Appendix B: Traffic Analysis Technical Report

for the

I-95 Access Improvements from Caton Avenue to Fort McHenry Tunnel – Environmental Assessment (EA)
Baltimore City, Maryland

Prepared for:

Maryland Transportation Authority

DEPARTMENT OF TRANSPORTATION
BALTIMORE CITY

and

U.S. Department of Transportation
Federal Highway Administration

March 2018

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ACRONYMS AND ABBREVIATIONS

BCDOT	Baltimore City Department of Transportation
BMC	Baltimore Metropolitan Council
C-D	Collector-Distributor
EA	Environmental Assessment
FFS	Free Flow Speed
FHWA	Federal Highway Administration
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HSM	Highway Safety Manual
IAPA	Interchange Access Point Approval
ITE	Institute of Transportation Engineers
ISATe	Enhanced Interchange Safety Analysis Tool
LOS	Level of Service
MDTA	Maryland Transportation Authority
MOEs	Measures of Effectiveness
MPH	Miles per Hour
NEPA	National Environmental Policy Act
NCHRP	National Cooperative Highway Research Program
S	Seconds
VPH	Vehicles per Hour
VPMPL	Vehicles per Mile per Lane
V/C	Volume-to-Capacity

1 EXECUTIVE SUMMARY

This Traffic Analysis Technical Report details the traffic operations analysis performed for the I-95 Access Improvements in Baltimore, Maryland Environmental Assessment (EA). It identifies the years of analysis, the study area limits, methodology for travel demand forecasting and modeling, scenario development, operational parameters, and discusses the results of the analysis.

The Maryland Transportation Authority (MDTA) and the Baltimore City Department of Transportation (BCDOT), in coordination with the Federal Highway Administration (FHWA), are proposing to modify the access ramps connecting I-95 with the Port Covington peninsula in south Baltimore. These improvements are collectively known as the I-95 Access Improvements from Caton Avenue to the Fort McHenry Tunnel (I-95 Access Improvements). The purpose of the proposed action is to address the increased transportation demand to Port Covington and increased traffic on I-95, the existing capacity and roadway geometry not being adequate to meet projected traffic demands, and the limited multi-modal connections around and across I-95 in the vicinity of Port Covington in addition to supporting the economic development and land use changes at Port Covington.

The study area for the traffic analysis includes I-95 from the southwest I-695 interchange to the Fort McHenry Tunnel Toll Plaza, inclusive of all interchanges between. This includes at least one interchange along I-95 in each direction from the interchanges where improvements are proposed. Portions of Hanover Street, McComas Street, and Key Highway are also included in the study area due to the changes proposed to the I-95 ramps that connect to these streets and provide access to Port Covington.

Several traffic operational analysis software programs were used to evaluate select measures of effectiveness (MOEs) for the Existing condition, 2040 No Build condition, and multiple Build alternatives. Highway Capacity Software (HCS), VISSIM, and Synchro were used for the I-95 Access Improvements project in conjunction with modeled long-range travel forecasts to form a comparison between the No Build and Build alternatives. Numerous analyses were performed to identify key traffic information for detailed engineering. Roadway capacity and traffic operations analyses were conducted for the freeway mainline, weaving segments, merge and diverge junctions, surface street intersections, and ramp terminal intersections within the study area.

Four alternatives evolved from an iterative process involving engineering, planning, and environmental considerations; review and comment; refinement and revision; and eventual screening of the alternatives presented in the Draft EA. Project planning and design criteria were developed in coordination with MDTA, BCDOT, and the community. It should be noted that the increase in traffic associated with the Port Covington development is part of the No Build condition.

A fifth alternative was developed using the optimal elements of the previous four alternatives. The proposed improvements for the I-95 ramps and local street network represent the refined design concept for the I-95 Access Improvements and are considered the Recommended Preferred Alternative. These improvements are shown in Figure ES-1 and are described below.

Northbound on I-95, the Recommended Preferred Alternative would add a second auxiliary lane from the Caton Avenue collector-distributor (C-D) roadway to the Russell Street exit, modify the exit ramp to Russell Street to add a ramp to McComas Street on the west side of the peninsula, and construct a new on ramp from McComas Street to merge with northbound I-95 north of the existing exit ramp to Key Highway. In order to accommodate the new on ramp from McComas Street, the existing off ramp to Key Highway will be reconstructed and will tie into a reconstructed two-way McComas Street at a signalized intersection.

These modifications would include the construction of a new connection between I-395 and the newly constructed exit ramp to the west side of the peninsula in order to maintain an important existing connection for traffic traveling from Baltimore City to points south.

Southbound on I-95, the Recommended Preferred Alternative would construct a new exit ramp to McComas Street just north of the existing on ramp from McComas Street. The proposed exit ramp would merge with the one-way section of westbound McComas Street under I-95 just west of the ramp to southbound I-95.

In order to accommodate changes to the Interstate and support the increase in traffic anticipated as a result of the development, the project would also modify Hanover Street, McComas Street and Key Highway and construct a new pedestrian and bicycle path under I-95 to connect Port Covington to South Baltimore. The modifications to Hanover Street would occur due to the removal of the existing I-95 northbound exit ramp to southbound Hanover Street. The modifications to McComas Street would include the reconstruction of one-way eastbound McComas Street south of I-95 to be a two-way roadway while maintaining the portion of one-way westbound McComas Street under I-95 to accommodate ramp movements to and from southbound I-95 and connecting to the reconstructed two-way McComas Street at a signalized intersection. The modifications to Key Highway would be to add one lane northbound between McComas Street and McHenry Row and add a southbound right turn lane approaching McComas Street.

2 INTRODUCTION

The Maryland Transportation Authority (MDTA) and the Baltimore City Department of Transportation (BCDOT), in coordination with the Federal Highway Administration (FHWA), are studying a suite of improvements to Interstate 95 (I-95) ramps and other nearby transportation facilities to support ongoing and planned redevelopment of the Port Covington peninsula in south Baltimore. These improvements are collectively known as the I-95 Access Improvements from Caton Avenue to the Fort McHenry Tunnel (I-95 Access Improvements). The purpose of the proposed action is to address the increased transportation demand to Port Covington and increased traffic on I-95, the existing capacity and roadway geometry not being adequate to meet projected traffic demands, and the limited multi-modal connections around and across I-95 in the vicinity of Port Covington in addition to supporting the economic development and land use changes at Port Covington.

The Port Covington redevelopment project will transform 266 acres on the peninsula from under-utilized industrial brownfields into a mixed-use urban development. As proposed, this mixed-use development is said to be the largest urban redevelopment project currently underway in the United States. The developer has committed to using technology and other incentives to reduce reliance on automobile trips as a means of accessing the site. As currently planned, the Port Covington redevelopment will increase population density and employment on the peninsula, which will generate a demand for infrastructure improvements. The program is as follows:

- 1.3 million square feet of retail
- 4.3 million square feet of office space (including 3.9 million square feet for the Under Armour World Headquarters)
- Over 5,300 residential units, including rental and for-sale properties at various price-points
- 303,000 square feet of maker and industrial/light manufacturing space
- 200+ hotel rooms
- Almost 10,000 square feet of civic and cultural uses
- 40+ acres of public parks, a public waterfront, and other public facilities
- Total development: 11.33 million square feet (in addition to 3.4 million square feet of parking)

The Port Covington peninsula is surrounded on three sides by the Middle Branch of the Patapsco River, with I-95 running on structure along the northern boundary. Transportation access to the peninsula is currently provided by east-west connections via ramps to/from I-95 and north-south connections via a principal arterial, Hanover Street, and a minor arterial, Key Highway. McComas Street is a minor arterial, generally running parallel to I-95, that provides direct access from the peninsula to these connections.

Interstate 95 is part of the Interstate Highway System in the City of Baltimore, and is owned, operated and maintained by MDTA. BCDOT is responsible for other arterial and collector roadways in the project area. The FHWA has approval authority over any changes to access points on the Interstate Highway System. Approval of any proposed modification to Interstate access constitutes a federal action subject to review under the National Environmental Policy Act (NEPA).

This Traffic Analysis Technical Report details the traffic operations analysis performed for the I-95 Access Improvements in Baltimore, MD Environmental Assessment (EA). It identifies the years of analysis, the study area limits, methodology for travel demand forecasting and modeling, scenario development, operational parameters, and discusses the results of the analysis to determine which improvements best supported the project's Purpose and Need, as outlined below:

- Ongoing and planned development in the Port Covington peninsula will result in increased transportation demand to Port Covington resulting in vehicular trips that are projected to be more than double today's volumes to and from the site on I-95, I-395 and Hanover Street by 2040.
- Existing capacity and roadway geometry are not adequate to meet projected traffic demands, with operations on most ramp segments and links within the study corridor projected to degrade to unacceptable Levels of Service (LOS) by 2040.
- Existing public infrastructure in and around the peninsula cannot efficiently support the City's approved economic development and land use changes at Port Covington.

It is important to note that the proposed Port Covington development described above has already been approved by the City of Baltimore, and is thus assumed to be fully constructed in all analyses of future conditions, including the "No Build" condition.

3 STUDY AREA LIMITS

The study area for the I-95 Access Improvements EA includes I-95 from Caton Avenue to the Fort McHenry Tunnel, inclusive of all interchanges in between. For Travel Forecasting and Traffic Analysis purposes, and to better understand the impact of the Port Covington development and the need for potential improvements, an expanded study area was established. This expanded area, which is called the traffic analysis study area in the remainder of this document, is shown in Figure TTR-01. (All figures may be found in Appendix A.) The traffic analysis study area includes:

- I-95 from the southwest I-695 interchange to the Fort McHenry Tunnel Toll Plaza
- Caton Avenue from Joh Avenue/Georgetown Road to Benson Avenue
- Washington Boulevard from Harman Avenue to Monroe Street
- Russell Street, from I-95 to Bush Street
- The Baltimore Washington Parkway (MD 295) from I-95 to the Annapolis Road interchange
- Annapolis Road from Manokin Street to the MD 295 southbound ramps
- Waterview Avenue from Annapolis Road to Hanover Street
- Hanover Street from Wells Street to Waterview Avenue in Cherry Hill
- I-395 from I-95 to Conway Street
- McComas Street from Hanover Street to Andre Street
- Cromwell Street from Hanover Street to Key Highway, and
- Key Highway from McComas Street to McHenry Row

4 ANALYSIS PROCEDURES

4.1 Traffic Operational Analysis Software

Several traffic operational analysis software programs were used to determine select measures of effectiveness for Existing, No Build, and Build scenarios. These are outlined below:

Highway Capacity Software 2010 (HCS), version 6.3 was used to evaluate freeway, weaving, and ramp operations, as well as to determine freeway travel speeds. This software program uses methodologies within the HCM. HCS is a tool that calculates measures of effectiveness at a point along a freeway without accounting for upstream and downstream effects.

VISSIM was used to model freeway and surface arterial operations and travel times for segments within the traffic analysis study area. The Existing conditions VISSIM network was developed in version 8.00 of the software. The links and connectors within the model were coded using a scaled aerial background of the traffic analysis study area, as well as an existing model for the Fort McHenry Toll Plaza provided by MDTA. VISSIM simulates traffic operations on roadway segments and provides traffic operational data such as vehicle delay, density, travel speeds, travel times, and queuing at intersections, including ramp terminals on freeway networks. This software is a microscopic model that simulates multi-modal traffic flows, including cars, trucks, and buses. VISSIM also simulates individual vehicle interaction throughout the transportation network.

Synchro version 8 software was used to assess traffic operations at signalized and unsignalized surface street intersections. The analysis utilizes signalized and stop-controlled intersection methodologies from the HCM.

These three programs were used for the I-95 Access Improvements project in conjunction with modeled long-range travel forecasts to form a comparison among the No Build and Build alternatives. Although these programs are used to determine similar measures of effectiveness, the results may differ due to the methodologies the programs use. The differences in methodologies of the software programs are discussed later in this section.

LOS as defined by the HCM is a quantitative stratification of a performance measure or measures that represents quality of service, measured on an A through F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst. The HCM thresholds used for analyses are shown in Tables 4.1-1 through 4.1-3 for freeway segments and signalized/unsignalized intersections.

Table 4.1-1: Freeway LOS

LOS	Freeway Mainline Density (pc/mi/ln)	Freeway Merge / Diverge Density (pc/mi/ln)	Freeway Weave Density (pc/mi/ln)
A	<= 11	<= 10	<= 10
B	> 11 – 18	> 10 – 20	> 10 – 20
C	> 18 – 26	> 20 – 28	> 20 – 28
D	> 26 – 35	> 28 – 35	> 28 – 35
E	> 35 – 45	> 35	> 35
F	> 45	Demand Exceeds Capacity	Demand Exceeds Capacity

Table 4.1-2: Signalized Intersection LOS

LOS	Signalized Intersection Average Delay (sec/veh)
A	<= 10
B	> 10 – 20
C	> 20 – 35
D	> 35 – 55
E	> 55 – 80
F	> 80

Table 4.1-3: Unsignalized Intersection LOS

LOS	Unsignalized Intersection Average Delay (sec/veh)
A	<= 10
B	> 10 – 15
C	> 15 – 25
D	> 25 – 35
E	> 35 – 50
F	> 50

4.2 Freeway Analysis Methodology

The freeway traffic analyses for the AM and PM peak hours were completed using HCS and VISSIM. The analyses were broken down into three categories: basic freeway segments, ramp junctions, and weaving segments. Basic freeway segments are segments that are outside the influence of interchanges and their associated ramp connections, such as merges, diverges, or weaves.

Ramp junctions with freeways are either merges or diverges unless connected to adjacent ramps via an auxiliary lane or they provide an additional lane. Merges and diverges are the ramp connections to a freeway that provide an exclusive connection onto (merge) or off-of (diverge) a facility. Merge ramps provide a connection to the freeway from another facility while diverge ramps provide a connection to another facility from the freeway. The operations of ramp junctions can be influenced by adjacent ramps. When a junction having multiple legs has a connection with each leg, the ramp operates as a major merge or diverge. Under these conditions, basic freeway capacities are analyzed to determine the capacity approaching or exiting the merge or diverge area. Other conditions where basic freeway capacities are analyzed are lane additions or lane drops. Under major merge, major diverge, lane add, or lane drop conditions, the operations of the ramps are identified as “Under”, “Near”, or “Over” capacity. To determine the operations, the volume to capacity (v/c) ratio was computed. If the v/c ratio was less than 0.90, the ramp was labeled as “Under”, if the v/c ratio was equal or greater than 0.90 and less than 1.0, the ramp was labeled as “Near”, and, if the v/c ratio was 1.0 or greater, the ramp was labeled as “Over”.

Weaving segments are segments of freeway where there is a crossing of two or more traffic streams traveling in the same direction without the aid of traffic control devices. Based on the HCM definition, a segment where a merge junction is followed by a diverge junction within 2,500 feet is classified as a weaving segment.

There are several limitations of using HCS, which is a macroscopic, deterministic model that uses HCM methodologies. The HCS analysis may show differing conditions than existing operations and conditions in the field because it does not consider upstream and downstream traffic impacts and is unable to model interactions between the two. The HCS model provides a snapshot at a certain location; therefore upstream and downstream operations are not taken into consideration and have no effect on the analyses. This is not the case for actual conditions, as upstream or downstream congestion may have direct impacts at a specific location causing a ripple effect along the corridor.

In order to get a more accurate picture, all scenarios were also analyzed using VISSIM, which is a microscopic, stochastic simulation model that simulates multi-modal dynamic flows of traffic along freeways and surface arterials. This simulation model evaluates each segment by taking into consideration vehicle interaction and driver behaviors, as well as the operation impacts of both upstream and downstream traffic conditions. VISSIM was used to determine numerous link and system-wide MOEs, which were generated over an average of ten computer simulation runs.

4.3 Freeway Parameters

Table 4.3-1 lists all freeway parameters and inputs that were assumed on this project. All of the freeway analysis was performed using HCS. VISSIM was used to supplement HCS for determining other MOEs that are dependent on upstream and downstream traffic conditions. The primary MOEs evaluated with VISSIM were freeway speeds, travel times, and lane densities; however, throughput and unmet demand (traffic unable to enter the roadway network due to congestion) were also considered. It was assumed that these parameters would be consistently used across all analysis scenarios.

Table 4.3-1: Freeway Operations Parameters / Assumptions by Scenario

Freeway Operations Parameters	Scenarios		
	Existing	No Build 2040	Build 2040
Peak Hour Volumes	Field Counts	Per BMC Model*	
Peak Hour Factor	0.94	0.94	0.94
Percent Heavy Vehicles	9%	9%	9%
Driver Population Adjustment	1.0	1.0	1.0
Base Free-flow Speed (mph)	55-65	55-65	55-65
Lane Width	Varies	Varies	Varies
Interchange Density (per mile)	1.3	1.3	1.3
Ramp Free-flow Speeds (mph)	Varies	Varies	Varies
LOS Criteria	LOS E for freeway & ramps in urban areas	LOS E for freeway & ramps in urban areas	LOS E for freeway & ramps in urban areas

* BMC Model is further discussed later in this report

4.4 Arterial Intersection Parameters

Table 4.4-1 lists all of the intersection parameters and inputs assumed for the I-95 Access Improvements traffic analysis. Synchro software was used to perform signalized and stop-controlled intersection analyses. It was assumed that these parameters would not change between scenarios unless otherwise noted.

Table 4.4-1: Arterial Operations Parameters / Assumptions by Scenario

Arterial Intersection Operations Parameters	Scenarios		
	Existing	No Build 2040	Build 2040
Peak Hour Volumes	Field Counts	Per BMC Model	
Peak Hour Factor	0.92	0.92	0.92
Conflicting Pedestrians / Bikes per hour	Field Counts	Forecast	Forecast
Percent Heavy Vehicles	2%	2%	2%
Ideal Saturated Flow Rate	1900 vph		
Lane Width	11-12 ft	11-12 ft	11-12 ft
Parking Maneuvers per Hour	0	0	0
Bus Blockages	0	0	0
Signal Phasing and Offsets	Field Measured + BCDOT Data	Optimized	Optimized
Signal Timing – Cycle Length	Field Measured + BCDOT Data	Varies; Coordinated along Corridors	Varies; Coordinated along Corridors
Signal Timing – Minimum Green	Field Measured + BCDOT Data	4-25 s	4-25 s
Signal Timing – Yellow + All-red	Field Measured + BCDOT Data	5-6 s	5-6 s
Right Turn on Red	Field Observations*		
Intersection LOS Criteria, per HCM	LOS E, v/c critical < 1.0	LOS E, v/c critical < 1.0	LOS E, v/c critical < 1.0

* Existing field observations assumed to be the same for future scenarios

5 EXISTING CONDITIONS

5.1 Existing Conditions Roadway Geometry

The I-95 Access Improvements traffic analysis study area includes numerous major roadways that serve considerable amounts of traffic to and from Baltimore, MD. These roadways are described below.

5.1.1 Interstate Highway and Freeway System

There are two major Interstates and freeways located within the traffic analysis study area for this report. All of these roadways provide critical connections to and from Baltimore City. A "wiring diagram", showing the existing lane configurations on these roadways, is shown in TTR-02. These roadways of particular concern for the traffic analysis are described below.

I-95 is an above-grade interstate highway that generally consists of four lanes in each direction and, within the study area, runs in the east-west direction. For the purpose of this study, however, all references to direction along I-95 will maintain the Interstate's cardinal north-south designation. The study segment of I-95 is bounded by the southwest I-695 interchange and the Fort McHenry Tunnel Toll Plaza.

I-395 is an above-grade interstate highway spur route that runs in the north-south direction and connects I-95 to Downtown Baltimore City to the north and terminates at Conway Street. It varies between two- and three-lanes in each direction, generally runs parallel to Russell Street, and also provides access to Martin Luther King Jr. Boulevard.

5.1.2 Existing Local Roadway Network

The existing local roadway network is comprised of north/south and east/west streets within and immediately adjacent to the Port Covington peninsula. The principal roadways of particular concern for the traffic analysis are described below.

<u>**North-South Roadways**</u>

Hanover Street (MD 2) is the primary north-south roadway that runs through Port Covington. Within the traffic analysis study area, it varies from four to seven lanes and provides access to South Baltimore neighborhoods to the north, extends south to Cherry Hill, and accesses southbound I-95 just north of McComas Street. The roadway consists of two through lanes in each direction between Wells Street and McComas Street. Between McComas Street and south of the Hanover Street Bridge, Hanover Street consists of five through lanes in addition to an add lane from the northbound I-95 Off Ramp to a right turn lane at Cromwell Street. This section of Hanover Street consists of a reversible lane system, providing three northbound travel lanes and two southbound travel lanes during the AM peak period and two northbound travel lanes and three southbound travel lanes during the PM peak period. South of the Hanover Street Bridge, Hanover Street splits into two one-way roadways. Northbound Hanover Street consists of three travel lanes while southbound Hanover Street consists of four travel lanes prior to becoming Potee Street.

Key Highway is a four-lane roadway that is used as a thoroughfare between I-95 via McComas Street to the South Baltimore neighborhoods of Locust Point and Federal Hill, the Inner Harbor and downtown. Key Highway is the last exit off of northbound I-95 for motorists to access South Baltimore prior to entering the Fort McHenry Tunnel, which passes under the Baltimore Harbor.

East-West Roadways

McComas Street varies from a two to five lane roadway that generally runs parallel to, and occasionally runs underneath, I-95. Through most of the study area, McComas Street is a divided roadway with U-Turns providing access to the opposing direction. McComas Street connects Hanover Street and Key Highway, two primary north-south roadways that connect Port Covington to adjacent neighborhoods. McComas Street also provides access to and from north- and southbound I-95 and the South Locust Point Marine Terminal.

5.2 Existing Traffic Volumes

To support the transportation analysis, peak hour counts for I-95 from the Fort McHenry Tunnel to the southwest I-695 interchange were conducted in 2012 and provided by MDTA. The balanced counts provided by MDTA for the I-95 mainline and ramp volumes were used for this study. Although 2015 counts are also available, these counts appear to be lower due to the fact that they were conducted immediately following completion of a construction project within the traffic analysis study area along I-95. As such, MDTA requested that the 2012 counts be used for this study. Manual counts were conducted in May 2016 along MD 295 ramps and for all surface intersections in the traffic analysis study area. Traffic counts were balanced based on the provided MDTA balanced counts for I-95. Existing volumes for the AM and PM peak hours are presented in Figures TTR-03 and TTR-04.

5.3 Freeway Traffic Analysis

5.3.1 VISSIM Model Calibration

Existing conditions AM and PM peak hour networks and volumes were coded for the entire traffic analysis study area with default VISSIM settings in order to provide a starting point for calibration of the simulation model. Per FHWA guidance, calibration is the adjustment of model parameters, such as local driver behavior and traffic performance characteristics, to improve the model's ability to reproduce traffic conditions. Calibrating the existing model is required before analyzing different scenarios. Without calibration, there is no assurance that the model will correctly predict traffic performance.

Calibration of the model was conducted based on a comparison of model conditions to field collected data and observations. VISSIM parameters were adjusted to reflect the higher than average density of the traffic analysis study area's urban environment as well as the more aggressive driving behavior observed. In addition to adjusting the model's freeway parameters, a separate driving behavior was created to reflect distinct behaviors observed approaching and within the Fort McHenry Tunnel. Field observations indicate that drivers are typically more cautious inside the tunnel, frequently leading to congestion during the PM peak hour, particularly in the northbound direction. It is not directly related to the capacity of the freeway, so a separate driving behavior was necessary for that section of I-95.

In addition to adjusting the model's local and global freeway parameters, the cooperative lane change parameter was enabled for both freeway and urban driving behaviors for select links/connectors in the network. This parameter allows a vehicle to recognize the lane change behavior of surrounding vehicles and adjusts its movement characteristics to make the lane change of other vehicles more cooperative. By incorporating this, if vehicle A observes a leading vehicle B in an adjacent lane wanting to change to the lane of vehicle A, it will use its acceleration/deceleration and lane change abilities to provide space for vehicle B to change lanes as long as the route for vehicle A is not compromised and the speed differential between the vehicles is within its safety parameters. Using the cooperative lane change helps prevent vehicles performing emergency stops when the route they are assigned to is heavily congested. All other default driving behaviors for both freeway and urban driving behaviors remained unchanged.

In addition to the measures noted above, desired speed decisions and reduced speed areas were modeled to replicate areas where speed reductions were observed. In the Fort McHenry Tunnel, vehicles were observed slowing down in the center of the tunnel. This may be attributed to either the grade change or the horizontal curve located near the center of the tunnel. Further, speed reductions were added to select locations at the end of the network to replicate downstream congestion that occurs and spills back into the network, particularly from I-695. Without these speed reductions, the vehicles would free-flow out of the network.

In order to replicate congestion in the northbound direction that begins prior to the PM peak hour but influences operations during the PM peak hour, volume was added during the 15-minute seeding period to certain segments of the network to create congestion at the beginning of the recording period. (The seed time is the initial period of the simulation used to allow time for the network to populate with vehicles.)

In order to calibrate the Existing conditions model, travel time data was collected within the traffic analysis study area during the AM and PM peak periods. A minimum of ten travel time runs were recorded in each direction of I-95 and averaged. The traffic analysis study area was broken into nine segments in the northbound direction and eight segments in the southbound direction. The average travel times for these segments were the primary metrics used for the calibration of the Existing conditions VISSIM model. The model was calibrated within 15 percent of the field recorded travel times for most segments and for the end-to-end model. It should be noted that it is not necessary for every segment to be within the acceptable threshold to accurately represent field conditions. The overall calibration criterion is that the majority of the segments and the overall corridor travel times fall within the targeted 15 percent threshold. Although there are a few segments that exceeded the targeted 15 percent threshold, this difference was considered acceptable given the low number of segments exceeding the threshold and the overall calibration of end-to-end travel times which are within approximately ten seconds or 2 percent for three of the four directions during the peak hours. The field measured and modeled travel times for the AM and PM peak hours are shown in Table 5.3-1 and Table 5.3-2, respectively.

Table 5.3-1: AM Peak Hour Model Validation Results

Segment Begin	Segment End	Segment Length (mi.)	Field Data Travel Times (s)	Model Data Travel Times (s)	Difference in Travel Times (%)
Southbound I-95					
EB I-695 Off Ramp	WB I-695 Off Ramp	0.35	20	21	6.1%
WB I-695 Off Ramp	I-695 On Ramp	0.36	22	22	0.0%
I-695 On Ramp	Caton Avenue Off Ramp	0.50	30	30	0.0%
Caton Avenue Off Ramp	Russell Street Off Ramp	2.11	172	178	3.5%
Russell Street Off Ramp	MD 295 On Ramp	0.77	57	60	5.3%
MD 295 On Ramp	Key Highway Off Ramp	0.60	34	35	2.9%
Key Highway Off Ramp	Enter Tunnel	1.13	62	70	12.9%
Enter Tunnel	Exit Tunnel	1.33	88	80	-9.1%
Exit Tunnel	Toll	0.30	27	27	0.0%
Total Northbound Travel Time		**7.45**	**512**	**523**	**2.2%**
Northbound I-95					
Toll	Enter Tunnel	0.28	84	96	14.3%
Enter Tunnel	Exit Tunnel	1.35	163	144	-11.7%
Exit Tunnel	Key Highway On Ramp	0.97	69	75	8.7%
Key Highway On Ramp	MD 295 Off Ramp	0.64	47	61	29.8%
MD 295 Off Ramp	Russell Street On Ramp	0.89	79	70	-11.4%
Russell Street On Ramp	Caton Avenue Off Ramp	0.98	73	72	-1.4%
Caton Avenue Off Ramp	WB I-695 Off Ramp	1.51	120	123	2.5%
WB I-695 Off Ramp	EB I-695 On Ramp	0.69	41	46	12.2%
Total Southbound Travel Time		**7.31**	**676**	**687**	**1.6%**

Table 5.3-2: PM Peak Hour Model Validation Results

Segment Begin	Segment End	Segment Length (mi.)	Field Data Travel Times (s)	Model Data Travel Times (s)	Difference in Travel Times (%)
Northbound I-95					
EB I-695 Off Ramp	WB I-695 Off Ramp	0.35	22	22	0.0%
WB I-695 Off Ramp	I-695 On Ramp	0.36	25	22	-12.0%
I-695 On Ramp	Caton Avenue Off Ramp	0.50	29	31	6.9%
Caton Avenue Off Ramp	Russell Street Off Ramp	2.11	203	227	11.8%
Russell Street Off Ramp	MD 295 On Ramp	0.77	104	88	-15.4%
MD 295 On Ramp	Key Highway Off Ramp	0.60	79	64	-19.0%
Key Highway Off Ramp	Enter Tunnel	1.13	218	196	-10.1%
Enter Tunnel	Exit Tunnel	1.33	203	183	-9.9%
Exit Tunnel	Toll	0.30	33	30	-9.1%
Total Northbound Travel Time		**7.45**	**916**	**863**	**-5.8%**
Southbound I-95					
Toll	Enter Tunnel	0.28	25	25	0.0%
Enter Tunnel	Exit Tunnel	1.35	87	84	-3.4%
Exit Tunnel	Key Highway On Ramp	0.97	64	64	0.0%
Key Highway On Ramp	MD 295 Off Ramp	0.64	31	36	16.1%
MD 295 Off Ramp	Russell Street On Ramp	0.89	73	70	-4.1%
Russell Street On Ramp	Caton Avenue Off Ramp	0.98	95	97	2.1%
Caton Avenue Off Ramp	WB I-695 Off Ramp	1.51	175	182	4.0%
WB I-695 Off Ramp	EB I-695 On Ramp	0.69	50	46	-8.0%
Total Southbound Travel Time		**7.31**	**600**	**604**	**0.7%**

5.3.2 Basic Freeway Segments Analysis

Figure TTR-05 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the Existing condition. The HCS and VISSIM results for the AM and PM peak hour for basic freeway segment analysis within the traffic analysis study area are summarized in Tables 5.3-3 and 5.3-4, respectively.

A. HCS Freeway Analysis

Table 5.3-3 shows the LOS for Existing conditions for the basic freeway segment analysis. The results do not clearly reflect the traffic conditions that exist in the field, which demonstrates the limitations of HCS discussed previously. For example, HCS indicates that northbound I-95 approaching the I-395 Off Ramp operates at LOS D during the AM and PM peak hours; however, the observed field conditions show substantial congestion approaching this off ramp during both peak hours. Further, queuing was observed in the northbound direction approaching the Fort McHenry Tunnel during the PM peak hour, adversely impacting upstream freeway segments which is not shown in these results.

All freeway segments operate at or above a LOS D under Existing conditions for both the AM and PM peak hours, except the segment on southbound I-95 between the MD 295 On Ramp and the Washington Boulevard On Ramp which operates at LOS E during the AM peak hour.

B. VISSIM Freeway Analysis

The VISSIM analysis provides results that are consistent with observed levels of congestion during the peak hours. The VISSIM output shows that under Existing conditions, seven freeway segments operate at LOS F, one during the morning peak hour and six during the evening peak hour. The MOEs for freeway mainline segments for the AM and PM peak hours are provided in Table 5.3-4.

VISSIM analysis of Existing conditions confirmed that traffic speeds were lower and densities were higher in the peak travel direction. The LOS at critical segments of the freeway during the AM and PM peak hours is shown in Table 5.3-4.

The VISSIM analysis for the Existing conditions shows that all of the freeway segments are performing at a LOS E or better in the peak travel direction during the AM peak hour (southbound), while poor levels of service exist on many segments in the peak travel direction during PM peak hour (northbound). During the AM peak hour, the only freeway segment that operates at LOS F is in the northbound direction between the Russell Street Off Ramp and the I-395 Off Ramp. This freeway segment experiences an average density of 52 vehicles per mile per lane (vpmpl) and an average speed of 28 mph. This congestion extends beyond the Washington Boulevard Off Ramp and is caused by the high volume of vehicles accessing downtown Baltimore City via I-395 northbound or Martin Luther King, Junior Boulevard.

In the PM peak hour, six freeway segments operate at LOS F, five of which occur in the northbound direction and one in the southbound direction. The greatest contributors to northbound congestion include the I-395 Off Ramp and the Fort McHenry Tunnel. Two freeway segments approaching the I-395 Off Ramp, F4 and F5, experience average densities of 78 and 53 vpmpl and average speeds of 21 and 34 mph, respectively. As previously noted, driver reaction to the Fort McHenry Tunnel causes reductions in speeds in the northbound direction during the PM peak hour. This slowdown of traffic, in conjunction with the short spacing between the I-395 On Ramp, the Hanover Street Off Ramp, and the Key Highway Off Ramp, creates failing conditions. Three freeway segments upstream of the tunnel, F8, F9, and F10, operate at LOS F and experience average speeds of less than or equal to 30 mph. In the southbound direction, the freeway segment between the Caton Avenue Off Ramp and the Caton Avenue On Ramp operates at LOS F with an average density of 47 vpmpl and an average speed of 37 mph.

Table 5.3-3: HCS Existing Condition Freeway Segments

No.	Freeway Segment	AM Peak Hour			PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	C	64	26	C	64	26
F2	WB I-695 Off Ramp to I-695 On Ramps	C	65	19	C	65	19
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	D	63	27	D	63	27
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	C	64	26	D	64	26
F5	MD 295 Off Ramp to I-395 Off Ramp	D	64	26	D	63	28
F6	I-395 Off Ramp to MD 295 On Ramp	B	65	15	C	65	25
F7	MD 295 On Ramp to I-395 On Ramp	B	65	14	C	65	24
F8	Hanover Street Off Ramp to Key Highway Off Ramp	B	65	14	D	63	28
F9	Key Highway Off Ramp to Key Highway On Ramp	A	65	11	C	65	23
F10	Key Highway On Ramp to Tunnel	B	65	12	D	64	26
Southbound Interstate 95							
F11	Tunnel to Key Highway Off Ramp	D	61	31	B	65	15
F12	Key Highway Off Ramp to Key Highway On Ramp	D	64	27	B	65	14
F13	Key Highway On Ramp to Hanover Street On Ramp	D	60	33	B	65	17
F14	I-395 Off Ramp to MD 295 Off Ramp	D	64	27	B	65	15
F15	MD 295 Off Ramp to I-395 On Ramp	D	63	28	B	65	17
F16	I-395 On Ramp to MD 295 On Ramp	D	61	32	D	64	27
F17	MD 295 On Ramp to Washington Blvd On Ramp	E	59	35	D	60	33
F18	Caton Ave Off Ramp to Caton Ave On Ramp	D	63	29	D	61	31
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	C	65	23	C	64	26
F20	WB I-695 On Ramp to EB I-695 On Ramp	C	65	23	C	65	24

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 5.3-4: VISSIM Existing Condition Freeway Segments

No.	Freeway Segment	AM Peak Hour				PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	57	23	5,959	5,947	52	28	5,969	6,061
F2	WB I-695 Off Ramp to I-695 On Ramps	61	18	4,354	4,356	60	18	4,362	4,422
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	53	29	6,250	5,919	53	32	6,250	6,152
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	44	37	5,900	5,521	34	52	6,050	5,836
F5	MD 295 Off Ramp to I-395 Off Ramp	28	52	6,000	5,470	21	78	6,350	6,181
F6	I-395 Off Ramp to MD 295 On Ramp	58	14	2,700	2,459	52	27	4,300	4,185
F7	MD 295 On Ramp to I-395 On Ramp	61	12	3,200	2,955	49	29	5,550	5,438
F8	Hanover Street Off Ramp to Key Highway Off Ramp	56	14	3,250	3,045	23	69	6,300	6,057
F9	Key Highway Off Ramp to Key Highway On Ramp	62	9	2,450	2,129	30	53	5,250	4,872
F10	Key Highway On Ramp to Tunnel	59	11	2,800	2,854	23	76	6,000	5,340
Southbound Interstate 95									
F11	Tunnel to Key Highway Off Ramp	51	33	6,900	6,711	61	15	3,600	3,594
F12	Key Highway Off Ramp to Key Highway On Ramp	57	27	6,150	5,974	61	13	3,150	3,112
F13	Key Highway On Ramp to Hanover Street On Ramp	37	43	7,100	6,867	59	14	3,900	3,756
F14	I-395 Off Ramp to MD 295 Off Ramp	44	35	6,200	6,024	59	15	3,550	3,434
F15	MD 295 Off Ramp to I-395 On Ramp	44	35	4,750	4,601	60	16	2,950	2,842
F16	I-395 On Ramp to MD 295 On Ramp	46	34	7,000	6,835	48	33	6,100	5,801
F17	MD 295 On Ramp to Washington Blvd On Ramp	53	31	7,450	7,270	49	31	7,150	6,841
F18	Caton Ave Off Ramp to Caton Ave On Ramp	49	35	6,550	6,293	37	47	6,850	6,409
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	52	21	5,379	5,052	51	23	5,918	5,265
F20	WB I-695 On Ramp to EB I-695 On Ramp	57	20	5,356	5,122	56	21	5,606	5,180

(green)	Light to Moderate Traffic (LOS A-C)
(yellow)	Heavy Traffic (LOS D)
(orange)	High Congestion (LOS E)
(red)	Severe Congestion (LOS F)

5.3.3 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour Existing conditions freeway weave section analysis within the traffic analysis study area are summarized in Tables 5.3-5 and 5.3-6, respectively.

A. HCS Weave Analysis

The weave analyses for the Existing conditions found that the only weaving segment operating at a LOS F is the segment from I-695 to Caton Avenue during both peak hours.

During the AM peak hour, two weaving segments operate at LOS E. These two segments include the southbound I-95 weaving segment between Hanover Street and I-395 and the southbound I-95 weaving segment between Washington Boulevard and Caton Avenue. All other weaving segments in the AM peak hour operate at a LOS D or better.

During the PM peak hour, the northbound I-95 weaving segment between I-395 and Hanover Street operates at LOS E. All other weaving segments in the PM peak hour operate at a LOS D or better.

B. VISSIM Weave Analysis

The weave analyses for Existing conditions found four weaving segments performing at LOS F, one during the AM Peak hour and three during the PM peak hour.

The VISSIM analysis for Existing conditions shows that during the AM peak hour, the southbound weave between Hanover Street and I-395 operates at LOS F and experiences an average density of 53 vpmpl and an average speed of 29 mph. During the PM Peak hour, two of the three weaves in the northbound direction operate at LOS F. The weave between Caton Avenue and Russell Street fails due to downstream congestion approaching the I-395 Off Ramp, and the weave between I-395 and Hanover Street fails because of short weave spacing, high volumes, and the downstream congestion approaching the Fort McHenry Tunnel. In the southbound direction, congestion occurs approaching the I-695 Off Ramp, causing the southbound weave between Caton Avenue and I-695 to operate at LOS F. It should be noted that capacity improvements are currently underway along the inner loop of I-695. These improvements will likely improve congestion that occurs southbound on I-95 approaching the I-695 Off Ramp.

Table 5.3-5 HCS Existing Condition Weaving Segments

No.	Weave Segment	AM Peak Hour			PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	1.9	F	-	1.7
W2	From Caton Avenue/C-D Roadway to MD 295	D	48	30	D	47	33
W3	From I-395 to Hanover Street	B	50	17	E	42	37
Southbound Interstate 95							
W4	From Hanover Street to I-395	E	41	43	C	49	20
W5	From Washington Boulevard to Caton Avenue	E	46	37	D	48	35
W6	From Caton Avenue to I-695	D	51	32	D	51	34

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 5.3-6: VISSIM Existing Condition Weaving Segments

No.	Weave Segment	AM Peak Hour				PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	57	23	7,300	6,942	57	22	7,100	6,922
W2	From Caton Avenue/C-D Roadway to MD 295	33	43	6,600	6,025	18	83	6,900	6,736
W3	From I-395 to Hanover Street	56	13	3,900	3,620	30	50	7,000	6,760
Southbound Interstate 95									
W4	From Hanover Street to I-395	29	53	7,800	7,561	55	16	4,450	4,297
W5	From Washington Boulevard to Caton Avenue	41	39	7,700	7,483	39	39	7,550	7,185
W6	From Caton Avenue to I-695	39	43	7,400	7,009	21	72	7,700	7,049

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

5.3.4 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour Existing conditions ramp junction analysis within the traffic analysis study area are summarized in Tables 5.3-7 and 5.3-8, respectively.

A. HCS Ramp Analysis

The analysis of merge and diverge operations at exit and entrance ramps is based on procedures presented in Chapter 13, Freeway Merge and Diverge Segments, of the HCM, which focuses on ramp-freeway junctions. The procedure focuses primarily on the interaction between the freeway mainline and the influence of entrance and exit ramps. Vehicle interactions are dynamic in ramp influence areas. Approaching freeway through vehicles will move left as long as there is capacity. The intensity of ramp flow influences the behavior of through freeway vehicles and general freeway congestion can also act to limit ramp flow, causing diversion to other interchanges or routes. The geometric characteristics of ramp-freeway junctions vary. The length and type (parallel, taper) of acceleration or deceleration lanes, the free-flow speed (FFS) of both the ramp and the freeway in the vicinity of the ramp, proximity of other ramps, and other elements all affect merging and diverging operations.

The HCS analysis for Existing conditions shows that all ramp segments in both the AM and PM peak hours operate at LOS E or better.

B. VISSIM Ramp Analysis

VISSIM outputs show that for the existing ramp analyses four segments operate at a LOS F during the AM and PM peak hours, two during the AM peak hour and two during the PM peak hour.

The VISSIM analysis indicates that two ramp segments operate at LOS F during the AM peak hour, both of which occur in the northbound direction. The westbound I-695 Off Ramp experiences an average density of 49 vpmpl and an average speed of 33 mph while the I-395 Off Ramp experiences an average density of 79 vpmpl and an average speed of 19 mph.

During the PM peak hour, the northbound off ramp to westbound I-695 experiences an average density of 50 vpmpl and an average speed of 33 mph while the I-395 On Ramp experiences an average density of 76 vpmpl and an average speed of 22 mph.

Table 5.3-7: HCS Existing Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	AM Peak Hour			PM Peak Hour		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	C	57	27	C	57	27
R2	WB I-695 Off Ramp	Diverge	E	52	36	E	52	36
R3	Washington Blvd Off Ramp	Diverge	D	53	31	D	53	31
R4	I-395 Off Ramp	Capacity	UNDER	-	0.9	UNDER	-	0.6
R5	MD 295 On Ramp	Merge	B	59	18	D	54	32
R6	Key Highway Off Ramp	Diverge	C	53	21	E	53	36
R7	Key Highway On Ramp	Merge	B	58	16	D	56	29
Southbound Interstate 95								
R8	Key Highway Off Ramp	Diverge	D	50	30	B	51	19
R9	Key Highway On Ramp	Merge	D	55	31	B	58	19
R10	MD 295 Off Ramp	Diverge	D	58	33	B	60	19
R11	I-395 On Ramp	Capacity	UNDER	-	0.6	UNDER	-	0.9
R12	MD 295 On Ramp	Merge	C	58	25	C	57	27
R13	EB I-695 Off Ramp	Diverge	D	58	29	C	58	31
R14	WB I-695 On Ramp	Merge	C	56	26	C	57	26
R15	EB I-695 On Ramp	Merge	E	48	37	D	54	32

* Volume-to-capacity ratio reported for capacity analysis.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 5.3-8: VISSIM Existing Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	AM Peak Hour				PM Peak Hour			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	51	9	474	459	55	9	511	514
R2	WB I-695 Off Ramp	Diverge	33	49	1,605	1,589	33	50	1,607	1,639
R3	Washington Blvd Off Ramp	Diverge	49	6	350	312	43	4	200	182
R4	I-395 Off Ramp	Major Diverge	19	79	3,300	2,884	49	20	2,050	1,961
R5	MD 295 On Ramp	Merge	53	9	500	500	52	25	1,250	1,265
R6	Key Highway Off Ramp	Diverge	35	21	800	737	33	31	1,050	987
R7	Key Highway On Ramp	Merge	41	9	350	334	29	27	750	647
Southbound Interstate 95										
R8	Key Highway Off Ramp	Diverge	33	32	750	732	60	8	450	480
R9	Key Highway On Ramp	Merge	43	24	950	937	39	18	750	671
R10	MD 295 Off Ramp	Diverge	47	32	1,450	1,404	59	10	600	571
R11	I-395 On Ramp	Major Merge	54	21	2,250	2,248	22	76	3,150	2,977
R12	MD 295 On Ramp	Merge	54	8	450	453	49	21	1,050	1,045
R13	EB I-695 Off Ramp	Diverge	50	15	782	724	50	15	852	755
R14	WB I-695 On Ramp	Merge	34	22	759	753	37	15	540	539
R15	EB I-695 On Ramp	Merge	55	15	2,246	1,829	58	11	1,448	1,293

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

5.4 Surface Street Intersection Analysis

Traffic operational analyses were conducted for existing intersections within the traffic analysis study area. The lane geometry at the surface street intersections for the Existing conditions is shown in Figure TTR-06. Table 5.4-1 shows the Existing conditions LOS for the AM and PM peak hours. Under Existing conditions, the intersection of Conway Street at Howard Street operates at LOS F during the AM and PM peak hours, Key Highway at McComas Street operates at LOS F during the PM peak hour, and Annapolis Road at Russell Street/Wenburn Street operates at LOS F during the AM peak hour . All other intersections operate at LOS E or better under Existing conditions.

