel-backed timber, consistent with the existing steel-backed timber guardrail throughout the corridor. The cost estimate assumes that the median is able to fit within the existing roadway without significant modifications to the curb, gutter, or drainage elements. A full roadway survey is necessary to determine the feasibility of installing a median.

The southbound off-ramp from RCPP to P Street was also considered for removal or permanent closure. The exit causes vehicles to slow significantly and the sight lines are limited due to the horizontal curve in the roadway, the hill to the right, and the Lauzun's Legion Bridge abutment. Official field measurements were not conducted due to the high level of traffic volumes along RCPP. Additional outreach with the Georgetown community and other key stakeholders is recommended before any formal recommendation is made.

Figure 45: Conceptual Plan of RCPP at P Street, Median Installation and Exit Ramp Closure

4.4. *Planning Level Cost Estimate*

Each preliminary mitigation measure includes a planning level cost estimate. The costs were estimated using the Massachusetts Department of Transportation (MassDOT) State Aid Reimbursable Programs Estimating Tool (SARPET)[13]. SARPET is a MassDOT tool using MassDOT bid pricing and item numbers. When applicable, the bid prices have been updated with local item numbers to reflect a more accurate cost estimate. The planning level cost estimate for the preliminary mitigation measures is shown in Table 7 and the total for all mitigation elements is shown in Table 8. Each estimate includes a roadway and multimodal component, a traffic control component, a lighting component, and a temporary traffic control component (estimated at 7% of the cost). Lastly a contingency of 20% and an inflation increase of 4.5% per year for a construction year of 2027 were added to the total cost. Lastly, an additional fee for survey and design is also included in the total. All costs were rounded up to the nearest ten thousand to simplify the cost. The unit item cost estimate and summary from the SARPET tool for each location is included in Appendix E.

Table 7. Planning Level Cost Estimate by Location

Location	RCPP at Shoreham/Beach	RCPP at Virginia	Ohio at E St Ext	Median along RCPP at P St
Roadway and Multimodal	$430,000	$480,000	$220,000	$630,000
Traffic Control	$1,090,000	$250,000	$320,000	$10,000
Lighting	$-	$-	$20,000	$-
Temporary Traffic Control (7%)	$100,000	$60,000	$40,000	$50,000
Contingency (20%)	$310,000	$150,000	$120,000	$130,000
Inflation (4.5% per year)	$270,000	$130,000	$100,000	$120,000
Survey & Design	$220,000	$140,000	$110,000	$120,000
Location Subtotal	**$2,430,000**	**$1,210,000**	**$930,000**	**$1,060,000**

Table 8. Planning Level Cost Estimate Total

Location	Cost
RCPP at Shoreham/ Beach	$2,430,000
RCPP at Virginia	$1,210,000
Ohio at E St Ext	$930,000
Median along RCPP at P St	$1,060,000
Total Cost	**$5,630,000**

[13] https://www.mass.gov/state-aid-reimbursable-programs-estimating-tool

5. Safety Analysis

Improving safety is integral to the mission of NPS, regardless of whether the reversible operations are eliminated or not. The study team used crash modification factors (CMFs) to evaluate the potential safety impacts of each preliminary mitigation measure. The CMFs are published from either the Highway Safety Manual or the CMF Clearinghouse[14], a database maintained by FHWA that includes hundreds of CMFs related to safety countermeasures. When selecting CMFs from the CMF Clearinghouse, CMFs with a higher quality ranking in urban areas were prioritized. A countermeasure with a CMF less than 1 indicates that crashes are expected to decrease, and a countermeasure with a CMF greater than 1 indicates that crashes are expected to increase.

Safety analyses are typically performed by first modeling the number of historic crashes along a corridor and converting that number into an expected number of crashes. The number of expected crashes is then multiplied by a published CMF that correlates to an identified countermeasure to calculate the number of predicted crashes.