Table 5.4-1: Existing Condition HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
1	Caton Avenue at Benson Avenue	D	37	C	35
2	Caton Avenue at Southbound I-95 On Ramp	A	2	A	8
3	Caton Avenue at Joh Avenue/Georgetown Road	C	34	D	47
4	Washington Boulevard at Northbound I-95 Off Ramp	C	22	B	15
5	Washington Boulevard at Southbound I-95 On Ramp	A	8	A	3
6	Washington Boulevard at Monroe Street	E	56	E	65
7	Russell Street at Bush Street	C	22	C	29
8	Annapolis Road at Manokin Street	A	10	A	9
10	Annapolis Road at Waterview Road	D	38	D	42
11	Annapolis Road at MD 295 Ramps	C	25	C	25
13	Waterview Avenue at Cherry Hill Road	C	21	C	35
14	Conway Street at Howard Street	F	104	F	94
15	Hanover Street at Wells Street	B	19	C	25
16	Hanover Street at McComas Street	B	18	B	18
17	Hanover Street at Cromwell Street	C	23	C	29
18	Hanover Street SB at Waterview Avenue	B	13	B	13
19	NB Hanover Street at Waterview Avenue	A	8	B	14
21	Key Highway at McComas Street	E	61	F	147
22	Key Highway at McHenry Row	B	13	B	14
24	Washington Boulevard at Harman Avenue	C	23	E	62
Unsignalized Intersections					
9	Annapolis Road at Russell Street/Wenburn Street	F	64	C	18
12	Waterview Avenue at MD 295 Off Ramp/Church Street	B	12	B	14
20	McComas Street at Cromwell Street	A	9	A	9
23	McComas Street at Andre Street	B	10	B	10

(green)	Light to Moderate Traffic (LOS A-C
(yellow)	Heavy Traffic (LOS D)
(orange)	High Congestion (LOS E)
(red)	Severe Congestion (LOS F)

5.5 Safety Analysis

A detailed crash analysis was conducted for mainline I-95, the interchange ramps within the study corridor, and the major intersections within the local street network. Three years of crash data, from January 1, 2012 to December 31, 2014, was provided by MDOT-SHA Office of Traffic and Safety for I-95 and the interchange ramps. Crash data for the major intersections within the local street network was provided by Baltimore City for the five year period between January 1, 2011 and December 31, 2015. The number of crashes, severity of crashes, and type of crashes were examined and summarized below.

<u>I-95 Mainline</u>

A total of 392 police reported crashes occurred along I-95 from January 1, 2012 to December 31, 2014. The crashes are summarized below and in Table 5.5-1:

- 122 crashes occurred in 2012, 116 occurred in 2013, and 154 occurred in 2014.
- Three (3) fatalities occurred during the study period, which is under one percent.
- Rear end collisions occurred at a rate significantly higher than the statewide average (20.8 vs 17.5) and were the most common collision type, accounting for more than half of all accidents (56%).
- Sideswipe and “other” crash types also occurred at a significantly higher rate than the statewide average; Sideswipe (8.9 vs 7.5) and “other” (1.4 vs. 0.4), accounting for 24% and 4% of all crashes, respectively.
- Truck related crashes also occurred at a significantly higher rate than the statewide average (8.0 vs 5.0) and accounted for 22% of all accidents; however, this may be attributable to the high truck percentage along I-95 (11.3%).
- Night time crashes accounted for 36% of all crashes, significantly higher than the statewide average of 31%.
- The most common probable causes of crashes were “too fast for conditions”, “followed too closely”, and “improper lane change”. 54% of all crashes were attributed to these three causes.

Table 5.5-1: Mainline Crash Summary – 2012 to 2014

Crashes	# of Accidents	Crash Rate [per 100 mvmt]	Statewide Average Rate
Crash Severity			
Fatal	3	0.3	0.3
Injury	137	12.9	15.8
Property Damage Only	252	23.7	28.2
Collision Type			
Rear End	221	**20.8***	17.5
Sideswipe	94	**8.9***	7.5
Fixed Object	57	5.4	11.9
Parked Vehicle	3	0.3	0.3
Pedestrian	2	0.2	0.1
Other	15	**1.4***	0.4
Aggregate			
Truck-Related	85	**8.0***	5.0
Night Time	142	**36%***	31%
Wet Surface	68	17%	21%
Alcohol Related	33	8%	8%
Total	***392***	***36.9***	***44.3***

* Rate significantly higher than statewide average

Interchange Ramps

A total of 65 police reported crashes occurred along the I-95 interchange ramps from January 1, 2012 to December 31, 2014. The crashes are summarized below and in Table 5.5-2:

- Most crashes occurred along the ramps of the I-95 at Caton Avenue and I-95 at I-395 interchanges, which contained 21 and 22 crashes, respectively.
- Rear end and fixed object crashes were the most common ramp collision types.
- 56% of ramp crashes occurred at night.
- No fatalities occurred during the study period.

Table 5.5-2: Ramp Crash Summary – 2012 to 2014

Crashes	Interchange Ramps (# of accidents)						
	I-95 at Caton Ave	I-95 at Washington Blvd	I-95 at MD 295	I-95 at I-395	I-95 at MD 2	I-95 at McComas St	I-95 at Keith Ave
Crash Severity							
Fatal	0	0	0	0	0	0	0
Injury	8	3	2	9	1	1	0
Property Damage Only	13	3	2	13	3	1	2
Collision Type							
Rear End	11	3	0	6	1	0	1
Fixed Object	8	1	3	10	3	1	1
Sideswipe	2	1	1	1	0	0	0
Parked Vehicle	0	0	0	1	0	0	0
Opposite Direction	0	0	0	1	0	0	0
Angle	0	1	0	0	0	0	0
Other	0	0	0	3	0	1	0
Aggregate							
Truck-related	2	2	1	1	0	0	1
Night Time	11	3	3	11	4	2	0
Wet Surface	3	0	2	6	2	1	1
Alcohol Related	4	0	0	4	1	1	0
Total	***21***	***6***	***4***	***22***	***4***	***2***	***2***

Surface Streets

Intersection crash data was obtained from Baltimore City for the five year period from January 1, 2011 to December 31, 2015. The data is summarized below and shown in Table 5.5-3:

- The Hanover Street at McComas Street intersection and the Hanover Street at Cromwell Street intersection showed the highest number of crashes, with 33 and 30 crashes, respectively.
- Eighteen (18) crashes occurred at the McComas Street at Key Highway intersection.
- The remaining intersections experienced an average of less than 2 crashes per year.
- No fatalities occurred during the study period.

Table 5.5-3: Intersection Crash Summary – 2011 to 2015

Crashes	Intersections (# of accidents)					
	Hanover St at Wells St	Hanover St at McComas St	Hanover St at Cromwell St	Cromwell St at McComas St	McComas St at Key Hwy	Key Hwy at Fort Ave
Crash Severity						
Fatal	0	0	0	0	0	0
Injury	1	17	8	1	7	0
Property Damage Only	8	16	22	0	11	4
Collision Types						
Sideswipe	3	12	13	0	5	1
Rear End	3	6	5	1	2	0
Angle	1	6	3	0	5	0
Fixed Object	0	0	4	0	5	0
Left Turn	0	6	1	0	0	0
Other	1	2	1	0	1	2
Opposing Direction	0	1	3	0	0	1
Parked Vehicle	1	0	0	0	0	0
Aggregate						
Night Time	3	12	8	0	3	2
Wet Surface	3	10	8	0	2	1
Total	***9***	***33***	***30***	***1***	***18***	***4***

6 TRAFFIC FORECASTING / DEMAND MODELING METHODOLOGY

The Baltimore Metropolitan Council (BMC) regional travel demand model and the Institute of Transportation Engineers (ITE) trip generation methodology were both used, in a hybrid approach, to generate traffic forecasts for the AM and PM peak hours for the 2040 design year. These traffic forecasts were used to assess and compare travel conditions under the No Build Alternative and each of the Build Alternatives. A complete discussion of the travel forecasting process is included in Appendix B. A brief overview is presented below.

6.1 BMC Model

The BMC regional travel demand model forecasts traffic volumes on major roadways in the Baltimore Region, using the transportation network and land use conditions in the region as inputs. The model was developed by BMC to provide a basis to predict travel trends based on planned development and transportation network changes at the regional level. The BMC model was used in this study as a starting point to develop traffic forecasts for the 2040 design year.

6.2 Trip Generation and Distribution

The BMC model does not explicitly include the development proposed for the Port Covington site. In order to account for this, the ITE methodology was used to generate site trips for the Port Covington development for the 2040 scenarios. The trip generation is summarized in Table 6.2-1.

Table 6.2-1: ITE Trip Generation of Port Covington

Land Use	ITE Code	Size	ITE Vehicle Trips					
			AM Peak			PM Peak		
			IN	OUT	TOTAL	IN	OUT	TOTAL
2040 Port Covington Development								
Office	710	4,300,000 SF	3,412	466	3,878	832	4,062	4,894
Retail	820	1,300,000 SF	462	283	745	1,604	1,737	3,341
Residential (Mid Rise)	223	5,300 DU	670	1,490	2,160	1,469	1,064	2,533
Hotel	310	200 Rooms	63	43	106	61	59	120
Manufacturing	140	303,000 SF	172	49	221	79	141	220
Park[1]	411	40.23 Acres	8	7	15	31	30	61
Internal Capture			(54)	(54)	(108)	(465)	(465)	(930)
Sum			**4,733**	**2,284**	**7,017**	**3,611**	**6,628**	**10,239**
Transit/Pedestrian/Bicycle Reduction		20%	(947)	(457)	(1,403)	(722)	(1,326)	(2,048)
Cumulative Total			**3,786**	**1,827**	**5,614**	**2,889**	**5,302**	**8,191**

1. The park space land use code provides a rate for a weekday, but does not provide rates for peak hours. It was assumed that all weekday trips occur during the peak hours (20% AM and 80% PM).

It should be noted that the trip generation assumes internal capture, i.e., that a portion of trips generated by the mixed-use development begin and end within the development.

Once the ITE trip generation analysis was completed, an adjustment factor was applied to the results, in order to account for transit, bicycle and walking trips. (Such an adjustment is typically applied to urban study areas with significant transit service and opportunities for walking/bicycling.) For Port Covington, a reduction of 20% was felt to be reasonable. As shown in Table 6.2-1, following the adjustments for internal capture and transit/pedestrian/bicycle use, the Port Covington development is projected to generate 5,614 and 8,191 vehicle trips during the AM and PM peak hours, respectively.

The BMC model was then modified to explicitly account for these trips. The Port Covington-generated trips were distributed throughout the traffic analysis study area by the regional model. The resulting trip distribution for Port Covington-generated trips is shown in Figure TTR-07. It should be noted that the trip generation and distribution were held constant for each of the future scenarios.

6.3 Post Processing

The modification of the BMC model to explicitly account for the Port Covington site trips in the 2040 forecasts resulted in some “double counting” of future trips. As a result, unrealistically high volumes were projected within the traffic analysis study area, particularly along the roadways directly accessing Port Covington. In order to address this, background annual growth rates were adjusted on Hanover Street and McComas Street to 0.25%, based on historical traffic count data.

The total number of vehicular trips estimated by the ITE method for the Port Covington development was held constant; however, due to the regional scale of the BMC travel demand model, it does not include all surface streets within the Port Covington peninsula. Merging ITE trip generation and the regional model was done to mitigate the limitations of both approaches, i.e. ITE does not capture the impact of proposed roadway projects, regional changes in demand, changes in destination choice, etc., while the regional model cannot generate peak hour trips at the parcel level. Therefore, engineering judgment based on capacity considerations and land use densities at various points within Port Covington were used to manually assign turning movements along Hanover Street and McComas Street at the proposed Port Covington development side streets.

It should be noted that the BMC regional model also forecasts significant growth on the northbound I-95 exit ramp to head north on Washington Boulevard unrelated to Port Covington, resulting in near grid lock conditions on Washington Boulevard which spilled back on the northbound off ramp and onto northbound I-95. For the purpose of this study, the projected volume on this northbound I-95 off ramp was distributed between north- and southbound Washington Boulevard in the Build scenarios in order to reduce spillback on the freeway to more accurately evaluate downstream freeway operations and to identify the most appropriate set of improvements.

7 ALTERNATIVES DEVELOPMENT

The alternatives evolved from an iterative process involving engineering, planning, and environmental considerations; review and comment; refinement and revision; and eventual screening of the alternatives presented in the Draft EA. Project planning and design criteria were developed in coordination with MDTA, BCDOT, and the community. The existing connectivity between South Baltimore, I-95, and the Port Covington peninsula is provided by various ramps to and from I-95, McComas Street, Hanover Street, and Key Highway. In an effort to simplify this complex project, these ramps and streets have been classified as six distinct Elements. In addition, a seventh Element, for pedestrian/bicycle connectivity, was included. A key map showing the existing Elements is provided in TTR-08 and are listed below:

- Element A: Northbound I-95 Off Ramps
- Element B: Northbound I-95 On Ramps
- Element C: Southbound I-95 Off Ramps
- Element D: Southbound I-95 On Ramps
- Element E: Hanover Street
- Element F: McComas Street and Key Highway
- Element G: Pedestrian and Bicycle Connections

Due to the size of the traffic analysis study area and the extent of potential improvements, a significant number of possible Alternatives could be developed by combining different improvements for the seven Elements. Rather than developing an alternative for every possible combination, each Element was first focused on individually, and an effort was made to develop multiple options for each Element. Next, the various options were combined into discrete alternatives for analysis purposes. The following Sections describe each Alternative evaluated. More detailed descriptions are provided in the Alternatives Development Technical Report.

8 ALTERNATIVE 1 (NO BUILD CONDITIONS)

8.1 No Build Roadway Geometry and Traffic Volumes

Under the No Build Alternative, the existing I-95 entrance and exit ramps would remain as they exist today, as shown in TTR-09. However, the No Build Alternative includes modifications to the surface street network to be made as part of the Port Covington development, and not as part of the I-95 Access Improvements. It is important to note that these surface street modifications will be in place even if no changes to access and egress to/from I-95 are made. These modifications include modifying the existing grade of Hanover Street, particularly south of McComas Street. Hanover Street will be widened to six lanes, and a median and turn lanes will be constructed along the corridor. Additional surface street intersections will also be included along Hanover Street and McComas Street as part of the Port Covington development.

The No Build Alternative includes the traffic associated with the full Port Covington development as described in Section 6 above. Forecasted volumes for the 2040 No Build AM and PM peak hours are presented in Figures TTR-10 and TTR-11. Lane configurations and traffic control for at-grade intersections are shown in Figure TTR-12.

8.2 Freeway Traffic Analysis

8.2.1 Basic Freeway Segments Analysis

Figure TTR-05 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the 2040 No Build condition, which are the same as those analyzed under the Existing condition. The HCS and VISSIM results of the AM and PM peak hour 2040 No Build freeway segments analysis within the traffic analysis study area are summarized in Tables 8.2-1 and 8.2-2, respectively.

A. HCS Freeway Analysis

HCS analysis was performed for the 2040 No Build scenario. The results for LOS, speed, and density for the freeway mainline segments for both the morning and evening peak hours are shown in Table 8.2-1.

All freeway segments in the 2040 No Build condition for both the AM and PM peak hours would operate at or above LOS D, except fourteen segments: nine in the morning and five in the evening peak hours.

During the AM peak hour, southbound I-95 would deteriorate significantly from Existing conditions within the study area, with the most congestion within the Fort McHenry Tunnel and between I-395 and Caton Avenue. Additionally, in the northbound direction, freeway segments between I-695 and MD 295 would degrade to LOS E or F. During the PM peak hour, all freeway segments on southbound I-95 south of I-395 are projected to operate at LOS E or below. As mentioned above, the HCS analysis does not take into account upstream and downstream conditions therefore may not accurately represent conditions in the field at a particular segment, nor how the system is working as a whole. These results indicate that if no improvements are made to the existing freeway infrastructure that future traffic operations will continually deteriorate.

B. VISSIM Freeway Analysis

VISSIM analysis was performed for the 2040 No Build scenario. MOEs for the freeway mainline segments for both the AM and PM peak hours are shown in Table 8.2-2.

VISSIM analysis for the 2040 No Build condition shows seventeen freeway segments would perform at LOS F, eight during the AM peak hour and nine during the PM peak hour. As expected, freeway conditions would continue to deteriorate under the 2040 No Build condition. In the northbound direction during the PM peak hour, the VISSIM model shows considerable improvements to freeway segments near Key Highway; however, the output volumes are considerably lower than the input volumes in these segments, indicating that the improved conditions are attributed to upstream congestion that is starving the downstream segments.

In the southbound direction during both peak hours, the severe congestion in the Fort McHenry Tunnel meters downstream segments. The queuing in the tunnel can be attributed to failing operations on the Key Highway Off Ramp (R10) and at the McComas Street at Key Highway intersection, as discussed in the following sections of this report.

Table 8.2-1: HCS 2040 No Build Condition Freeway Segments

No.	Freeway Segment	AM Peak Hour			PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	E	54	42	D	61	32
F2	WB I-695 Off Ramp to I-695 On Ramps	D	63	28	C	65	22
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	F	50	48	D	60	34
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	E	57	38	D	61	32
F5	MD 295 Off Ramp to I-395 Off Ramp	E	55	40	D	59	34
F6	I-395 Off Ramp to MD 295 On Ramp	C	65	23	D	63	29
F7	MD 295 On Ramp to I-395 On Ramp	C	65	20	D	63	28
F8	Hanover Street Off Ramp to Key Highway Off Ramp	B	65	15	D	63	28
F9	Key Highway Off Ramp to Key Highway On Ramp	B	65	11	C	65	22
F10	Key Highway On Ramp to Tunnel	B	65	15	D	59	35
Southbound Interstate 95							
F11	Tunnel to Key Highway Off Ramp	F	52	45	C	65	19
F12	Key Highway Off Ramp to Key Highway On Ramp	D	62	30	B	65	14
F13	Key Highway On Ramp to Hanover Street On Ramp	E	55	41	C	65	21
F14	I-395 Off Ramp to MD 295 Off Ramp	D	60	34	C	65	22
F15	MD 295 Off Ramp to I-395 On Ramp	D	59	34	C	64	25
F16	I-395 On Ramp to MD 295 On Ramp	E	54	42	E	54	42
F17	MD 295 On Ramp to Washington Blvd On Ramp	F	50	48	F	45	58
F18	Caton Ave Off Ramp to Caton Ave On Ramp	E	56	40	F	47	54
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	D	62	30	E	55	41
F20	WB I-695 On Ramp to EB I-695 On Ramp	D	62	30	E	57	38

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 8.2-2: VISSIM 2040 No Build Condition Freeway Segments

No.	Freeway Segment	AM Peak Hour				PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	16	79	8,166	5,546	11	97	7,029	4,509
F2	WB I-695 Off Ramp to I-695 On Ramps	11	95	6,356	4,142	7	105	5,217	3,052
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	12	105	8,707	4,875	6	138	7,277	2,999
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	9	114	7,814	4,095	4	155	6,964	2,290
F5	MD 295 Off Ramp to I-395 Off Ramp	9	112	8,007	4,128	3	157	7,331	2,003
F6	I-395 Off Ramp to MD 295 On Ramp	4	148	4,014	1,950	2	178	4,850	1,172
F7	MD 295 On Ramp to I-395 On Ramp	4	143	4,621	2,131	2	169	6,363	1,250
F8	Hanover Street Off Ramp to Key Highway Off Ramp	50	8	3,461	1,572	2	157	6,357	969
F9	Key Highway Off Ramp to Key Highway On Ramp	62	5	2,609	1,187	59	3	5,239	798
F10	Key Highway On Ramp to Tunnel	59	8	3,430	1,437	57	5	7,350	882
Southbound Interstate 95									
F11	Tunnel to Key Highway Off Ramp	32	69	8,454	5,523	29	92	4,411	3,082
F12	Key Highway Off Ramp to Key Highway On Ramp	56	22	6,729	4,830	58	12	3,217	2,855
F13	Key Highway On Ramp to Hanover Street On Ramp	56	22	8,094	5,587	60	11	4,960	3,062
F14	I-395 Off Ramp to MD 295 Off Ramp	53	24	7,241	5,063	60	11	5,093	2,749
F15	MD 295 Off Ramp to I-395 On Ramp	55	23	5,479	3,817	59	13	4,367	2,353
F16	I-395 On Ramp to MD 295 On Ramp	55	23	8,202	5,486	59	12	8,179	3,137
F17	MD 295 On Ramp to Washington Blvd On Ramp	59	23	8,687	5,999	59	16	9,312	4,302
F18	Caton Ave Off Ramp to Caton Ave On Ramp	59	24	7,953	5,509	59	19	9,095	4,453
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	56	19	6,700	4,808	56	18	8,117	4,421
F20	WB I-695 On Ramp to EB I-695 On Ramp	57	20	6,674	5,067	58	17	7,765	4,556

	Light to Moderate Traffic (LOS A-C)
	Heavy Traffic (LOS D)
	High Congestion (LOS E)
	Severe Congestion (LOS F)

8.2.2 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 No Build weave section analysis within the traffic analysis study area are summarized in Tables 8.2-3 and 8.2-4, respectively.

A. HCS Weave Analysis

The weave analyses for the 2040 No Build condition found nine weaving segments would operate at a LOS F, four during the AM peak hour and five during the PM peak hour.

It can be seen that traffic conditions would get considerably worse than Existing conditions under future No Build conditions.

B. VISSIM Weave Analysis

The weave analyses for the 2040 No Build condition found six weaving segments would perform at LOS F, three during each of the peak hours.

As discussed in the 2040 No Build freeway analysis, the VISSIM weave analysis shows that, in the northbound direction, severe congestion would occur near I-395 and cause significant queuing on I-95 that spills back to upstream segments. This queuing on northbound I-95 would cause each of the weaves south of I-395 to perform at LOS F during both peak hours. In the southbound direction, severe congestion that occurs within the Fort McHenry Tunnel due to the exit to Key Highway would starve downstream segments, thus artificially improving all weaving segments south of the Fort McHenry Tunnel.

Table 8.2-3: HCS 2040 No Build Condition Weaving Segments

No.	Weave Segment	AM Peak Hour			PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	2.3	F	-	1.9
W2	From Caton Avenue/C-D Roadway to MD 295	E	44	43	E	45	39
W3	From I-395 to Hanover Street	F	-	1.1	F	-	1.3
Southbound Interstate 95							
W4	From Hanover Street to I-395	F	-	1.3	F	-	1.2
W5	From Washington Boulevard to Caton Avenue	E	41	50	F	-	1.0
W6	From Caton Avenue to I-695	F	-	1.1	F	-	1.0

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

- Light to Moderate Traffic (LOS A-C)
- Heavy Traffic (LOS D)
- High Congestion (LOS E)
- Severe Congestion (LOS F)

Table 8.2-4: VISSIM 2040 No Build Condition Weaving Segments

No.	Weave Segment	AM Peak Hour				PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	12	92	9,978	6,000	7	111	8,305	4,209
W2	From Caton Avenue/C-D Roadway to MD 295	9	106	8,654	4,554	4	147	7,924	2,440
W3	From I-395 to Hanover Street	5	118	5,621	2,502	2	157	8,132	1,353
Southbound Interstate 95									
W4	From Hanover Street to I-395	42	31	9,193	6,424	57	12	6,491	3,492
W5	From Washington Boulevard to Caton Avenue	53	24	9,258	6,404	56	17	9,878	4,756
W6	From Caton Avenue to I-695	56	23	8,979	6,434	53	22	10,127	5,471

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

8.2.3 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 No Build conditions ramp junction analysis within the traffic analysis study area are summarized in Tables 8.2-5 and 8.2-6, respectively.

A. HCM Ramp Analysis

The 2040 No Build ramp analyses show fifteen segments at LOS F, eight in the AM peak hour and seven in the PM peak hour. All other ramp segments would operate at LOS E or better under 2040 No Build conditions.

B. VISSIM Ramp Analysis

VISSIM outputs show that for the 2040 No Build conditi analyses six segments would operate at a LOS F during the AM and PM peak hours, three during the AM peak hour and three during the PM peak hour. All other ramp segments would operate at LOS E or better.

As discussed previously, the queuing on the southbound I-95 exit ramp to Key Highway would spill back onto and adversely affect the upstream freeway segment within the Fort McHenry Tunnel. This ramp failure can be attributed to both the limited ramp capacity in the 2040 No Build Condition, as documented in the Table 8.2-6 ramp segment HCS results for the AM peak hour, and the failing surface street intersection of McComas Street at Key Highway, is detailed in Section 8.3 below. In the northbound direction during the PM peak hour, congestion on the Key Highway Off Ramp (R6) would cause significant queuing on northbound I-95 which would extend the length of study network, causing queuing on the upstream merge segment (R5) and starving the upstream diverge segments. The significant queuing on the Key Highway Off Ramp can be attributed to congestion from failing operations at the downstream surface street intersections as shown in Section 8.3, including the intersections of McComas Street at Key Highway and McComas Street at the eastbound to westbound U-turn.

Table 8.2-5: HCS 2040 No Build Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	AM Peak Hour			PM Peak Hour		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	F	57	36	D	57	32
R2	WB I-695 Off Ramp	Diverge	F	51	47	F	51	42
R3	Washington Blvd Off Ramp	Diverge	F	52	45	E	53	35
R4	I-395 Off Ramp	Capacity	OVER	-	1.1	UNDER	-	0.7
R5	MD 295 On Ramp	Merge	C	57	26	F	47	37
R6	Key Highway Off Ramp	Diverge	C	53	23	E	53	36
R7	Key Highway On Ramp	Merge	C	57	20	E	48	40
Southbound Interstate 95								
R8	Key Highway Off Ramp	Diverge	F	48	36	C	49	22
R9	Key Highway On Ramp	Merge	E	51	37	C	56	27
R10	MD 295 Off Ramp	Diverge	F	57	42	C	60	27
R11	I-395 On Ramp	Capacity	UNDER	-	0.8	OVER	-	1.1
R12	MD 295 On Ramp	Merge	F	55	30	F	48	35
R13	EB I-695 Off Ramp	Diverge	E	58	36	F	57	42
R14	WB I-695 On Ramp	Merge	D	54	34	F	51	37
R15	EB I-695 On Ramp	Merge	F	30	44	F	42	41

* Volume-to-capacity ratio reported for capacity analysis.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 8.2-6: VISSIM 2040 No Build Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	AM Peak Hour				PM Peak Hour			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	50	7	535	362	50	7	576	364
R2	WB I-695 Off Ramp	Diverge	33	37	1,810	1,233	32	38	1,812	1,223
R3	Washington Blvd Off Ramp	Diverge	15	52	893	441	43	2	313	95
R4	I-395 Off Ramp	Major Diverge	43	24	3,993	2,024	50	7	2,481	653
R5	MD 295 On Ramp	Merge	2	150	607	289	1	197	1,513	177
R6	Key Highway Off Ramp	Diverge	33	16	852	380	1	196	1,118	96
R7	Key Highway On Ramp	Merge	40	14	821	531	38	7	2,111	257
Southbound Interstate 95										
R8	Key Highway Off Ramp	Diverge	5	126	1,725	675	2	175	1,194	193
R9	Key Highway On Ramp	Merge	47	17	1,365	780	47	5	1,743	217
R10	MD 295 Off Ramp	Diverge	51	26	1,762	1,222	56	7	726	391
R11	I-395 On Ramp	Major Merge	53	16	2,723	1,639	53	7	3,812	728
R12	MD 295 On Ramp	Merge	53	9	485	484	48	24	1,133	1,108
R13	EB I-695 Off Ramp	Diverge	50	13	882	626	51	10	961	521
R14	WB I-695 On Ramp	Merge	34	25	856	850	35	17	609	604
R15	EB I-695 On Ramp	Merge	55	11	2,533	1,269	56	8	1,633	872

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

8.3 Surface Street Intersection Analysis

Traffic operational analyses were conducted for No Build intersections under 2040 No Build conditions. Table 8.3-1 shows the LOS at local intersections within the traffic analysis study area with Port Covington traffic and the proposed changes to Hanover Street and McComas Street under the No Build condition. Existing signal timings were maintained except at locations where roadway geometrics were modified as part of the 2040 No Build condition, i.e., those proposed by the Port Covington development. Table 8.3-1 shows that nine intersections would operate at LOS F in the AM peak hour and twelve intersections would operate at LOS F in the PM peak hour. As expected, control delays and LOS significantly deteriorate in the forecast 2040 No Build scenario.

Table 8.3-1: 2040 No Build HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
1	Caton Avenue at Benson Avenue	D	50	D	45
2	Caton Avenue at Southbound I-95 On Ramp	B	11	B	13
3	Caton Avenue at Joh Avenue/Georgetown Road	E	63	E	57
4	Washington Boulevard at Northbound I-95 Off Ramp	E	77	B	16
5	Washington Boulevard at Southbound I-95 On Ramp	A	8	A	4
6	Washington Boulevard at Monroe Street	F	178	F	217
7	Russell Street at Bush Street	D	45	D	45
8	Annapolis Road at Manokin Street	B	12	A	10
10	Annapolis Road at Waterview Road	D	41	D	47
11	Annapolis Road at MD 295 Ramps	C	30	D	36
13	Waterview Avenue at Cherry Hill Road	C	32	E	58
14	Conway Street at Howard Street	F	167	F	196
15	Hanover Street at Wells Street	F	139	F	161
16	Hanover Street at McComas Street	F	102	F	194
17	Hanover Street at Cromwell Street	C	30	F	134
18	Hanover Street SB at Waterview Avenue	B	12	B	14
19	Northbound Hanover Street at Waterview Avenue	A	9	C	34
21	Key Highway at McComas Street	F	***	F	***
22	Key Highway at McHenry Row	B	18	B	19
24	Washington Boulevard at Harman Avenue	C	26	F	***
25	Hanover Street at Magenta Street	B	11	B	19
26	Hanover Street at Blue Street	F	265	F	183
27	Hanover Street at Red Street	D	37	E	69
28	McComas Street at Tan Street	B	18	C	26
29	McComas Street at Gray Street	B	14	D	39
Unsignalized Intersections					
9	Annapolis Road at Russell Street/Wenburn Street	F	***	D	34
12	Waterview Avenue at MD 295 Off Ramp/Church Street	B	13	C	20
20	McComas Street at Cromwell Street/White Street	F	137	F	***
23	McComas Street at Andre Street	B	11	B	11
30	McComas Street at Violet Street	A	10	F	92
31	McComas Street at Teal Street	F	196	F	***
32	McComas Street at Pink Street	D	33	F	***

*** Delay exceeds 300 seconds

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

9 ALTERNATIVE 2

9.1 Alternative 2 Roadway Geometry and Traffic Volumes

The geometric improvements analyzed as part of Alternative 2 are summarized below. A wiring diagram for the Alternative 2 freeway system is shown in Figure TTR-13 and a key map of element improvements for Alternative 2 is shown in Figure TTR-14. Forecasted volumes for the 2040 Alternative 2 scenario are presented in Figures TTR-15 and TTR-16. Lane configurations and traffic control for at-grade intersections are shown in Figure TTR-17.

Northbound Off Ramps:

<u>Construct an off ramp from Northbound I-395 (Exit 53) to McComas Street (West of Hanover Street) [Removes Existing Hanover Street Off Ramp]</u>

The existing two-lane off ramp from northbound I-95 to I-395 northbound would be modified to result in a choice lane (A-B ramp) to access I-395 northbound as well as McComas Street. The proposed off ramp to McComas Street would span the Middle Branch touching down on the west side of Port Covington.

- Proposed Conditions
  - Exit 53 would be converted into an A-B ramp.
    - The right-most lane of the existing two-lane ramp would become a choice lane, with Ramp A diverging on the right to continue east onto West McComas Street.
    - Ramp B would remain a two-lane ramp that continues north towards Downtown Baltimore.
  - The proposed one-lane Ramp A would span the Middle Branch, merging with the proposed northbound MD 295 Off Ramp, becoming the two eastbound lanes of West McComas Street.
  - The existing northbound I-95 Off Ramp to Hanover Street would be removed.
  - The existing ramp from northbound MD 295 to northbound I-95 would be converted into an A-B ramp using a choice lane.
    - Ramp A would diverge from the existing ramp on the right and become the new off ramp to McComas Street.

<u>Reconstruct the Key Highway Off Ramp Terminus with Two-Way McComas Street</u>

The existing tie-in to McComas Street for the single lane northbound I-95 Off Ramp would be relocated to the west. In addition, the existing lane between the I-395 southbound On Ramp to northbound I-95 and the demolished northbound I-95 Off Ramp to Hanover Street would be extended east to tie into the relocated Key Highway Off Ramp.

- Proposed Conditions
  - In order to allow traffic from this off ramp to access the Port Covington development street grid, the gore point for Exit 55 would be moved 400 feet to the west
  - The lane between the I-395 On Ramp to northbound I-95 and the northbound I-95 Off Ramp to Key Highway would provide approximately 1,500 feet for traffic to weave.
  - Since McComas Street would be a two-way street, the off ramp would end at a signal controlled intersection with McComas Street. In order to provide the necessary capacity at the signal, the one-lane off ramp would widen to three lanes as it approaches the intersection.

Northbound On Ramps:

Construct an on ramp from the Hanover Street at McComas Street Intersection

A new on ramp would originate from the Hanover Street at McComas Street intersection. The proposed single lane on ramp from Hanover Street to northbound I-95 would serve as a second access point to northbound I-95, providing additional access to supplement the existing Key Highway On Ramp to northbound I-95. A second point of access is provided to the same new on ramp two blocks east of Hanover Street which would reduce demand along Hanover Street.

- Proposed Conditions
  - The new northbound I-95 On Ramp would be added as a fifth leg in the northeast quadrant of the Hanover Street at McComas Street intersection.
  - The ramp would run north of McComas Street and remain at grade for 600 feet, until it connects with a spur from a signal-controlled intersection within the Port Covington development.
    - The spur would allow traffic to access the ramp without having to use Hanover Street
  - The on ramp from Hanover Street and the spur would rise and pass over the relocated northbound I-95 Off Ramp to Key Highway.
  - The northbound I-95 mainline would be widened to allow for the necessary acceleration and taper length of the proposed on ramp.

Southbound Off Ramps:

Improve the Existing Key Highway Off Ramp

The existing single lane off ramp from southbound I-95 to Key Highway would widen to two lanes after the gore. Widening the off ramp would require McComas Street, which runs parallel to the existing off ramp, to shift north. The off ramp and McComas Street would merge prior to the Key Highway intersection.

- Proposed Conditions
  - Where the ramp leaves southbound I-95, it would remain a one-lane off ramp.
  - 60 feet downstream of the painted gore, the ramp would begin to widen to a two-lane off ramp.
  - The two-lane ramp would merge with McComas Street 675 feet downstream of the southbound I-95 painted gore, becoming a three-lane road.
    - In order to accommodate these additional lanes, the ramp would be widened to the north, into the existing retained fill adjacent to the CSX tracks.
  - The ramp intersects Key Highway underneath the I-95 viaduct.
    - An exclusive right turn lane would be separated by a median to accommodate two of the piers for the southbound I-95 viaduct, allowing this construction to occur without affecting the mainline.
    - In order to accommodate this additional right turn lane, the roadway would be widened into the fill slope adjacent to the CSX tracks. The CSX bridge which crosses over Key Highway just north of the intersection would need to be reconstructed.

Southbound On Ramps:

Widen the Existing Hanover Street On Ramp

The existing single lane on ramp from Hanover Street to southbound I-95 would be widened to two lanes. The two lanes would merge prior to joining the I-95 mainline. The increased capacity of the on ramp would help reduce congestion along northbound Hanover Street.

- Proposed Conditions
    - The two-lane ramp would leave Hanover Street as a choice and an exclusive right turn lane north of the Hanover Street at McComas Street intersection.
    - The two-lane section would narrow down to one-lane, matching the existing section, before the ramp meets the I-95 viaduct, allowing this second lane to be constructed without affecting the mainline.

Hanover Street:

Reconstruct Hanover Street Between Wells Street and McComas Street

The grade of Hanover Street would be modified in order to facilitate multimodal connections across Hanover Street.

- Proposed Conditions
    - The CSX Bridge between Wells Street and McComas Street would be reconstructed in order to accommodate a wider Hanover Street typical section.
    - Hanover Street would be lowered south of the CSX bridge in order to construct at-grade intersections with the Port Covington street grid south of McComas Street. This would allow for enhanced pedestrian and bicycle access across Hanover Street.
    - Hanover Street would be reconstructed as part of the Port Covington development as a six lane section south of McComas Street with a median and turn lanes.

McComas Street:

Construct Two-Way McComas Street

One-way eastbound McComas Street would be reconstructed as a two-way roadway. Westbound McComas Street would be maintained and would connect to two-way McComas Street at a signalized intersection.

- Proposed Conditions
    - Eastbound McComas Street would be modified and widened to a four to six lane divided, two-way roadway.
    - Connections to the Port Covington street grid would be constructed.

Pedestrians and Bicyclists:

Construct Additional Pedestrian Connection to South Baltimore

- Proposed Conditions
    - The existing sidewalks on Hanover Street would remain unchanged on the bridge over the CSX tracks. South of the bridge, a new sidewalk is proposed along the west side of Hanover Street, running south to the McComas Street intersection. An 11-foot wide shared-use path would be provided on the east side of Key Highway between the intersections of McHenry Row and McComas Street, and sidewalks would be installed along both sides of the new McComas Street boulevard. Likewise, a shared-use path would be installed along the north side of McComas Street between the Cromwell Street and Key Highway intersections.
    - Further, a new shared-use path, linking South Baltimore to Port Covington would be constructed. The shared use path would originate near the intersection of Winder Street

at Light Street, where it would run parallel to Winder as it inclines per ADA ramp standards to meet the proper elevation to cross over the CSX tracks. Additional access to the path would be provided via a staircase at the intersection of Winder Street at Charles Street. At the Charles Street intersection, the ramp would turn south, bridge over the CSX tracks and under I-95, then turn east to connect to the shared-use path proposed along the north side of McComas Street.

9.2 Freeway Traffic Analysis

9.2.1 Basic Freeway Segments Analysis

Figure TTR-18 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the 2040 Alternative 2 condition. The HCS and VISSIM results for the AM and PM peak hour Alternative 2 condition for basic freeway segment analysis within the traffic analysis study area are summarized in Tables 9.2-1 and 9.2-2, respectively.

A. HCM Freeway Analysis

All freeway segments in the Alternative 2 condition for both the AM and PM peak hours would operate at or above a LOS E, except five segments, three in the morning and two in the evening peak hour.

B. VISSIM Freeway Analysis

VISSIM analysis was performed for the 2040 Alternative 2 scenario, and the results show that thirteen freeway segments would perform at LOS F, six during the AM peak hour and seven during the PM peak hour. All other freeway segments would operate at LOS E or better in the Alternative 2 condition.

Table 9.2-1: HCS 2040 Alternative 2 Condition Freeway Segments

No	Freeway Segment	Alt 2 AM			Alt 2 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	E	54	42	D	61	32
F2	WB I-695 Off Ramp to I-695 On Ramps	D	63	28	C	65	22
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	F	50	48	D	60	34
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	E	57	38	D	61	32
F5	MD 295 Off Ramp to I-395 Off Ramp	E	55	40	D	59	34
F6	I-395 Off Ramp to MD 295 On Ramp	B	65	14	C	65	21
F7	MD 295 On Ramp to I-395 On Ramp	B	65	12	C	65	21
F8	Key Highway Off Ramp to New McComas Street On Ramp	B	65	12	C	65	22
F9	New McComas St On Ramp to Key Highway On Ramp	B	65	13	D	64	27
F10	Key Highway On Ramp to Tunnel	B	65	15	D	59	35
Southbound Interstate 95							
F11	Tunnel to Key Highway Off Ramp	F	52	46	C	65	19
F12	Key Highway Off Ramp to Key Highway On Ramp	D	62	30	B	65	14
F13	Key Highway On Ramp to Hanover Street On Ramp	E	55	41	C	65	21
F14	I-395 Off Ramp to MD 295 Off Ramp	D	60	34	C	65	22
F15	MD 295 Off Ramp to I-395 On Ramp	D	59	34	C	64	25
F16	I-395 On Ramp to MD 295 On Ramp	E	54	42	E	54	42
F17	MD 295 On Ramp to Washington Boulevard On Ramp	F	50	48	F	45	58
F18	Caton Ave Off Ramp to Caton Ave On Ramp	E	56	40	F	47	54
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	D	62	30	E	55	41
F20	WB I-695 On Ramp to EB I-695 On Ramp	D	62	30	E	57	38

(green)	Light to Moderate Traffic (LOS A-C)
(yellow)	Heavy Traffic (LOS D)
(orange)	High Congestion (LOS E)
(red)	Severe Congestion (LOS F)

Table 9.2-2: VISSIM 2040 Alternative 2 Condition Freeway Segments

No.	Freeway Segment	Alt 2 AM				Alt 2 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	17	78	8,166	5,923	17	79	7,029	5,430
F2	WB I-695 Off Ramp to I-695 On Ramps	11	100	6,356	4,471	14	78	5,217	3,820
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	14	100	8,707	5,443	11	104	7,277	4,267
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	11	106	7,814	4,743	8	117	6,964	3,659
F5	MD 295 Off Ramp to I-395 Off Ramp	19	69	8,007	5,066	8	113	7,331	3,610
F6	I-395 Off Ramp to MD 295 On Ramp	58	9	2,395	1,501	53	13	3,743	1,874
F7	MD 295 On Ramp to I-395 On Ramp	62	8	2,870	1,961	48	22	4,991	3,057
F8	Key Hwy Off Ramp to New McComas Street On Ramp	62	8	2,609	2,002	54	16	5,239	3,418
F9	New McComas St On Ramp to Key Hwy On Ramp	37	9	2,945	2,216	36	16	6,224	3,983
F10	Key Highway On Ramp to Tunnel	59	11	3,430	2,806	54	24	7,350	5,087
Southbound Interstate 95									
F11	Tunnel to Key Highway Off Ramp	35	60	8,454	6,211	32	67	4,411	3,842
F12	Key Highway Off Ramp to Key Highway On Ramp	56	24	6,729	5,252	57	13	3,217	3,067
F13	Key Highway On Ramp to Hanover Street On Ramp	51	27	8,094	6,117	59	15	4,960	3,974
F14	I-395 Off Ramp to MD 295 Off Ramp	47	29	7,241	5,463	54	19	5,093	3,877
F15	MD 295 Off Ramp to I-395 On Ramp	49	28	5,479	4,111	49	25	4,367	3,295
F16	I-395 On Ramp to MD 295 On Ramp	44	35	8,202	6,773	41	37	8,179	6,038
F17	MD 295 On Ramp to Washington Blvd On Ramp	49	35	8,687	7,220	40	45	9,312	7,011
F18	Caton Ave Off Ramp to Caton Ave On Ramp	47	39	7,953	6,439	32	60	9,095	6,648
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	51	23	6,700	5,355	49	27	8,117	5,910
F20	WB I-695 On Ramp to EB I-695 On Ramp	55	23	6,674	5,549	56	24	7,765	5,865

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

9.2.2 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 2 condition weave section analysis within the traffic analysis study area are summarized in Tables 9.2-3 and 9.2-4, respectively.

A. HCS Weave Analysis

The weave analyses for the Alternative 2 condition found eight weaving segments would operate at a LOS F, three during the AM peak hour and five during the PM peak hour. All other weave segments would operate at LOS E or better.

B. VISSIM Weave Analysis

The weave analyses for the Alternative 2 condition found nine weaving segments would perform at LOS F, four during the AM peak hour and five during the PM peak hour. All other weave segments would operate at LOS E or better.

Table 9.2-3: HCS 2040 Alternative 2 Condition Weaving Segments

No.	Weave Segment	Alt 2 AM			Alt 2 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	2.3	F	-	1.9
W2	From Caton Avenue/C-D Roadway to MD 295	E	44	43	E	45	39
W3	From I-395 to Key Highway Off Ramp	B	50	17.1	F	-	1.2
Southbound Interstate 95							
W4	From Hanover Street to I-395	F	-	1.3	F	-	1.2
W5	From Washington Boulevard to Caton Avenue	E	41	50	F	-	1.0
W6	From Caton Avenue to I-695	F	-	1.1	F	-	1.0

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 9.2-4: VISSIM 2040 Alternative 2 Condition Weaving Segments

No.	Weave Segment	Alt 2 AM				Alt 2 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	14	87	9,978	6,571	14	83	8,305	5,446
W2	From Caton Avenue/C-D Roadway to MD 295	12	92	8,654	5,399	7	115	7,924	4,021
W3	From I-395 to Key Highway Off Ramp	60	10	3,870	2,931	25	52	6,760	4,361
Southbound Interstate 95									
W4	From Hanover Street to I-395	34	42	9,193	6,925	50	20	6,491	4,936
W5	From Washington Boulevard to Caton Avenue	35	48	9,258	7,574	30	56	9,878	7,328
W6	From Caton Avenue to I-695	37	47	8,979	7,245	22	74	10,127	7,434

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

9.2.3 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 2 condition ramp junction analysis within the traffic analysis study area are summarized in Tables 9.2-5 and 9.2-6, respectively.

A. HCS Ramp Analysis

The Alternative 2 ramp analyses show fourteen locations at LOS F, eight in the AM peak hour and six in the PM peak hour. All other ramp segments would operate at LOS E or better.

B. VISSIM Ramp Analysis

VISSIM outputs show that for the Alternative 2 ramp analyses, five segments would operate at a LOS F during the AM and PM peak hours, two during the AM peak hour and three during the PM peak hour. All other ramp segments would operate at LOS E or better.

Table 9.2-5: HCS 2040 Alternative 2 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt 2 AM			Alt 2 PM		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	F	57	36	D	57	32
R2	WB I-695 Off Ramp	Diverge	F	51	47	F	51	42
R3	Washington Boulevard Off Ramp	Diverge	F	52	45	E	53	35
R4	I-395 Off Ramp	Capacity	OVER	-	1.6	UNDER	-	1.0
R5	I-295 On Ramp	Merge	B	59	16	D	56	29
R16	New McComas Street On Ramp	Merge	B	59	13	C	57	27
R7	Key Highway On Ramp	Merge	B	57	19	E	53	35
Southbound Interstate 95								
R8	Key Highway Off Ramp	Diverge	F	48	36	C	49	22
R9	Key Highway On Ramp	Merge	E	51	37	C	56	27
R10	MD 295 Off Ramp	Diverge	F	57	42	C	60	30
R11	I-395 On Ramp	Capacity	UNDER	-	0.76	OVER	-	1.1
R12	MD 295 On Ramp	Merge	F	55	30	F	48	35
R13	EB I-695 Off Ramp	Diverge	E	58	36	F	57	42
R14	WB I-695 On Ramp	Merge	D	54	34	F	51	37
R15	EB I-695 On Ramp	Merge	F	30	44	F	42	41

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 9.2-6: VISSIM 2040 Alternative 2 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt 2 AM				Alt 2 PM			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	50	8	535	386	50	9	576	439
R2	WB I-695 Off Ramp	Diverge	34	39	1,810	1,312	32	46	1,812	1,426
R3	Washington Boulevard Off Ramp	Diverge	15	61	893	480	43	3	313	146
R4	I-395 Off Ramp	Major Diverge	39	45	5,612	2,898	32	60	3,588	1,298
R5	I-295 On Ramp	Merge	57	8	475	461	47	29	1,248	1,176
R16	New McComas Street On Ramp	Merge	53	5	336	240	50	12	985	611
R7	Key Highway On Ramp	Merge	41	10	485	381	37	21	1,126	718
Southbound Interstate 95										
R8	Key Highway Off Ramp	Diverge	12	81	1,725	945	6	127	1,194	723
R9	Key Highway On Ramp	Merge	46	20	1,365	895	46	21	1,743	932
R10	MD 295 Off Ramp	Diverge	49	29	1,762	1,317	55	11	726	548
R11	I-395 On Ramp	Ramp Capacity	51	27	2,723	2,686	44	36	3,812	2,832
R12	MD 295 On Ramp	Merge	54	9	485	485	44	27	1,133	1,097
R13	EB I-695 Off Ramp	Diverge	50	14	882	699	50	14	961	688
R14	WB I-695 On Ramp	Merge	34	25	856	850	35	17	609	604
R15	EB I-695 On Ramp	Merge	56	12	2,533	1,330	56	9	1,633	1,014

(green)	Light to Moderate Traffic (LOS A-C)
(yellow)	Heavy Traffic (LOS D)
(orange)	High Congestion (LOS E)
(red)	Severe Congestion (LOS F)

9.3 Surface Street Intersection Analysis

Traffic operational analyses were conducted for the Alternative 2 condition. As previously noted, Figure TTR-17 illustrates the intersection lane geometry and traffic control assumed for the Alternative 2 intersection analyses.

It should be noted that a number of the intersections for which volumes are provided in Figure TTR-16 are not shown in Figure TTR-17, and were not analyzed for Alternative 2. This is due to the following:

- Volume forecasts along Caton Avenue, Washington Boulevard, Russell Street, MD 295, Annapolis Road, Waterview Avenue and I-395 are identical for Alternative 2 and No Build. Similarly, volumes at the Key Highway/McHenry Row intersection are identical for Alternative 2 and No Build. Thus, there was no need to repeat the analyses performed for No Build conditions, for these locations.
- Volume forecasts along Hanover Street, from south of Cromwell Street to south of McComas Street, are different for Alternative 2 than they are for No Build. It was necessary to develop volume forecasts for each of these intersections, in order to verify that all of the trips generated by Port Covington are included in the analyses. However, any improvements recommended by the I-95 Improvements EA will be limited to ramps to/from I-95, the surface arterials upon which those ramps terminate, and surface arterials whose traffic operations might affect traffic operations on the I-95 mainline. (For example, if vehicles on eastbound McComas Street approaching Key Highway were to queue back through the McComas Street/I-95 Northbound Off Ramp intersection, this might result in queues on the ramp stretching back onto the I-95 mainline.) Since there are no I-95 off ramps that connect directly to Hanover Street, and since none of the changes proposed along Hanover Street by the Port Covington development would impact I-95 operations, Hanover Street south of McComas Street has not been included in the analyses performed for Alternative 2.

The explanation above is applicable to Alternatives 3, 4 and 5 as well.

Table 9.3-1 shows the LOS at local intersections within the traffic analysis study area with the Alternative 2 condition traffic and lane geometry. As previously noted above in Section 3, only the results for intersections that are directly affected by the improvements analyzed as part of the Build Alternatives are shown. It should also be noted that several intersections were signalized as part of the Alternative 2 condition in order to improve surface street operation. Table 9.3-1 shows that four intersections would operate at LOS F, three fail during the PM peak hour and one would fail during both peak hours. All other intersections would operate at LOS E or better.

Table 9.3-1: Alternative 2 Condition HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
15	Hanover Street at Wells Street	D	41	F	101
16	Hanover Street at McComas Street	C	32	F	134
20	McComas Street at Cromwell Street/White Street	B	20	F	89
21	Key Highway at McComas Street	F	153	F	185
22	Key Highway at McHenry Row	B	18	B	19
29	McComas Street at Gray Street	A	10	C	20
30	McComas Street at Violet Street	C	31	C	32
32	McComas Street at Pink Street	B	14	D	48
33	McComas Street at Brown Street	B	19	B	17
34	McComas Street at Yellow Street	B	11	A	6
Unsignalized Intersections					
28	McComas Street at Tan Street	A	10	B	12
31	McComas Street at Teal Street	B	11	B	14

	Light to Moderate Traffic (LOS A-C)
	Heavy Traffic (LOS D)
	High Congestion (LOS E)
	Severe Congestion (LOS F)

10 ALTERNATIVE 3

10.1 Alternative 3 Roadway Geometry and Traffic Volumes

The geometric improvements analyzed as part of Alternative 3 are summarized below. A wiring diagram for the Alternative 3 freeway system is shown in Figure TTR-19 and a key map of element improvements for Alternative 3 is shown in Figure TTR-20. Forecasted volumes for the 2040 Alternative 3 scenario are presented in Figures TTR-21 and TTR-22. Lane configurations and traffic control for at-grade intersections are shown in Figure TTR-23.

Northbound Off Ramps:

<u>Construct an off ramp from Russell Street (Exit 52) to McComas Street (West of Hanover Street) [Maintains Existing Hanover Street Off Ramp]</u>

The existing one-lane off ramp from northbound I-95 to Russell Street would be modified to result in a choice lane (A-B ramp) to access Russell Street as well as McComas Street. The proposed off ramp to McComas Street would span the Middle Branch touching down on the west side of Port Covington.

- Proposed Conditions
  - This option includes an off ramp to McComas Street that would tie-in to the existing I-95 Russell Street Off Ramp (Exit 52).
  - Exit 52 would be converted into an A-B off ramp. Exit 52A would exit onto Russell Street while Exit 52B would exit to McComas Street.
  - The existing northbound I-95 Off Ramp to Hanover Street ramp would be maintained.

<u>Shift the Existing Key Highway Off Ramp Under I-95</u>

The existing Key Highway Ramp would be shifted beneath I-95 as it approaches McComas Street. The ramp would then join McComas Street at a signalized intersection.

- Proposed Conditions
  - The Key Highway Ramp would shift under I-95 and weave between piers before joining McComas Street.
  - Since McComas Street would be a two-way street, the off ramp would end at a signal controlled intersection with McComas Street.

Northbound On Ramps:

<u>Construct an on ramp from McComas Street East of Hanover Street</u>

A new on ramp would be constructed along McComas Street. The proposed single lane on ramp from McComas Street to northbound I-95 would serve as a second access point to northbound I-95, reducing the demand at the existing Key Highway On Ramp to northbound I-95.

- Proposed Conditions
  - The new northbound I-95 On Ramp originates east of Hanover Street at a signalized intersection with McComas Street.
  - The ramp would follow along the northern edge of McComas Street and cross over the proposed northbound I-95 Off Ramp to McComas Street once it has the vertical clearance before tying into the northbound I-95 mainline.

Southbound Off Ramps:

<u>Provide a Two Lane Exit at the Key Highway Off Ramp</u>

The existing single lane off ramp from southbound I-95 to Key Highway would widen to two lanes before the gore with the construction of a deceleration lane. The proposed improvements would provide additional capacity for traffic from the interstate to Port Covington and surrounding areas.

- Proposed Conditions
  - A deceleration lane would be constructed prior to the southbound I-95 painted gore.
  - A two-lane exit would be provided, maintaining one as a choice lane.

Southbound On Ramps:

<u>Maintain the Existing Hanover Street and Key Highway On Ramps</u>

The existing Hanover Street On Ramp and Key Highway On Ramp to southbound I-95 would be maintained.

Hanover Street:

<u>Reconstruct Hanover Street Between Wells Street and McComas Street</u>

The grade of Hanover Street would be modified in order to facilitate multimodal connections across Hanover Street.

- Proposed Conditions
  - The CSX Bridge between Wells Street and McComas Street would be reconstructed in order to accommodate a wider Hanover Street typical section.
  - Hanover Street would be lowered south of the CSX bridge in order to construct at-grade intersections with the Port Covington street grid south of McComas Street. This would allow for enhanced pedestrian and bicycle access across Hanover Street.
  - Hanover Street would be reconstructed as part of the Port Covington development as a six lane section south of McComas Street with a median and turn lanes. A portion of the northbound I-95 Off Ramp to Hanover Street would be reconstructed to tie into Hanover Street as the sixth lane.

McComas Street:

<u>Construct Two-Way McComas Street</u>

One-way eastbound McComas Street would be reconstructed as a two-way roadway. Westbound McComas Street would be maintained and would connect to two-way McComas Street at a signalized intersection.

- Proposed Conditions
  - Eastbound McComas Street would be modified and widened to a four to six lane divided, two-way roadway.
  - Connections to the Port Covington street grid would be constructed.

Pedestrians and Bicyclists:

<u>Construct Additional Pedestrian Connection to South Baltimore</u>

- Proposed Conditions
  - The existing sidewalks on Hanover Street would remain unchanged on the bridge over the CSX tracks. South of the bridge, a new sidewalk is proposed along the west side of Hanover Street, running south to the McComas Street intersection. An 11-foot wide shared-use path would be provided on the east side of Key Highway between the intersections of McHenry Row and McComas Street, and sidewalks would be installed along both sides of the new McComas Street boulevard. Likewise, a shared-use path would be installed along the north side of McComas Street between the Cromwell Street and Key Highway intersections.
  - Further, a new shared-use path, linking South Baltimore to Port Covington would be constructed. The shared use path would originate near the intersection of Winder Street at Light Street, where it would run parallel to Winder as it inclines per ADA ramp standards

to meet the proper elevation to cross over the CSX tracks. Additional access to the path would be provided via a staircase at the intersection of Winder Street at Charles Street. At the Charles Street intersection, the ramp would turn south, bridge over the CSX tracks and under I-95, then turn east to connect to the shared-use path proposed along the north side of McComas Street.

10.2 Freeway Traffic Analysis

10.2.1 Basic Freeway Segments Analysis

Figure TTR-24 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the 2040 Alternative 3 condition. The HCS and VISSIM results for the AM and PM peak hour 2040 Alternative 3 condition for basic freeway segment analysis within the traffic analysis study area are summarized in Tables 10.2-1 and 10.2-2, respectively.

A. HCS Freeway Analysis

All freeway segments in the Alternative 3 condition for both the AM and PM peak hours would operate at or above a LOS E, except five segments: three in the morning and two in the evening peak hour.

B. VISSIM Freeway Analysis

VISSIM analysis was performed for the Alternative 3 condition. MOEs for the freeway mainline segments for both the AM and PM peak hours are shown in Table 12.2-2. The results show nine freeway segments would perform at LOS F, five during the AM peak hour and four during the PM peak hour.

Table 10.2-1: HCS 2040 Alternative 3 Condition Freeway Segments

No.	Freeway Segment	Alt 3 AM			Alt 3 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	E	54	42	D	61	32
F2	WB I-695 Off Ramp to I-695 On Ramps	D	63	28	C	65	22
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	F	50	48	D	60	34
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	E	57	38	D	61	32
F5	MD 295 Off Ramp to I-395 Off Ramp	D	61	32	D	63	28
F6	I-395 Off Ramp to MD 295 On Ramp	B	65	17	C	65	22
F7	MD 295 On Ramp to I-395 On Ramp	B	65	16	C	65	23
F8	Hanover Street Off Ramp to Key Highway Off Ramp	B	65	17	D	62	29
F21	Key Highway Off Ramp to New McComas St On Ramp	B	65	11	C	65	22
F9	New McComas St On Ramp to Key Highway On Ramp	B	65	13	D	64	27
F10	Key Highway On Ramp to Tunnel	B	65	15	D	59	35
Southbound Interstate 95							
F11	Tunnel to Key Highway Off Ramp	F	52	45	C	65	19
F12	Key Highway Off Ramp to Key Highway On Ramp	D	62	30	B	65	14
F13	Key Highway On Ramp to Hanover Street On Ramp	E	55	41	C	65	21
F14	I-395 Off Ramp to MD 295 Off Ramp	D	60	34	C	65	22
F15	MD 295 Off Ramp to I-395 On Ramp	D	59	34	C	64	25
F16	I-395 On Ramp to MD 295 On Ramp	E	54	42	E	54	42
F17	MD 295 On Ramp to Washington Boulevard On Ramp	F	50	48	F	45	58
F18	Caton Ave Off Ramp to Caton Ave On Ramp	E	56	40	F	47	54
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	D	62	30	E	55	41
F20	WB I-695 On Ramp to EB I-695 On Ramp	D	62	30	E	57	38

(green)	Light to Moderate Traffic (LOS A-C)
(yellow)	Heavy Traffic (LOS D)
(orange)	High Congestion (LOS E)
(red)	Severe Congestion (LOS F)

Table 10.2-2: VISSIM 2040 Alternative 3 Condition Freeway Segments

No.	Freeway Segment	Alt 3 AM				Alt 3 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	31	52	8,166	6,785	40	46	7,029	6,782
F2	WB I-695 Off Ramp to I-695 On Ramps	21	63	6,356	5,145	58	22	5,217	5,059
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	21	76	8,707	6,278	57	30	7,277	6,763
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	45	33	7,814	5,518	57	29	6,964	6,474
F5	MD 295 Off Ramp to I-395 Off Ramp	28	53	7,006	5,076	53	28	6,295	5,880
F6	I-395 Off Ramp to MD 295 On Ramp	58	13	3,013	2,182	39	36	3,814	3,543
F7	MD 295 On Ramp to I-395 On Ramp	61	11	3,620	2,768	12	94	5,327	4,377
F8	Hanover Street Off Ramp to Key Highway Off Ramp	38	26	3,961	3,137	24	50	6,589	4,750
F21	Key Hwy Off Ramp to New McComas St On Ramp	60	9	2,609	2,044	55	18	5,239	3,842
F9	New McComas St On Ramp to Key Hwy On Ramp	62	9	2,945	2,307	58	18	6,224	4,450
F10	Key Highway On Ramp to Tunnel	59	11	3,430	2,704	53	27	7,350	5,165
Southbound Interstate 95									
F11	Tunnel to Key Highway Off Ramp	33	79	8,454	6,203	31	94	4,411	3,931
F12	Key Highway Off Ramp to Key Highway On Ramp	56	25	6,729	5,238	58	14	3,217	3,090
F13	Key Highway On Ramp to Hanover Street On Ramp	46	31	8,094	6,184	58	16	4,960	4,179
F14	I-395 Off Ramp to MD 295 Off Ramp	47	30	7,241	5,498	57	18	5,093	4,028
F15	MD 295 Off Ramp to I-395 On Ramp	49	29	5,479	4,149	57	20	4,367	3,439
F16	I-395 On Ramp to MD 295 On Ramp	45	35	8,202	6,818	54	24	8,179	5,567
F17	MD 295 On Ramp to Washington Blvd On Ramp	50	34	8,687	7,292	56	27	9,312	6,700
F18	Caton Ave Off Ramp to Caton Ave On Ramp	50	36	7,953	6,530	45	45	9,095	6,522
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	52	23	6,700	5,446	50	27	8,117	5,959
F20	WB I-695 On Ramp to EB I-695 On Ramp	55	23	6,674	5,627	55	24	7,765	5,910

	Light to Moderate Traffic (LOS A-C)
	Heavy Traffic (LOS D)
	High Congestion (LOS E)
	Severe Congestion (LOS F)

10.2.2 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 3 condition weave section analysis within the traffic analysis study area are summarized in Tables 10.2-3 and 10.2-4, respectively.

A. HCS Weave Analysis

The weave analyses for the Alternative 3 condition found nine weaving segments would operate at a LOS F, four during the AM peak hour and five during the PM peak hour.

B. VISSIM Weave Analysis

The weave analyses for the Alternative 3 condition found five weaving segments would perform at LOS F, three during the AM peak hour and two during the PM peak hour.

Table 10.2-3: HCS 2040 Alternative 3 Condition Weaving Segments

No.	Weaving Segment	Alt 3 AM			Alt 3 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	2.3	F	-	1.9
W2	From Caton Avenue/C-D Roadway to MD 295	F	-	1.2	F	-	1.2
W3	From I-395 to Hanover Street	B	52	20	E	44	36
Southbound Interstate 95							
W4	From Hanover Street to I-395	F	-	1.3	F	-	1.2
W5	From Washington Boulevard to Caton Avenue	E	41	49.9	F	-	1.0
W6	From Caton Avenue to I-695	F	-	1.1	F	-	1.0

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

Table 10.2-4: VISSIM 2040 Alternative 3 Condition Weaving Segments

No.	Weaving Segment	Alt 3 AM				Alt 3 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	21	67	9,978	7,490	55	27	8,305	7,702
W2	From Caton Avenue/C-D Roadway to MD 295	35	45	8,654	6,216	55	27	7,924	7,330
W3	From I-395 to Hanover Street Off Ramp	53	14	4,620	3,728	12	93	7,096	5,144
Southbound Interstate 95									
W4	From Hanover Street to I-395	32	47	9,193	6,969	50	21	6,491	5,120
W5	From Washington Boulevard to Caton Avenue	34	49	9,258	7,669	48	33	9,878	7,118
W6	From Caton Avenue to I-695	40	44	8,979	7,349	35	56	10,127	7,457

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

10.2.3 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 3 condition ramp junction analysis within the traffic analysis study area are summarized in Tables 10.2-5 and 10.2-6, respectively.

A. HCS Ramp Analysis

The Alternative 3 ramp analyses show thirteen locations at LOS F, seven in the AM peak hour and six in the PM peak hour. All other ramp segments would operate at LOS E or better under Alternative 3 conditions.

B. VISSIM Ramp Analysis

VISSIM outputs show that for the Alternative 3 ramp analyses, eight segments would operate at a LOS F during the AM and PM peak hours, four during the AM peak hour and four during the PM peak hour.

Table 10.2-5: HCS 2040 Alternative 3 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	2040 Alt 3 AM			2040 Alt 3 PM		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	F	57	36	D	57	32
R2	WB I-695 Off Ramp	Diverge	F	51	47	F	51	42
R3	Washington Boulevard Off Ramp	Diverge	F	52	45	E	53	35
R4	I-395 Off Ramp	Capacity	OVER	-	1.1	UNDER	-	0.7
R5	I-295 On Ramp	Merge	C	59	20	D	54	32
R6	Key Higway Off Ramp	Diverge	C	52	27	D	52	33
R16	New McComas Street On Ramp	Merge	B	59	13	C	57	27
R7	Key Highway On Ramp	Merge	B	57	19	E	53	35
Southbound Interstate 95								
R8	Key Highway Off Ramp	Diverge	B	48	10	A	49	3
R9	Key Highway On Ramp	Merge	E	51	37	C	56	27
R10	MD 295 Off Ramp	Diverge	F	57	42	C	60	27
R11	I-395 On Ramp	Capacity	UNDER	-	0.8	OVER	-	1.1
R12	MD 295 On Ramp	Merge	F	55	30	F	48	35
R13	EB I-695 Off Ramp	Diverge	E	58	36	F	57	42
R14	WB I-695 On Ramp	Merge	D	54	34	F	51	37
R15	EB I-695 On Ramp	Merge	F	30	44	F	42	41

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 10.2-6: VISSIM 2040 Alternative 3 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt 3 AM				Alt 3 PM			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	51	9	535	442	51	11	576	545
R2	WB I-695 Off Ramp	Diverge	34	45	1,810	1,502	31	56	1,812	1,715
R3	Washington Boulevard Off Ramp	Diverge	4	134	893	526	47	6	313	280
R4	I-395 Off Ramp	Major Diverge	19	81	3,993	2,843	51	23	2,481	2,288
R5	I-295 On Ramp	Merge	56	10	607	584	8	122	1,513	910
R6	Key Higway Off Ramp	Diverge	17	76	1,352	1,068	8	120	1,350	887
R16	New McComas Street On Ramp	Merge	52	6	336	289	49	14	985	669
R7	Key Highway On Ramp	Merge	40	10	485	387	36	21	1,126	708
Southbound Interstate 95										
R8	Key Highway Off Ramp	Diverge	3	143	1,725	938	2	157	1,194	755
R9	Key Highway On Ramp	Merge	43	24	1,365	975	45	26	1,743	1,114
R10	MD 295 Off Ramp	Diverge	49	29	1,762	1,321	55	11	726	568
R11	I-395 On Ramp	Ramp Capacity	50	28	2,723	2,675	51	21	3,812	2,094
R12	MD 295 On Ramp	Merge	54	9	485	485	48	24	1,133	1,106
R13	EB I-695 Off Ramp	Diverge	50	14	882	708	50	14	961	693
R14	WB I-695 On Ramp	Merge	34	25	856	850	35	17	609	604
R15	EB I-695 On Ramp	Merge	55	14	2,533	1,553	56	11	1,633	1,271

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

10.3 Surface Street Intersection Analysis

Traffic operational analyses were conducted for the Alternative 3 condition. Table 10.3-1 shows the LOS at local intersections within the traffic analysis study area with the Alternative 3 condition traffic volumes and lane geometry. It should be noted that several intersections were signalized as part of the Alternative 3 condition in order to improve surface street operations. Table 10.3-1 shows that four intersections would operate at LOS F, three would fail during the PM peak hour and one would fail during both peak hours. All other intersections would operate at LOS D or better.

Table 10.3-1:Alternative 3 Condition HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
15	Hanover Street at Wells Street	D	45	F	108
16	Hanover Street at McComas Street	C	34	F	122
20	McComas Street at Cromwell Street/White Street	C	21	F	88
21	Key Highway at McComas Street	F	149	F	191
22	Key Highway at McHenry Row	B	16	B	18
29	McComas Street at Gray Street	B	12	D	42
30	McComas Street at Violet Street	C	30	C	31
32	McComas Street at Pink Street	B	15	C	24
33	McComas Street at Brown Street	B	15	B	13
34	McComas Street at Yellow Street	A	4	A	7
Unsignalized Intersections					
28	McComas Street at Tan Street	B	11	C	16
31	McComas Street at Teal Street	B	11	B	14

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

11 ALTERNATIVE 4

11.1 Alternative 4 Roadway Geometry and Traffic Volumes

The geometric improvements analyzed as part of Alternative 4 are summarized below. A wiring diagram for the Alternative 4 freeway system is shown in Figure TTR-25 and a key map of element improvements for Alternative 4 is shown in Figure TTR-26. Forecasted volumes for the 2040 Alternative 4 scenario are presented in Figures TTR-27 and TTR-28. Lane configurations and traffic control for at-grade intersections are shown in Figure TTR-29.

Northbound Off Ramps:

<u>Construct an off ramp from Caton Avenue (Exit 50) to McComas Street (West of Hanover Street) [Replaces Existing Hanover Street Off Ramp]</u>

The existing Caton Avenue C-D roadway would be modified to provide access to Caton Avenue as well as McComas Street. The proposed off ramp to McComas Street would span the Middle Branch touching down on the west side of Port Covington.

- Proposed Conditions
  - This option includes an off ramp to McComas Street that would tie-in to the existing Caton Avenue C-D Road (Exit 50).
  - Exit 50 would be converted into an A-B-C off ramp. Exit 50A-B would exit onto Caton Avenue while Exit 50C would exit to McComas Street.
  - Access to Hanover Street for vehicles on southbound I-395 is provided with the construction of a ramp from the existing I-395 ramp to northbound I-95 that would join with the proposed northbound I-95 Off Ramp from Caton Avenue.

<u>Construct a Diverging Diamond Interchange at McComas Street</u>

McComas Street would be built as a two-way diverging section between the McComas Street Off Ramp and Key Highway in order to minimize impacts to the existing traffic on the McComas Street ramp destined for Key Highway while providing access to Port Covington.

- Proposed Conditions
  - McComas Street would be built as a two-way diverging diamond section between the McComas Street Off Ramp and Key Highway.
  - The McComas Street Off Ramp would shift under I-95 and weave between piers before joining McComas Street at a signalized diverging diamond interchange. This would allow the existing free movement from the McComas Street Off Ramp to eastbound McComas Street to be maintained. This ramp would split prior to joining McComas Street, providing an option to access the Port Covington peninsula via an overpass of McComas Street.

Northbound On Ramps:

<u>Construct an on ramp from McComas Street East of Hanover Street</u>

A new on ramp would be constructed along McComas Street. The proposed single lane on ramp from Hanover Street to northbound I-95 would serve as a second access point to northbound I-95, reducing the demand at the existing Key Highway On Ramp to northbound I-95.

- Proposed Conditions
  - The new northbound I-95 On Ramp originates east of Hanover Street at a signalized intersection with McComas Street.
  - The ramp would follow along the northern edge of McComas Street and cross over the proposed northbound I-95 Off Ramp to McComas Street once it has the vertical clearance before tying into the northbound I-95 mainline.

Southbound Off Ramps:

<u>Provide an Additional I-95 Southbound Off Ramp at a New Location</u>

An additional southbound I-95 Off Ramp would be constructed west of the Key Highway Off Ramp.

- Proposed Conditions
  - A new southbound I-95 Off Ramp would be constructed approximately 4,000 feet from the tunnel bores and 3,000 feet from the existing Exit 55 (Key Highway) painted gore.
  - The ramp would be braided with the southbound I-95 On Ramp in this location, impacting the existing CSX Riverside Rail Yard located immediately north of I-95.

Southbound On Ramps:

<u>Reconstruct the Existing Hanover Street On Ramp to Lengthen the Weave</u>

The existing single lane on ramp from Hanover Street to southbound I-95 would be reconstructed in order to lengthen the weave section along the interstate between Hanover Street and I-395.

- Proposed Conditions
  - The newly reconstructed on ramp would originate at the intersection of Hanover Street at Wells Street.
  - Reconstructing the on ramp would allow the weave section along southbound I-95 to be lengthened by up to 500 feet.
  - This connection would also provide more direct access to southbound I-95 from the neighborhoods north of the interstate.

Hanover Street:

<u>Reconstruct Hanover Street Between Wells Street and McComas Street</u>

The grade of Hanover Street would be modified in order to facilitate multimodal connections across Hanover Street.

- Proposed Conditions
  - The CSX Bridge between Wells Street and McComas Street would be reconstructed in order to accommodate a wider Hanover Street typical section.
  - Hanover Street would be lowered south of the CSX bridge in order to construct at-grade intersections with the Port Covington street grid south of McComas Street. This would allow for enhanced pedestrian and bicycle access across Hanover Street.
  - Hanover Street would be reconstructed as part of the Port Covington development as a six lane section south of McComas Street with a median and turn lanes.

McComas Street:

<u>Construct Two-Way McComas Street with a Diverging Diamond Section</u>

One-way eastbound McComas Street would be reconstructed as a two-way roadway with a diverging diamond section between the McComas Street Ramp and Key Highway. Westbound McComas Street would be maintained and would connect to two-way McComas Street at a signalized intersection.

- Proposed Conditions
  - Eastbound McComas Street would be modified and widened to a four lane, two-way diverging diamond roadway.
  - The portion of one-way westbound McComas Street would be maintained and would connect to the two-way McComas Street at a signalized intersection.

Pedestrians and Bicyclists:

Construct Additional Pedestrian Connection to South Baltimore

- Proposed Conditions
    - The existing sidewalks on Hanover Street would remain unchanged on the bridge over the CSX tracks. South of the bridge, a new sidewalk is proposed along the west side of Hanover Street, running south to the McComas Street intersection. An 11-foot wide shared-use path would be provided on the east side of Key Highway between the intersections of McHenry Row and McComas Street, and sidewalks would be installed along both sides of the new McComas Street boulevard. Likewise, a shared-use path would be installed along the north side of McComas Street between the Cromwell Street and Key Highway intersections.
    - Further, a new shared-use path, linking South Baltimore to Port Covington would be constructed. The shared use path would originate near the intersection of Winder Street at Light Street, where it would run parallel to Winder as it inclines per ADA ramp standards to meet the proper elevation to cross over the CSX tracks. Additional access to the path would be provided via a staircase at the intersection of Winder Street at Charles Street. At the Charles Street intersection, the ramp would turn south, bridge over the CSX tracks and under I-95, then turn east to connect to the shared-use path proposed along the north side of McComas Street.

11.2 Freeway Traffic Analysis

11.2.1 Basic Freeway Segments Analysis

Figure TTR-30 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the 2040 Alternative 4 condition. The HCS and VISSIM results for the AM and PM peak hour 2040 Alternative 4 condition for basic freeway segment analysis within the traffic analysis study area are summarized in Tables 11.2-1 and 11.2-2, respectively.

A. HCS Freeway Analysis

All freeway segments in the Alternative 4 condition for both the AM and PM peak hours operate at or above a LOS E, except four segments, two in the morning and two in the evening peak hour.

B. VISSIM Freeway Analysis

VISSIM analysis was performed for the Alternative 4 scenario. The results show eleven freeway segments perform at LOS F, five during the AM peak hour and six during the PM peak hour. All other freeway segments operate at LOS E or better.

Table 11.2-1: HCS 2040 Alternative 4 Condition Freeway Segments

No.	Freeway Segment	Alt 4 AM			Alt 4 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	E	54	42	D	61	32
F2	WB I-695 Off Ramp to I-695 On Ramps	D	63	28	C	65	22
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	E	57	38	D	62	29
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	D	61	31	D	63	28
F5	MD 295 Off Ramp to I-395 Off Ramp	D	61	32	D	62	30
F6	I-395 Off Ramp to MD 295 On Ramp	B	65	17	C	65	24
F7	MD 295 On Ramp to I-395 On Ramp	B	65	16	C	65	25
F8	Key Highway Off Ramp to New McComas St On Ramp	B	65	12	C	65	22
F9	New McComas St On Ramp to Key Highway On Ramp	B	65	13	D	64	27
F10	Key Highway On Ramp to Tunnel	B	65	15	D	59	35
Southbound Interstate 95							
F11	Tunnel to Key Highway Off Ramp	F	52	46	C	65	19
F12	Key Hwy Off Ramp to New McComas St Off Ramp	E	56	39	B	65	17
F22	New McComas St Off Ramp to Key Hwy On Ramp	D	62	30	B	65	14
F13	Key Hwy On Ramp to Hanover Street On Ramp	E	55	41	C	65	21
F14	I-395 Off Ramp to MD 295 Off Ramp	D	60	34	C	65	22
F15	MD 295 Off Ramp to I-395 On Ramp	D	59	34	C	64	25
F16	I-395 On Ramp to MD 295 On Ramp	E	54	42	E	54	42
F17	MD 295 On Ramp to Washington Blvd On Ramp	F	50	48	F	45	58
F18	Caton Ave Off Ramp to Caton Ave On Ramp	E	56	40	F	47	54
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	D	62	30	E	55	41
F20	WB I-695 On Ramp to EB I-695 On Ramp	D	62	30	E	57	38

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 11.2-2: VISSIM 2040 Alternative 4 Condition Freeway Segments

No.	Freeway Segment	Alt 4 AM				Alt 4 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	39	43	8,166	7,072	40	46	7,029	6,788
F2	WB I-695 Off Ramp to I-695 On Ramps	25	59	6,356	5,396	58	22	5,217	5,062
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	20	71	7,739	5,538	58	27	6,603	6,121
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	44	32	6,846	4,774	58	25	6,290	5,828
F5	MD 295 Off Ramp to I-395 Off Ramp	24	60	7,039	4,979	52	30	6,657	6,205
F6	I-395 Off Ramp to MD 295 On Ramp	57	13	3,046	2,149	46	30	4,176	3,855
F7	MD 295 On Ramp to I-395 On Ramp	60	11	3,653	2,735	23	60	5,689	4,946
F8	Key Highway Off Ramp to New McComas St On Ramp	62	9	2,609	2,111	54	20	5,239	4,359
F9	New McComas St On Ramp to Key Highway On Ramp	42	9	2,945	2,328	40	21	6,224	4,876
F10	Key Highway On Ramp to Tunnel	59	11	3,430	2,945	51	35	7,350	6,120
Southbound Interstate 95									
F11	Tunnel to Key Highway Off Ramp	52	33	8,454	6,770	32	46	4,411	4,026
F12	Key Hwy Off Ramp to New McComas St Off Ramp	56	28	7,850	6,344	26	50	3,993	3,548
F22	New McComas St Off Ramp to Key Hwy On Ramp	55	26	6,729	5,532	55	16	3,217	2,848
F13	Key Hwy On Ramp to Hanover Street On Ramp	46	33	8,094	6,536	58	15	4,960	3,973
F14	I-395 Off Ramp to MD 295 Off Ramp	41	36	7,241	5,659	51	21	5,093	3,880
F15	MD 295 Off Ramp to I-395 On Ramp	38	40	5,479	4,238	41	33	4,367	3,310
F16	I-395 On Ramp to MD 295 On Ramp	35	48	8,202	6,785	34	44	8,179	5,784
F17	MD 295 On Ramp to Washington Blvd On Ramp	38	45	8,687	7,183	27	63	9,312	6,857
F18	Caton Ave Off Ramp to Caton Ave On Ramp	30	58	7,953	6,258	22	76	9,095	6,511
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	50	22	6,700	5,103	49	27	8,117	5,812
F20	WB I-695 On Ramp to EB I-695 On Ramp	56	21	6,674	5,327	56	23	7,765	5,788

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

11.2.2 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 4 condition weave section analysis within the traffic analysis study area are summarized in Tables 11.2-3 and11.2-4, respectively.

A. HCS Weave Analysis

The weave analyses for Alternative 4 condition found eight weaving segments would operate at a LOS F, three during the AM peak hour and five during the PM peak hour. All other weaving segments would operate at LOS E or better.

B. VISSIM Weave Analysis

The weave analyses for the Alternative 4 condition found seven weaving segments would perform at LOS F, four during the AM peak hour and three during the PM peak hour.

Table 11.2-3: HCS 2040 Alternative 4 Condition Weaving Segments

No.	Weaving Segment	Alt 4 AM			Alt 4 PM		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	2.7	F	-	2.2
W2	From Caton Avenue/C-D Roadway to MD 295	E	46	38	E	46	35
W3	From I-395 to Hanover Street	B	49	18	F	-	1.3
Southbound Interstate 95							
W4	From Hanover Street to I-395	F	-	1.3	F	-	1.2
W5	From Washington Boulevard to Caton Avenue	E	41	50	F	-	1.0
W6	From Caton Avenue to I-695	F	-	1.1	F	-	1.0

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 11.2-4: VISSIM 2040 Alternative 4 Condition Weaving Segments

No.	Weaving Segment	Alt 4 AM				Alt 4 PM			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	20	74	9,978	7,543	47	32	8,305	7,700
W2	From Caton Avenue/C-D Roadway to MD 295	34	46	7,686	5,376	57	23	7,250	6,655
W3	From I-395 to Key Highway Off Ramp	60	10	4,004	3,068	15	79	6,825	5,455
Southbound Interstate 95									
W4	From Hanover Street to I-395	36	42	9,193	7,192	53	19	6,491	4,789
W5	From Washington Boulevard to Caton Avenue	25	64	9,258	7,471	20	76	9,878	7,208
W6	From Caton Avenue to I-695	20	72	8,979	6,924	17	85	10,127	7,314

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

11.2.3 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour 2040 Alternative 4 condition ramp junction analysis within the traffic analysis study area are summarized in Tables 11.2-5 and 11.2-6, respectively.

A. HCS Ramp Analysis

The Alternative 4 ramp analyses show twelve locations at LOS F, six in the AM peak hour and six in the PM peak hour. All other ramp segments would operate at LOS E or better.

B. VISSIM Ramp Analysis

VISSIM outputs show that for the Alternative 4 ramp analyses, six segments would operate at a LOS F during the AM and PM peak hours, three during the AM peak hour and three during the PM peak hour. All other ramp segments would operate at LOS E or better.

Table 11.2-5: HCS 2040 Alternative 4 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt 4 AM			Alt 4 PM		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	F	567	36	D	57	32
R2	WB I-695 Off Ramp	Diverge	F	51	47	F	51	42
R3	Washington Blvd Off Ramp	Diverge	E	52	40	D	53	33
R4	I-395 Off Ramp	Capacity	OVER	-	1.1	UNDER	-	0.7
R5	MD 295 On Ramp	Merge	C	59	21	D	52	34
R16	New McComas St On Ramp	Merge	B	59	13	C	57	27
R7	Key Highway On Ramp	Merge	B	57	19	E	53	35
Southbound Interstate 95								
R8	Key Highway Off Ramp	Diverge	E	51	36	C	51	22
R17	New McComas St Off Ramp	Diverge	E	50	42	C	50	24
R9	Key Highway On Ramp	Merge	E	51	37	C	56	27
R10	MD 295 Off Ramp	Diverge	F	57	42	C	60	27
R11	I-395 On Ramp	Capacity	UNDER	-	0.8	OVER	-	1.1
R12	MD 295 On Ramp	Merge	F	55	30	F	48	35
R13	EB I-695 Off Ramp	Diverge	E	58	36	F	57	42
R14	WB I-695 On Ramp	Merge	D	54	34	F	51	37
R15	EB I-695 On Ramp	Merge	F	30	44	F	42	41

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 11.2-6: VISSIM 2040 Alternative 4 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt 4 AM				Alt 4 PM			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	51	9	535	458	51	11	576	546
R2	WB I-695 Off Ramp	Diverge	34	47	1,810	1,565	31	56	1,812	1,717
R3	Washington Blvd Off Ramp	Diverge	4	139	893	494	48	6	313	280
R4	I-395 Off Ramp	Major Diverge	16	90	3,993	2,749	51	23	2,481	2,283
R5	MD 295 On Ramp	Merge	56	10	607	585	17	80	1,513	1,165
R16	New McComas St On Ramp	Merge	52	5	336	239	49	12	985	586
R7	Key Highway On Ramp	Merge	40	10	485	392	31	30	1,126	832
Southbound Interstate 95										
R8	Key Highway Off Ramp	Diverge	41	18	604	415	22	37	418	328
R17	New McComas St Off Ramp	Diverge	55	16	1,121	893	7	99	776	591
R9	Key Highway On Ramp	Merge	43	28	1,365	1,147	45	28	1,743	1,208
R10	MD 295 Off Ramp	Diverge	48	30	1,762	1,365	55	11	726	550
R11	I-395 On Ramp	Ramp Capacity	42	35	2,723	2,637	44	35	3,812	2,477
R12	MD 295 On Ramp	Merge	54	9	485	485	42	28	1,133	1,103
R13	EB I-695 Off Ramp	Diverge	50	13	882	664	50	14	961	677
R14	WB I-695 On Ramp	Merge	34	25	856	850	35	17	609	604
R15	EB I-695 On Ramp	Merge	56	12	2,533	1,379	56	11	1,633	1,271

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

11.3 Surface Street Intersection Analysis

Traffic operational analyses were conducted for the Alternative 4 condition. Table 11.3-1shows the LOS at local intersections within the traffic analysis study area with the Alternative 4 traffic volumes and lane geometry. It should be noted that several intersections were signalized as part of the Alternative 4 condition in order to improve surface street operations. Table 11.3-1 shows that three intersections would operate at LOS F, two in the PM peak hour and one in both peak hours. All other intersections would operate at LOS D or better under Alternative 4 condition.

Table 11.3-1: Alternative 4 HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
15	Hanover Street at Wells Street	F	85	F	90
16	Hanover Street at McComas Street	C	27	F	93
21	Key Highway at McComas Street	D	51	F	101
22	Key Highway at McHenry Row	B	16	B	19
29	McComas Street at Gray Street	B	14	D	39
30	McComas Street at Violet Street	B	17	D	48
32	McComas Street at Pink Street	A	8	D	47
33	McComas Street at Brown Street	B	16	B	19
34	McComas Street at Yellow Street	A	6	A	8
35	McComas Street at EB to WB U-turn	B	10	B	18
Unsignalized Intersections					
28	McComas Street at Tan Street	A	9	C	16
31	McComas Street at Teal Street	A	10	B	14

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

12 COMPARISON OF ALTERNATIVES

The results of the freeway analyses were evaluated to determine which improvements best supported the project's Purpose and Need, as outlined below:

- Ongoing and planned development in the Port Covington peninsula will result in increased transportation demand to Port Covington resulting in vehicular trips that are projected to be more than double today's volumes to and from the site on I-95, I-395 and Hanover Street by 2040.
- Existing capacity and roadway geometry are not adequate to meet projected traffic demands, with operations on most ramp segments and links within the study corridor projected to degrade to unacceptable LOS by 2040.
- Existing public infrastructure in and around the peninsula cannot efficiently support the City's approved economic development and land use changes at Port Covington.
- The limited multi-modal connections around and across I-95 between the surrounding neighborhoods and the Port Covington peninsula are insufficient to support future planned growth on the peninsula.