For this analysis, the number of expected crashes cannot be modeled because the Highway Safety Manual, which outlines the preferred way for conducting safety analyses, notes that the predictive safety analysis methodology does not account for the influence of reversible lanes. If the additional safety improvements are implemented concurrently with the elimination of the reversible operations, safety is expected to improve, and the number of crashes and the severity of crashes is expected to be reduced.

Table 9 shows the safety countermeasures that are associated with the preliminary mitigation measures, and the CMF's that are associated with each safety countermeasure. CMFs are shown for all crashes as well as fatal and injury crashes (F&I) for Multiple countermeasures are listed for each location to model the potential crash reduction.

[14] http://www.cmfclearinghouse.org/index.cfm

Table 9. Crash Modification Factors
Source: CMF Clearing House and the 2010 Highway Capacity Manual, Transportation Research Board

Location/Countermeasure	CMF All Crashes	CMF F&I Crashes
RCPP at Shoreham Dr/ Beach Dr	---	---
Installing a single roundabout	0.56	0.21
Installing a multi-lane roundabout	0.95	0.367
RCPP at Virginia Avenue	---	---
Installing a left turn lane	0.748	0.566
Providing a left-turn lane on one major approach	0.67	0.71
Changing from permissive to protected	0.45	N/A
Ohio Dr at E St	---	---
Install a traffic signal	0.77	N/A
Provide a left-turn lane on one major-road approach	0.67	0.71
Install a protected pedestrian phase	0.65	N/A
RCPP at P St	---	---
Install a median	0.29	0.81
Eliminate an off-ramp[1] (Under Consideration)	N/A	N/A
Install a wider hatched double yellow[2]	N/A	N/A
Install wider edge lines (4 in. to 6 in.)	0.825	0.635
Install rumble strips	0.60	0.36

1: A CMF is not associated with closing a ramp, this countermeasure would eliminate any crashes along the ramp and any crashes caused by traffic slowing down and diverging off RCPP. The countermeasure would likely reduce rear-end crashes. Several CMFs exist for "provide on-ramp" in rural area types that are all over 1.0.
2: A CMF is not associated with installing a wider double yellow centerline, but the CMF for a wider edge line can closely correlate to the CMF for installing a wider double yellow centerline.

All the CMFs are below 1.0, showing that if these changes are implemented, the number of crashes can be expected to decrease. The following CMFs represent the most impactful at each location:

- The roundabout at the intersection of RCPP at Shoreham Drive/Beach Drive could have significant safety benefits for fatal and injury crashes as the CMF for a roundabout is between 0.21 and 0.367 indicating it could reduce fatal and injury crashes by 63% to 79%. Fatal and injury crashes accounted for about 16% of crashes at this location.
- The left-lane installation at the intersection of RCPP at Virginia Avenue has a CMF of 0.75 and the protected left-turn phase has a CMF of 0.45, which can decrease crashes by 25% to 55%. The southbound left-turn movement currently operates as permissive only during just the regular two-way operation of RCPP. At this intersection, approximately 78% of crashes occurred during regular two-way operations.
- Installing a traffic signal at the intersection of Ohio Drive at E Street Extension has a CMF of 0.77 indicating it can reduce crashes by 23%. Some CMFs for signalization have been shown to increase crashes, especially rear-end crashes. The protected pedestrian phase only applies to pedestrian crashes.
- Installing a median guardrail near P Street has a CMF of 0.29 indicating that it could reduce crashes by about 71%. Combining the median guardrail with the elimination of the off-ramp would eliminate many head-on or sideswipe opposite direction crashes as well as rear-end crashes, which account for 63% of the crashes.
- A CMF is not provided for converting a four-lane one-way roadway into a four-lane two-way roadway, which could provide good insight into the safety of eliminating the reversible operations.

6. Capacity Operations Analysis

The vehicular traffic operations analysis is determined through the Level of Service (LOS) and volume to capacity (v/c) calculations, which determine a resultant grade based on calculated modal delay, in seconds per vehicle. LOS and delay at the signalized and unsignalized intersections was calculated using Synchro 11. The intersection geometry and traffic volumes play critical roles in determining the LOS and delay. Table 10, an excerpt from the Transportation Research Board's Highway Capacity Manual (HCM), Sixth Edition, provides LOS criteria for signalized and unsignalized intersections. LOS A defines the most favorable condition, with minimum traffic delay. LOS F represents the worst condition, with the most traffic delay. The delay and LOS displayed are from the HCM Methodology reported in Synchro.

Table 10. Vehicle Level of Service Criteria

Source: 2010 Highway Capacity Manual, Transportation Research Board

Level of Service	Average Stopped Delay (seconds/vehicle) at Signalized Intersection	Average Stopped Delay (seconds/vehicle) at Unsignalized Intersection
A	≤10	≤10
B	>10 – ≤20	>10 – ≤15
C	>20 – ≤35	>15 – ≤25
D	>35 – ≤55	>25 – ≤35
E	>55 – ≤80	>35 – ≤50
F	≥80	≥50

In addition to delay and LOS, the operational capacity and vehicular queues are calculated and used to further quantify traffic operations at intersections. The following describes the other calculated measures.

The volume-to-capacity ratio (v/c ratio) is a measure of congestion at an intersection approach. A v/c ratio less than one indicates that the intersection approach has adequate capacity to process the arriving traffic volumes over the course of an hour. A v/c ratio of one or greater indicates that the traffic volume on the intersection approach exceeds capacity.

The queue is shown for the 50^{th} percentile and 95^{th} percentile maximum queue length, measured in feet. The 50^{th} percentile maximum queue is the maximum back of queue during a cycle of the traffic signal with typical (or median) entering traffic volumes. The 95th percentile maximum queue is the maximum back of queue during a cycle of the traffic signal with the worst (or 95^{th} percentile) entering traffic volumes.

The 95^{th} percentile queue will not be seen during each cycle. The queue would be this long only five percent of the time and would typically not occur during off-peak hours. Since volumes fluctuate throughout the hour, the 95th percentile queue represents what can be considered a "worst case" scenario. Queues at the intersection are generally below the 95th percentile queue throughout the course of the peak hour. It is also unlikely that the 95th percentile queues for each approach to the intersection will occur simultaneously.

6.1. Traffic Model Setup and Calibration

In accordance with DDOT guidelines, the peak 15 minutes of data collected during the peak hour were isolated to calculate the peak-hour factors for each approach. The percentage of heavy vehicles was also applied for each movement individually. DDOT provided all existing signal timings and offsets used in the Existing Conditions analysis. Calibrations and factors used in the Synchro analysis are shown in Table 11.

Table 11. Model Input Parameters and Calibration

Adjustment Factor	Notes
Lane Widths	Based on DDOT supplied traffic model and field measurements
Area Type	Assumed Central Business District (CBD)
Right-Turn-On-Red	Based on current and proposed conditions
Conflicting Pedestrians/Bicyclists	Based on TMC data and supplied Synchro file
Peak Hour Factor	Based on TMC data by approach
Heavy Vehicle Percentage	Based on TMC data by movement
Signal Phasing	Based on DDOT supplied phasing plans
Coordination	Based on DDOT supplied timing plans
Signal Timing	Based on DDOT supplied timing plans and adjusted based on field measurements

6.2. Summary of Capacity Operations Analysis

Figure 46 and Figure 47 includes a summary map of the overall LOS grades at each intersection for each scenario to compare all the intersection LOS information. The summary maps include the LOS under the Existing Scenario, the Baseline Scenario, and the Elimination of the Reversible Operations Scenario for both the short-term (2025) and long-term (2045) horizon. Additionally, the maps include the LOS information for the intersections with proposed mitigation. Unsignalized intersections and roundabouts are indicated in the map with a “U” or an “R”. The detailed capacity operations analysis tables for all scenarios during both the weekday a.m. and p.m. peak hours are provided in Appendix F.