A comparison of the AM and PM peak hour VISSIM freeway analyses results for Alternatives 1-4 is shown in Tables 12-1 and 12-2, respectively.

In addition to the density, demand, and throughput results shown in Tables 12-1 and 12-2, other MOEs were evaluated to compare the build alternatives. Total delay, unserved demand, end-to-end travel times, and average speeds were evaluated for each of the four alternatives, as shown in Table 12-3.

Overall, the Alternative 2, Alternative 3, and Alternative 4 conditions have less total delay, do a much better job of accommodating the traffic demand, and have faster travel times than the Alternative 1 (No Build) condition. The travel times for Alternatives 3 and 4 were approximately half of Alternative 1.

A comparison of the AM and PM peak hour surface street intersection control delays is shown in Tables 12-4 and 12-5, respectively. The comparison of intersection delays only considered the intersections directly affected by the improvements included in the Build Alternatives.

Table 12 -1: Comparison of VISSIM Freeway Analyses Results – AM Peak Hour

No.	Freeway/Ramp/Weave Segment	2040 No Build				Alt 2				Alt 3				Alt 4			
		Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)
Northbound Interstate 95																	
W1	From I-695 to Caton Avenue/C-D Roadway	12	92	9,978	6,000	14	87	9,978	6,571	21	67	9,978	7,490	20	74	9,978	7,543
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	12	105	8,707	4,875	14	100	8,707	5,443	21	76	8,707	6,278	20	71	7,739	5,538
R3	Washington Boulevard Off Ramp	15	52	893	441	15	61	893	480	4	134	893	526	4	139	893	494
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	9	114	7,814	4,095	11	106	7,814	4,743	45	33	7,814	5,518	44	32	6,846	4,774
W2	From Caton Avenue/C-D Roadway to MD 295	9	106	8,654	4,554	12	92	8,654	5,399	35	45	8,654	6,216	34	46	7,686	5,376
F5	MD 295 Off Ramp to I-395 Off Ramp	9	112	8,007	4,128	19	69	8,007	5,066	28	53	7,006	5,076	24	60	7,039	4,979
R4	I-395 Off Ramp	43	24	3,993	2,024	39	45	5,612	2,898	19	81	3,993	2,843	16	90	3,993	2,749
F6	I-395 Off Ramp to MD 295 On Ramp	4	148	4,014	1,950	58	9	2,395	1,501	58	13	3,013	2,182	57	13	3,046	2,149
R5	MD 295 On Ramp	2	150	607	289	57	8	475	461	56	10	607	584	56	10	607	585
F7	MD 295 On Ramp to I-395 On Ramp	4	143	4,621	2,131	62	8	2,870	1,961	61	11	3,620	2,768	60	11	3,653	2,735
W3	From I-395 to Hanover Street (or Key Hwy Off Ramp)	5	118	5,621	2,502	60	10	3,870	2,931	53	14	4,620	3,728	60	10	4,004	3,068
F8	Hanover Street Off Ramp to Key Highway Off Ramp	50	8	3,461	1,572					38	26	3,961	3,137				
R6	Key Highway Off Ramp	33	16	852	380					17	76	1,352	1,068				
F21	Key Highway Off Ramp to NEW McComas St On Ramp					62	8	2,609	2,002	60	9	2,609	2,044	62	9	2,609	2,111
R16	New McComas St On Ramp					53	5	336	240	52	6	336	289	52	5	336	239
F9	Key HwyOff Ramp (or New McComas St On Ramp) to Key Hwy On Ramp	62	5	2,609	1,187	37	9	2,945	2,216	62	9	2,945	2,307	42	9	2,945	2,328
R7	Key Highway On Ramp	40	14	821	531	41	10	485	381	40	10	485	387	40	10	485	392
F10	Key Highway On Ramp to Tunnel	59	8	3,430	1,437	59	11	3,430	2,806	59	11	3,430	2,704	59	11	3,430	2,945
Southbound Interstate 95																	
F11	Tunnel to Key Highway Off Ramp	32	69	8,454	5,523	35	60	8,454	6,211	33	79	8,454	6,203	52	33	8,454	6,770
R8	Key Highway Off Ramp	5	126	1,725	675	12	81	1,725	945	3	143	1,725	938	41	18	604	415
F22	Key Highway Off Ramp to NEW McComas St Off Ramp													56	28	7,850	6,344
R17	NEW McComas St Off Ramp													55	16	1,121	893
F12	New McComas St Off Ramp to Key Highway On Ramp	56	22	6,729	4,830	56	24	6,729	5,252	56	25	6,729	5,238	55	26	6,729	5,532
R9	Key Highway On Ramp	47	17	1,365	780	46	20	1,365	895	43	24	1,365	975	43	28	1,365	1,147
F13	Key Highway On Ramp to Hanover Street On Ramp	56	22	8,094	5,587	51	27	8,094	6,117	46	31	8,094	6,184	46	33	8,094	6,536
W4	From Hanover Street to I-395	42	31	9,193	6,424	34	42	9,193	6,925	32	47	9,193	6,969	36	42	9,193	7,192
F14	I-395 Off Ramp to MD 295 Off Ramp	53	24	7,241	5,063	47	29	7,241	5,463	47	30	7,241	5,498	41	36	7,241	5,659
R10	MD 295 Off Ramp	51	26	1,762	1,222	49	29	1,762	1,317	49	29	1,762	1,321	48	30	1,762	1,365
F15	MD 295 Off Ramp to I-395 On Ramp	55	23	5,479	3,817	49	28	5,479	4,111	49	29	5,479	4,149	38	40	5,479	4,238
R11	I-395 On Ramp	53	16	2,723	1,639	51	27	2,723	2,686	50	28	2,723	2,675	42	35	2,723	2,637
F16	I-395 On Ramp to MD 295 On Ramp	55	23	8,202	5,486	44	35	8,202	6,773	45	35	8,202	6,818	35	48	8,202	6,785
R12	MD 295 On Ramp	53	9	485	484	54	9	485	485	54	9	485	485	54	9	485	485
F17	MD 295 On Ramp to Washington Boulevard On Ramp	59	23	8,687	5,999	49	35	8,687	7,220	50	34	8,687	7,292	38	45	8,687	7,183
W5	From Washington Boulevard to Caton Avenue	53	24	9,258	6,404	35	48	9,258	7,574	34	49	9,258	7,669	25	64	9,258	7,471
F18	Caton Ave Off Ramp to Caton Ave On Ramp	59	24	7,953	5,509	47	39	7,953	6,439	50	36	7,953	6,530	30	58	7,953	6,258

Table 12-2: Comparison of VISSIM Freeway Analyses Results – PM Peak Hour

No.	Freeway/Ramp/Weave Segment	2040 No Build				Alt 2				Alt 3				Alt 4			
		Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)
Northbound Interstate 95																	
W1	From I-695 to Caton Avenue/C-D Roadway	7	111	8,305	4,209	14	83	8,305	5,446	55	27	8,305	7,702	47	32	8,305	7,700
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	6	138	7,277	2,999	11	104	7,277	4,267	57	30	7,277	6,763	58	27	6,603	6,121
R3	Washington Boulevard Off Ramp	43	2	313	95	43	3	313	146	47	6	313	280	48	6	313	280
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	4	155	6,964	2,290	8	117	6,964	3,659	57	29	6,964	6,474	58	25	6,290	5,828
W2	From Caton Avenue/C-D Roadway to MD 295	4	147	7,924	2,440	7	115	7,924	4,021	55	27	7,924	7,330	57	23	7,250	6,655
F5	MD 295 Off Ramp to I-395 Off Ramp	3	157	7,331	2,003	8	113	7,331	3,610	53	28	6,295	5,880	52	30	6,657	6,205
R4	I-395 Off Ramp	50	7	2,481	653	32	60	3,588	1,298	51	23	2,481	2,288	51	23	2,481	2,283
F6	I-395 Off Ramp to MD 295 On Ramp	2	178	4,850	1,172	53	13	3,743	1,874	39	36	3,814	3,543	46	30	4,176	3,855
R5	MD 295 On Ramp	1	197	1,513	177	47	29	1,248	1,176	8	122	1,513	910	17	80	1,513	1,165
F7	MD 295 On Ramp to I-395 On Ramp	2	169	6,363	1,250	48	22	4,991	3,057	12	94	5,327	4,377	23	60	5,689	4,946
W3	From I-395 to Hanover Street (or Key Hwy Off Ramp)	2	157	8,132	1,353	25	52	6,760	4,361	12	93	7,096	5,144	15	79	6,825	5,455
F8	Hanover Street Off Ramp to Key Highway Off Ramp	2	157	6,357	969					24	50	6,589	4,750				
R6	Key Highway Off Ramp	1	196	1,118	96					8	120	1,350	887				
F21	Key Highway Off Ramp to NEW McComas St On Ramp					54	16	5,239	3,418	55	18	5,239	3,842	54	20	5,239	4,359
R16	New McComas St On Ramp					50	12	985	611	49	14	985	669	49	12	985	586
F9	Key Hwy Off Ramp (or New McComas St On Ramp) to Key Hwy On Ramp	59	3	5,239	798	36	16	6,224	3,983	58	18	6,224	4,450	40	21	6,224	4,876
R7	Key Highway On Ramp	38	7	2,111	257	37	21	1,126	718	36	21	1,126	708	31	30	1,126	832
F10	Key Highway On Ramp to Tunnel	57	5	7,350	882	54	24	7,350	5,087	53	27	7,350	5,165	51	35	7,350	6,120
Southbound Interstate 95																	
F11	Tunnel to Key Highway Off Ramp	29	92	4,411	3,082	32	67	4,411	3,842	31	94	4,411	3,931	32	46	4,411	4,026
R8	Key Highway Off Ramp	2	175	1,194	193	6	127	1,194	723	2	157	1,194	755	22	37	418	328
F22	Key Highway Off Ramp to NEW McComas St Off Ramp													26	50	3,993	3,548
R17	NEW McComas St Off Ramp													7	99	776	591
F12	New McComas St Off Ramp to Key Highway On Ramp	58	12	3,217	2,855	57	13	3,217	3,067	58	14	3,217	3,090	55	16	3,217	2,848
R9	Key Highway On Ramp	47	5	1,743	217	46	21	1,743	932	45	26	1,743	1,114	45	28	1,743	1,208
F13	Key Highway On Ramp to Hanover Street On Ramp	60	11	4,960	3,062	59	15	4,960	3,974	58	16	4,960	4,179	58	15	4,960	3,973
W4	From Hanover Street to I-395	57	12	6,491	3,492	50	20	6,491	4,936	50	21	6,491	5,120	53	19	6,491	4,789
F14	I-395 Off Ramp to MD 295 Off Ramp	60	11	5,093	2,749	54	19	5,093	3,877	57	18	5,093	4,028	51	21	5,093	3,880
R10	MD 295 Off Ramp	56	7	726	391	55	11	726	548	55	11	726	568	55	11	726	550
F15	MD 295 Off Ramp to I-395 On Ramp	59	13	4,367	2,353	49	25	4,367	3,295	57	20	4,367	3,439	41	33	4,367	3,310
R11	I-395 On Ramp	53	7	3,812	728	44	36	3,812	2,832	51	21	3,812	2,094	44	35	3,812	2,477
F16	I-395 On Ramp to MD 295 On Ramp	59	12	8,179	3,137	41	37	8,179	6,038	54	24	8,179	5,567	34	44	8,179	5,784
R12	MD 295 On Ramp	48	24	1,133	1,108	44	27	1,133	1,097	48	24	1,133	1,106	42	28	1,133	1,103
F17	MD 295 On Ramp to Washington Boulevard On Ramp	59	16	9,312	4,302	40	45	9,312	7,011	56	27	9,312	6,700	27	63	9,312	6,857
W5	From Washington Boulevard to Caton Avenue	56	17	9,878	4,756	30	56	9,878	7,328	48	33	9,878	7,118	20	76	9,878	7,208
F18	Caton Ave Off Ramp to Caton Ave On Ramp	59	19	9,095	4,453	32	60	9,095	6,648	45	45	9,095	6,522	22	76	9,095	6,511

Table 12-3: Additional MOEs Alternatives Comparison Summary

	Traffic Impacts											
	Network Measures of Effectiveness (from VISSIM)				Travel Time Comparison (I-695 to/from Fort McHenry Toll Plaza)							
	AM		PM		AM				PM			
	Total Delay (Hours)	Unserved Demand (Vehicles)	Total Delay (Hours)	Unserved Demand (Vehicles)	NB Travel Time (MM:SS)	NB Average Speed (MPH)	SB Travel Time (MM:SS)	SB Average Speed (MPH)	NB Travel Time (MM:SS)	NB Average Speed (MPH)	SB Travel Time (MM:SS)	SB Average Speed (MPH)
Alternative 1 / No-Build	5,221	11,304	7,312	22,629	21:30	21	13:17	33	20:20	22	13:26	33
Alternative 2	4,055	9,557	4,903	9,719	16:40	27	13:11	33	13:44	33	14:58	29
Alternative 3	3,670	8,149	3,615	9,726	11:10	40	13:17	33	9:19	48	13:15	33
Alternative 4	3,699	8,519	3,506	7,403	10:47	41	12:59	34	8:53	50	13:37	32

Table 12-4: Comparison of HCM Intersection Control Delays – AM Peak Hour

No.	Intersection	2040 No Build		Alt 2		Alt 3		Alt 4	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections									
15	Hanover Street at Wells Street	F	139	D	41	D	45	F	85
16	Hanover Street at McComas Street	F	102	C	32	C	34	C	27
20	McComas Street at Cromwell Street/White Street			B	20	C	21	B	10
21	Key Highway at McComas Street	F	***	F	153	F	149	D	51
22	Key Highway at McHenry Row	B	18	B	18	B	16	B	16
28	McComas Street at Tan Street	B	18						
29	McComas Street at Gray Street	B	14	A	10	B	12	B	14
30	McComas Street at Violet Street			C	31	C	30	B	17
32	McComas Street at Pink Street			B	14	B	15	A	8
33	McComas at Brown Street			B	19	B	15	B	16
34	McComas at Yellow Street			B	11	A	4	A	6
35	McComas Street at EB to WB U-turn[1]							B	10
Unsignalized Intersections									
28	McComas Street at Tan Street			A	10	B	11	A	9
30	McComas Street at Violet Street	A	10						
31	McComas Street at Teal Street	F	196	B	11	B	11	A	10
32	McComas Street at Pink Street	D	33						

*** Delay exceeds 300 seconds

1 – Intersection was not analyzed for Alternatives 1-3

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

Table 12-5: Comparison of HCM Intersection Control Delays – PM Peak Hour

No.	Intersection	2040 No Build		Alt 2		Alt 3		Alt 4	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections									
15	Hanover Street at Wells Street	F	161	F	101	F	108	F	90
16	Hanover Street at McComas Street	F	194	F	134	F	122	F	93
20	McComas Street at Cromwell Street/White Street			F	89	F	88	B	18
21	Key Highway at McComas Street	F	***	F	185	F	191	F	101
22	Key Highway at McHenry Row	B	19	B	19	B	18	B	19
28	McComas Street at Tan Street	C	26						
29	McComas Street at Gray Street	D	39	C	20	D	42	D	39
30	McComas Street at Violet Street			C	32	C	31	D	48
32	McComas Street at Pink Street			D	48	C	24	D	47
33	McComas at Brown Street			B	17	B	13	B	19
34	McComas at Yellow Street			A	6	A	7	A	8
35	McComas Street at EB to WB U-turn[1]							B	18
Unsignalized Intersections									
28	McComas Street at Tan Street			B	12	C	16	C	16
30	McComas Street at Violet Street	F	92						
31	McComas Street at Teal Street	F	***	B	14	B	14	B	14
32	McComas Street at Pink Street	F	***						

*** Delay exceeds 300 seconds

1 – Intersection was not analyzed for Alternatives 1-3

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

13 ALTERNATIVE 5 (RECOMMENDED PREFERRED ALTERNATIVE)

The network changes considered as part of the Alternative 2, Alternative 3, and Alternative 4 conditions provide noticeable improvements when compared to the No Build condition. The improvements, however, vary in effectiveness and a better combination of the network improvements was believed to be possible that could improve upon the results. By comparing the performance of each element's options, the most optimal options or variations of options for each element were combined to develop a fourth Build Alternative – Alternative 5. The draft of Alternative 5 was then fine-tuned by making minor modifications to the elements that were found to improve the key performance measures. The geometric improvements analyzed as part of Alternative 5 are summarized below. A wiring diagram for the Alternative 5 freeway system is shown in Figure TTR-31 and a key map of element improvements for Alternative 5 is shown in Figure TTR-32. Forecasted volumes for the 2040 Alternative 5 scenario are presented in Figures TTR-33 and TTR-34. Lane configurations and traffic control for at-grade intersections are shown in Figure TTR-35.

13.1 Alternative 5 Roadway Geometry

Northbound Off Ramps:

<u>Construct an off ramp spur from Russell Street (Exit 52) to McComas Street (West of Hanover Street)</u>

A variation of Alternative 3, existing northbound I-95 between the Caton Avenue On Ramp and the Russell Street Off Ramp would be widened to six lanes, providing two auxiliary lanes rather than the one auxiliary lane which exists today. The Russell Street Off Ramp would also be widened to two lanes until it overpasses MD 295, at which point the two lanes would split. One lane would continue along the existing ramp alignment to northbound Russell Street. The second would continue east, over the Middle Branch, as a new ramp spur parallel to the existing ramps adjacent to northbound I-95, and merge with the new spur ramp from I-395 southbound, connecting to McComas Street at an at-grade intersection on the western side of Port Covington.

<u>Construct a Ramp Spur from I-395 SB to McComas Street (West of Hanover Street)</u>

A new ramp spur, splitting off from the existing I-395 ramp to northbound I-95, is proposed. It would run southeast and merge with the new spur ramp from Russell Street described above, connecting to McComas Street at an at-grade intersection on the western side of Port Covington.

<u>Remove the Existing Hanover Street Off Ramp (Exit 54)</u>

A part of Alternative 2 and Alternative 4, the existing ramp would be removed. Vehicles traveling from I-395 to Hanover Street would be accommodated by the new ramp spur from I-395.

<u>Shift the Key Highway Off Ramp Under I-95</u>

A part of Alternative 3, the existing ramp would remain in a similar location, but would be realigned to accommodate the new northbound I-95 On Ramp (see below), modifications to McComas Street (see below), and the removal of the existing Hanover Street Off Ramp (Exit 54). The realigned ramp would extend the existing auxiliary lane that terminates at the Hanover Street Off Ramp to a two lane exit located approximately 1,600 feet from the existing I-395 On Ramp gore. The new two-lane exit ramp would run under northbound I-95, weave through the existing piers to an at-grade signalized intersection with McComas Street.

Northbound On Ramps:

Construct an on ramp from McComas Street East of Hanover Street

Alternative 5 includes a new on ramp that would be constructed along McComas Street. This new on ramp was previously analyzed as part of Alternative 3. The proposed single lane on ramp from McComas Street to northbound I-95 would serve as a second access point to northbound I-95, reducing the demand at the existing Key Highway On Ramp to northbound I-95. The new northbound I-95 On Ramp originates east of Hanover Street at a signalized intersection with McComas Street and would follow along the northern edge of McComas Street and cross over the proposed northbound I-95 Off Ramp to McComas Street once it has the vertical clearance before tying into the northbound I-95 mainline.

Maintain the Existing Key Highway On Ramp

No modifications to the existing ramp are proposed.

Southbound Off Ramps:

Provide an Additional Southbound I-95 Off Ramp from a New Location

A variation of Alternative 4, a new off ramp with a gore located approximately 400 feet west of the Key Highway overpass is proposed. It would provide access to the one-way section of westbound McComas Street located directly beneath southbound I-95. The new ramp would braid with the realigned westbound McComas Street to southbound I-95 Ramp. The improvements would require the relocation of two CSX storage tracks.

Southbound On Ramps:

Reconstruct the Existing Key Highway On Ramp

The existing ramp would remain in place horizontally, but would be reconstructed vertically to minimize construction cost and duration. It would braid with the southbound off ramp to westbound McComas Street.

Maintain the Existing Hanover Street On Ramp

No modifications to the existing ramp are proposed.

Hanover Street:

Hanover Street between Wells Street and McComas Street would not be reconstructed as part of the I-95 Access Improvements project. South of McComas Street, Hanover Street would be reconstructed as part of the Port Covington development to lower the grade and widen to a six lane section with a median and turn lanes.

McComas Street:

Construct Two-Way McComas Street

The existing two-way section of McComas Street and the one-way section of eastbound McComas Street would be converted to a two-way boulevard from the western side of the Port Covington peninsula to Key Highway. The boulevard would accommodate vehicular and multi-modal connections between South Baltimore, I-95, and the Port Covington development. The existing one-way section of westbound McComas Street beneath southbound I-95 would remain in its current location, but be modified to accommodate the addition of an exclusive right-turn lane at the approach to the Key Highway intersection, the addition of the southbound I-95 Off Ramp (see above), and the tie-in to the proposed two-way McComas Street boulevard.

Key Highway:
Widen Key Highway

As part of Alternative 5, the existing roadway would be widened from a four-lane section (two northbound and two southbound) to a five-lane section (three northbound and two southbound) between the McHenry Row and McComas Street intersections Additionally, a 450 foot long southbound right-turn lane would be added at the McComas Street intersection. The CSX bridge over Key Highway, just north of the McComas Street intersection, would be reconstructed to accommodate the new width of Key Highway.

Pedestrians and Bicyclists:
Construct Additional Pedestrian Connection to South Baltimore

The existing sidewalks on Hanover Street would remain unchanged on the bridge over the CSX tracks. South of the bridge, a new sidewalk is proposed along the west side of Hanover Street, running south to the McComas Street intersection. An 11-foot wide shared-use path would be provided on the east side of Key Highway between the intersections of McHenry Row and McComas Street, and sidewalks would be installed along both sides of the new McComas Street boulevard. Likewise, a shared-use path would be installed along the north side of McComas Street between the Cromwell Street and Key Highway intersections.

Further, a new shared-use path, linking South Baltimore to Port Covington would be constructed. The shared use path would originate near the intersection of Winder Street at Light Street, where it would run parallel to Winder as it inclines per ADA ramp standards to meet the proper elevation to cross over the CSX tracks. Additional access to the path would be provided via a staircase at the intersection of Winder Street at Charles Street. At the Charles Street intersection, the ramp would turn south, bridge over the CSX tracks and under I-95, then turn east to connect to the shared-use path proposed along the north side of McComas Street.

13.2 Freeway Traffic Analysis

13.2.1 Basic Freeway Segments Analysis

Figure TTR-36 shows all freeway facilities; including basic freeway segments, merge and diverge junctions, weaving segments, freeway ramps, and local ramps for the Alternative 5. The HCS and VISSIM results for the AM and PM peak hour Alternative 5 condition for basic freeway segment analysis within the traffic analysis study area are summarized in Tables 13.2-1 and 13.2-2, respectively.

A. HCS Freeway Analysis

Similar to the 2040 No Build conditions, all freeway segments in the Alternative 5 condition for both the AM and PM peak hours would operate at or above a LOS D, except fourteen segments: nine in the morning and five in the evening peak hour.

The proposed improvements to the I-95 freeway under the Alternative 5 condition would improve freeway operations in the northbound direction during both peak hours north of MD 295. In the southbound direction, the proposed southbound I-95 Off Ramp does not appear to adversely impact freeway segments downstream.

B. VISSIM Freeway Analysis

VISSIM analysis was performed for the Alternative 5 scenario, and the results show twelve freeway segments would perform at LOS F, seven during the AM peak hour and five during the PM peak hour.

The VISSIM analysis shows that in the AM peak hour, throughput on the freeway would be significantly improved on both north- and southbound I-95 when compared to the 2040 No Build condition. While many southbound segments appear to degrade during the AM and PM peak hours based on segment density, the increased throughput shows that severe congestion within the Fort McHenry Tunnel would no longer starve downstream freeway segments as it was in the 2040 No Build condition. In the northbound direction during the PM peak hour, throughput and segment density would be significantly improved as a result of the freeway modifications proposed near Hanover Street, including the removal of the Hanover Street Off Ramp, in the Alternative 5 condition.

Table 13.2-1: HCS 2040 Alternative 5 Condition Freeway Segments

No.	Freeway Segment	Alt 5. AM Peak Hour			Alt 5. PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	E	54	42	D	61	32
F2	WB I-695 Off Ramp to I-695 On Ramps	D	63	28	C	65	22
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	F	50	48	D	60	34
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	E	57	38	D	61	32
F5	MD 295 Off Ramp to I-395 Off Ramp	D	61	32	D	62	30
F6	I-395 Off Ramp to MD 295 On Ramp	B	65	17	C	65	24
F7	MD 295 On Ramp to I-395 On Ramp	B	65	16	C	65	25
F21	Key Hwy Off Ramp to NEW McComas St On Ramp	B	65	11	C	65	22
F9	NEW McComas St On Ramp to Key Hwy On Ramp	B	65	13	D	64	27
F10	Key Hwy On Ramp to Tunnel	B	65	15	D	59	35
Southbound Interstate 95							
F11	Tunnel to Key Hwy Off Ramp	F	52	45	C	65	19
F22	Key Hwy Off Ramp to NEW McComas St Off Ramp	E	56	39	B	65	17
F12	NEW McComas St Off Ramp to Key Hwy On Ramp	D	62	30	B	65	14
F13	Key Hwy On Ramp to Hanover St On Ramp	E	55	41	C	65	21
F14	I-395 Off Ramp to MD 295 Off Ramp	D	60	34	C	65	22
F15	MD 295 Off Ramp to I-395 On Ramp	D	59	34	C	64	25
F16	I-395 On Ramp to MD 295 On Ramp	E	54	42	E	54	42
F17	MD 295 On Ramp to Washington Blvd On Ramp	F	50	48	F	45	58
F18	Caton Ave Off Ramp to Caton Ave On Ramp	E	56	40	F	47	54
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	D	62	30	E	55	41
F20	WB I-695 On Ramp to EB I-695 On Ramp	D	62	30	E	57	38

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 13.2-2: VISSIM 2040 Alternative 5 Condition Freeway Segments

No.	Freeway Segment	Alt. 5 AM Peak Hour				Alt. 5 PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
F1	EB I-695 Off Ramp to WB I-695 Off Ramp	46	38	8,166	7,233	40	47	7,029	6,782
F2	WB I-695 Off Ramp to I-695 On Ramps	36	44	6,356	5,525	58	23	5,217	5,059
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	28	62	8,707	6,814	57	30	7,277	6,763
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	22	70	7,814	5,955	57	29	6,964	6,474
F5	MD 295 Off Ramp to I-395 Off Ramp	18	72	7,039	5,242	54	30	6,657	6,231
F6	I-395 Off Ramp to MD 295 On Ramp	57	14	3,046	2,275	58	23	4,176	3,911
F7	MD 295 On Ramp to I-395 On Ramp	61	12	3,653	2,853	58	24	5,689	5,372
F21	Key Hwy Off Ramp to NEW McComas St On Ramp	62	10	2,609	2,215	58	22	5,239	4,968
F9	NEW McComas St On Ramp to Key Hwy On Ramp	62	10	2,945	2,483	56	25	6,224	5,611
F10	Key Hwy On Ramp to Tunnel	58	13	3,430	2,933	52	33	7,350	6,546
Southbound Interstate 95									
F11	Tunnel to Key Hwy Off Ramp	56	24	8,454	6,664	57	16	4,411	4,351
F22	Key Hwy Off Ramp to NEW McComas St Off Ramp	54	31	7,850	6,509	58	19	3,993	4,172
F12	NEW McComas St Off Ramp to Key Hwy On Ramp	49	30	6,729	5,525	58	15	3,217	3,236
F13	Key Hwy On Ramp to Hanover St On Ramp	34	46	8,094	6,560	48	23	4,960	4,512
F14	I-395 Off Ramp to MD 295 Off Ramp	37	41	7,241	5,753	29	41	5,093	4,251
F15	MD 295 Off Ramp to I-395 On Ramp	32	49	5,479	4,319	21	58	4,367	3,557
F16	I-395 On Ramp to MD 295 On Ramp	33	58	8,202	6,840	23	68	8,179	6,091
F17	MD 295 On Ramp to Washington Blvd On Ramp	39	44	8,687	7,260	23	74	9,312	7,028
F18	Caton Ave Off Ramp to Caton Ave On Ramp	40	47	7,953	6,399	22	75	9,095	6,641
F19	WB I-695 Off Ramp to EB I-695 Off Ramp	51	24	6,700	5,266	49	28	8,117	5,915
F20	WB I-695 On Ramp to EB I-695 On Ramp	56	23	6,674	5,471	55	24	7,765	5,868

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

13.2.2 Weave Analysis

The HCS and VISSIM results of the AM and PM peak hour Alternative 5 weave section analysis within the traffic analysis study area are summarized in Tables 13.2-3 and 13.2-4, respectively.

A. HCS Weave Analysis

The weave analyses for the Alternative 5 condition found eight weaving segments operating at a LOS F, three during the AM peak hour and five during the PM peak hour.

The results show that the segments projected to perform at LOS F in the 2040 No Build conditions would still operate at LOS F under the Alternative 5 condition, with the exception of the weave between I-395 and Key Highway during the AM peak hour due to the removal of the Hanover Street ramp which lengthened the available weaving distance to Key Highway. All other weaving segments would operate at LOS E or better.

B. VISSIM Weave Analysis

The weave analyses for the Alternative 5 condition found seven weaving segments would perform at LOS F, five during the AM peak hour and two during the PM peak hour.

Due to the improved freeway throughput in the Alternative 5 condition on both north- and southbound I-95 discussed previously, weave operations would improve for the northbound I-95 weaves during the PM peak hour when compared to the 2040 No Build condition. While the weaves on southbound I-95 appear to degrade when compared to No Build conditions, this deterioration is caused by improved freeway conditions upstream of the southbound weaving segments which would reduce queuing on the freeway as a whole and allow more vehicles to reach the southbound weaves. All other weaving segments would operate at LOS E or better during both peak hours under Alternative 5 conditions.

Table 13.2-3: HCS 2040 Alternative 5 Condition Weaving Segments

No.	Weave Segment	Alt 5. AM Peak Hour			Alt 5. PM Peak Hour		
		LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95							
W1	From I-695 to Caton Avenue/C-D Roadway	F	-	2.3	F	-	1.9
W2	From Caton Avenue/C-D Roadway to MD 295	E	41	47	E	43	41
W3	From I-395 to Key Highway	B	49	18	F	-	1.3
Southbound Interstate 95							
W4	From Hanover Street to I-395	F	-	1.3	F	-	1.2
W5	From Washington Boulevard to Caton Avenue	E	41	50	F	-	1.0
W6	From Caton Avenue to I-695	F	-	1.1	F	-	1.0

*When weaving segment is LOS F, volume-to-capacity ratio is reported.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 13.2-4: VISSIM 2040 Alternative 5 Condition Weaving Segments

No.	Weave Segment	Alt 5. AM Peak Hour				Alt 5. PM Peak Hour			
		Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95									
W1	From I-695 to Caton Avenue/C-D Roadway	29	55	9,978	8,025	55	27	8,305	7,702
W2	From Caton Avenue/C-D Roadway to MD 295	18	74	8,654	6,603	57	26	7,924	7,400
W3	From I-395 to Key Highway	60	11	4,004	2,660	57	22	6,825	6,150
Southbound Interstate 95									
W4	From Hanover Street to I-395	24	62	9,193	7,294	35	36	6,491	5,453
W5	From Washington Boulevard to Caton Avenue	27	62	9,258	7,579	18	82	9,878	7,354
W6	From Caton Avenue to I-695	29	59	8,979	7,123	18	83	10,127	7,442

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

13.2.3 Ramp Analysis

The HCS and VISSIM results of the AM and PM peak hour Alternative 5 condition ramp junction analysis within the traffic analysis study area are summarized in Tables 13.3-5 and 13.3-6, respectively.

A. HCS Analysis

The Alternative 5 ramp analyses show thirteen locations at LOS F, seven in the AM peak hour and six in the PM peak hour. All other ramp segments would operate at LOS E or better under Alternative 5 conditions.

B. VISSIM Analysis

VISSIM outputs show that for the Alternative 5 ramp analyses, five segments would operate at a LOS F during the AM and PM peak hours, three during the AM peak hour and two during the PM peak hour.

The Alternative 5 ramp junction analysis show that output volumes would increase or would be closer to the segment demand than in the 2040 No Build condition, indicating that congestion from downstream freeway or weaves would no longer starve upstream diverges. In both the AM and PM peak hours, there would be noticeable improvement in the southbound direction on the existing Key Highway exit ramp due to the construction of the new I-95 exit ramp to McComas Street. The new ramp would reduce congestion on southbound I-95 leaving the Fort McHenry Tunnel, thus increasing output volumes at the downstream ramp segments R9, R10, and R11. In the northbound direction during both peak hours, Alternative 5 shows improved traffic conditions when compared to the 2040 No Build scenario.

Table 13.2-5: HCS 2040 Alternative 5 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt. 5 AM Peak Hour			Alt. 5 PM Peak Hour		
			LOS	Speed (mph)	Density or v/c (pc/mi/ln)	LOS	Speed (mph)	Density or v/c (pc/mi/ln)
Northbound Interstate 95								
R1	EB I-695 Off Ramp	Diverge	F	57	36	D	57	32
R2	WB I-695 Off Ramp	Diverge	F	51	47	F	51	42
R3	Washington Blvd Off Ramp	Diverge	F	52	45	E	53	35
R4	I-395 Off Ramp	Capacity	OVER	-	1.1	UNDER	-	0.7
R5	MD 295 On Ramp	Merge	C	59	21	D	52	34
R16	NEW McComas St On Ramp	Merge	B	59	13	C	57	27
R7	Key Hwy On Ramp	Merge	B	57	19	E	53	35
Southbound Interstate 95								
R8	Key Hwy Off Ramp	Diverge	E	51	36	C	51	22
R17	NEW McComas St Off Ramp	Diverge	E	50	42	C	50	24
R9	Key Hwy On Ramp	Merge	E	51	37	C	56	27
R10	MD 295 Off Ramp	Diverge	F	57	42	C	60	27
R11	I-395 On Ramp	Capacity	UNDER	-	0.8	OVER	-	1.1
R12	MD 295 On Ramp	Merge	F	55	30	F	48	35
R13	EB I-695 Off Ramp	Diverge	E	58	36	F	57	42
R14	WB I-695 On Ramp	Merge	D	54	34	F	51	37
R15	EB I-695 On Ramp	Merge	F	30	44	F	42	41

* Volume-to-capacity ratio reported for capacity analysis.

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

Table 13.2-6: VISSIM 2040 Alternative 5 Condition Ramp Segments

No.	Ramp Segment	Ramp Analysis	Alt. 5 AM Peak Hour				Alt. 5 PM Peak Hour			
			Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)	Speed (mph)	Density (vpmpl)	Demand (vph)	Output Volumes (vph)
Northbound Interstate 95										
R1	EB I-695 Off Ramp	Diverge	51	10	535	464	51	11	576	545
R2	WB I-695 Off Ramp	Diverge	34	49	1,810	1,606	31	56	1,812	1,715
R3	Washington Blvd Off Ramp	Diverge	41	17	893	657	48	7	313	280
R4	I-395 Off Ramp	Major Diverge	15	96	3,993	2,851	51	23	2,481	2,289
R5	MD 295 On Ramp	Merge	56	11	607	579	53	28	1,513	1,467
R16	NEW McComas St On Ramp	Merge	52	6	336	296	49	15	985	685
R7	Key Hwy On Ramp	Merge	38	12	485	442	36	27	1,126	891
Southbound Interstate 95										
R8	Key Hwy Off Ramp	Diverge	57	8	604	420	57	8	418	400
R17	NEW McComas St Off Ramp	Diverge	41	23	1,121	894	48	17	776	775
R9	Key Hwy On Ramp	Merge	38	38	1,365	1,217	42	34	1,743	1,362
R10	MD 295 Off Ramp	Diverge	47	32	1,762	1,381	51	15	726	616
R11	I-395 On Ramp	Major Merge	35	46	2,723	2,622	19	72	3,812	2,702
R12	MD 295 On Ramp	Merge	54	10	485	486	40	30	1,133	1,099
R13	EB I-695 Off Ramp	Diverge	50	14	882	682	50	14	961	688
R14	WB I-695 On Ramp	Merge	34	25	856	850	35	18	609	604
R15	EB I-695 On Ramp	Merge	55	15	2,533	1,635	56	12	1,633	1,271

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

13.3 Surface Street Intersection Analysis

Traffic operational analyses were conducted for the Alternative 5 condition. Table 13.3-1 shows the LOS at local intersections within the traffic analysis study area with the Alternative 5 traffic volumes and lane geometry. It should be noted that several intersections were signalized as part of the Alternative 5 condition in order to improve surface street operations. Existing and No Build signal timings were initially optimized and later modified to reduce the impacts of surface street queuing onto the interstate. Table 13.3-1 shows that four intersections would operate at LOS F, all of which occur during the PM peak hour. All other intersections would operate at LOS E or better under the Alternative 5 condition. The HCM LOS results show significant improvement when compared to the 2040 No Build condition, with a significant reduction in control delays along Hanover Street and McComas Street.

Table 13.3-1 Alternative 5 HCM Intersection Control Delay

No.	Intersection	AM Peak Hour		PM Peak Hour	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections					
15	Hanover Street at Wells Street	C	35	E	68
16	Hanover Street at McComas Street	C	33	F	114
20	McComas Street at Cromwell Street/White Street	D	35	F	119
21	Key Highway at McComas Street	C	23	C	23
22	Key Highway at McHenry Row	B	15	B	17
29	McComas Street at Gray Street	B	16	F	100
30	McComas Street at Violet Street	B	15	E	74
32	McComas Street at Pink Street	B	12	F	116
33	McComas Street at Brown Street	C	22	B	16
34	McComas Street at Yellow Street	A	7	A	6
35	McComas Street at EB to WB U-turn	B	12	E	56
Unsignalized Intersections					
28	McComas Street at Tan Street	A	9	B	11
31	McComas Street at Teal Street	A	10	B	13

Light to Moderate Traffic (LOS A-C)
Heavy Traffic (LOS D)
High Congestion (LOS E)
Severe Congestion (LOS F)

13.4 Comparison of Alternatives

A comparison of the AM and PM peak hour VISSIM freeway analyses results for Alternatives 1-5 is shown in Tables 13.4-1 and 13.4-2, respectively. The results show that throughput is typically greatest under Alternative 5, indicating that the improvements identified as part of the Alternative 5 condition would most adequately accommodate the demand. Densities are generally less under Alternative 5, with the exception of those on southbound I-95, particularly south of the Port Covington peninsula. While many southbound segments appear to degrade during the AM and PM peak hours based on segment density, the increased throughput shows that severe congestion within the Fort McHenry Tunnel would no longer starve downstream freeway segments as it was in Alternatives 1-3.

Total delay, unserved demand, end-to-end travel times, and average speeds for Alternatives 1-5 are shown in Table 13.4-3. The results show Alternative 5 would have the lowest total delay, lowest unserved demand, shortest travel time, and highest average speeds.

A comparison of the AM and PM peak hour surface street intersection control delays is shown in Tables 13.4-4 and 13.4-5, respectively. The comparison of intersection delays only considered the intersections directly affected by the improvements included in the Build Alternatives. During the AM peak hour, all of the intersections would operate at LOS D or better under Alternative 5, while at least one intersection is projected to fail in each of the other Alternatives. While four intersections would fail under Alternative 5 during the PM peak hour, multiple intersections would also fail under each of the other Alternatives.