Figure 46: Capacity Operations Analysis Summary, Weekday a.m. Peak Hour

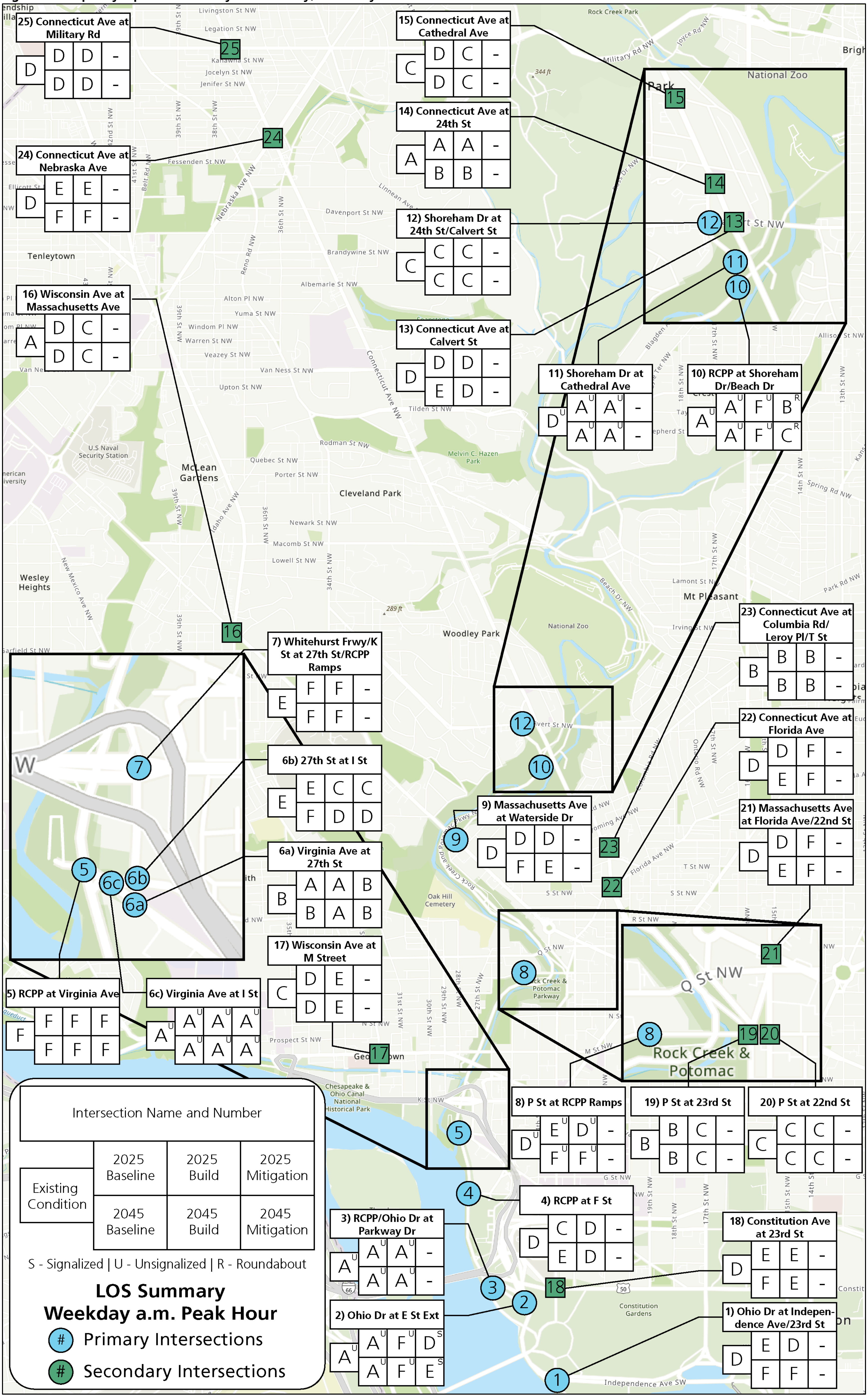
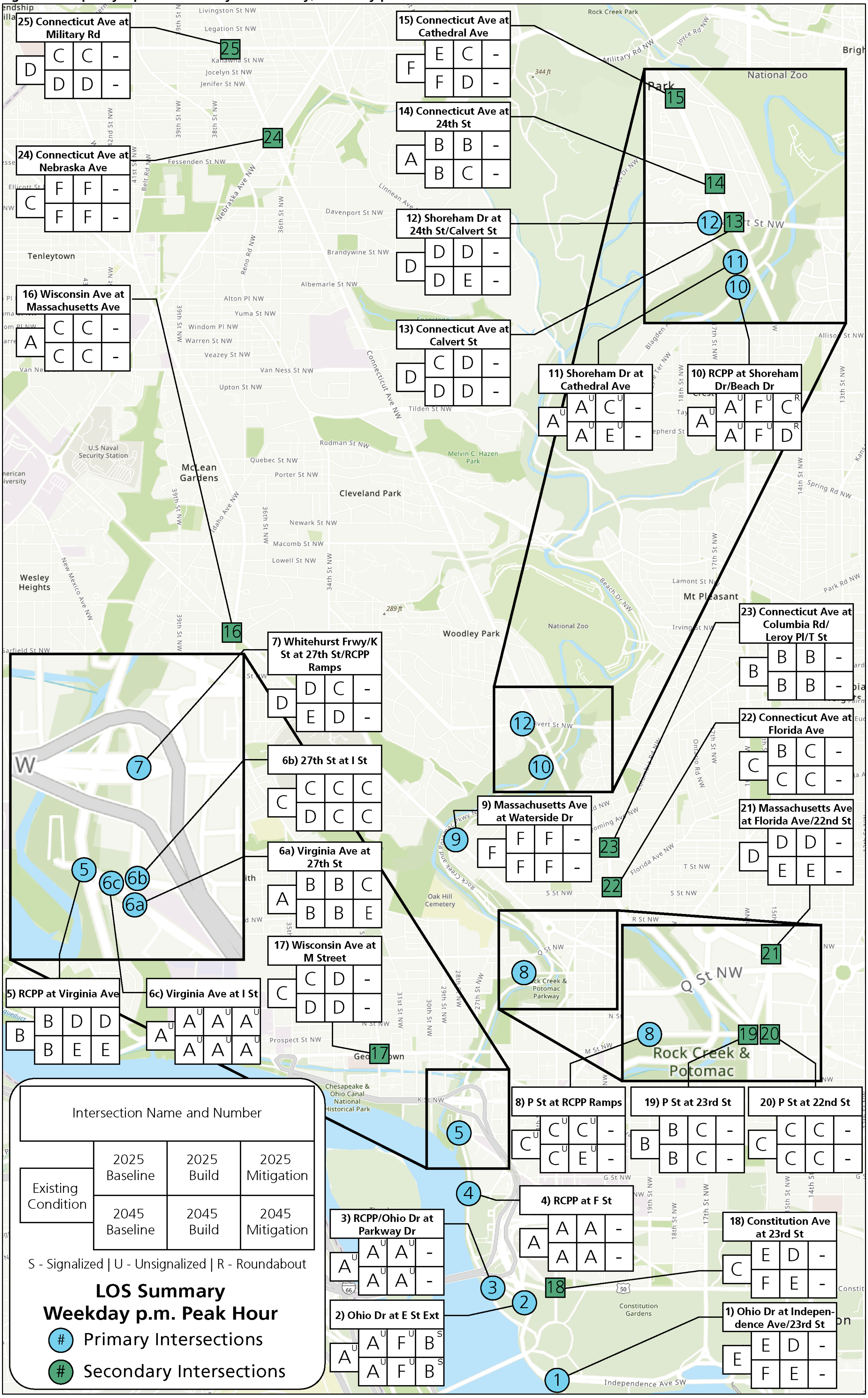


Figure 47: Capacity Operations Analysis Summary, Weekday p.m. Peak Hour



6.3. Capacity Operations Analysis of Preliminary Mitigation Measures

6.3.1. Capacity Operation Analysis for the Roundabout at RCPP at Shoreham Drive/Beach Drive

The capacity operations analysis for the preliminary mitigation measures during the weekday a.m. and p.m. peak hours under the short-term (2025) and long-term (2045 horizon, at the intersections of RCPP at Shoreham Drive/Beach Drive, are shown in Table 12, Table 13, Table 14, and Table 15, respectively.

Table 12. Capacity Operations Analysis, Roundabout at RCPP at Shoreham Drive/Beach Drive, Weekday a.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	95th %ile Queue Length
Roundabout Total	**B**	**11.7**	**-**	**-**
Shoreham EB Left	A	5.1	0.00	0
Shoreham EB Right	B	14.3	0.59	100
RCPP NB Left	A	5.8	0.34	50
RCPP NB Thru	A	4.5	0.23	25
Beach SB Thru/Right	C	17.3	0.74	175

Table 13. Capacity Operations Analysis, Roundabout at RCPP at Shoreham Drive/Beach Drive, Weekday p.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	95th %ile Queue Length
Roundabout Total	**C**	**19.2**	**-**	**-**
Shoreham EB Left	A	4.1	0.00	0
Shoreham EB Right	C	21.9	0.81	225
RCPP NB Left	A	8.7	0.55	75
RCPP NB Thru	B	12.3	0.71	175
Beach SB Thru/Right	E	37.5	0.91	300

Table 14. Capacity Operations Analysis, Roundabout at RCPP at Shoreham Drive/Beach Drive, Weekday a.m. Peak Hour, Long-Term (2045) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	95th %ile Queue Length
Roundabout Total	**C**	**20.6**	**-**	**-**
Shoreham EB Left	A	5.7	0.00	0
Shoreham EB Right	D	33.9	0.87	250
RCPP NB Left	A	5.8	0.34	50
RCPP NB Thru	A	4.5	0.23	25
Beach SB Thru/Right	D	25.3	0.85	275

Table 15. Capacity Operations Analysis, Roundabout at RCPP at Shoreham Drive/Beach Drive, Weekday p.m. Peak Hour, Long-Term (2045) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	95th %ile Queue Length
Roundabout Total	**D**	**28.3**	**-**	**-**
Shoreham EB Left	A	4.1	0.00	0
Shoreham EB Right	C	21.9	0.81	225
RCPP NB Left	B	10.9	0.65	125
RCPP NB Thru	C	16.5	0.81	250
Beach SB Thru/Right	F	76.0	1.06	475

The roundabout operates at an acceptable level during all the study scenarios. The longest queues are expected to occur in the Beach Drive southbound approach during both the a.m. and p.m. peak hours. The maximum queue lengths are expected to extend approximately 175 to 275 feet during the a.m. peak hour, 7 to 11 vehicles, and approximately 300 to 475 feet during the p.m. peak hour, 12 to 19 vehicles. The queue lengths are not expected to impact any adjacent intersections. This mitigation results in improved traffic operations compared with the future baseline scenarios.

6.3.2. Capacity Operation Analysis for RCPP at Virigina Avenue

The capacity operations analysis for the preliminary mitigation measures during the weekday a.m. and p.m. peak hours under the short-term (2025) and long-term (2045 horizon, at the intersections of RCPP at Virginia Avenue are shown in Table 16, Table 17, Table 18, and Table 19, respectively.