Table 13.4-1: Comparison of VISSIM Freeway Analyses Results – AM Peak Hour

No.	Freeway/Ramp Segment	2040 No Build				Alt 2				Alt 3				Alt 4				Alt 5			
		Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)
Northbound Interstate 95																					
W1	From I-695 to Caton Avenue/C-D Roadway	12	92	9,978	6,000	14	87	9,978	6,571	21	67	9,978	7,490	20	74	9,978	7,543	29	55	9,978	8,025
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	12	105	8,707	4,875	14	100	8,707	5,443	21	76	8,707	6,278	20	71	7,739	5,538	28	62	8,707	6,814
R3	Washington Boulevard Off Ramp	15	52	893	441	15	61	893	480	4	134	893	526	4	139	893	494	41	17	893	657
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	9	114	7,814	4,095	11	106	7,814	4,743	45	33	7,814	5,518	44	32	6,846	4,774	22	70	7,814	5,955
W2	From Caton Avenue/C-D Roadway to MD 295	9	106	8,654	4,554	12	92	8,654	5,399	35	45	8,654	6,216	34	46	7,686	5,376	18	74	8,654	6,603
F5	MD 295 Off Ramp to I-395 Off Ramp	9	112	8,007	4,128	19	69	8,007	5,066	28	53	7,006	5,076	24	60	7,039	4,979	18	72	7,039	5,242
R4	I-395 Off Ramp	43	24	3,993	2,024	39	45	5,612	2,898	19	81	3,993	2,843	16	90	3,993	2,749	15	96	3,993	2,851
F6	I-395 Off Ramp to MD 295 On Ramp	4	148	4,014	1,950	58	9	2,395	1,501	58	13	3,013	2,182	57	13	3,046	2,149	57	14	3,046	2,275
R5	MD 295 On Ramp	2	150	607	289	57	8	475	461	56	10	607	584	56	10	607	585	56	11	607	579
F7	MD 295 On Ramp to I-395 On Ramp	4	143	4,621	2,131	62	8	2,870	1,961	61	11	3,620	2,768	60	11	3,653	2,735	61	12	3,653	2,853
W3	From I-395 to Hanover Street (or Key Hwy Off Ramp)	5	118	5,621	2,502	60	10	3,870	2,931	53	14	4,620	3,728	60	10	4,004	3,068	60	11	4,004	2,660
F8	Hanover Street Off Ramp to Key Highway Off Ramp	50	8	3,461	1,572					38	26	3,961	3,137								
R6	Key Highway Off Ramp	33	16	852	380					17	76	1,352	1,068								
F21	Key Highway Off Ramp to NEW McComas St On Ramp					62	8	2,609	2,002	60	9	2,609	2,044	62	9	2,609	2,111	62	10	2,945	2,483
R16	New McComas St On Ramp					53	5	336	240	52	6	336	289	52	5	336	239	52	6	336	296
F9	Key Hwy Off Ramp (or New McComas St On Ramp) to Key Hwy On Ramp	62	5	2,609	1,187	37	9	2,945	2,216	62	9	2,945	2,307	42	9	2,945	2,328	62	10	2,945	2,483
R7	Key Highway On Ramp	40	14	821	531	41	10	485	381	40	10	485	387	40	10	485	392	38	12	485	442
F10	Key Highway On Ramp to Tunnel	59	8	3,430	1,437	59	11	3,430	2,806	59	11	3,430	2,704	59	11	3,430	2,945	58	13	3,430	2,933
Southbound Interstate 95																					
F11	Tunnel to Key Highway Off Ramp	32	69	8,454	5,523	35	60	8,454	6,211	33	79	8,454	6,203	52	33	8,454	6,770	56	24	8,454	6,664
R8	Key Highway Off Ramp	5	126	1,725	675	12	81	1,725	945	3	143	1,725	938	41	18	604	415	57	8	604	420
F22	Key Highway Off Ramp to NEW McComas St Off Ramp													56	28	7,850	6,344	54	31	7,850	6,509
R17	NEW McComas St Off Ramp													55	16	1,121	893	41	23	1,121	894
F12	New McComas St Off Ramp to Key Highway On Ramp	56	22	6,729	4,830	56	24	6,729	5,252	56	25	6,729	5,238	55	26	6,729	5,532	49	30	6,729	5,525
R9	Key Highway On Ramp	47	17	1,365	780	46	20	1,365	895	43	24	1,365	975	43	28	1,365	1,147	38	38	1,365	1,217
F13	Key Highway On Ramp to Hanover Street On Ramp	56	22	8,094	5,587	51	27	8,094	6,117	46	31	8,094	6,184	46	33	8,094	6,536	34	46	8,094	6,560
W4	From Hanover Street to I-395	42	31	9,193	6,424	34	42	9,193	6,925	32	47	9,193	6,969	36	42	9,193	7,192	24	62	9,193	7,294
F14	I-395 Off Ramp to MD 295 Off Ramp	53	24	7,241	5,063	47	29	7,241	5,463	47	30	7,241	5,498	41	36	7,241	5,659	37	41	7,241	5,753
R10	MD 295 Off Ramp	51	26	1,762	1,222	49	29	1,762	1,317	49	29	1,762	1,321	48	30	1,762	1,365	47	32	1,762	1,381
F15	MD 295 Off Ramp to I-395 On Ramp	55	23	5,479	3,817	49	28	5,479	4,111	49	29	5,479	4,149	38	40	5,479	4,238	32	49	5,479	4,319
R11	I-395 On Ramp	53	16	2,723	1,639	51	27	2,723	2,686	50	28	2,723	2,675	42	35	2,723	2,637	35	46	2,723	2,622
F16	I-395 On Ramp to MD 295 On Ramp	55	23	8,202	5,486	44	35	8,202	6,773	45	35	8,202	6,818	35	48	8,202	6,785	33	58	8,202	6,840
R12	MD 295 On Ramp	53	9	485	484	54	9	485	485	54	9	485	485	54	9	485	485	54	10	485	486
F17	MD 295 On Ramp to Washington Boulevard On Ramp	59	23	8,687	5,999	49	35	8,687	7,220	50	34	8,687	7,292	38	45	8,687	7,183	39	44	8,687	7,260
W5	From Washington Boulevard to Caton Avenue	53	24	9,258	6,404	35	48	9,258	7,574	34	49	9,258	7,669	25	64	9,258	7,471	27	62	9,258	7,579
F18	Caton Ave Off Ramp to Caton Ave On Ramp	59	24	7,953	5,509	47	39	7,953	6,439	50	36	7,953	6,530	30	58	7,953	6,258	40	47	7,953	6,399

Table 13.4-2: Comparison of VISSIM Freeway Analyses Results – PM Peak Hour

No.	Freeway/Ramp Segment	2040 No Build				Alt 2				Alt 3				Alt 4				Alt 5			
		Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)	Speed (mph)	Density or v/c (pc/mi/ln)	Demand (VPH)	Output Volumes (VPH)
Northbound Interstate 95																					
W1	From I-695 to Caton Avenue/C-D Roadway	7	111	8,305	4,209	14	83	8,305	5,446	55	27	8,305	7,702	47	32	8,305	7,700	55	27	8,305	7,702
F3	Caton Ave Off Ramp to Washington Blvd Off Ramp	6	138	7,277	2,999	11	104	7,277	4,267	57	30	7,277	6,763	58	27	6,603	6,121	57	30	7,277	6,763
R3	Washington Boulevard Off Ramp	43	2	313	95	43	3	313	146	47	6	313	280	48	6	313	280	48	7	313	280
F4	Washington Blvd Off Ramp to Caton Ave On Ramp	4	155	6,964	2,290	8	117	6,964	3,659	57	29	6,964	6,474	58	25	6,290	5,828	57	29	6,964	6,474
W2	From Caton Avenue/C-D Roadway to MD 295	4	147	7,924	2,440	7	115	7,924	4,021	55	27	7,924	7,330	57	23	7,250	6,655	57	26	7,924	7,400
F5	MD 295 Off Ramp to I-395 Off Ramp	3	157	7,331	2,003	8	113	7,331	3,610	53	28	6,295	5,880	52	30	6,657	6,205	54	30	6,657	6,231
R4	I-395 Off Ramp	50	7	2,481	653	32	60	3,588	1,298	51	23	2,481	2,288	51	23	2,481	2,283	51	23	2,481	2,289
F6	I-395 Off Ramp to MD 295 On Ramp	2	178	4,850	1,172	53	13	3,743	1,874	39	36	3,814	3,543	46	30	4,176	3,855	58	23	4,176	3,911
R5	MD 295 On Ramp	1	197	1,513	177	47	29	1,248	1,176	8	122	1,513	910	17	80	1,513	1,165	53	28	1,513	1,467
F7	MD 295 On Ramp to I-395 On Ramp	2	169	6,363	1,250	48	22	4,991	3,057	12	94	5,327	4,377	23	60	5,689	4,946	58	24	5,689	5,372
W3	From I-395 to Hanover Street (or Key Hwy Off Ramp)	2	157	8,132	1,353	25	52	6,760	4,361	12	93	7,096	5,144	15	79	6,825	5,455	57	22	6,825	6,150
F8	Hanover Street Off Ramp to Key Highway Off Ramp	2	157	6,357	969					24	50	6,589	4,750								
R6	Key Highway Off Ramp	1	196	1,118	96					8	120	1,350	887								
F21	Key Highway Off Ramp to NEW McComas St On Ramp					54	16	5,239	3,418	55	18	5,239	3,842	54	20	5,239	4,359	56	25	6,224	5,611
R16	New McComas St On Ramp					50	12	985	611	49	14	985	669	49	12	985	586	49	15	985	685
F9	Key Hwy Off Ramp (or New McComas St On Ramp) to Key Hwy On Ramp	59	3	5,239	798	36	16	6,224	3,983	58	18	6,224	4,450	40	21	6,224	4,876	56	25	6,224	5,611
R7	Key Highway On Ramp	38	7	2,111	257	37	21	1,126	718	36	21	1,126	708	31	30	1,126	832	36	27	1,126	891
F10	Key Highway On Ramp to Tunnel	57	5	7,350	882	54	24	7,350	5,087	53	27	7,350	5,165	51	35	7,350	6,120	52	33	7,350	6,546
Southbound Interstate 95																					
F11	Tunnel to Key Highway Off Ramp	29	92	4,411	3,082	32	67	4,411	3,842	31	94	4,411	3,931	32	46	4,411	4,026	57	16	4,411	4,351
R8	Key Highway Off Ramp	2	175	1,194	193	6	127	1,194	723	2	157	1,194	755	22	37	418	328	57	8	418	400
F22	Key Highway Off Ramp to NEW McComas St Off Ramp													26	50	3,993	3,548	58	19	3,993	4,172
R17	NEW McComas St Off Ramp													7	99	776	591	48	17	776	775
F12	New McComas St Off Ramp to Key Highway On Ramp	58	12	3,217	2,855	57	13	3,217	3,067	58	14	3,217	3,090	55	16	3,217	2,848	58	15	3,217	3,236
R9	Key Highway On Ramp	47	5	1,743	217	46	21	1,743	932	45	26	1,743	1,114	45	28	1,743	1,208	42	34	1,743	1,362
F13	Key Highway On Ramp to Hanover Street On Ramp	60	11	4,960	3,062	59	15	4,960	3,974	58	16	4,960	4,179	58	15	4,960	3,973	48	23	4,960	4,512
W4	From Hanover Street to I-395	57	12	6,491	3,492	50	20	6,491	4,936	50	21	6,491	5,120	53	19	6,491	4,789	35	36	6,491	5,453
F14	I-395 Off Ramp to MD 295 Off Ramp	60	11	5,093	2,749	54	19	5,093	3,877	57	18	5,093	4,028	51	21	5,093	3,880	29	41	5,093	4,251
R10	MD 295 Off Ramp	56	7	726	391	55	11	726	548	55	11	726	568	55	11	726	550	51	15	726	616
F15	MD 295 Off Ramp to I-395 On Ramp	59	13	4,367	2,353	49	25	4,367	3,295	57	20	4,367	3,439	41	33	4,367	3,310	21	58	4,367	3,557
R11	I-395 On Ramp	53	7	3,812	728	44	36	3,812	2,832	51	21	3,812	2,094	44	35	3,812	2,477	19	72	3,812	2,702
F16	I-395 On Ramp to MD 295 On Ramp	59	12	8,179	3,137	41	37	8,179	6,038	54	24	8,179	5,567	34	44	8,179	5,784	23	68	8,179	6,091
R12	MD 295 On Ramp	48	24	1,133	1,108	44	27	1,133	1,097	48	24	1,133	1,106	42	28	1,133	1,103	40	30	1,133	1,099
F17	MD 295 On Ramp to Washington Boulevard On Ramp	59	16	9,312	4,302	40	45	9,312	7,011	56	27	9,312	6,700	27	63	9,312	6,857	23	74	9,312	7,028
W5	From Washington Boulevard to Caton Avenue	56	17	9,878	4,756	30	56	9,878	7,328	48	33	9,878	7,118	20	76	9,878	7,208	18	82	9,878	7,354
F18	Caton Ave Off Ramp to Caton Ave On Ramp	59	19	9,095	4,453	32	60	9,095	6,648	45	45	9,095	6,522	22	76	9,095	6,511	22	75	9,095	6,641

Table 13.4-3: Additional MOE's Alternatives Comparison Summary

	Traffic Impacts											
	Network Measures of Effectiveness (from VISSIM)				Travel Time Comparison (I-695 to/from Fort McHenry Toll Plaza)							
	AM		PM		AM				PM			
	Total Delay (Hours)	Unserved Demand (Vehicles)	Total Delay (Hours)	Unserved Demand (Vehicles)	NB Travel Time (MM:SS)	NB Average Speed (MPH)	SB Travel Time (MM:SS)	SB Average Speed (MPH)	NB Travel Time (MM:SS)	NB Average Speed (MPH)	SB Travel Time (MM:SS)	SB Average Speed (MPH)
Alternative 1 / No-Build	5,221	11,304	7,312	22,629	21:30	21	13:17	33	20:20	22	13:26	33
Alternative 2	4,055	9,557	4,903	9,719	16:40	27	13:11	33	13:44	33	14:58	29
Alternative 3	3,670	8,149	3,615	9,726	11:10	40	13:17	33	9:19	48	13:15	33
Alternative 4	3,699	8,519	3,506	7,403	10:47	41	12:59	34	8:53	50	13:37	32
Alternative 5	3,355	6,910	3,027	7,025	10:42	42	12:44	34	8:28	53	13:09	33

Table 13.4-4: Comparison of HCM Intersection Control Delays – AM Peak Hour

No.	Intersection	2040 No Build		Alt 2		Alt 3		Alt 4		Alt 5	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections											
15	Hanover Street at Wells Street	F	139	D	41	D	45	F	85	C	35
16	Hanover Street at McComas Street	F	102	C	32	C	34	C	27	C	33
20	McComas Street at Cromwell Street/White Street			B	20	C	21	B	10	D	35
21	Key Highway at McComas Street	F	***	F	153	F	149	D	51	C	23
22	Key Highway at McHenry Row	B	18	B	18	B	16	B	16	B	15
28	McComas Street at Tan Street	B	18								
29	McComas Street at Gray Street	B	14	A	10	B	12	B	14	B	16
30	McComas Street at Violet Street			C	31	C	30	B	17	B	15
32	McComas Street at Pink Street			B	14	B	15	A	8	B	12
33	McComas at Brown Street			B	19	B	15	B	16	C	22
34	McComas at Yellow Street			B	11	A	4	A	6	A	7
35	McComas Street at EB to WB U-turn[1]							B	10	B	12
Unsignalized Intersections											
28	McComas Street at Tan Street			A	10	B	11	A	9	A	9
30	McComas Street at Violet Street	A	10								
31	McComas Street at Teal Street	F	196	B	11	B	11	A	10	A	10
32	McComas Street at Pink Street	D	33								

*** Delay exceeds 300 seconds

1 – Intersection was not analyzed for Alternatives 1-3

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

Table 13.4-5: Comparison of HCM Intersection Control Delays – PM Peak Hour

No.	Intersection	2040 No Build		Alt 2		Alt 3		Alt 4		Alt 5	
		LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)	LOS	Control Delay (sec)
Signalized Intersections											
15	Hanover Street at Wells Street	F	161	F	101	F	108	F	90	E	68
16	Hanover Street at McComas Street	F	194	F	134	F	122	F	93	F	114
20	McComas Street at Cromwell Street/White Street			F	89	F	88	B	18	F	119
21	Key Highway at McComas Street	F	***	F	185	F	191	F	101	C	23
22	Key Highway at McHenry Row	B	19	B	19	B	18	B	19	B	17
28	McComas Street at Tan Street	C	26								
29	McComas Street at Gray Street	D	39	C	20	D	42	D	39	F	100
30	McComas Street at Violet Street			C	32	C	31	D	48	E	74
32	McComas Street at Pink Street			D	48	C	24	D	47	F	116
33	McComas at Brown Street			B	17	B	13	B	19	B	16
34	McComas at Yellow Street			A	6	A	7	A	8	A	6
35	McComas Street at EB to WB U-turn							B	18	E	56
Unsignalized Intersections											
28	McComas Street at Tan Street			B	12	C	16	C	16	B	11
30	McComas Street at Violet Street	F	92								
31	McComas Street at Teal Street	F	***	B	14	B	14	B	14	B	13
32	McComas Street at Pink Street	F	***								

*** Delay exceeds 300 seconds

1 – Intersection was not analyzed for Alternatives 1-3

Light to Moderate Traffic (LOS A-C)

Heavy Traffic (LOS D)

High Congestion (LOS E)

Severe Congestion (LOS F)

13.5 2040 Safety Analysis

A safety analysis of the I-95 corridor, from Washington Boulevard (milepoint 1.64) to the roadway separation prior to the Fort McHenry Tunnel (milepoint 4.35), was performed for the design year of 2040 using the Enhanced Interchange Safety Analysis Tool (ISATe). ISATe is a spreadsheet-based tool which applies the predictive method included in Part C of the Highway Safety Manual (HSM). The 2040 Safety Analysis evaluates only the section of I-95 where geometric changes are proposed, i.e., between the Washington Boulevard interchange and south of the Fort McHenry Tunnel. There are no changes proposed south of Washington Boulevard, and since the Build geometry and volumes remain the same as the No Build, there would be no change in the number of expected crashes along that section of I-95.

ISATe predicts an expected number of crashes for a defined study period based on geometric and vehicle demand inputs. 2040 No Build and 2040 Build were coded in ISATe. The predicted number of crashes for 2040 No Build and 2040 Build conditions were then determined from the ISATe outputs.

The results of the ISATe analysis are presented in Tables 13.5-1, 13.5-2, and 13.5-3. Table 13.5-1 presents the mainline annual predicted crashes for 2040 No Build and 2040 Build conditions. Note that the number of mainline crashes includes ramp merge, diverge, and weaves, so the increased number of ramps leads to an increased number of crashes in these critical areas. That said, the Recommended Preferred Alternative still results in a decrease in predicted mainline crashes from 50.1 to 48.2. The increase in the northernmost section of the corridor (from 16.7 to 17.3) is a result of the two new McComas Street ramps (one in each direction), which shift traffic from the two existing Key Highway ramps and increase the mainline volume north of these two new ramps.

Table 13.5-1: I-95 Mainline – ISATe Predicted Annual Crashes

Northbound Segment Limits	Southbound Segment Limits	Predicted Crashes	
		2040 No Build	2040 Build
Caton Ave On-Ramp to Russell St Off-Ramp	Russell St. On-Ramp to MP 1.64	11.0	10.7
Russell St Off-Ramp to I-395 Off Ramp	MP 2.52 to Russell St On-Ramp	7.1	6.6
I-395 Off Ramp to MP 2.67	I-395 On-Ramp to MP 2.52	3.1	2.8
MP 2.67 to MD 295 On-Ramp	MD 295 Off-Ramp to I-395 On-Ramp	3.8	3.4
MD 295 On-Ramp to I-395 On-Ramp	MP 2.96 to MD 295 Off-Ramp	1.4	1.2
I-395 On-Ramp to MP 3.09	I-395 Off-Ramp to MP 2.96	2.7	2.4
MP 3.09 to MP 3.28 (Hanover St Off-Ramp)	Hanover St. On-Ramp to I-395 Off-Ramp	4.3	3.8
MP 3.28 (Hanover St. Off-Ramp) to MP 4.35	MP 4.35 to Hanover St On-Ramp	16.7	17.3
Total		**50.1**	**48.2**

The annual predicted crashes along the ramps are presented in **Tables 13.5-2**, **13.5-3**, and **13.5-4**. The increase in ramp crashes is mainly due to the introduction of new ramps and ramp spurs, and length of these new ramps. The Recommended Preferred Alternative incudes two additional ramps in the northbound direction and one additional ramp in the southbound direction as well as over a mile of additional ramp lanes. This results in an increase in ramp crashes from 31.0 to 33.9.

Table 13.5-2: Northbound Ramps – ISATe Predicted Annual Crashes

Northbound Ramps	Predicted Crashes		Northbound Ramps	Predicted Crashes	
	2040 No Build	2040 Build		2040 No Build	2040 Build
Caton Ave CD to NB I-95	0.8	1.1	Spur from SB I-395 to Hanover St	--	0.5
NB I-95 to Russell St	1.6	2.3	NB I-95 to SB Hanover St	2.5	--
Spur from Russell St Ramp to Hanover St	--	2.5	NB I-95 to McComas St (New)	--	1.1
NB I-95 to NB I-395	4.2	4.2	NB I-95 to McComas St (Existing)	1.1	--
NB MD 295 to NB I-95	2.5	2.5	McComas St to NB I-95 (New)	--	1.0
SB I-395 to NB I-95	3.2	2.8	**Total Northbound**	15.9	18.0

Table 13.5-3: Southbound Ramps – ISATe Predicted Annual Crashes

Southbound Ramps	Predicted Crashes		Southbound Ramps	Predicted Crashes	
	2040 No Build	2040 Build		2040 No Build	2040 Build
SB I-95 to McComas St (New)	--	0.9	SB I-95 to SB MD 295	2.7	2.7
McComas St to SB I-95	1.2	1.2	SB I-395 to SB I-95	6.3	6.3
Hanover St to SB I-95	2.0	2.0	SB Russell St to SB I-95	1.0	0.9
SB I-95 to NB I-395	1.9	1.9	**Total Southbound**	15.1	15.9

Table 13.5-4: Northbound and Southbound Ramps – ISATe Predicted Annual Crashes

Northbound and Southbound Total	Predicted Crashes	
	2040 No Build	2040 Build
	31.0	33.9

An ISATe analysis of existing conditions indicates that the outputs overestimate the number of crashes compared to the actual number of crashes for both mainline and ramps. Table 13.5-5 compares the actual number of mainline and ramp crashes against the ISATe predicted number of crashes along the same section of I-95. The calculated adjustment factor shown is applied to the design year analysis results in Table 13.5-6.

Table 13.5-5: Comparison of Historical and Modeled Crashes

Location	Existing Predicted Crashes per Year	Historic Crash Data (2012-2014)		Adjustment Factor
		3 Years	Yearly Avg.	
Mainline	40.3	89	29.7	0.74
Ramps	23.1	32	10.7	0.46

Table 13.5-6: Modeled Crash Adjustments

Location	Raw		Adjustment Factor	Adjusted		% Change
	2040 No Build	2040 Build		2040 No Build	2040 Build	
Mainline	50.1	48.2	0.74	37.1	35.7	-3.8%
Ramps	31.0	33.9	0.46	14.3	15.6	9.1%
				51.4	**51.3**	**-0.2%**

As shown in Table 13.5-6, the recommended preferred alternative results in a 3.8% decrease in mainline crashes, a 9.1% increase in ramp crashes, and an overall 0.2% decrease in total predicted crashes along the study facility.

14 SUMMARY

This Draft Traffic Analysis Technical Report details the traffic operations analysis performed for the I-95 Access Improvements EA on behalf of the MDTA and BCDOT. These improvements aim to accommodate forecasted increased transportation demand on I-95 and the surrounding transportation network by minimizing effects on mobility and safety, as well as enhancing multi-modal connections to the Port Covington peninsula.

Four alternatives evolved from an iterative process involving engineering, planning, and environmental considerations; review and comment; refinement and revision; and eventual screening. Project planning and design criteria were developed in coordination with MDTA, BCDOT, and the community.

A fifth alternative was developed using the optimal elements of the previous four alternatives. The proposed improvements for the I-95 ramps and local street network represent the refined design concept for the I-95 Access Improvements and are considered the Recommended Preferred Alternative.

Northbound on I-95, the Recommended Preferred Alternative would add an additional auxiliary lane from the Caton Avenue C-D roadway to the Russell Street exit, modify the exit ramp to Russell Street to add a ramp to McComas Street on the west side of the peninsula, and construct a new on ramp from McComas Street to merge with northbound I-95 north of the existing exit ramp to Key Highway. In order to accommodate the new on ramp from McComas Street, the existing off ramp to Key Highway will be reconstructed and will tie into a reconstructed two-way McComas Street at a signalized tee intersection. These modifications would include the construction of a new connection between I-395 and the newly constructed exit ramp to the west side of the peninsula in order to maintain an important existing connection for traffic traveling from Baltimore City to points south.

Southbound on I-95, the Recommended Preferred Alternative would construct a new exit ramp to McComas Street just north of the existing on ramp from McComas Street. The proposed exit ramp would merge with the one-way section of westbound McComas Street under I-95 just west of the ramp to southbound I-95.

In order to accommodate changes to I-95 and support the increase in traffic anticipated as a result of the development, the project would also modify Hanover Street, McComas Street and Key Highway and construct a new pedestrian and bicycle path to connect Port Covington to South Baltimore under I-95. The modifications to Hanover Street are limited to south of the CSX bridge and a result of changes proposed by the Port Covington development as part of the No Build condition. The modifications to McComas Street would include the reconstruction of one-way eastbound McComas Street south of I-95 to be a two-way roadway while maintaining the portion of one-way westbound McComas Street under I-95 to accommodate ramp movements to and from southbound I-95 and connecting to the reconstructed two-way McComas Street at a signalized intersection. Changes to Key Highway would include constructing a third northbound lane from McComas Street to the existing right turn only lane at McHenry Row, and the addition of a southbound right turn lane at McComas Street

Roadway capacity and traffic operations analyses were conducted for the freeway mainline, weaving segments, merge and diverge junctions, surface street intersections, and ramp terminal intersections within the traffic analysis study area. <u>The evaluation of freeway operations confirm that the proposed modifications under the Recommended Preferred Alternative improve the overall operation along the Interstate when compared to the No Build condition and all other Build Alternatives. The evaluation of surface street intersections confirms that the majority of intersections operate at improved or similar LOS</u>

under the Recommended Preferred Alternative when compared to the No Build condition and all other Build Alternatives.

15 APPENDICES

APPENDIX A: FIGURES

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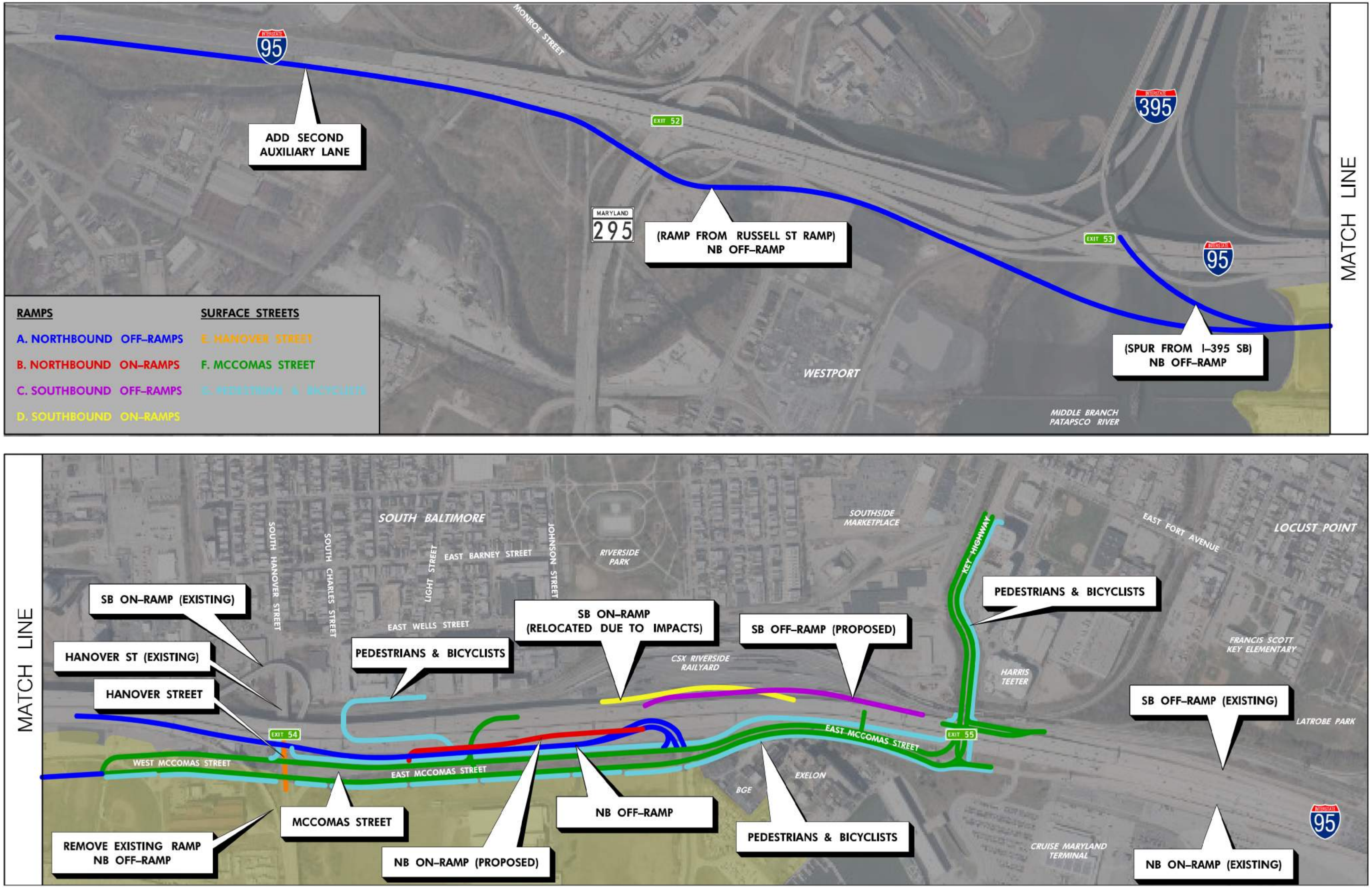

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: ES-01

RECOMMENDED PREFERRED ALTERNATIVE IMPROVEMENTS

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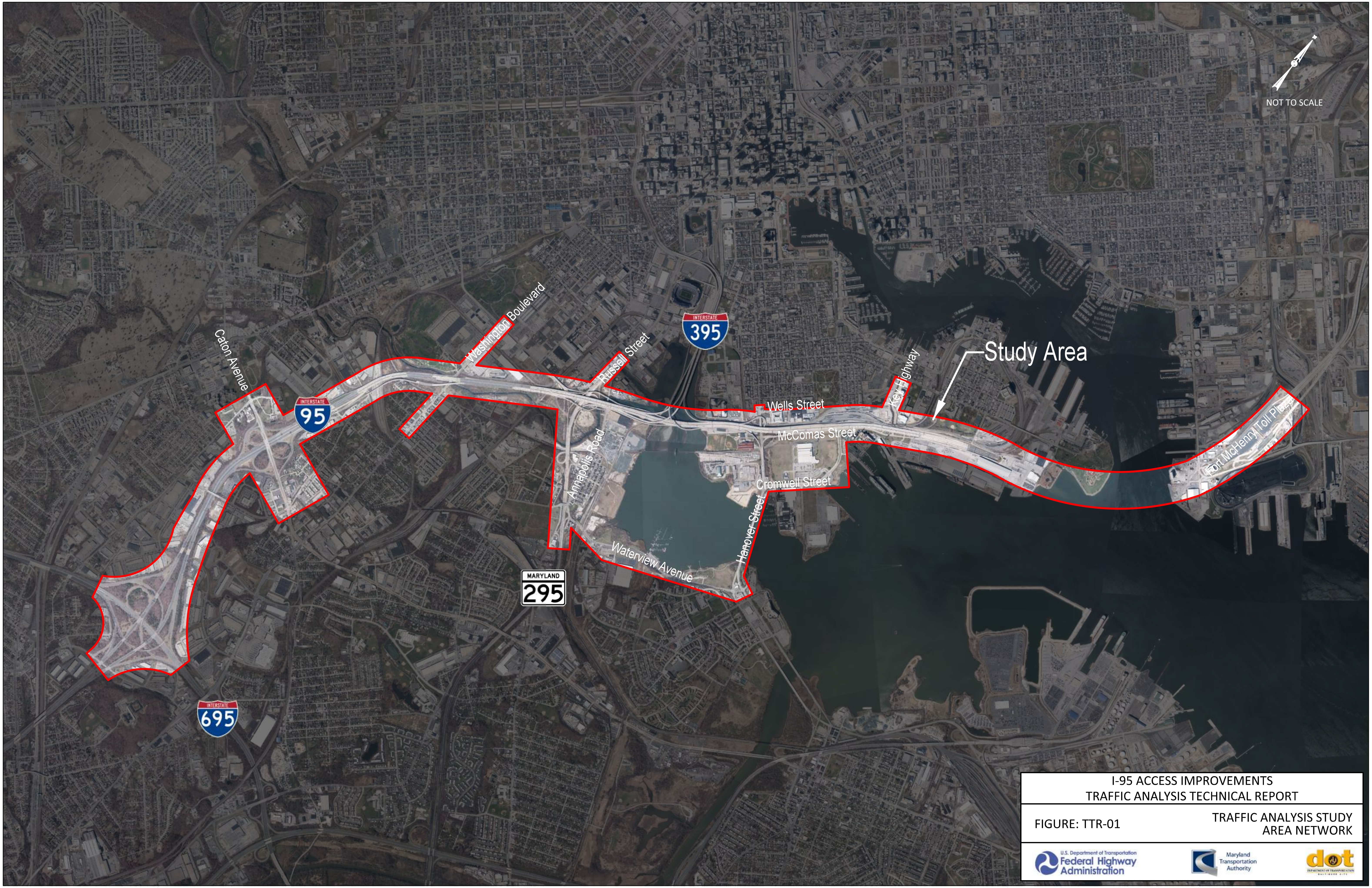

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-01

TRAFFIC ANALYSIS STUDY AREA NETWORK

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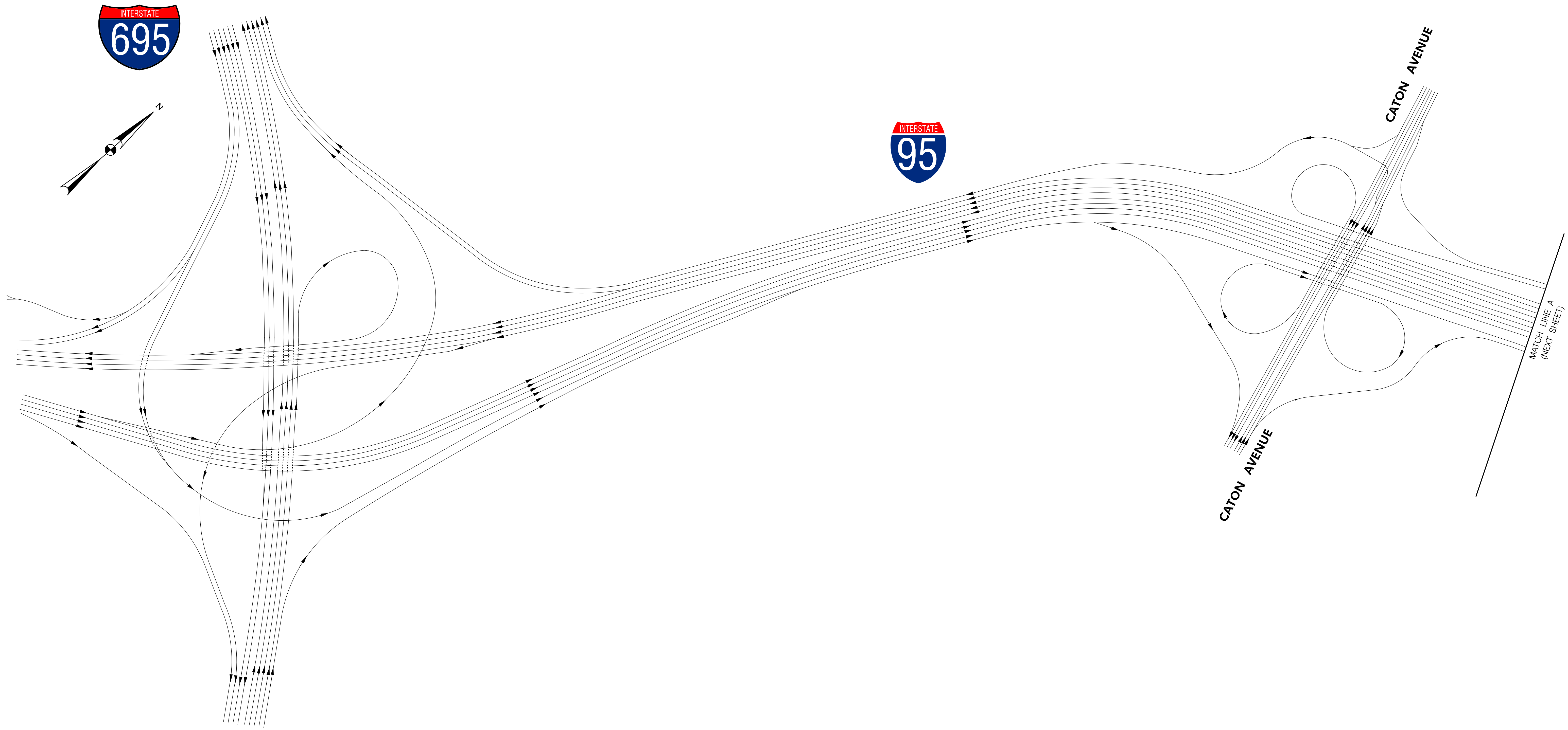


NOT TO SCALE

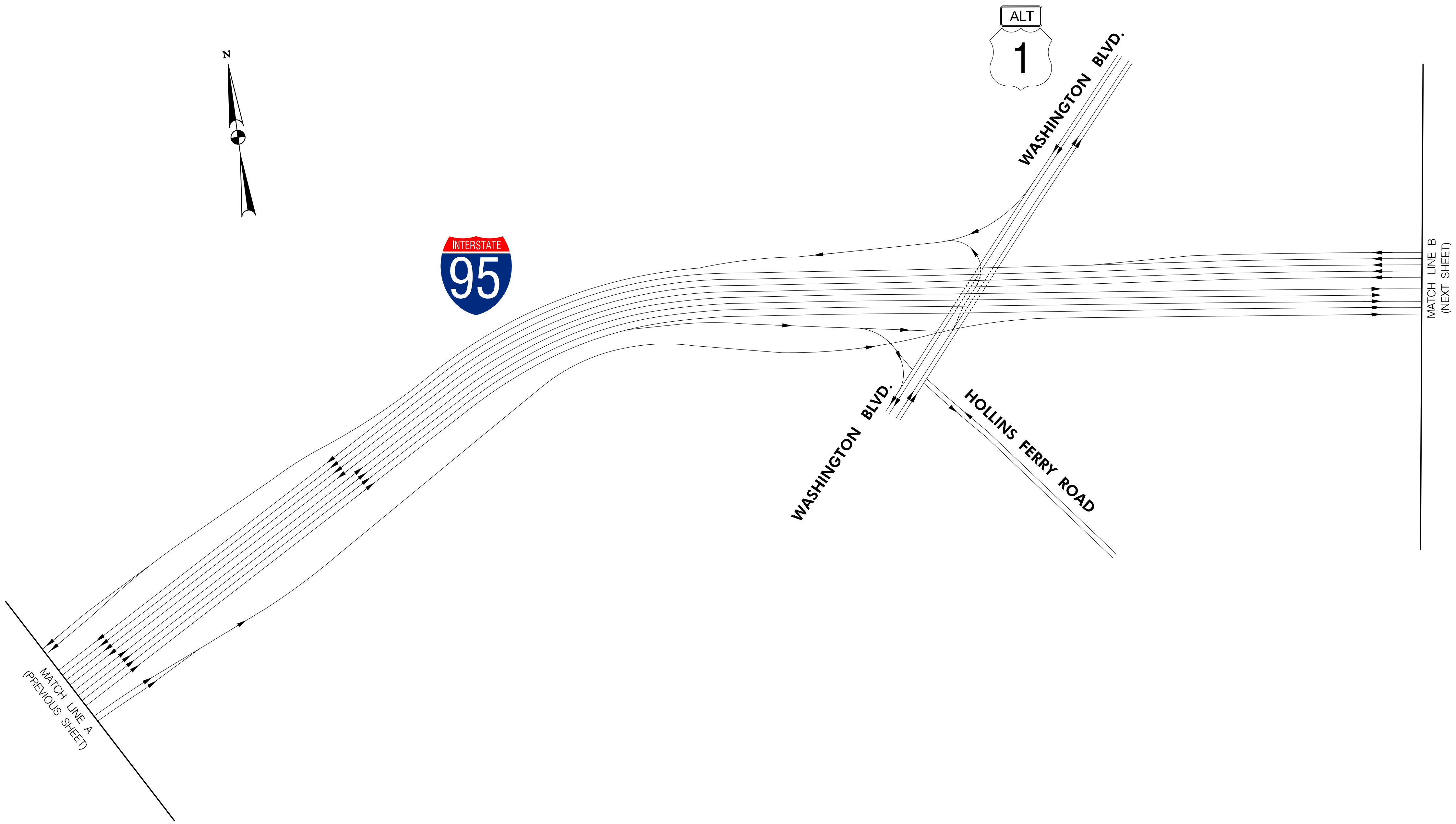
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 2A WIRING DIAGRAM - EX. CONDITION

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

NOT TO SCALE

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FIGURE: TTR - 2B WIRING DIAGRAM - EX. CONDITION

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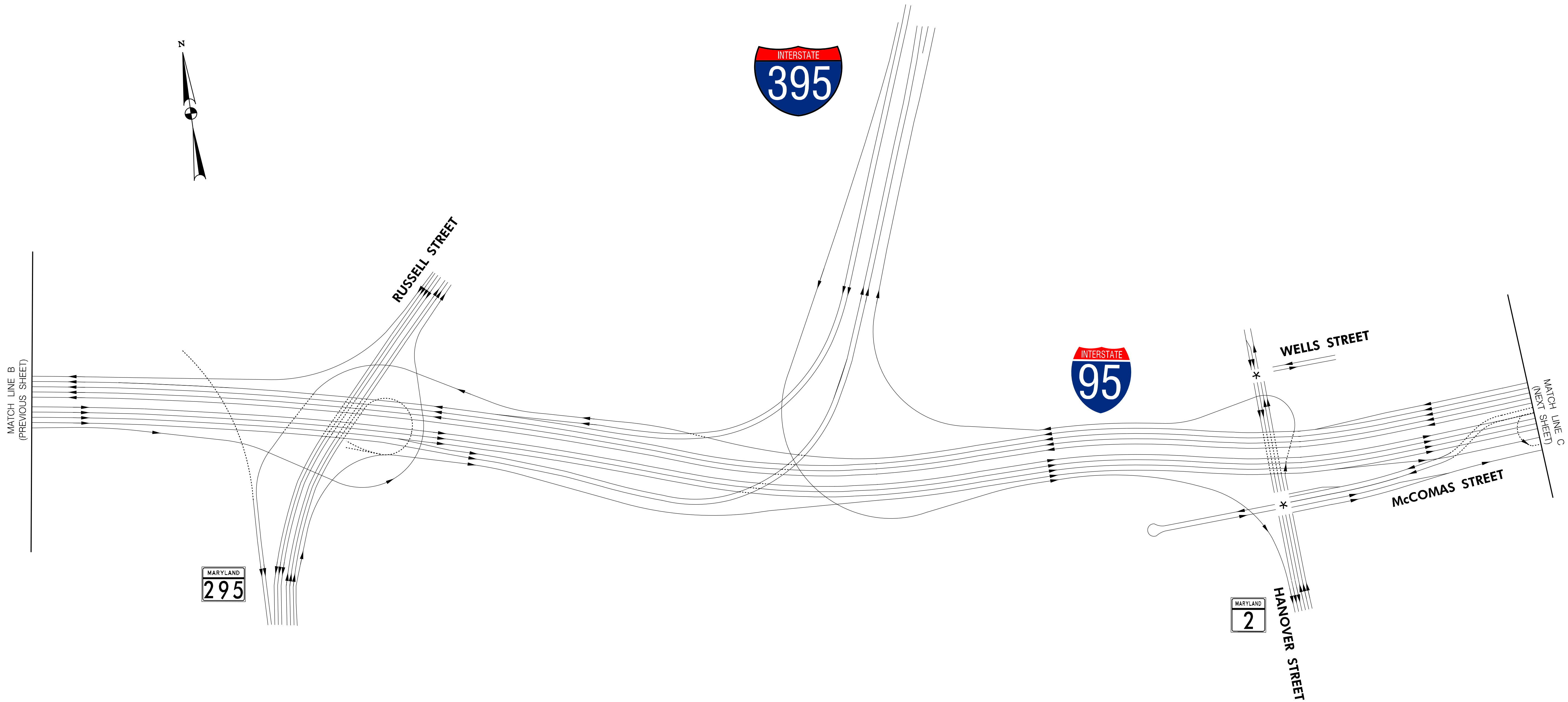

NOT TO SCALE

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FIGURE: TTR - 2C WIRING DIAGRAM - EX. CONDITION

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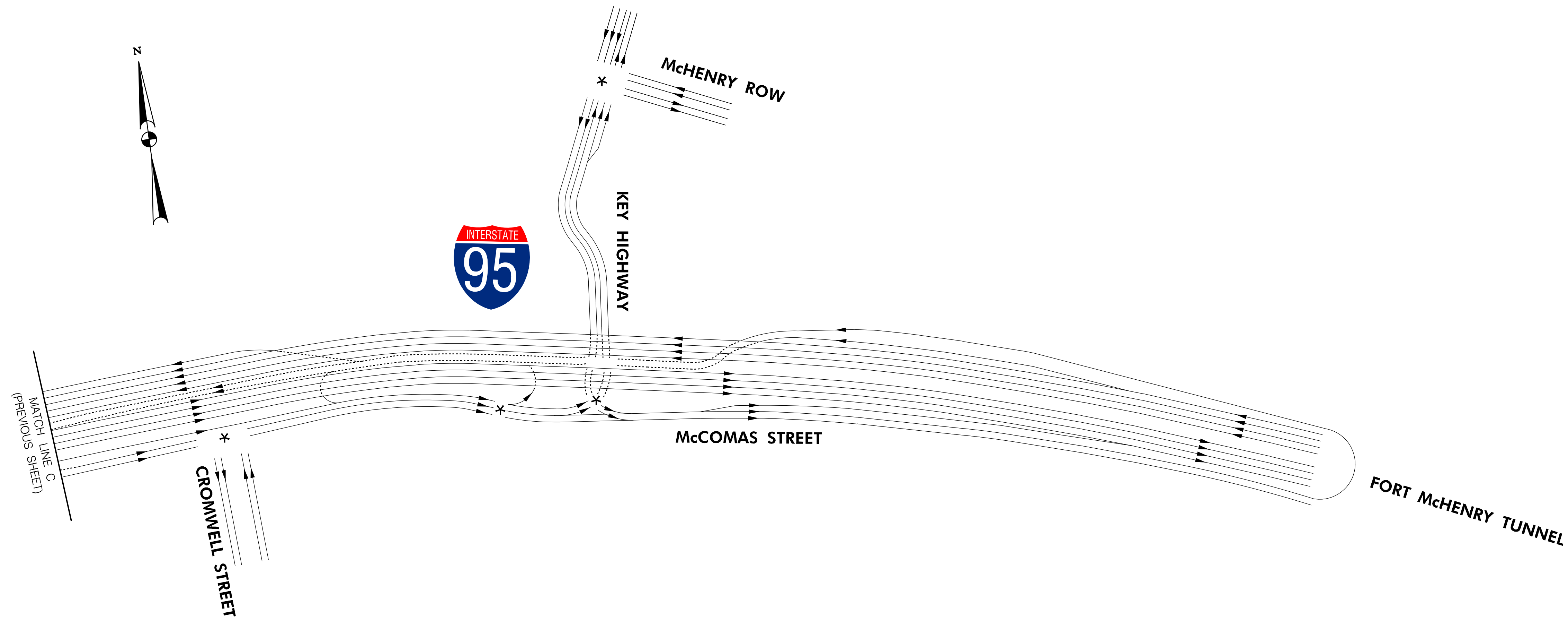
LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-06 FOR SURFACE STREET INTERSECTION LANE USE



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

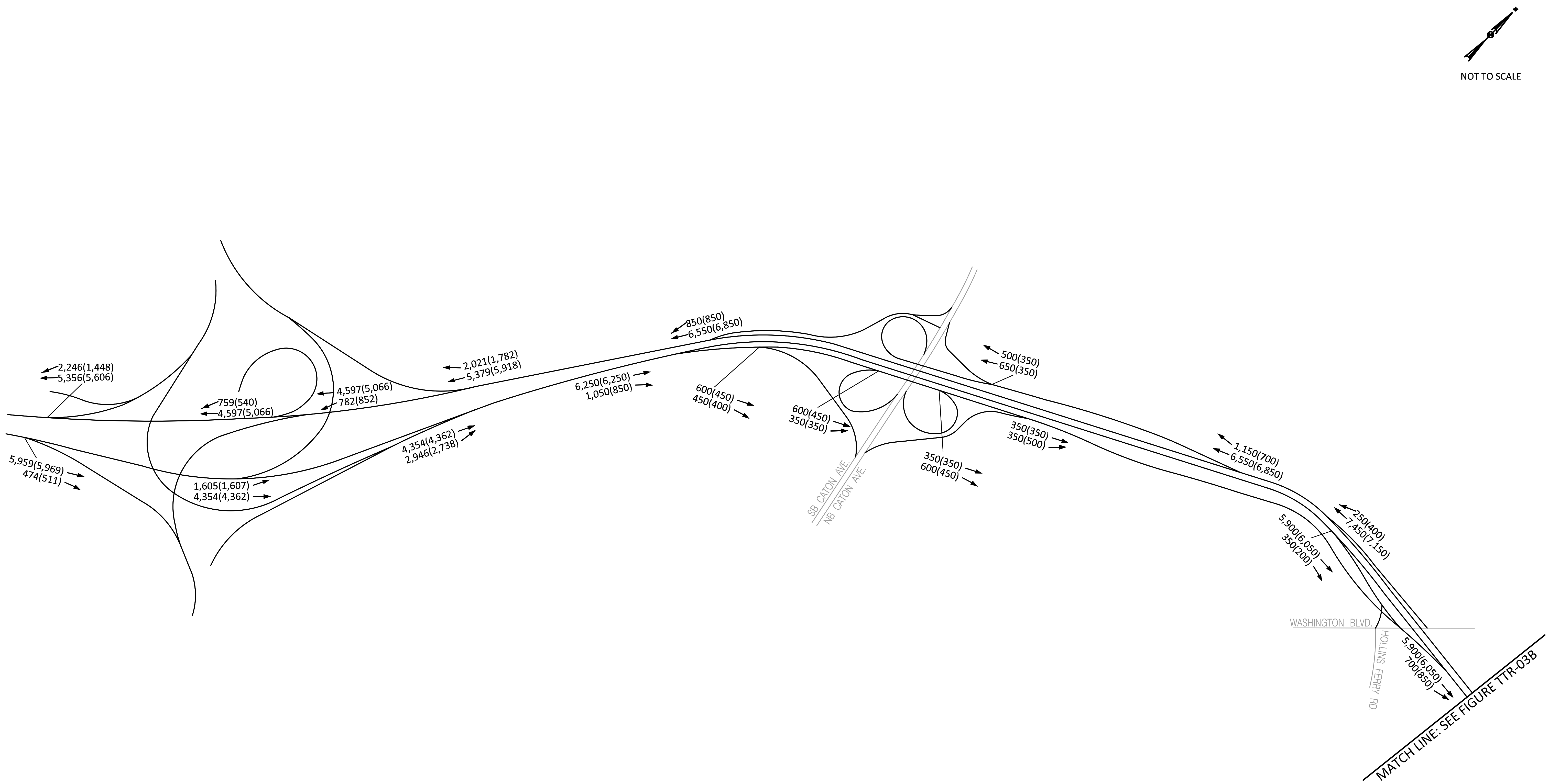
FIGURE: TTR - 2D WIRING DIAGRAM - EX. CONDITION

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-06 FOR SURFACE STREET INTERSECTION LANE USE



LEGEND
AM (PM)

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 03A

EXISTING FREEWAY
TRAFFIC VOLUMES

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 03B

EXISTING FREEWAY TRAFFIC VOLUMES

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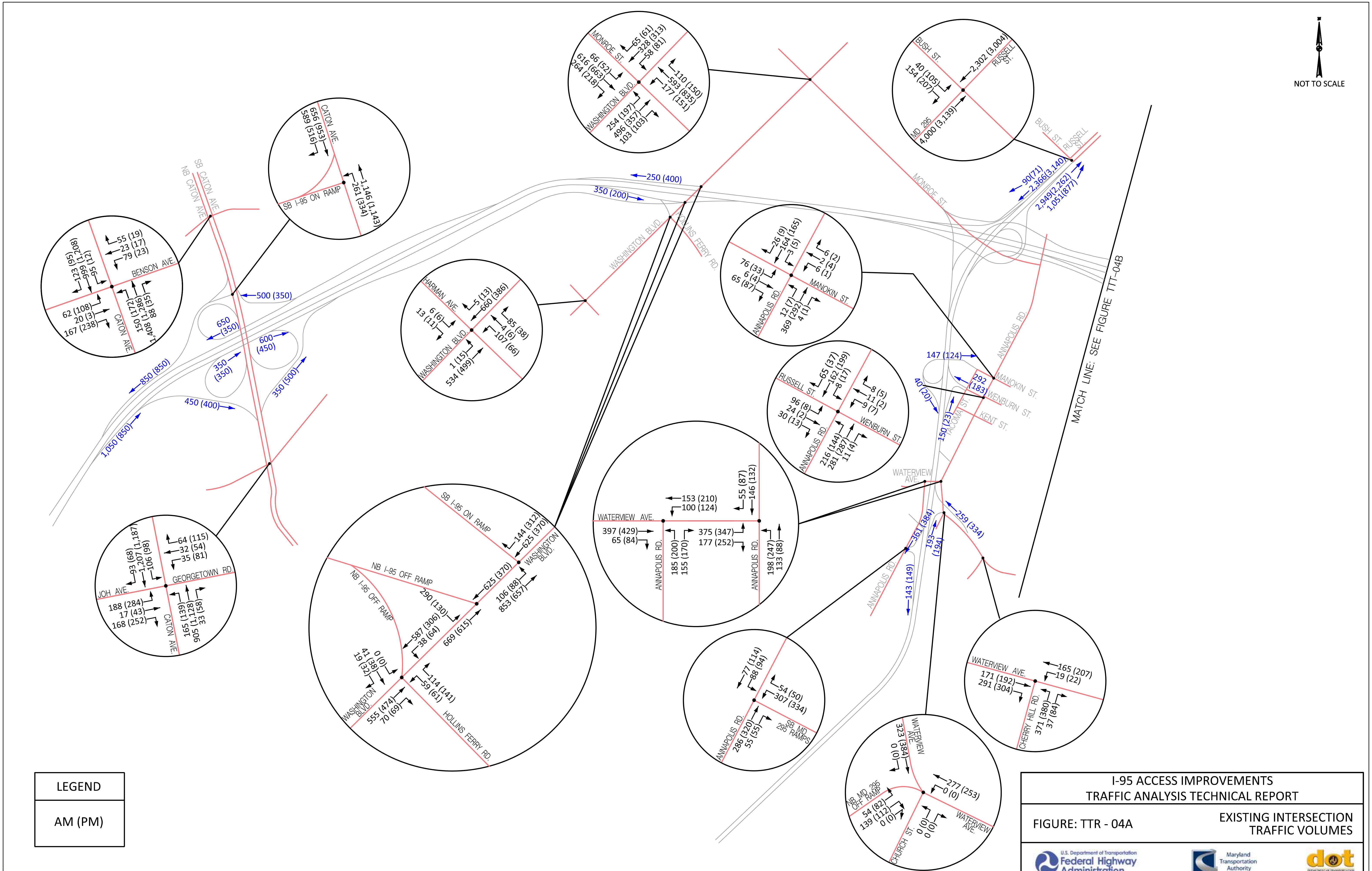

LEGEND

AM (PM)

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 04A

EXISTING INTERSECTION TRAFFIC VOLUMES

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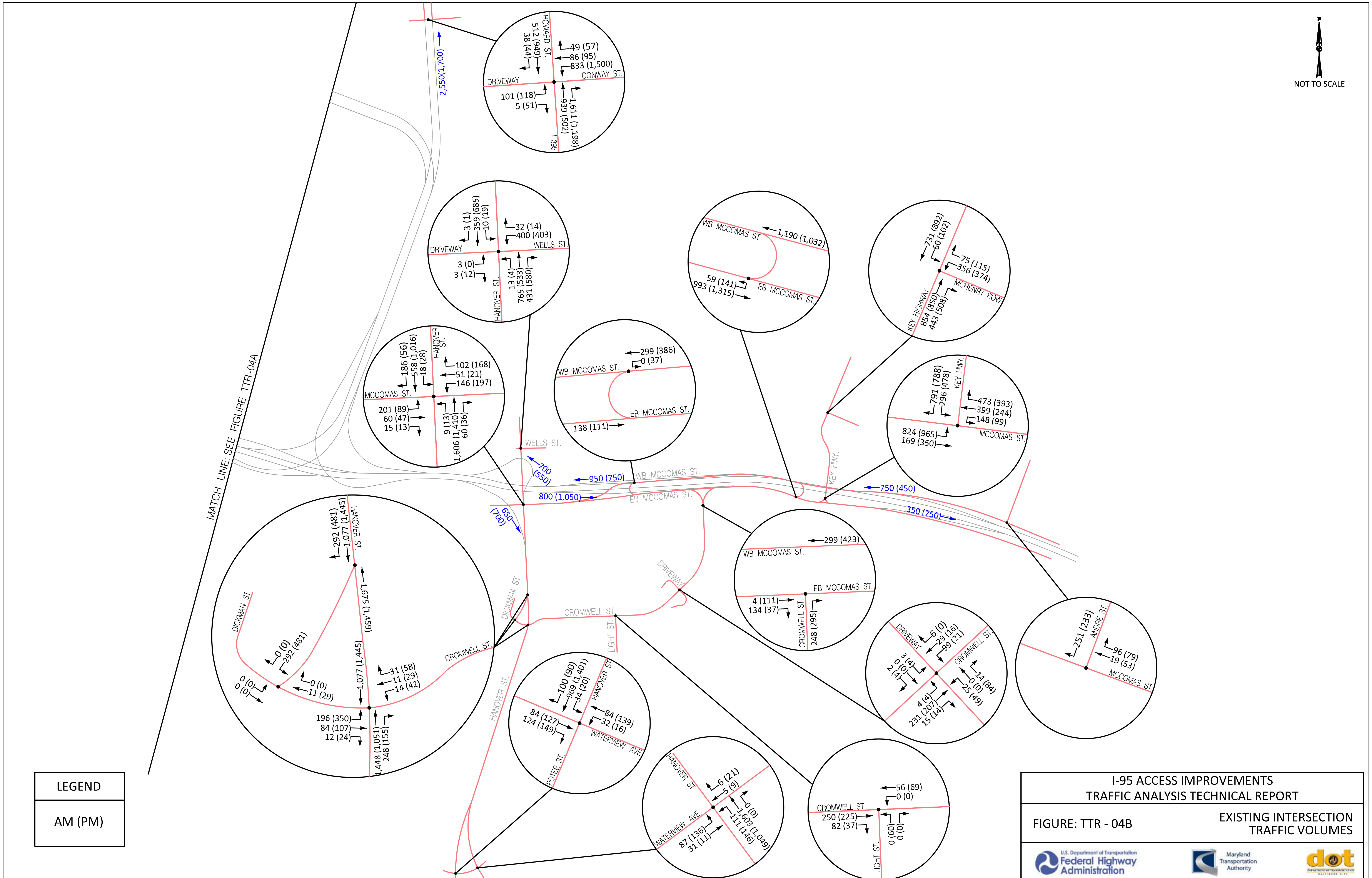

LEGEND
AM (PM)

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FIGURE: TTR - 04B

EXISTING INTERSECTION TRAFFIC VOLUMES

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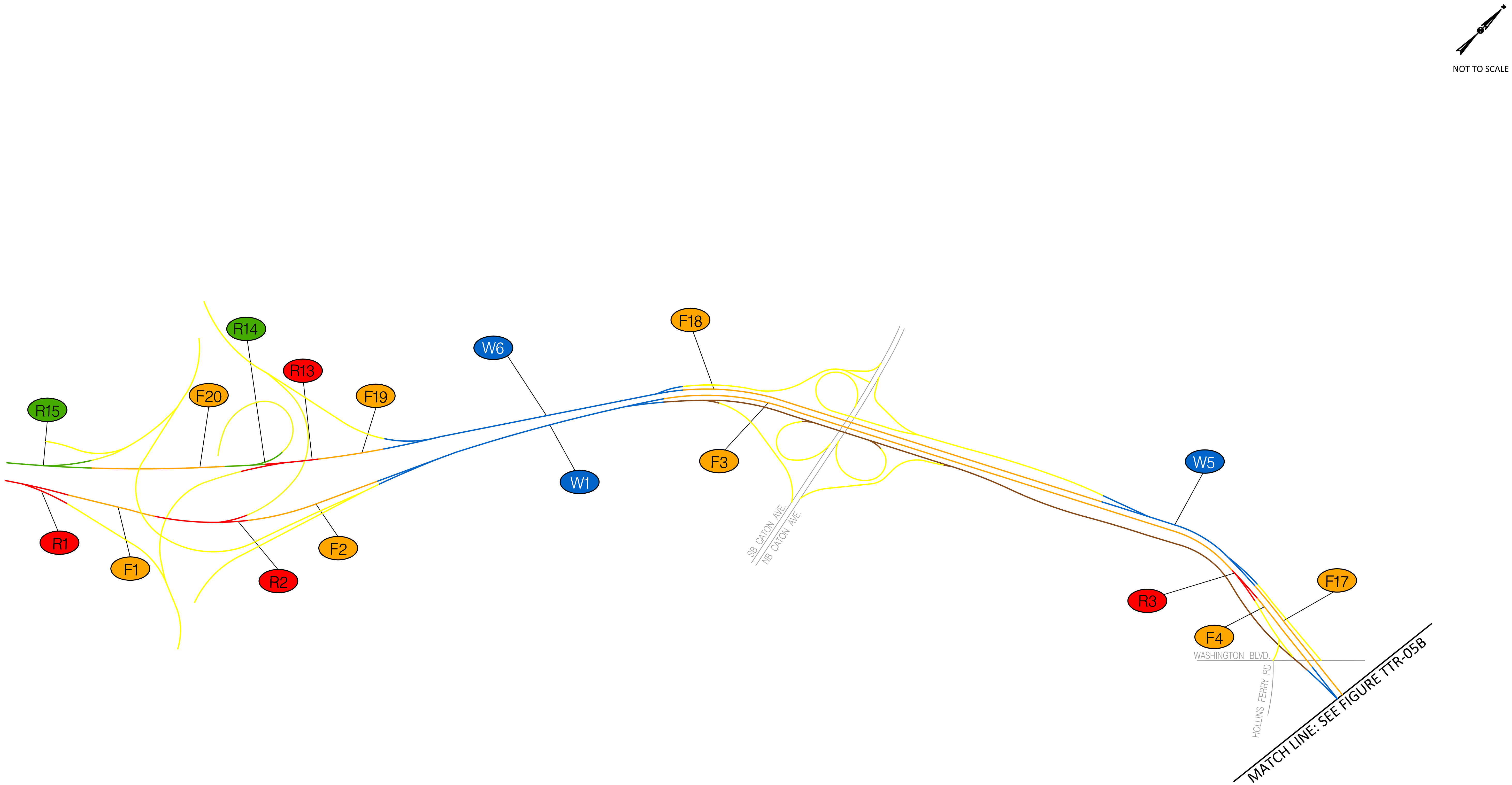

LEGEND

BASIC FREEWAY SEGMENT:		FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:		RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:		WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:			
FREEWAY RAMP:			
LOCAL RAMP			

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 05A

EXISTING / NO BUILD FREEWAY ANALYSIS SEGMENT LOCATION

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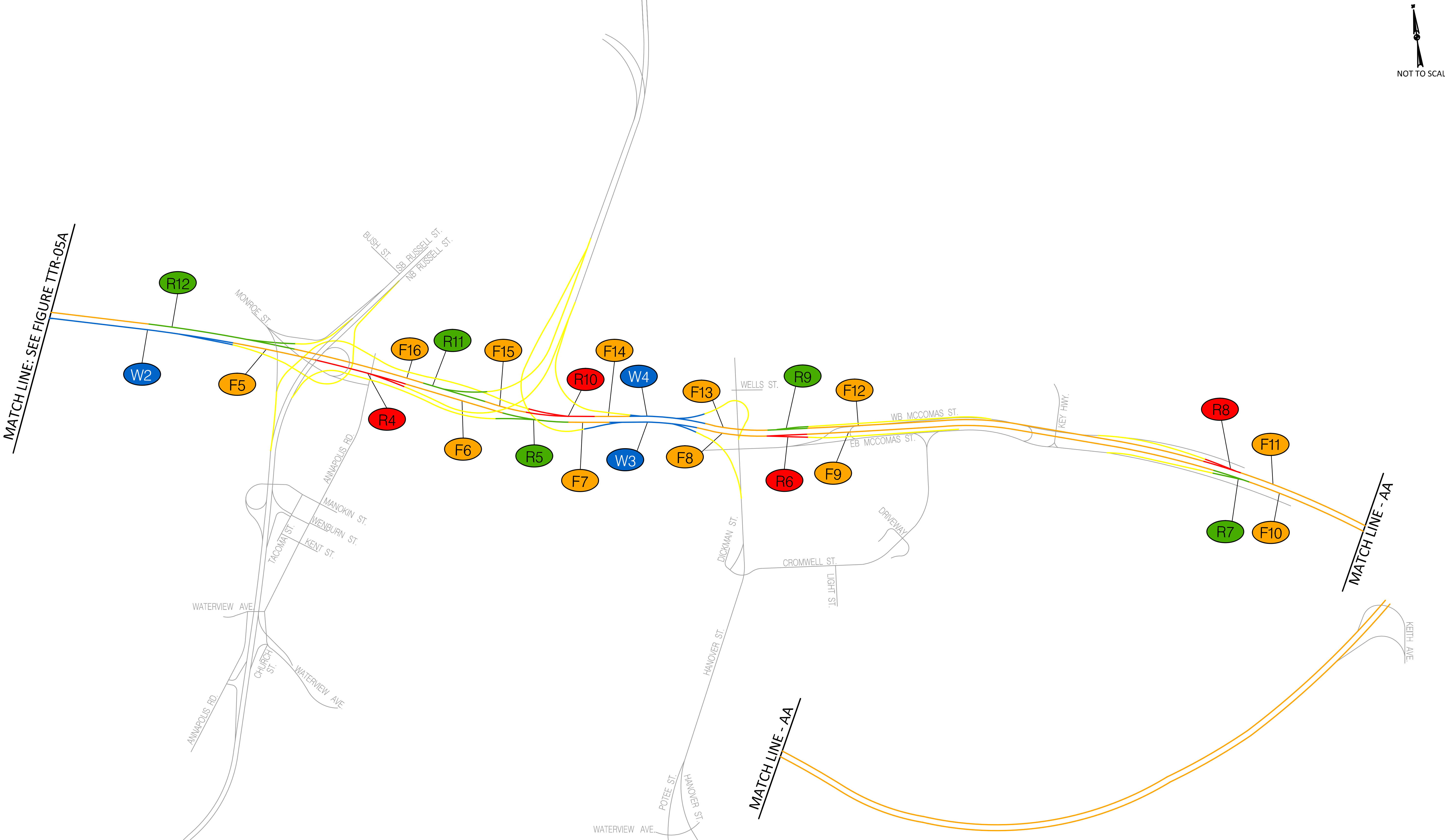

LEGEND

BASIC FREEWAY SEGMENT:	(orange line)	FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:	(blue line)	RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:	(red line)	WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:	(green line)		
FREEWAY RAMP:	(yellow line)		
LOCAL RAMP	(brown line)		

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 05B

EXISTING / NO BUILD FREEWAY ANALYSIS SEGMENT LOCATION

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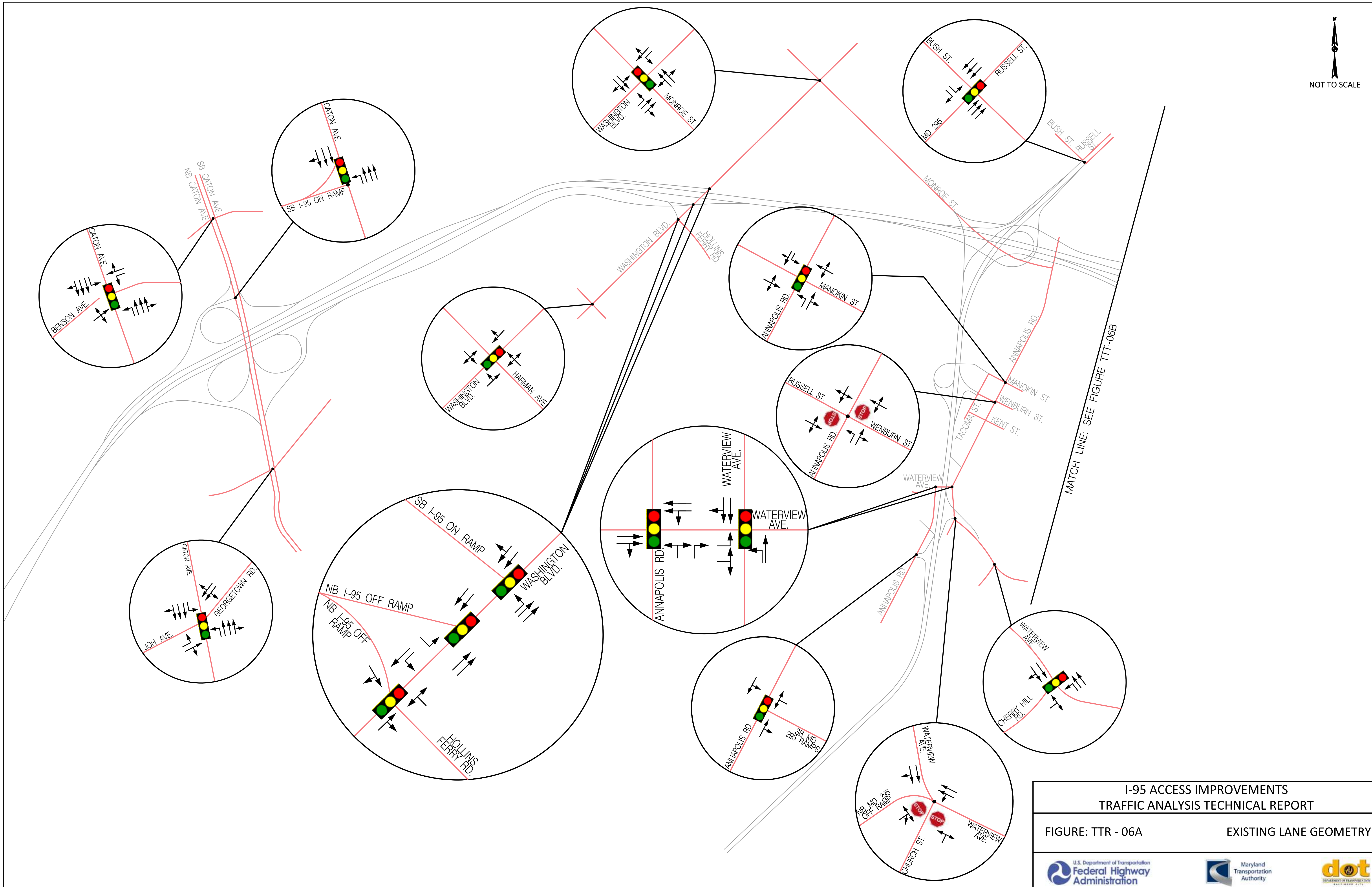
Maryland Transportation Authority



I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 06A

EXISTING LANE GEOMETRY

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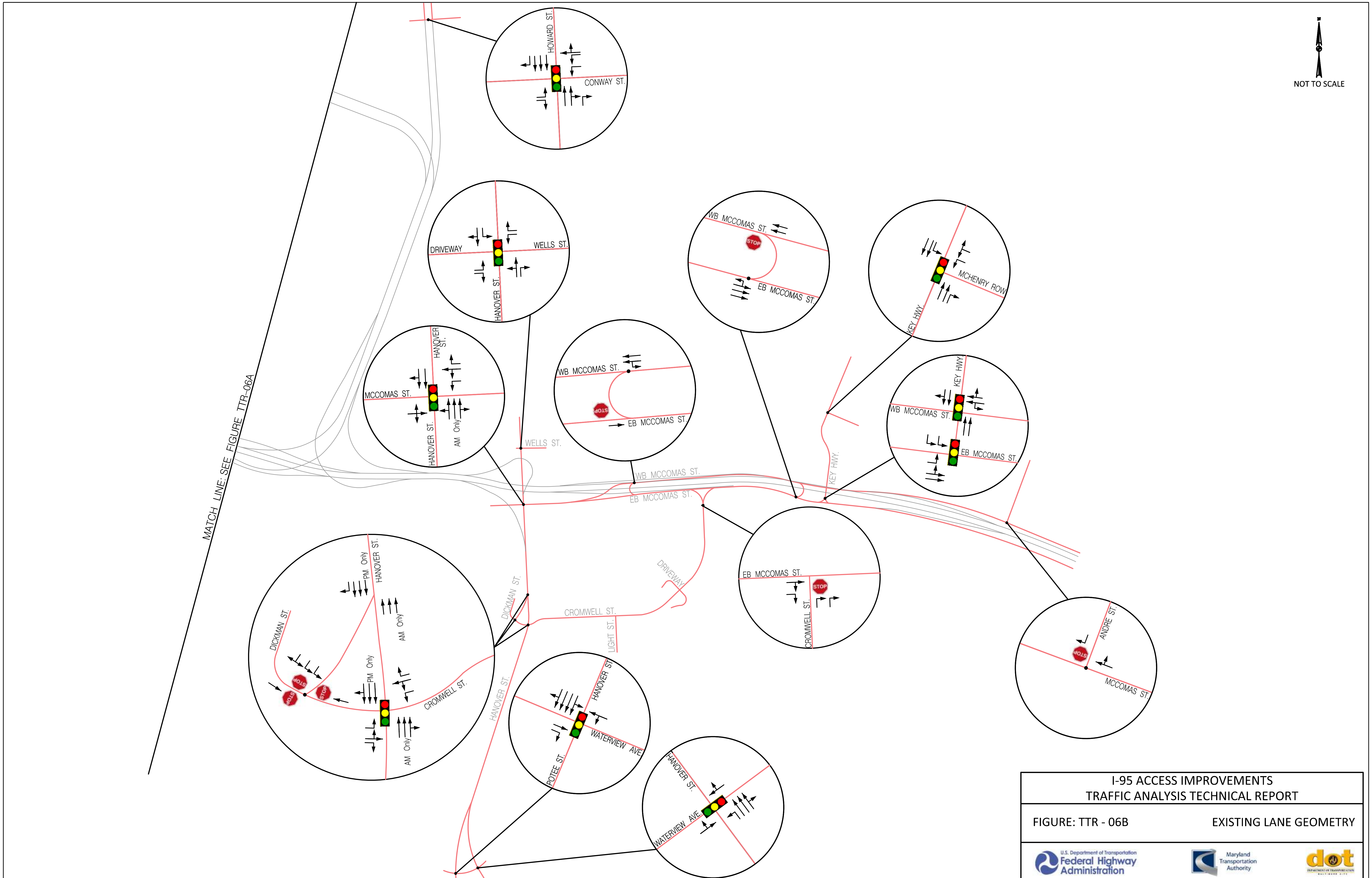
Maryland Transportation Authority



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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 06B

EXISTING LANE GEOMETRY

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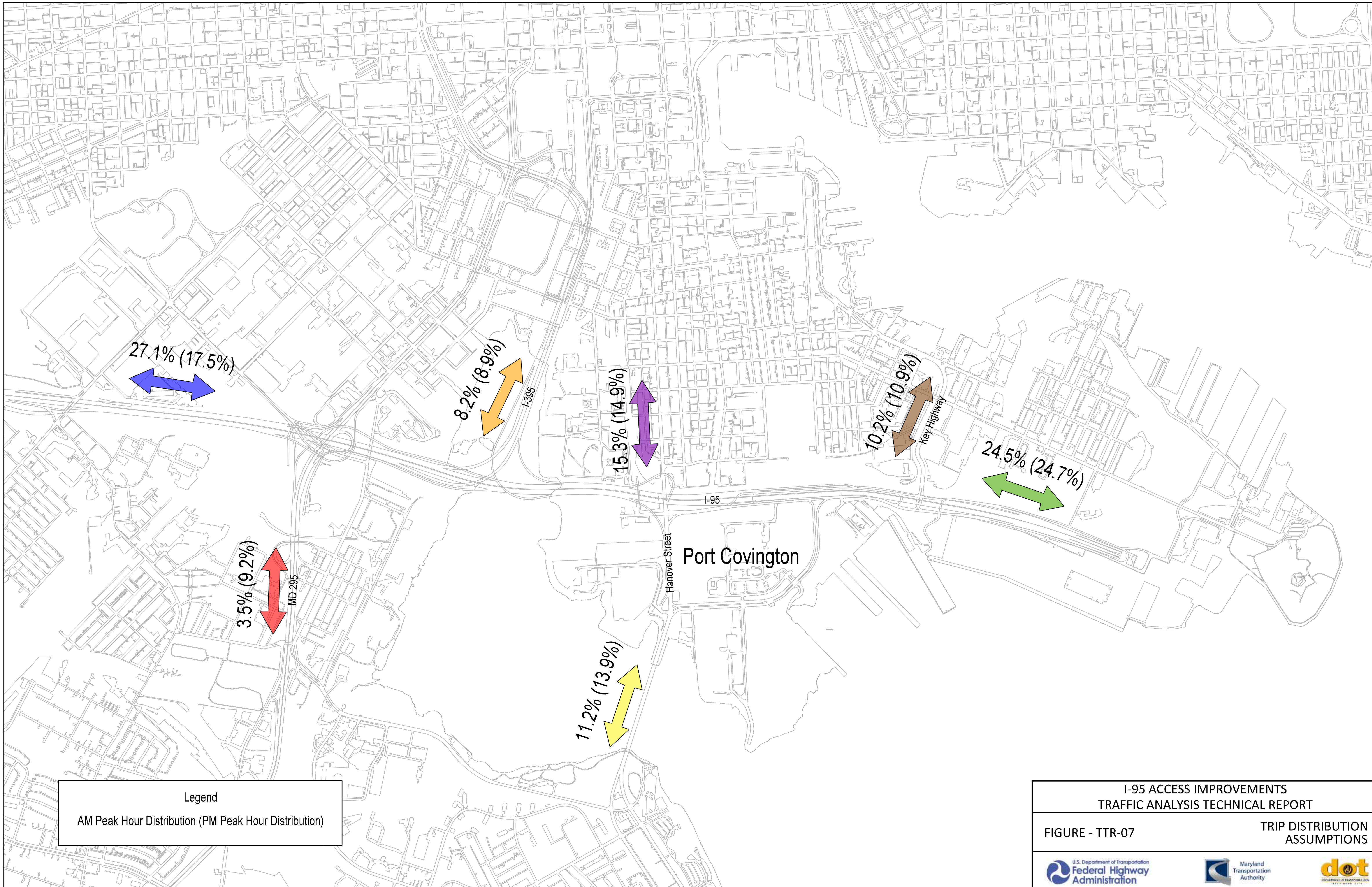
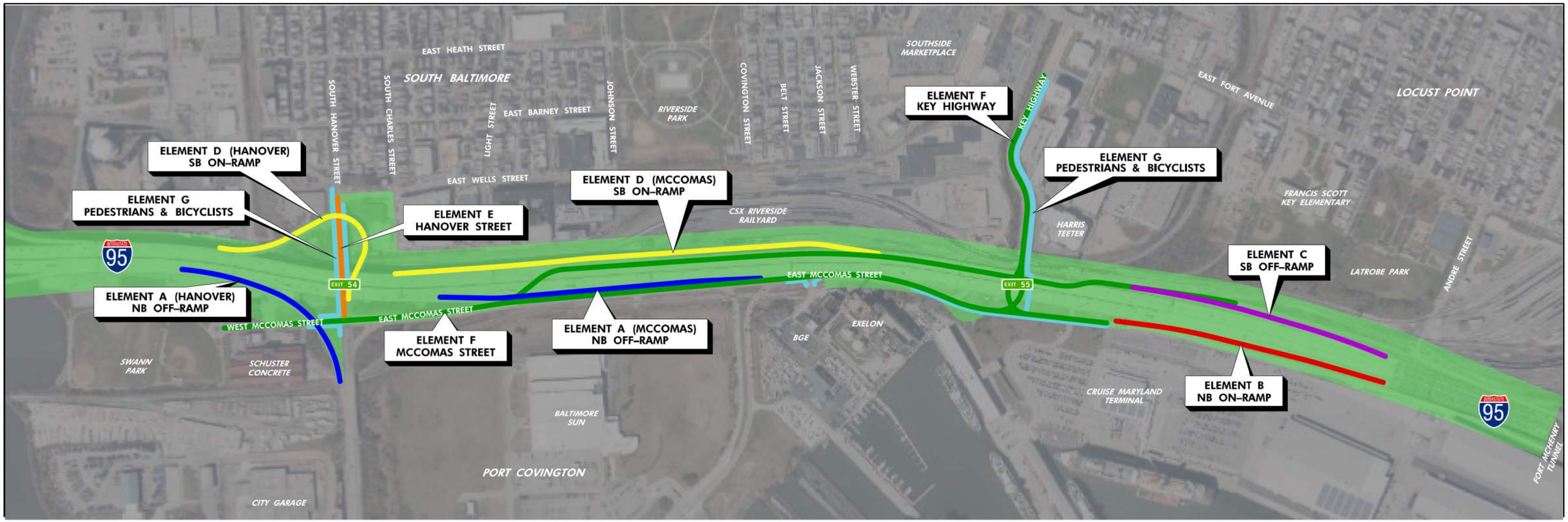
Maryland Transportation Authority



I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE - TTR-07

TRIP DISTRIBUTION ASSUMPTIONS



I-95 ACCESS IMPROVEMENTS TRAFFIC ANALYSIS TECHNICAL REPORT	
FIGURE: TTR-08	EXISTING CONDITIONS ELEMENTS KEY MAP

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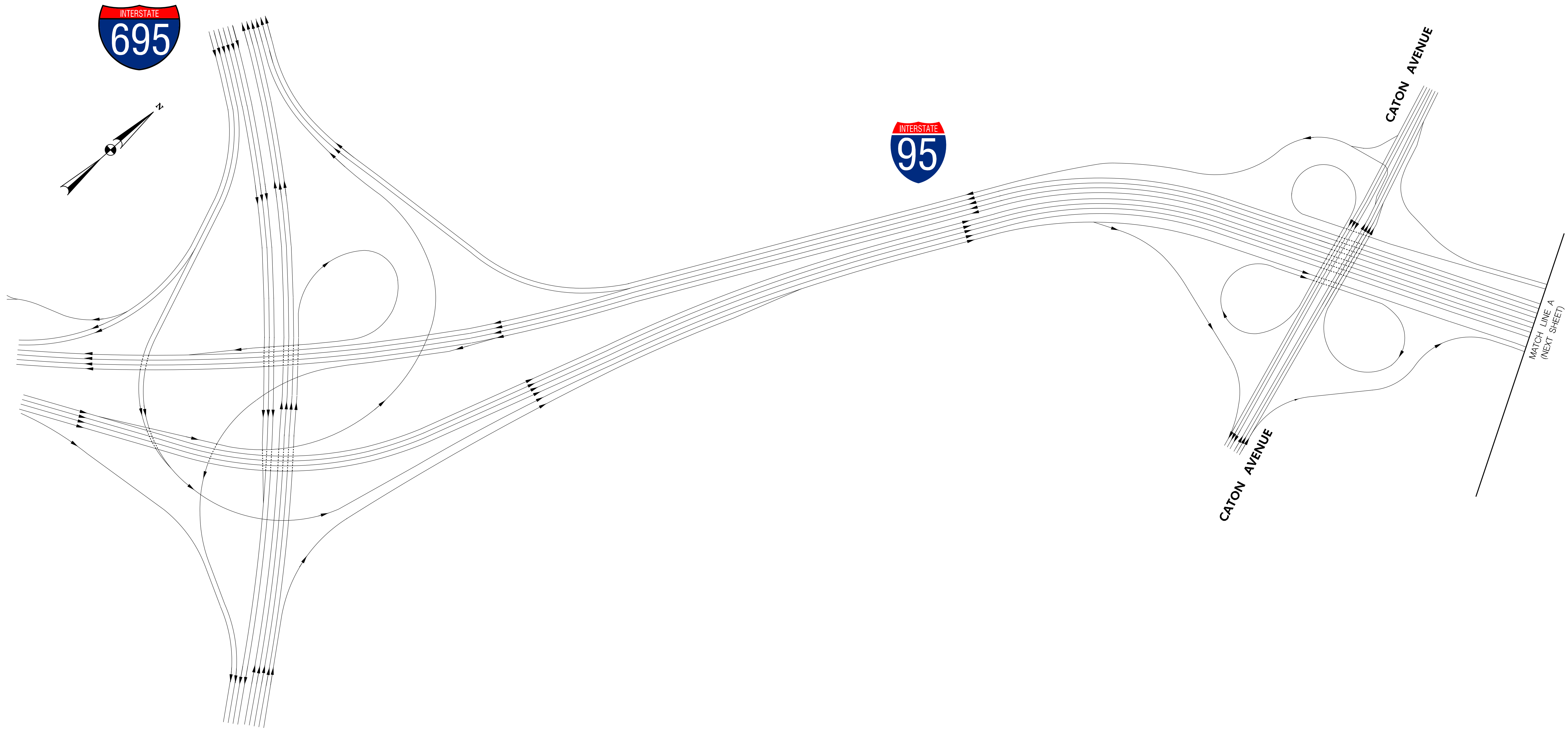

NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 9A WIRING DIAGRAM - ALTERNATIVE 1

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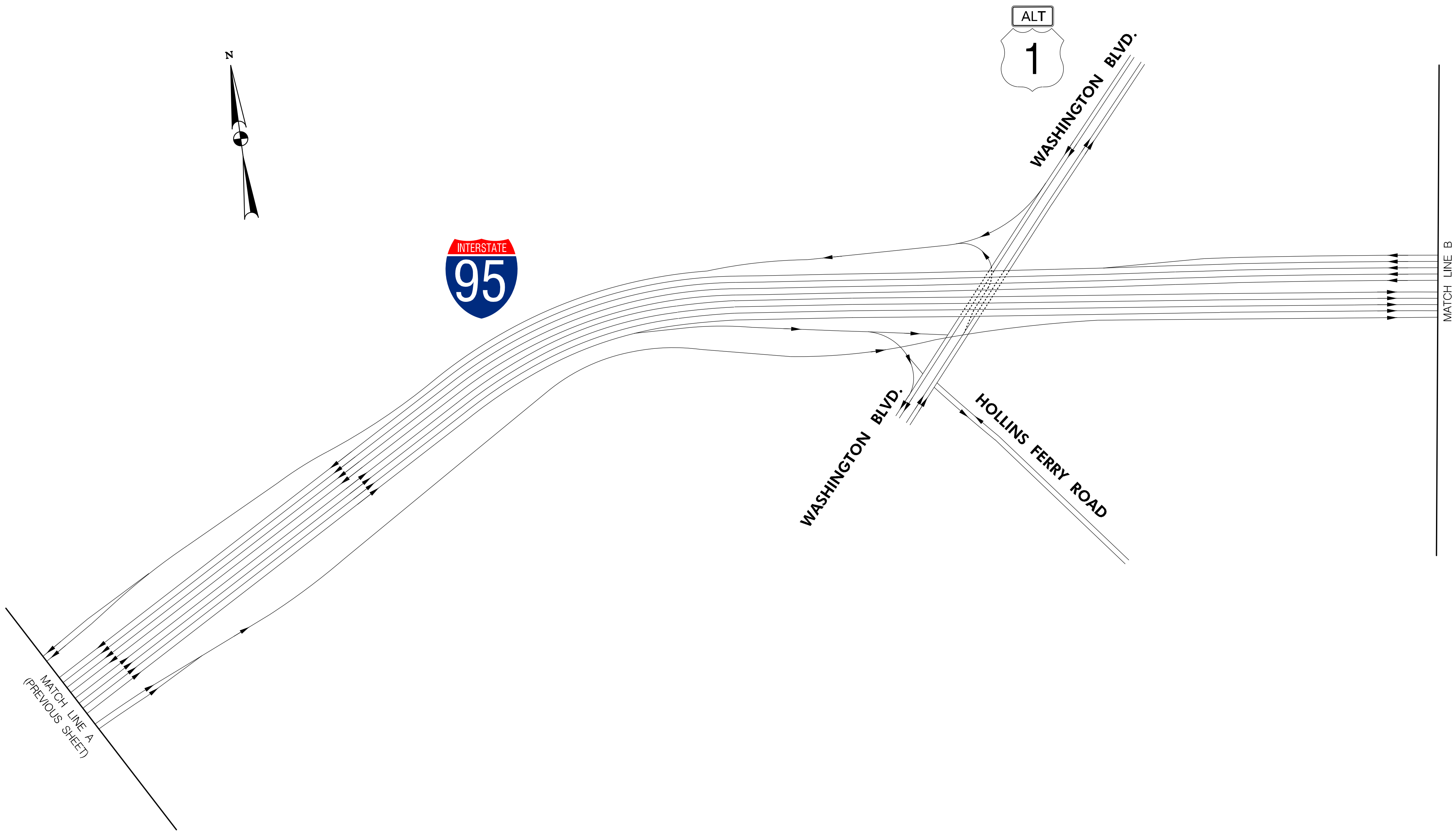
Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 9B WIRING DIAGRAM - ALTERNATIVE 1