Table 16. Capacity Operations Analysis, Geometric and Phasing Modifications, RCPP at Virginia Avenue, Weekday a.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Total	**F**	**80.5**	**-**	**-**	**-**
Driveway EB Left/Thru/Right	E	56.6	0.02	0	0
Virginia WB Right | Right	A	8.7	0.29	50	126
RCPP NB Thru | Thru	F	134.7	1.16	~395	#522
RCPP NB Right	A	0.0	0.02	0	0
RCPP SB Left	F	160.2	1.29	~1152	#1514
RCPP SB Thru | Thru/Right	B	13.0	0.74	309	386

~ *50th percentile volume exceeds capacity; queue may be longer.*
# *95th percentile volume exceeds capacity; queue may be longer.*

Table 17. Capacity Operations Analysis, Geometric and Phasing Modifications, RCPP at Virginia Avenue, Weekday p.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Total	**D**	**36.4**	-	-	-
Driveway EB L/T/R	E	56.5	0.01	0	0
VA WB R | R	D	47.8	0.98	467	#776
RCPP NB T | T	E	68.5	1.00	396	#545
RCPP NB R	A	0.2	0.15	0	0
RCPP SB L	C	25.8	0.72	279	504
RCPP SB T | T/R	A	9.0	0.56	181	225

\# *95th percentile volume exceeds capacity; queue may be longer.*

Table 18. Capacity Operations Analysis, Geometric and Phasing Modifications, RCPP at Virginia Avenue, Weekday a.m. Peak Hour, Long-Term (2045) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Total	**F**	**111.9**	-	-	-
Driveway EB L/T/R	E	56.6	0.02	0	0
VA WB R | R	A	7.2	0.27	44	115
RCPP NB T | T	F	219.1	1.36	~437	#565
RCPP NB R	A	0.0	0.03	0	0
RCPP SB L	F	211.4	1.41	~1415	#1782
RCPP SB T | T/R	B	17.4	0.87	437	554

~ *50th percentile volume exceeds capacity; queue may be longer.*
\# *95th percentile volume exceeds capacity; queue may be longer.*

Table 19. Capacity Operations Analysis, Geometric and Phasing Modifications, RCPP at Virginia Avenue, Weekday p.m. Peak Hour, Long-Term (2045) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Total	**E**	**67.6**	-	-	-
Driveway EB L/T/R	E	56.5	0.01	0	0
VA WB R | R	F	93.3	1.12	~651	#951
RCPP NB T | T	F	130.3	1.18	~561	#696
RCPP NB R	A	0.3	0.16	0	0
RCPP SB L	C	25.8	0.72	279	504
RCPP SB T | T/R	A	9.0	0.56	181	225

~ *50th percentile volume exceeds capacity; queue may be longer.*
\# *95th percentile volume exceeds capacity; queue may be longer.*

The signalized intersections of RCPP at Virginia Avenue is expected to operate at LOS F during the weekday a.m. peak hour and LOS D during the p.m. peak hour under the short-term horizon. During the a.m. peak hour, the maximum queue length is expected occur in the southbound left-turn lane and extend approximately 1,500 feet, 60 vehicles. During the weekday p.m. peak hour, the maximum queue length is expected to occur at the Virginia Avenue westbound approach and extend approximately 775 feet, 31 vehicles.

6.3.3. Capacity Operation Analysis for Ohio Drive at E Street Extension

The capacity operations analysis for the preliminary mitigation measures during the weekday a.m. and p.m. peak hours under the short-term (2025) and long-term (2045 horizon, at the intersections of Ohio Drive at E Street Extension is shown in Table 20, Table 21, Table 22, and Table 23, respectively.

Table 20. Capacity Operations Analysis, Signalization, Ohio at E Street Extension, Weekday a.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Signalized Total	**D**	**48.8**	-	-	-
Ohio EB Thru	F	84.1	1.10	~739	#982
Ohio WB Thru	C	31.8	0.86	423	#667
Ohio WB Right | Right	B	12.4	0.83	24	44
E Ext SB Left | Left	F	86.3	1.10	~597	#732
E Ext SB Right	B	17.4	0.06	7	32

~ *50th percentile volume exceeds capacity; queue may be longer.*
\# *95th percentile volume exceeds capacity; queue may be longer.*