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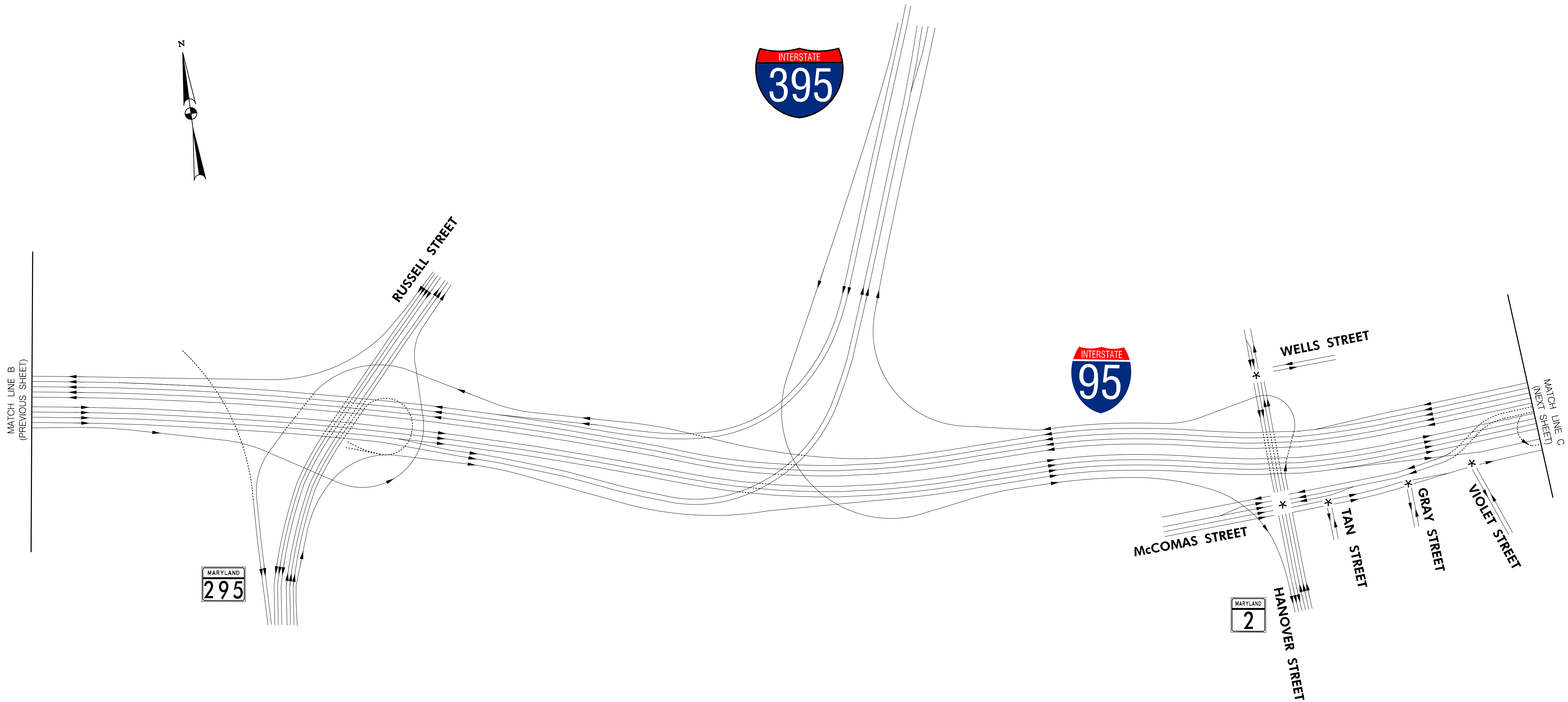
LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS TRAFFIC ANALYSIS TECHNICAL REPORT
FIGURE: TTR - 9C WIRING DIAGRAM - ALTERNATIVE 1
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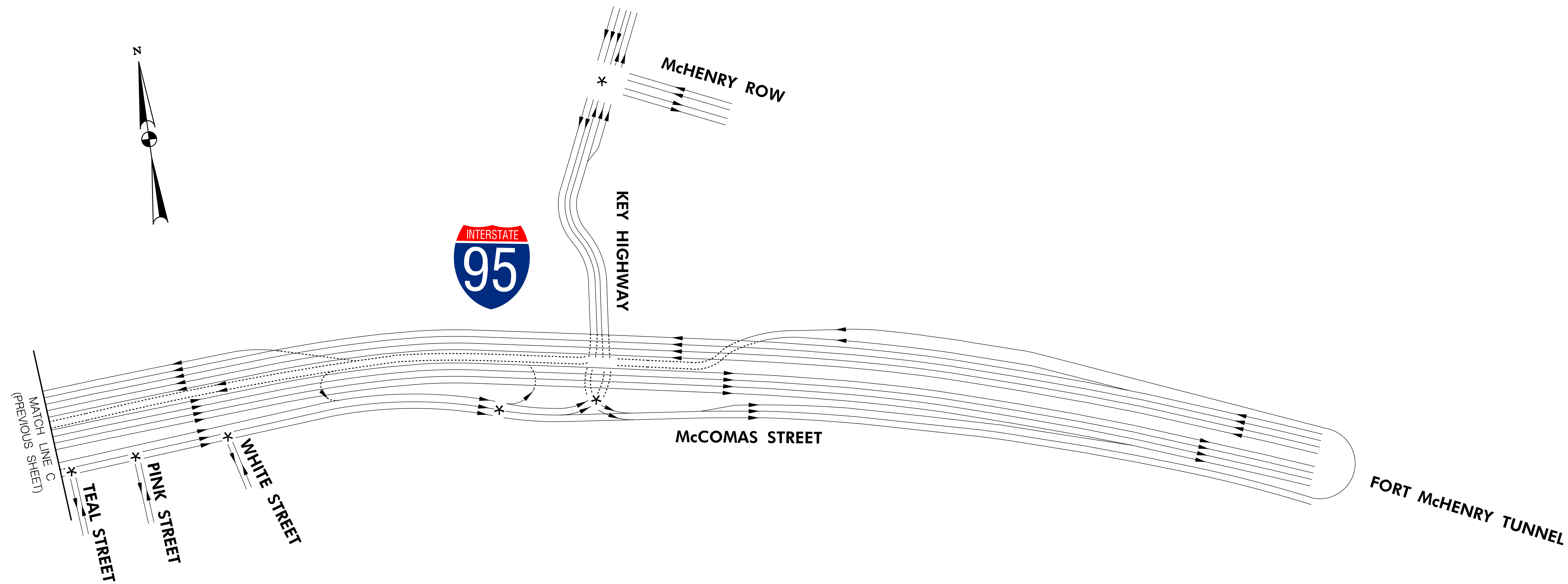
LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-12 FOR SURFACE STREET INTERSECTION LANE USE



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 9D WIRING DIAGRAM - ALTERNATIVE 1

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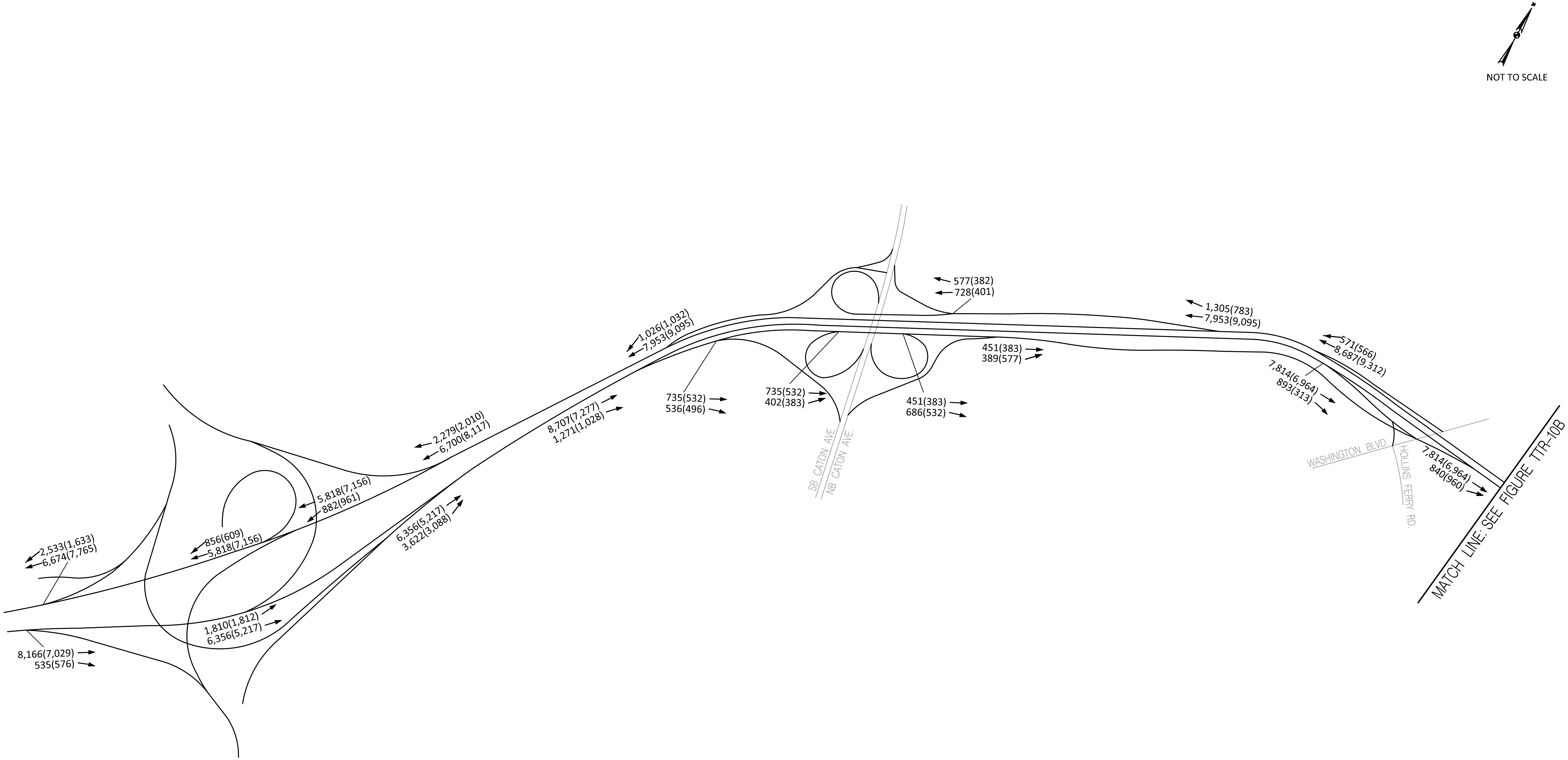
LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR–12 FOR SURFACE STREET INTERSECTION LANE USE



LEGEND
AM (PM)

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 10A

2040 NO BUILD ALTERNATIVE
FREEWAY TRAFFIC VOLUMES

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Maryland Transportation Authority
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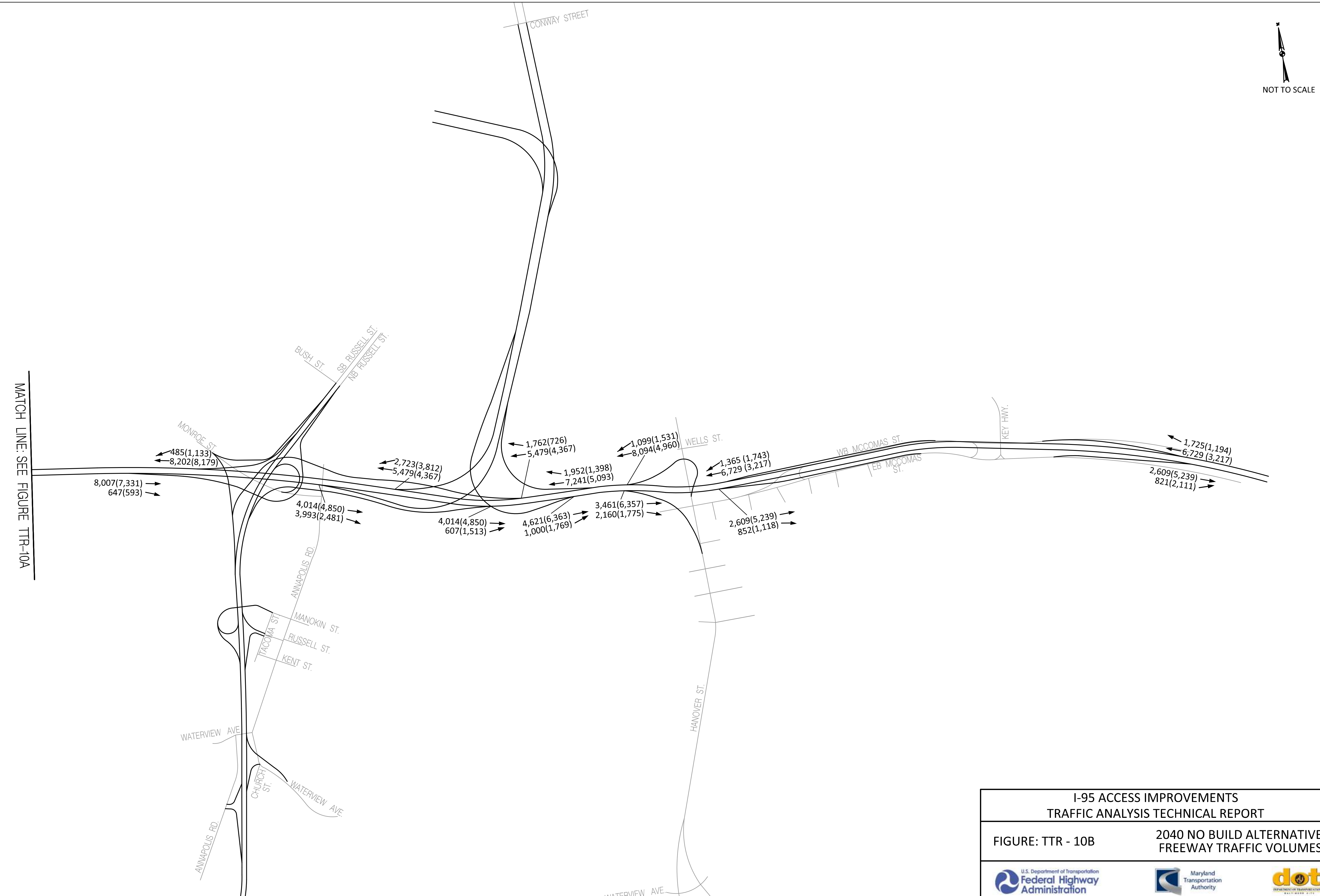

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 10B

2040 NO BUILD ALTERNATIVE
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

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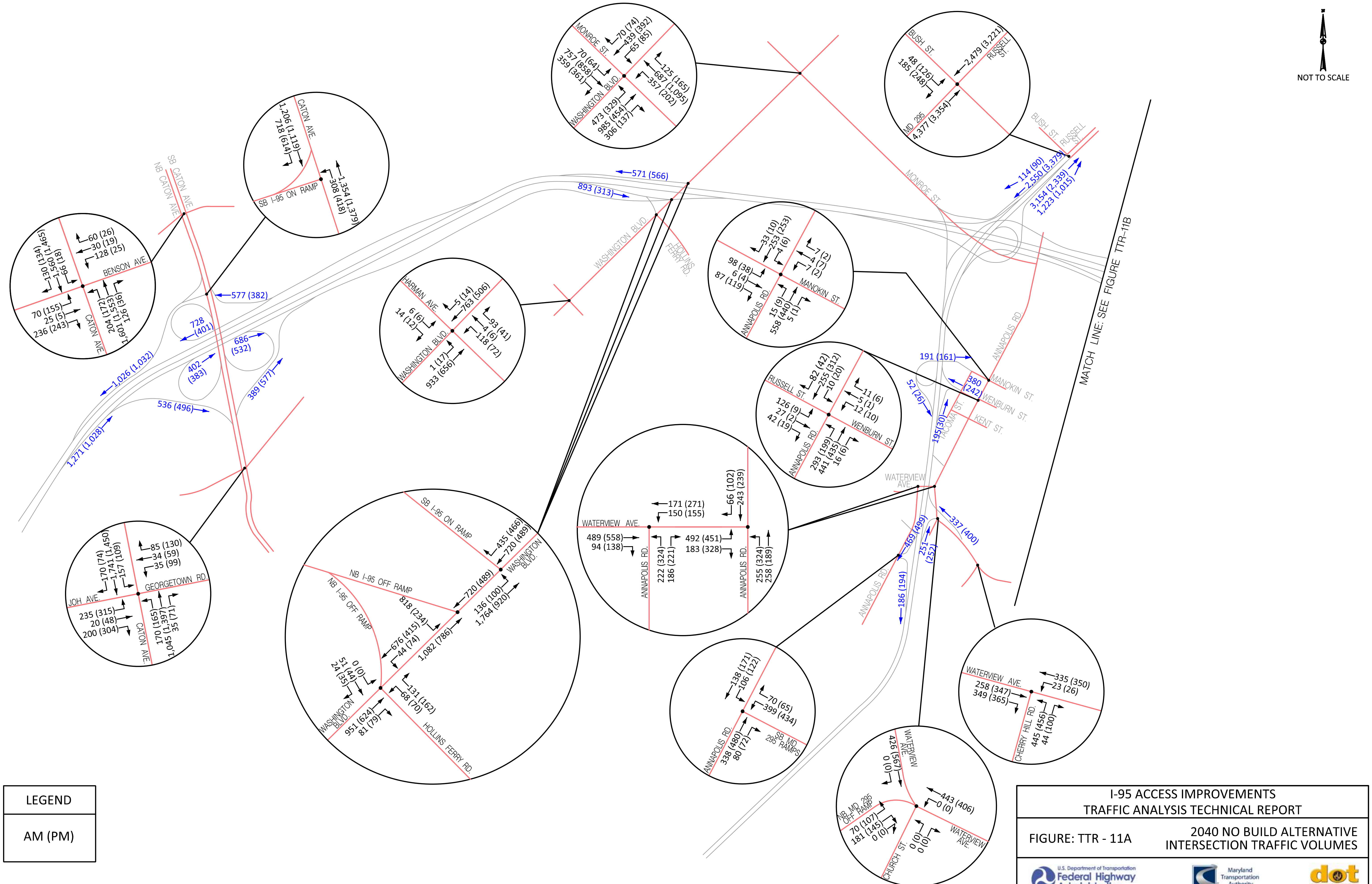


LEGEND

AM (PM)

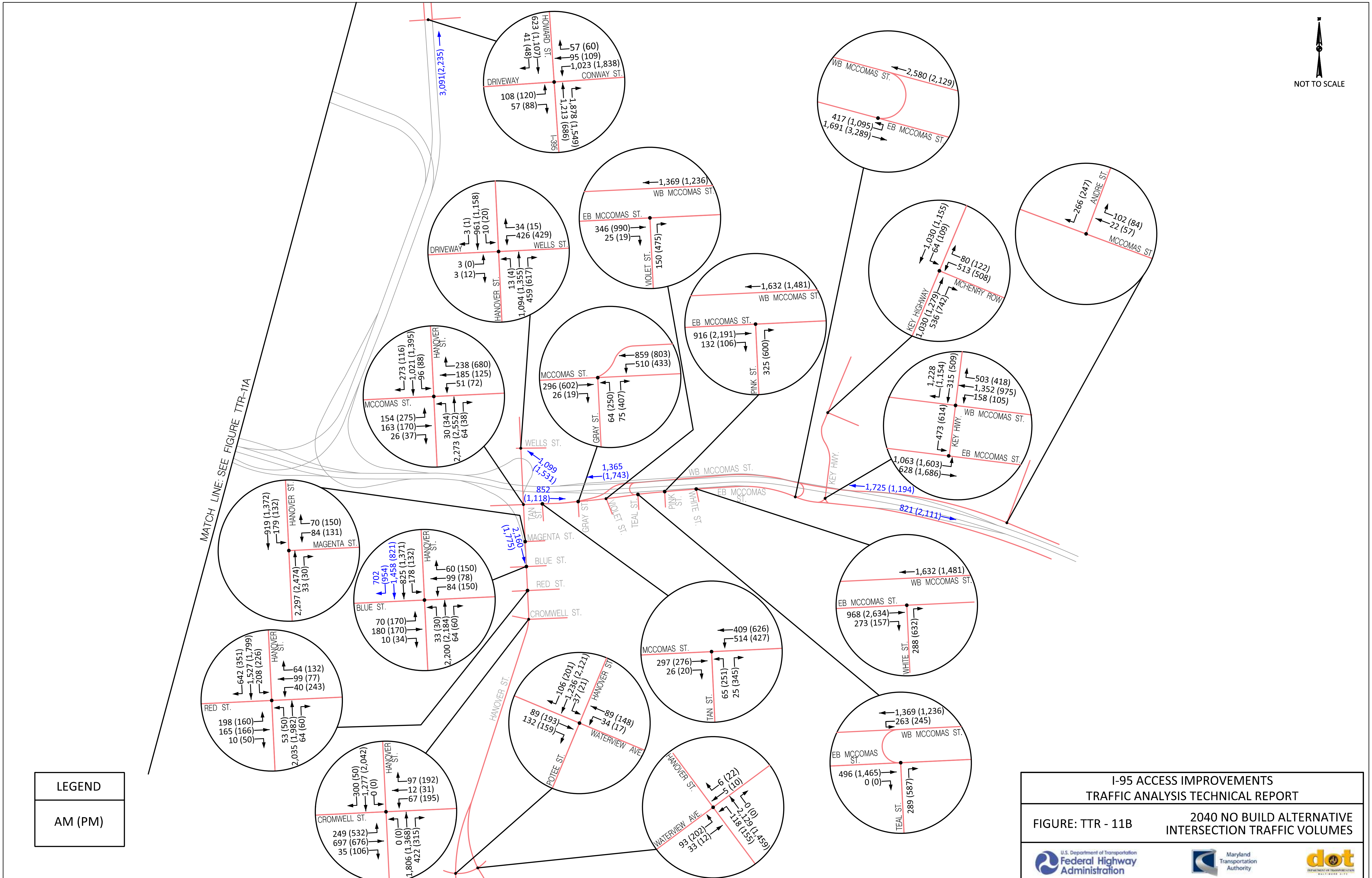
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 11A

2040 NO BUILD ALTERNATIVE
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

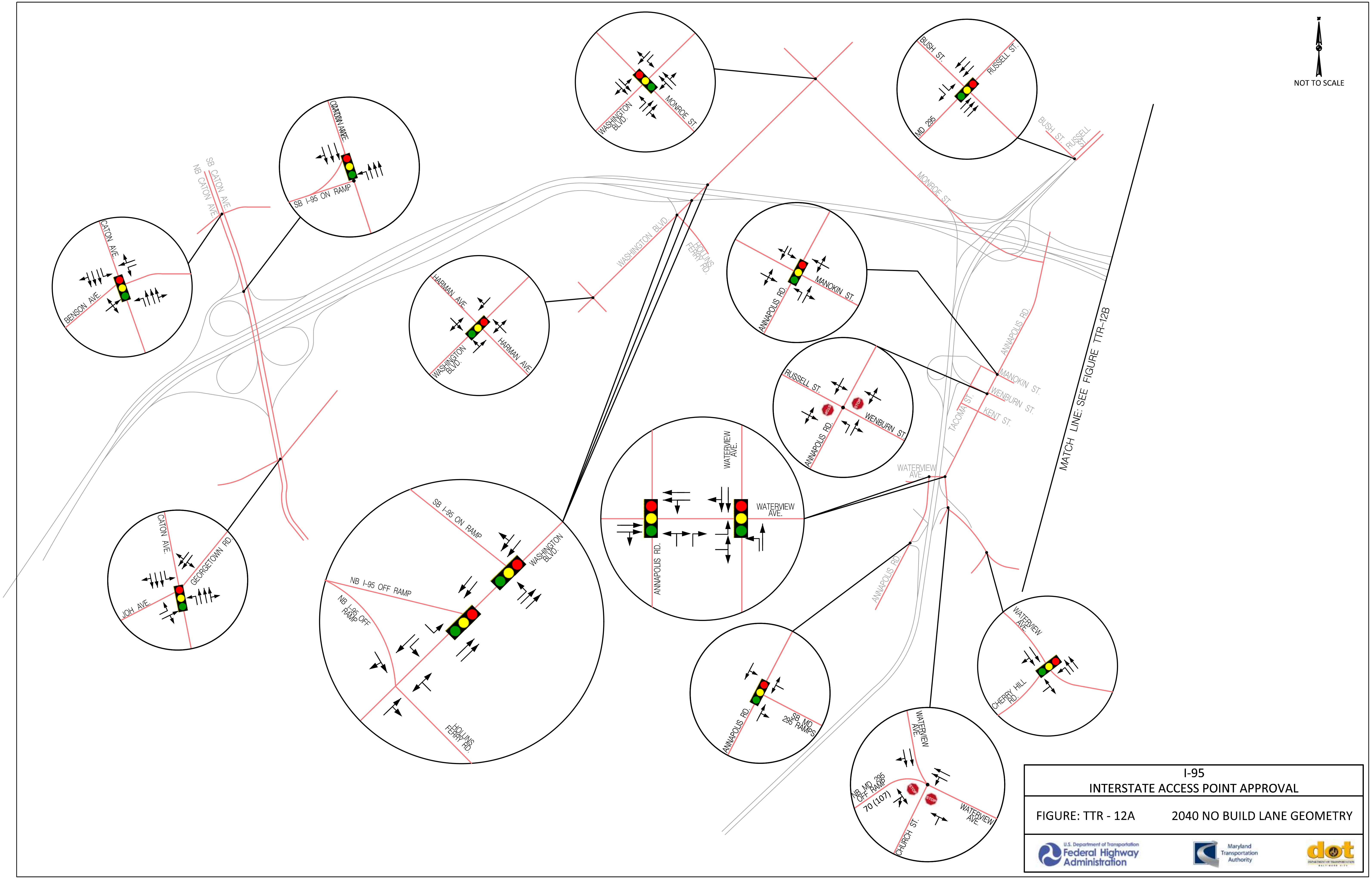
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 11B

2040 NO BUILD ALTERNATIVE
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



I-95

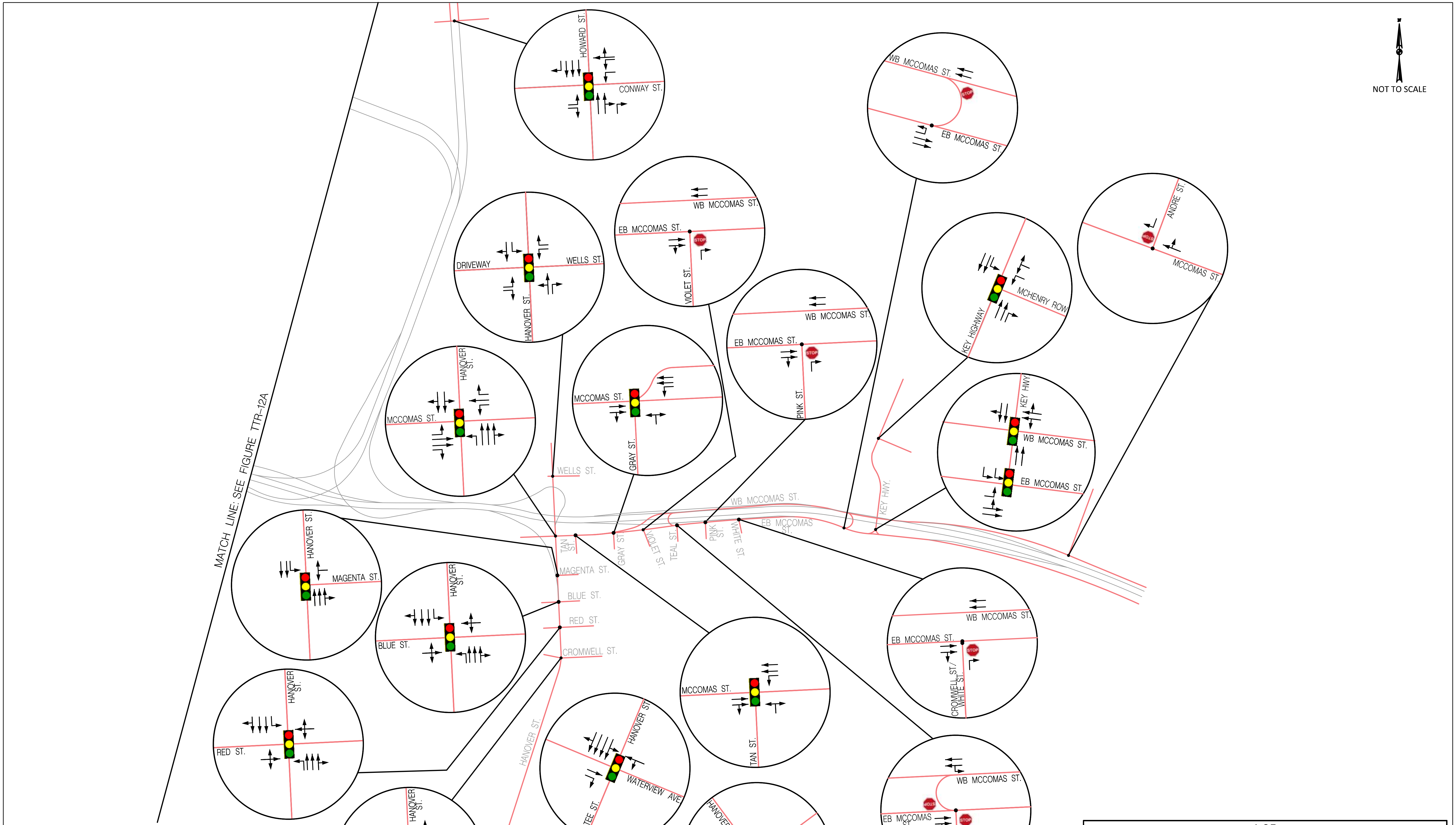
INTERSTATE ACCESS POINT APPROVAL

FIGURE: TTR - 12A

2040 NO BUILD LANE GEOMETRY

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



I-95

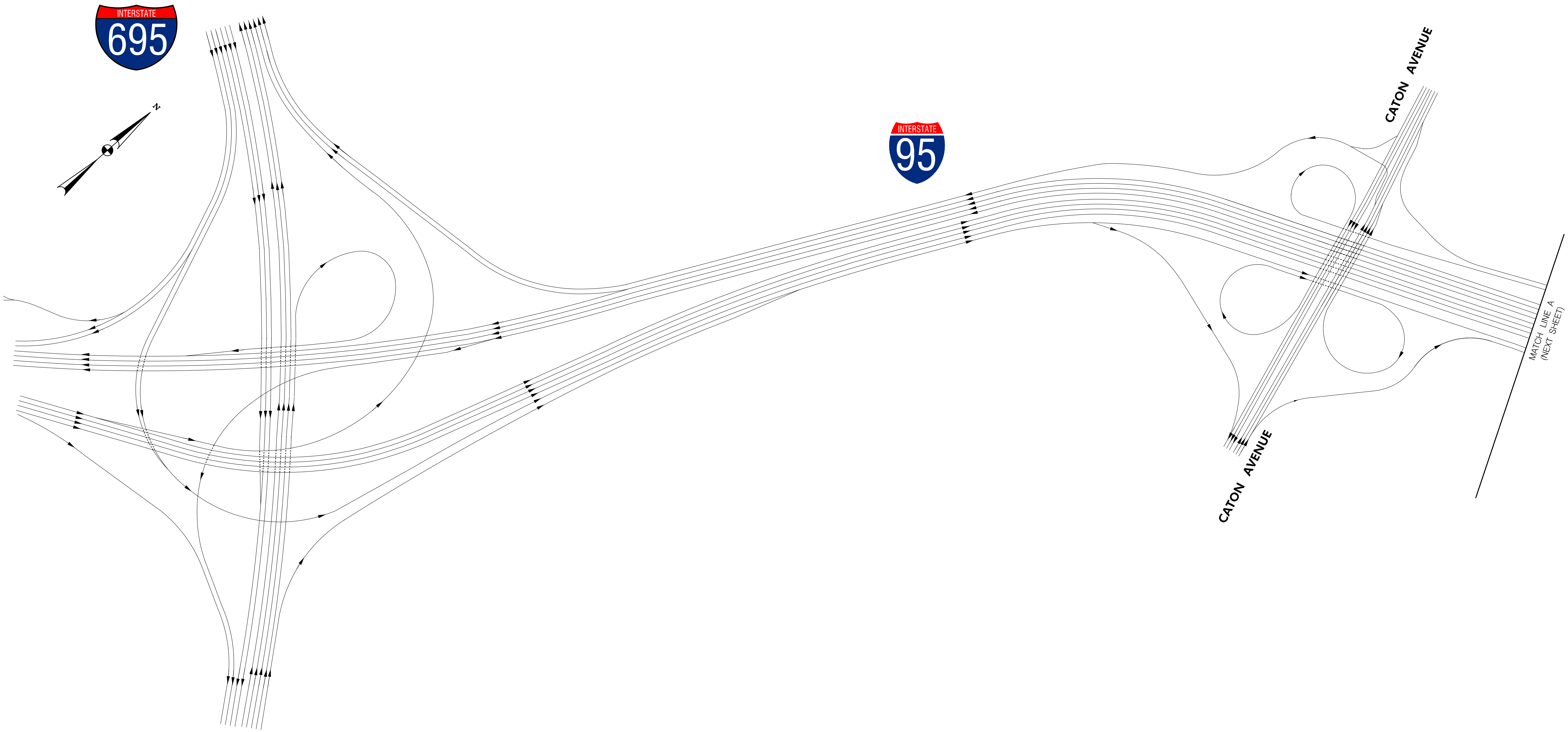
INTERSTATE ACCESS POINT APPROVAL

FIGURE: TTR - 12B

2040 NO BUILD LANE GEOMETRY

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 13A WIRING DIAGRAM - ALTERNATIVE 2

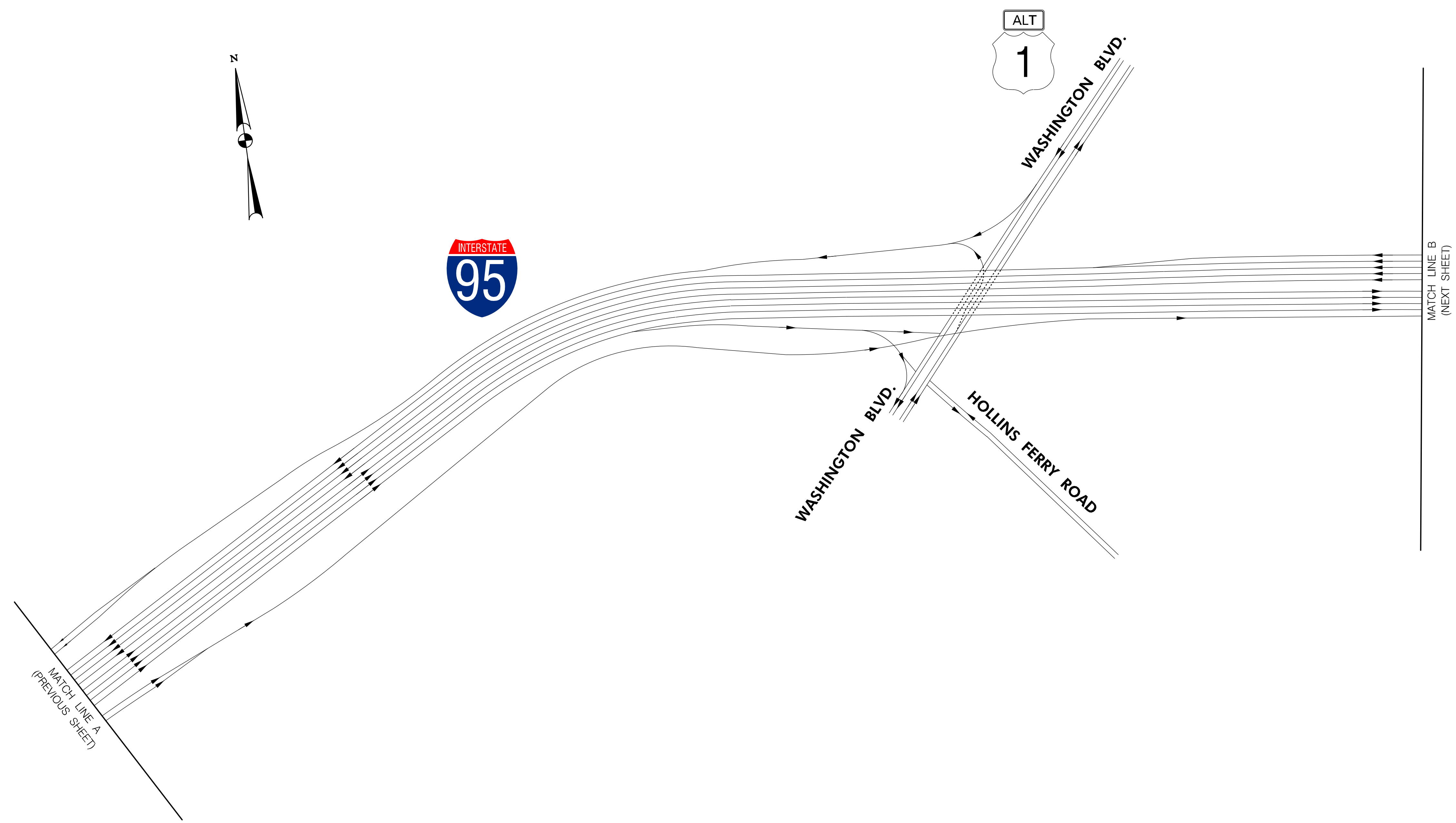
U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 13B WIRING DIAGRAM - ALTERNATIVE 2

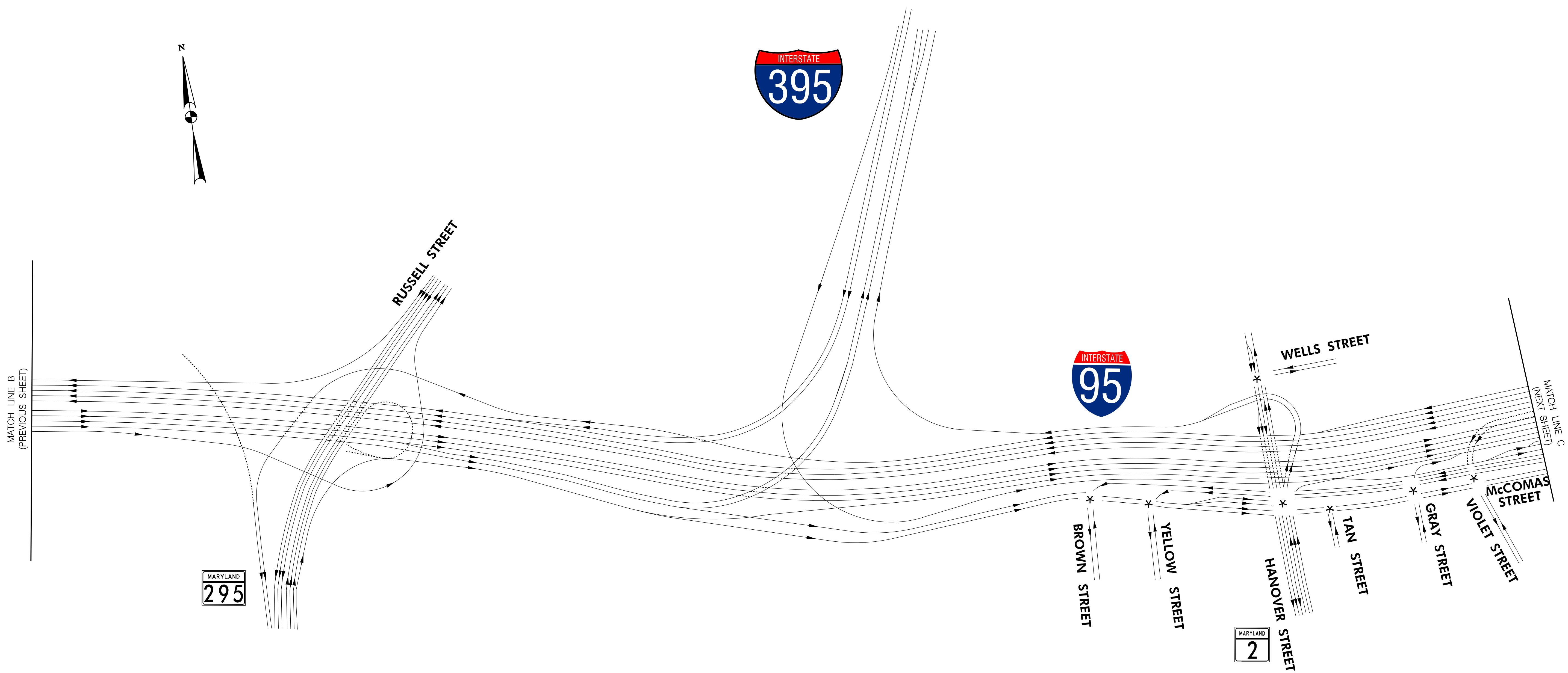
U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 13C WIRING DIAGRAM - ALTERNATIVE 2

U.S. Department of Transportation Federal Highway Administration

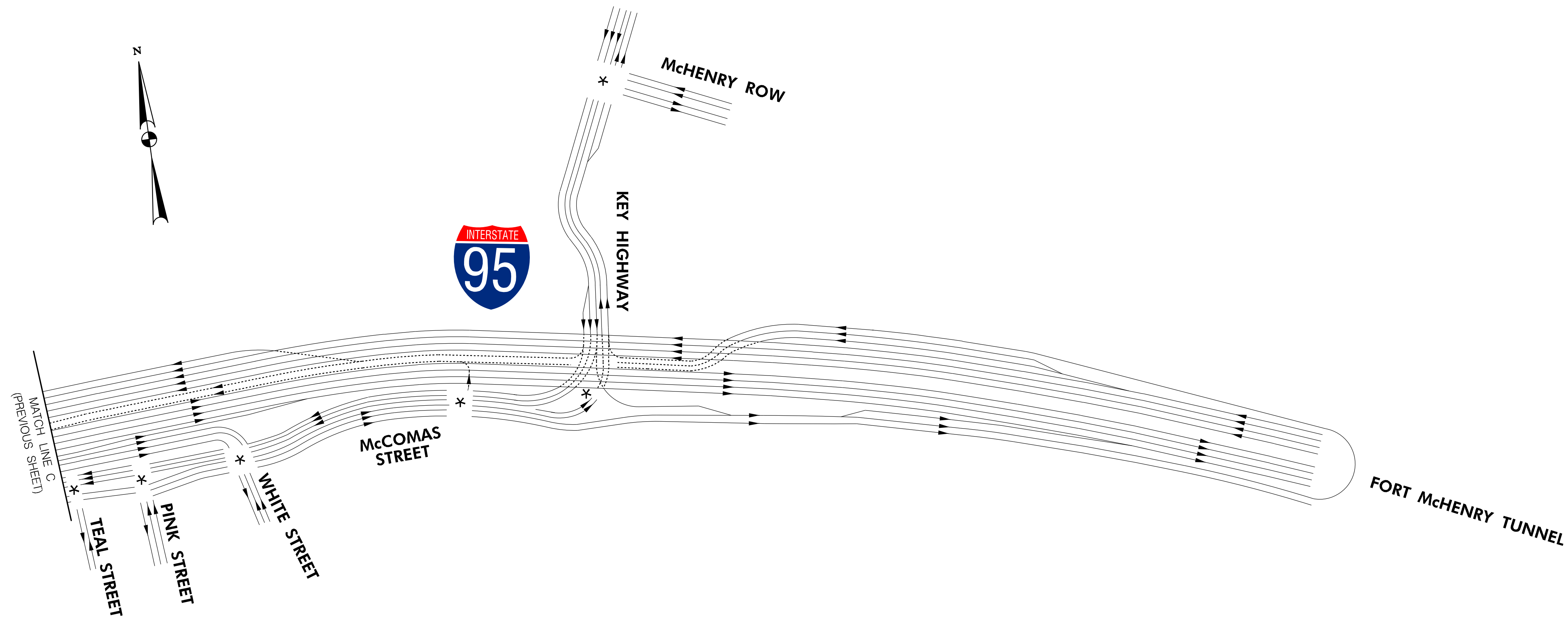
Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR–17 FOR SURFACE STREET INTERSECTION LANE USE