Table 21. Capacity Operations Analysis, Signalization, Ohio at E Street Extension, Weekday p.m. Peak Hour, Short-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Signalized Total	**B**	**14.0**	-	-	-
Ohio EB Thru	A	9.3	0.51	193	273
Ohio WB Thru	B	13.5	0.72	344	495
Ohio WB Right | Right	A	3.9	0.46	0	11
E Ext SB Left | Left	D	37.0	0.42	101	144
E Ext SB Right	D	40.7	0.49	82	182

Table 22. Capacity Operations Analysis, Signalization, Ohio at E Street Extension, Weekday a.m. Peak Hour, Long-Term (2055) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Signalized Total	**E**	**78.3**	-	-	-
Ohio EB Thru	F	146.5	1.25	~952	#1202
Ohio WB Thru	C	29.8	0.84	413	#624
Ohio WB Right | Right	B	19.2	0.95	41	#886
E Ext SB Left | Left	F	140.5	1.23	~708	#843
E Ext SB Right	B	18.0	0.06	9	34

~ *50th percentile volume exceeds capacity; queue may be longer.*
\# *95th percentile volume exceeds capacity; queue may be longer.*

Table 23. Capacity Operations Analysis, Signalization, Ohio at E Street Extension, Weekday p.m. Peak Hour, Long-Term (2025) Horizon

Intersection/Approach	LOS	Delay (seconds)	V/C Ratio	50th %ile Queue Length	95th %ile Queue Length
Signalized Total	**B**	**16.0**	**-**	**-**	**-**
Ohio EB Thru	A	8.4	0.51	172	247
Ohio WB Thru	B	17.6	0.84	441	681
Ohio WB Right | Right	A	4.4	0.49	0	12
E Ext SB Left | Left	D	35.6	0.44	94	137
E Ext SB Right	D	50.0	0.75	142	#291

The signalized intersection of Ohio Drive at E Street Extension is expected to operate at LOS D during the weekday a.m. peak hour and at LOS B during the weekday p.m. peak hour under the short-term (2025) horizon. The signal is proposed to operate with two phases easily allowing for the movements to be served depending on the demand. The two phases each include a pedestrian phase that does not conflict with vehicle movements leading to an overall safe and efficient signal. The longest queue during the weekday a.m. peak hour is expected to occur at the eastbound approach and will extend to a maximum of 1,000 feet, 40 vehicles. The longest queue during the weekday p.m. peak hour is expected to occur at the Ohio Drive westbound approach and extend to a maximum of approximately 500 feet, 20 vehicles.

Most traffic delay caused by the elimination of the one-way reversible operations could be largely mitigated through geometric and operational changes along the RCPP corridor. The mitigation would also improve safety through all times of day in addition to the peak periods.

7. Conclusion and Next Steps

The findings of this study demonstrate that the anticipated benefits of eliminating the reversible operations, if implemented with proper mitigation measures, stakeholder engagement, and public communication, would outweigh the potential impact on commuting traffic. These anticipated benefits include improving safety for roadway users and USPP staff, decreasing congestion and travel times for reverse commuters, and preserving USPP staff time and equipment.

In 2024, NPS, in partnership with the FHWA, will begin designing a pavement rehabilitation project of RCPP and Ohio Drive between Shoreham Drive and Independence Ave. In addition to replacing deteriorating asphalt along the corridor, the project will look for feasible opportunities to improve parkway safety and operations. NPS will take the findings of this report into the project design process, which will include the detailed design of safety improvements, further coordination with partner agencies, completion of the National Environmental Policy Act (NEPA) and National Historic Preservation Act (NHPA) processes, and public outreach.

Appendix

All appendices are available upon request.

A. 2013 Road Safety Audit
B. Vehicular Traffic Data
C. Vehicle Diversion Methodology Memorandum
D. Traffic Signal Warrant
E. Planning Level Cost Estimate
F. Detailed Capacity Operations Analysis Tables and Synchro Outputs