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

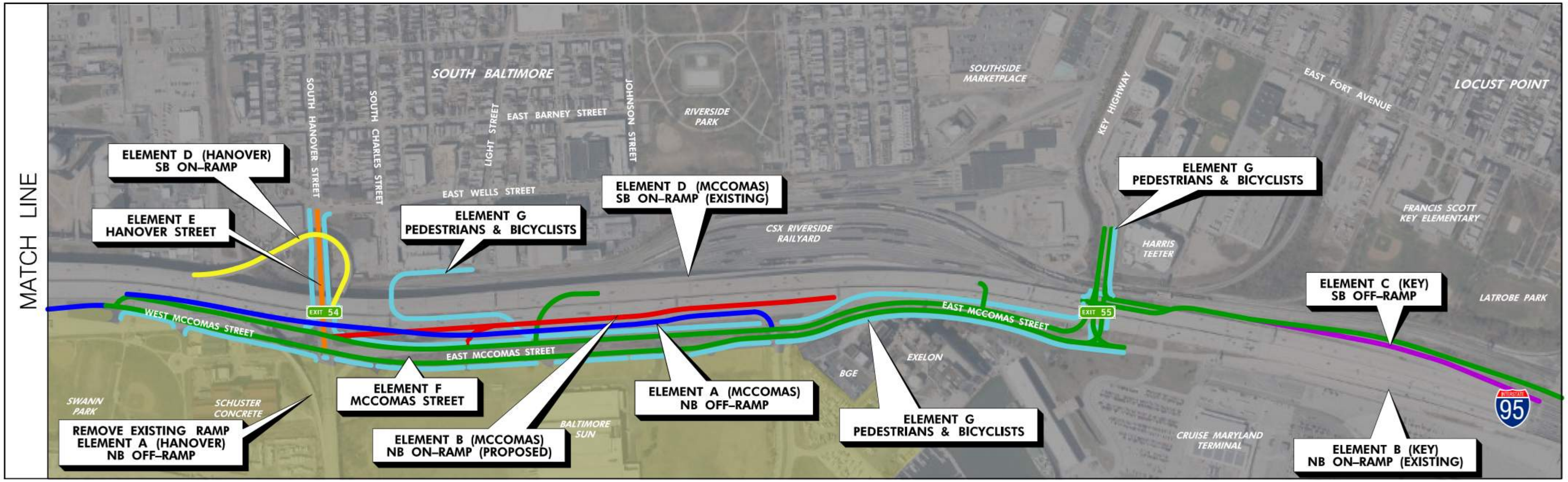
ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR–17 FOR SURFACE STREET INTERSECTION LANE USE

NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 13D WIRING DIAGRAM - ALTERNATIVE 2



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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-14

ALTERNATIVE 2
ELEMENTS KEY MAP

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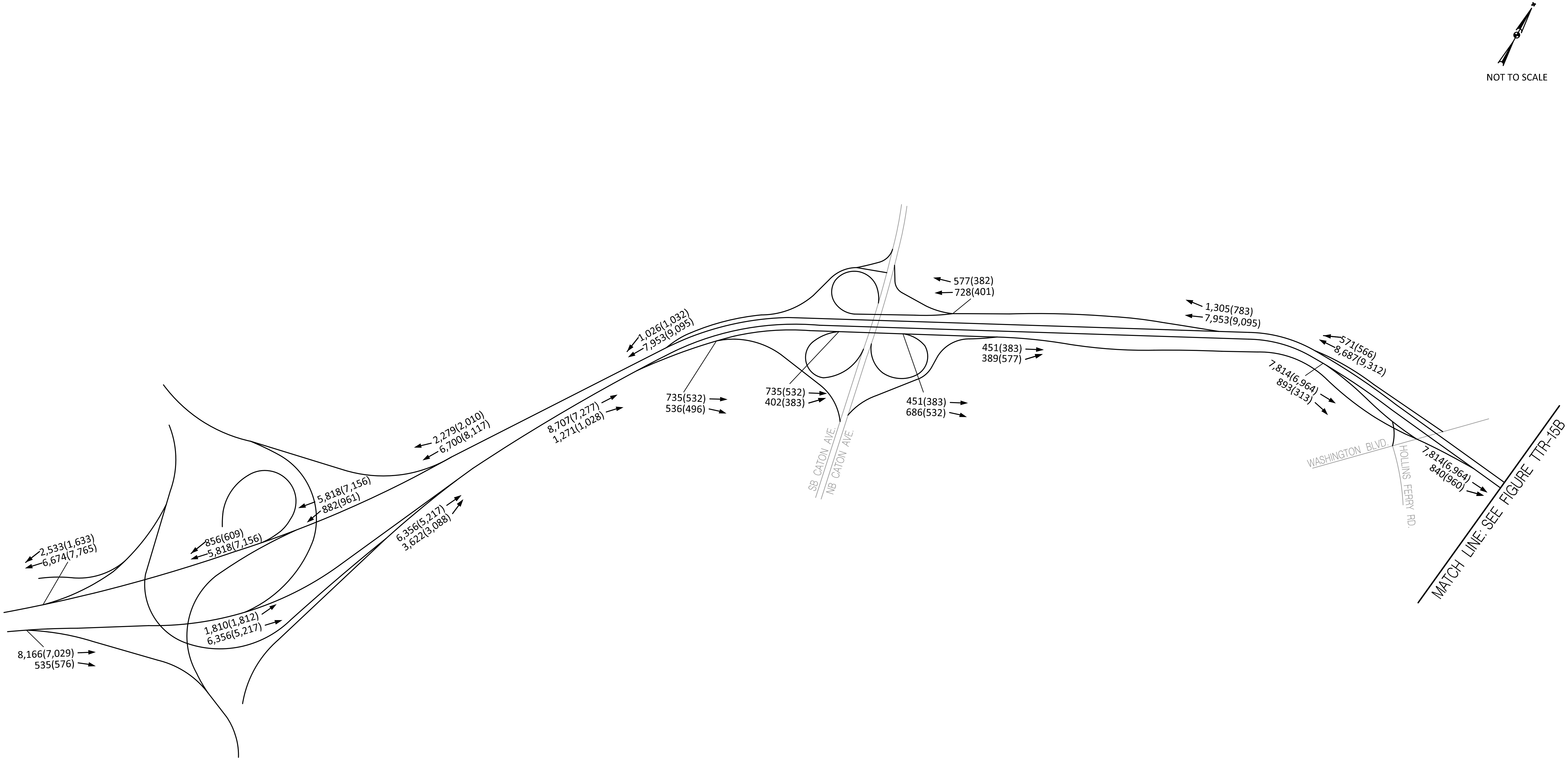
Maryland Transportation Authority



LEGEND

AM (PM)

New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

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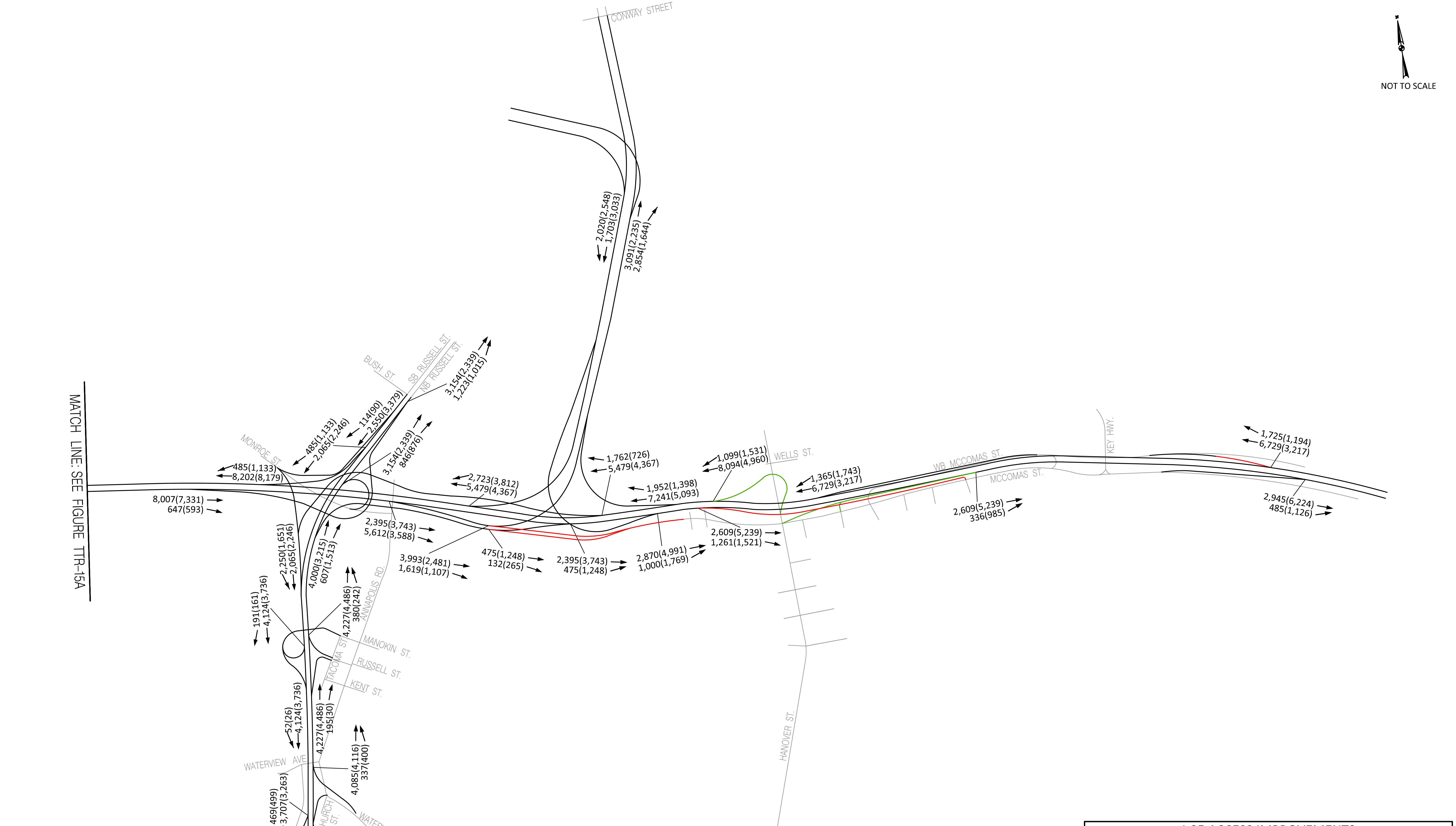
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 15A

2040 ALTERNATIVE 2
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

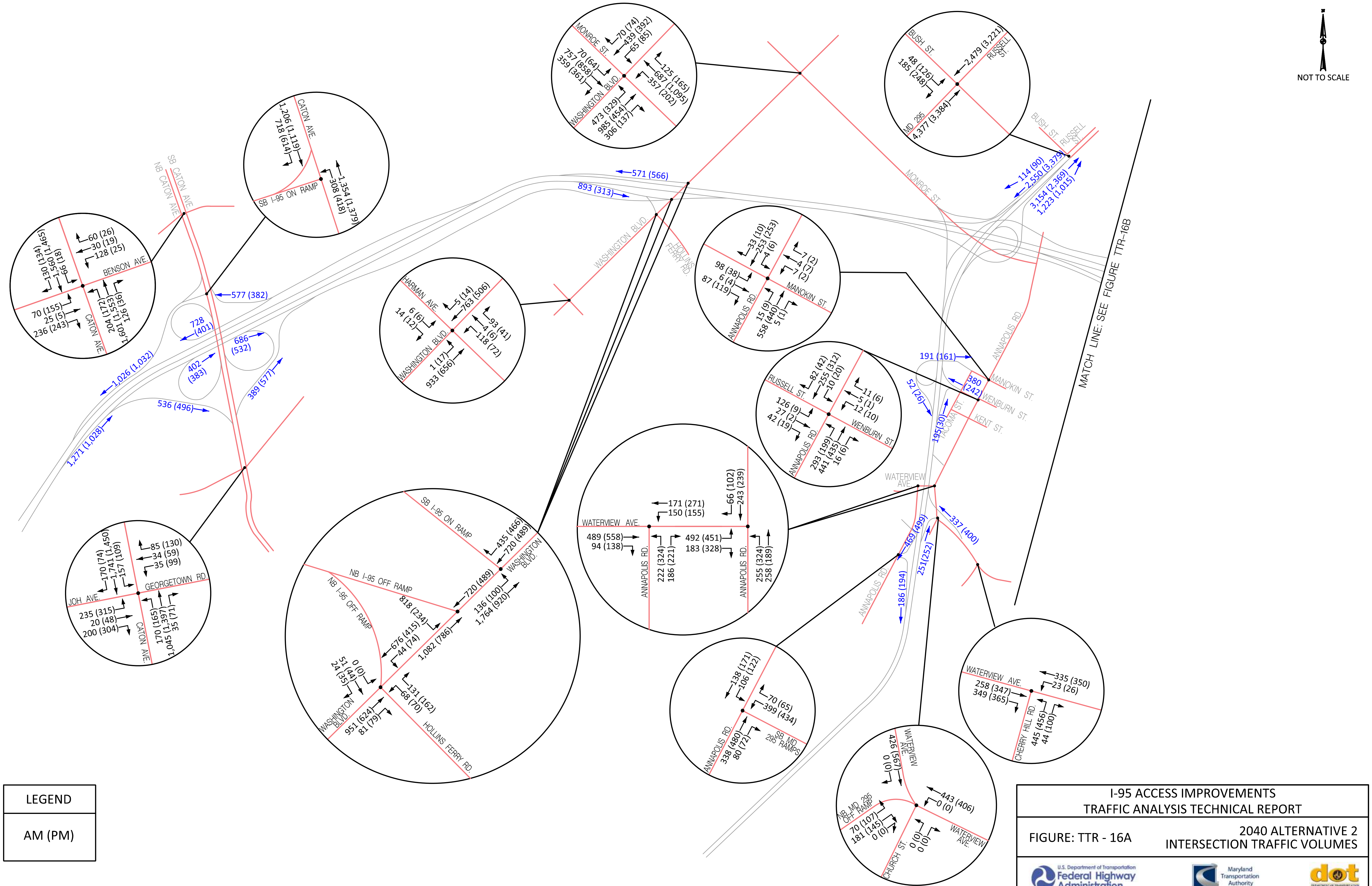
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 15B

2040 ALTERNATIVE 2
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND
AM (PM)

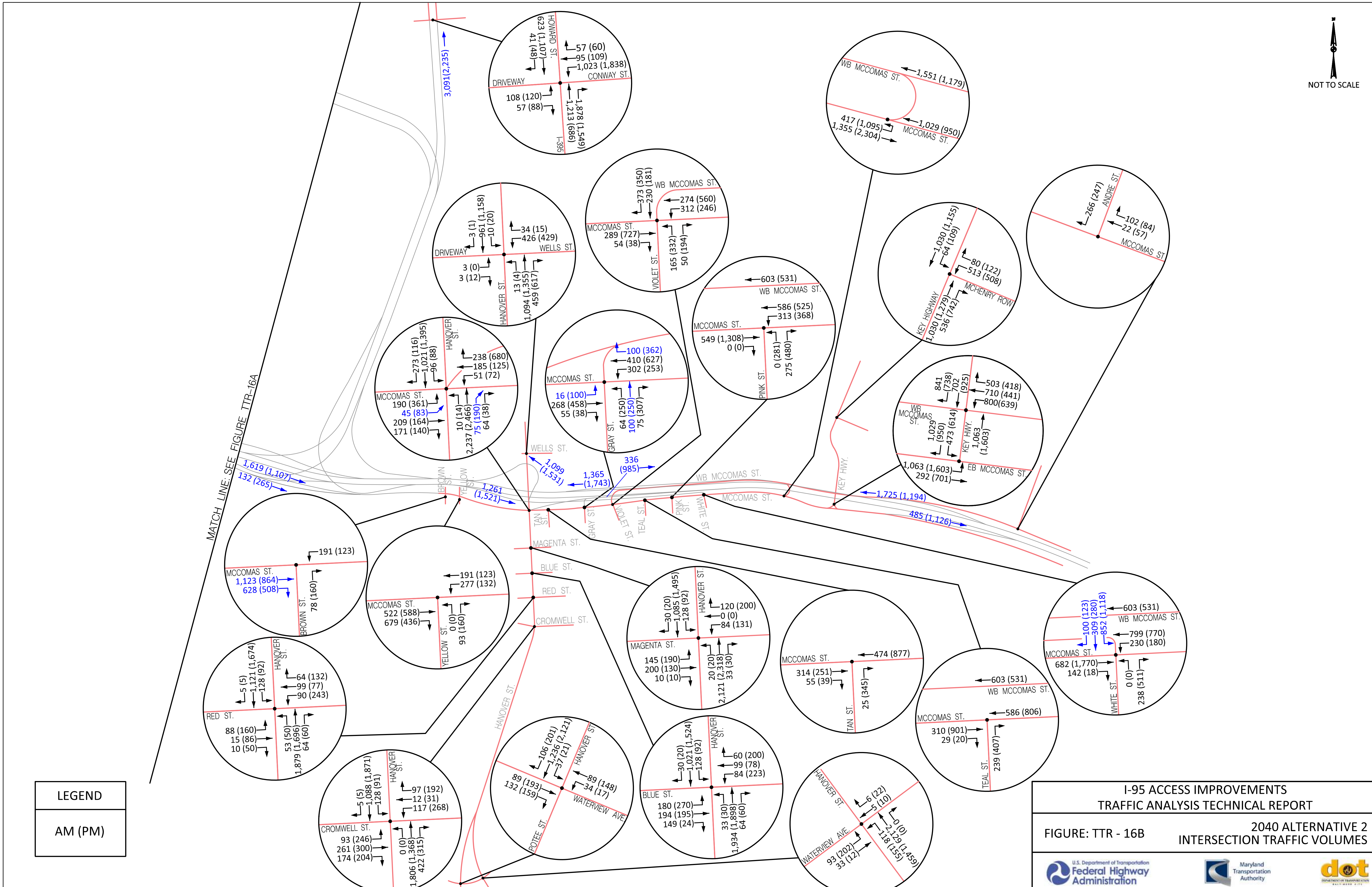
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 16A

2040 ALTERNATIVE 2
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

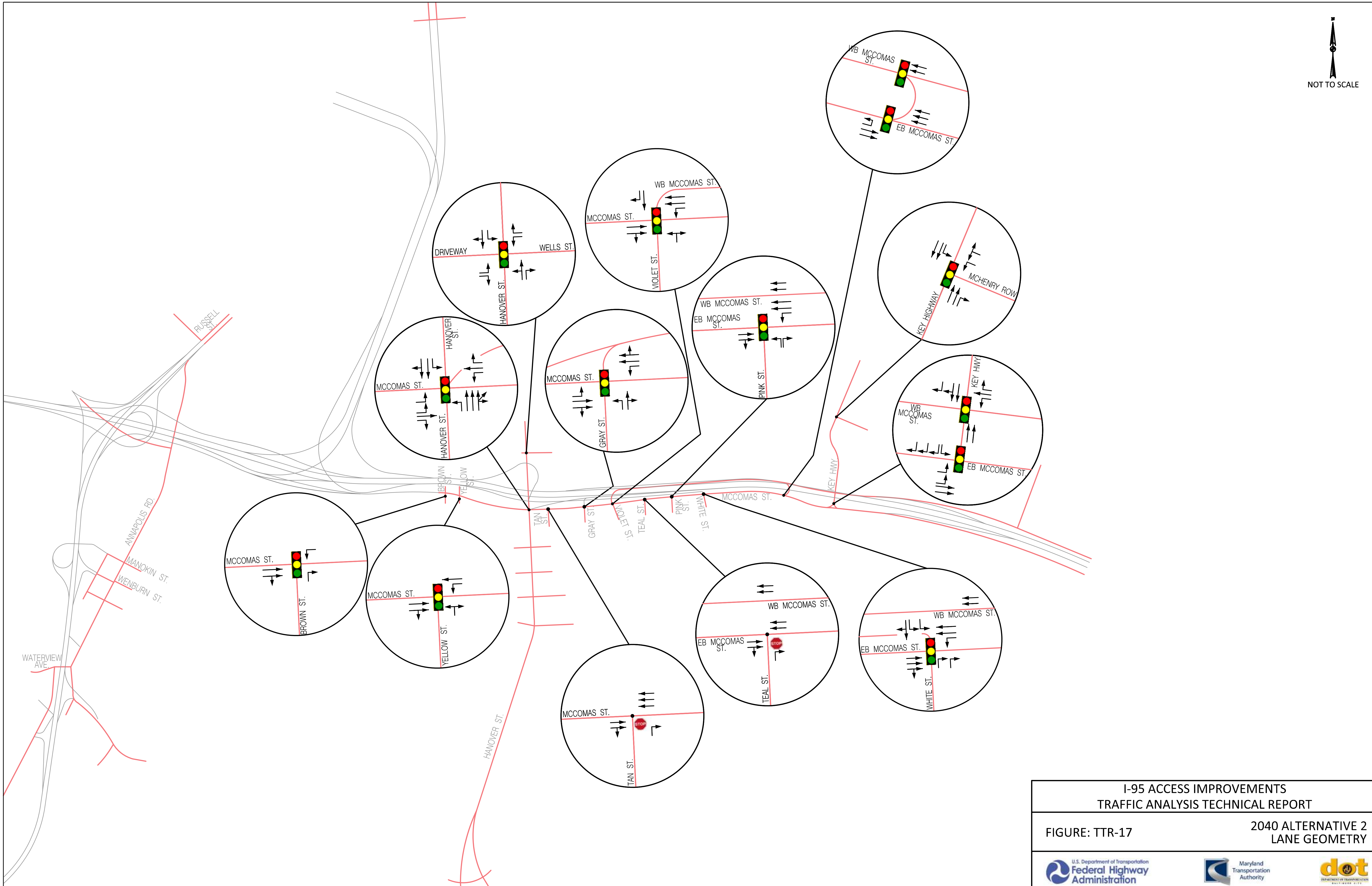
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 16B

2040 ALTERNATIVE 2
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



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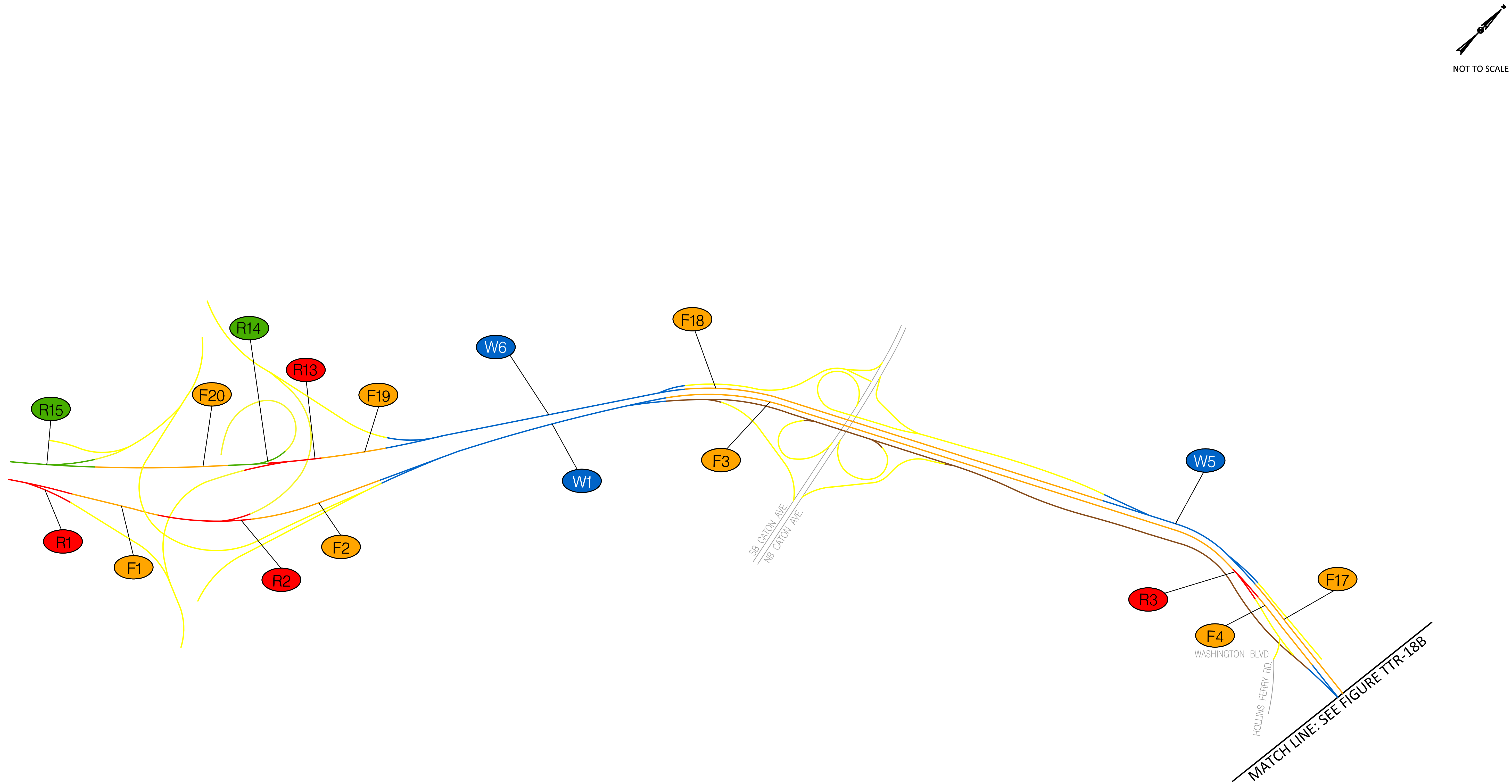
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-17

2040 ALTERNATIVE 2
LANE GEOMETRY

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



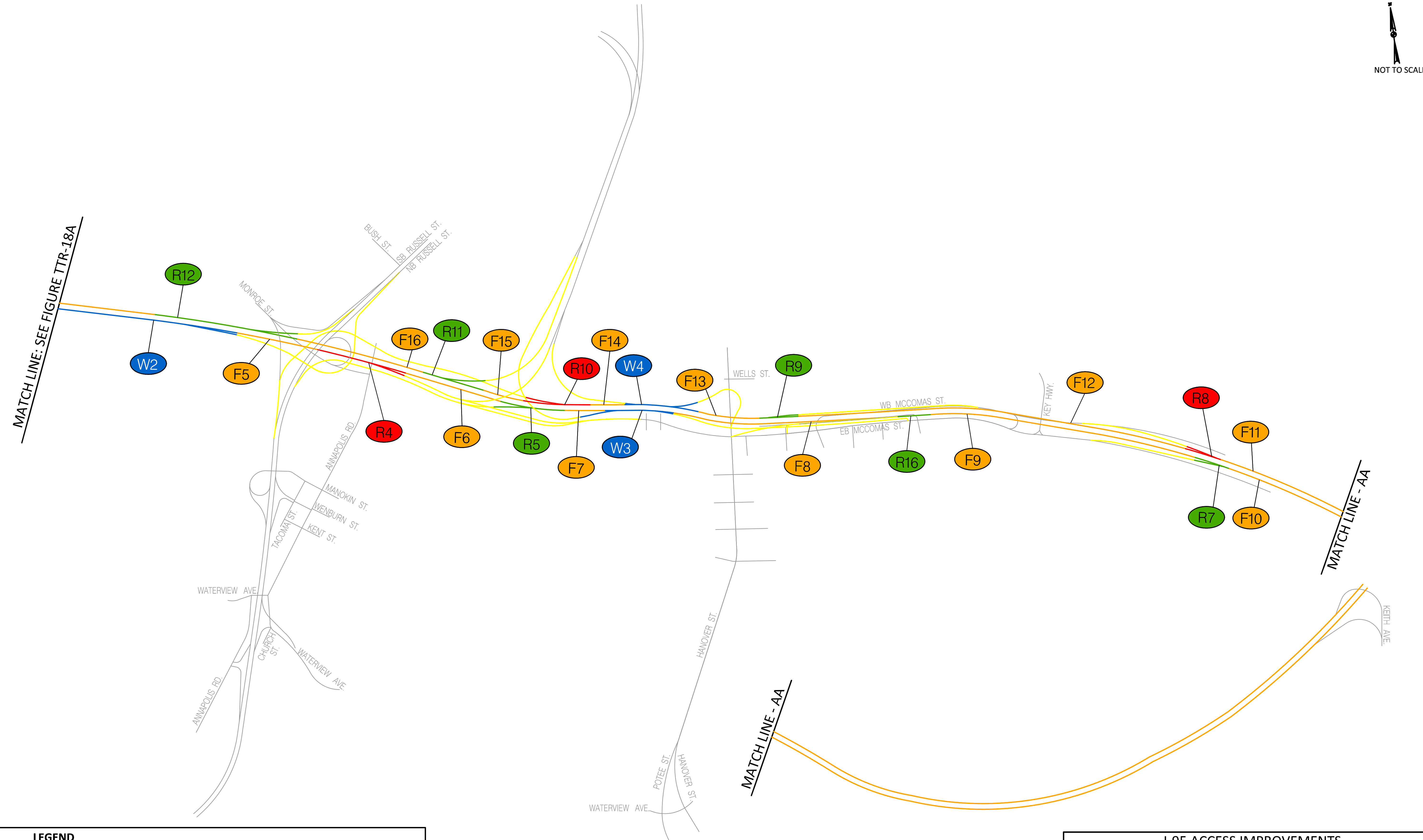
LEGEND

BASIC FREEWAY SEGMENT:		FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:		RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:		WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:			
FREEWAY RAMP:			
LOCAL RAMP			

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 18A

2040 ALTERNATIVE 2 FREEWAY ANALYSIS SEGMENT LOCATION



LEGEND

BASIC FREEWAY SEGMENT:		FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:			
DIVERGE SEGMENT:		RX	RAMP SEGMENT ID NUMBER
MERGE SEGMENT:			
FREEWAY RAMP:		WX	WEAVING SEGMENT ID NUMBER
LOCAL RAMP			

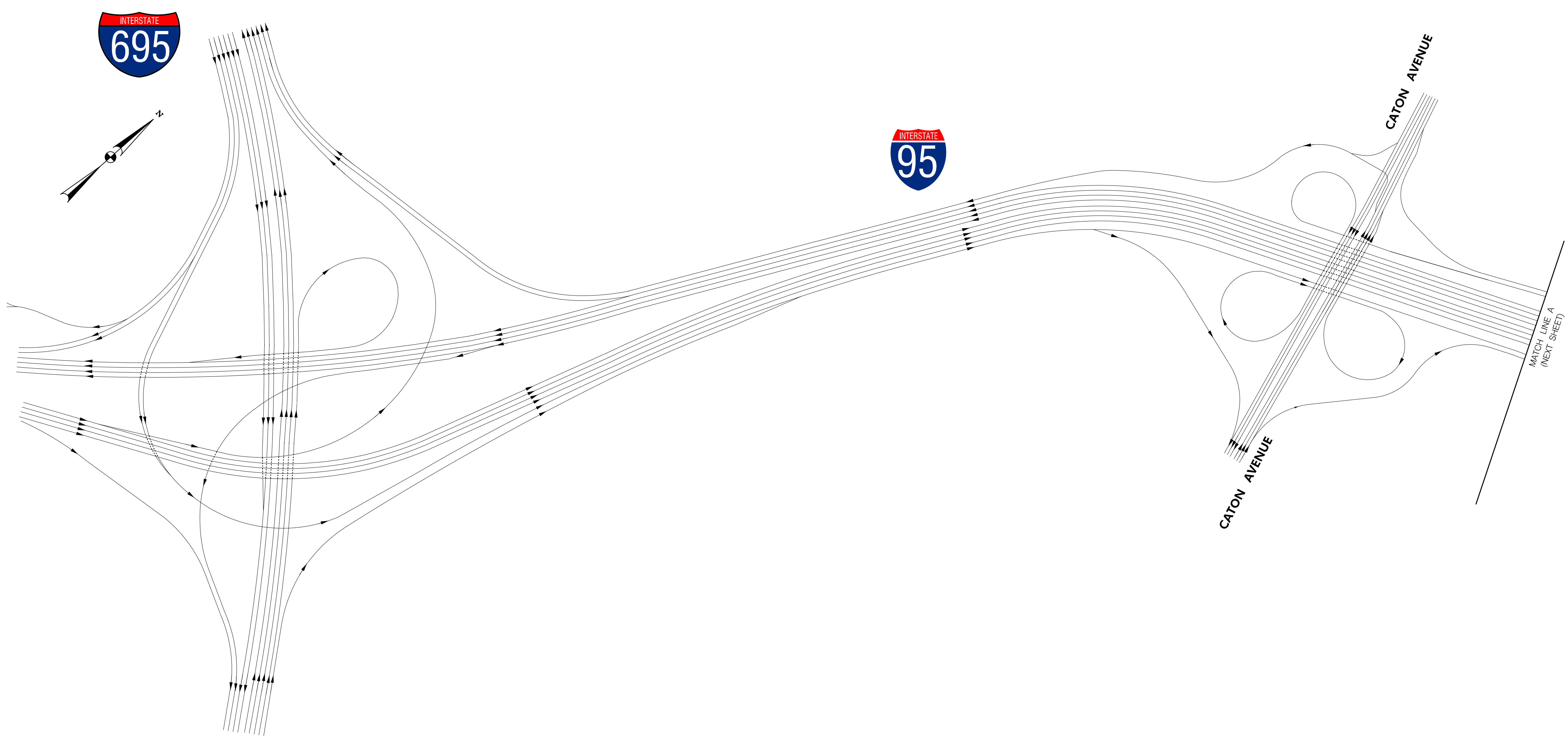
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 18B

2040 ALTERNATIVE 2 FREEWAY ANALYSIS SEGMENT LOCATION

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 19A WIRING DIAGRAM - ALTERNATIVE 3

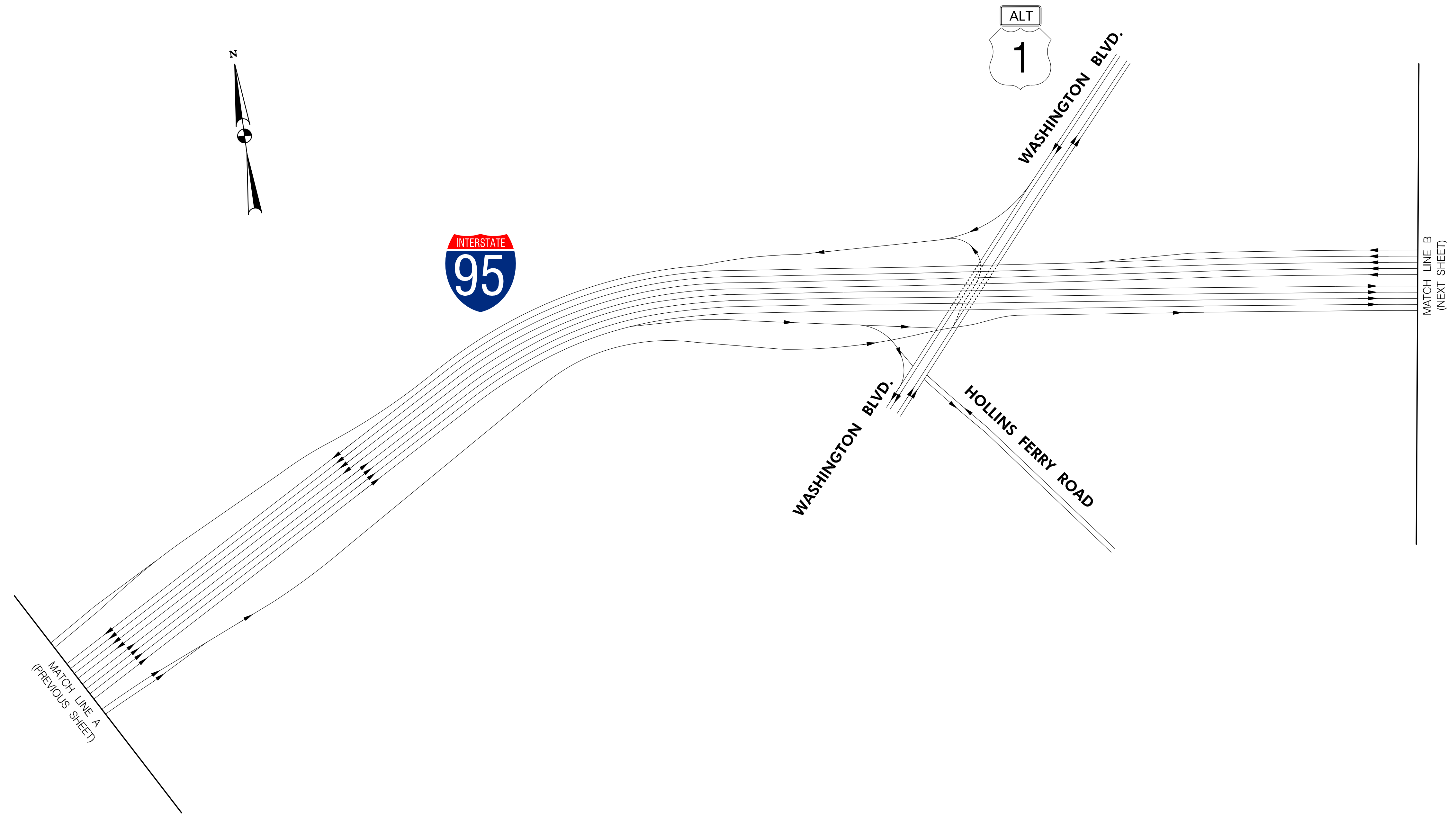
U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

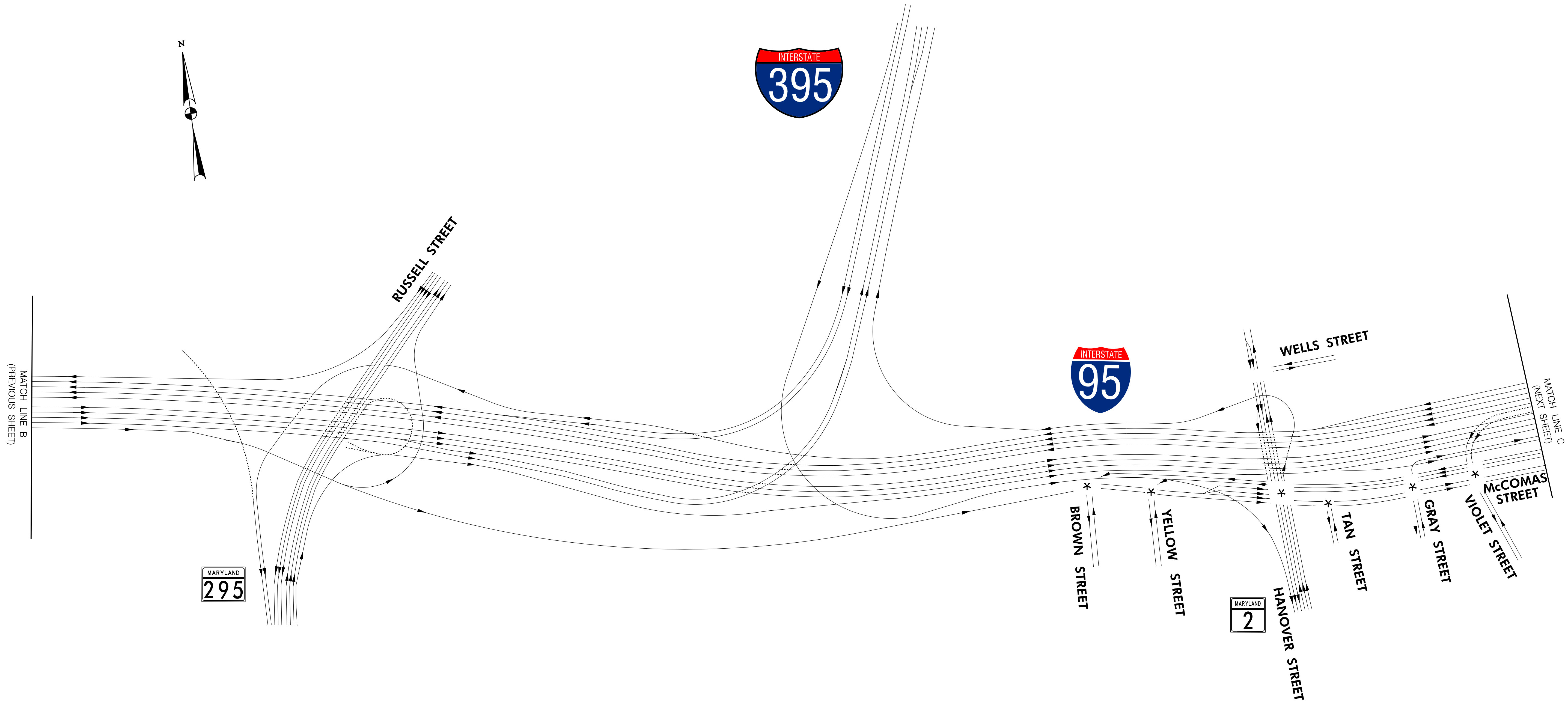
I-95 ACCESS IMPROVEMENTS TRAFFIC ANALYSIS TECHNICAL REPORT	
FIGURE: TTR - 19B	WIRING DIAGRAM - ALTERNATIVE 3

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-23 FOR SURFACE STREET INTERSECTION LANE USE

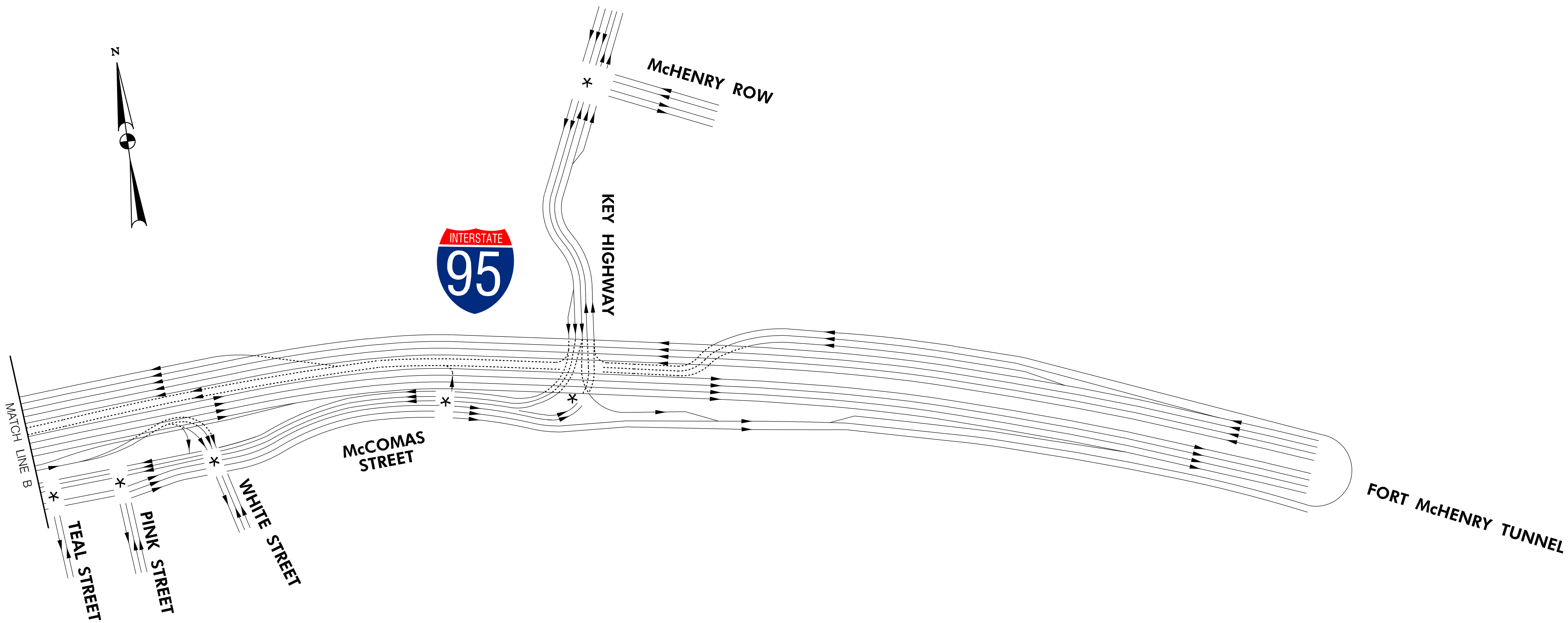
NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 19C WIRING DIAGRAM - ALTERNATIVE 3

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

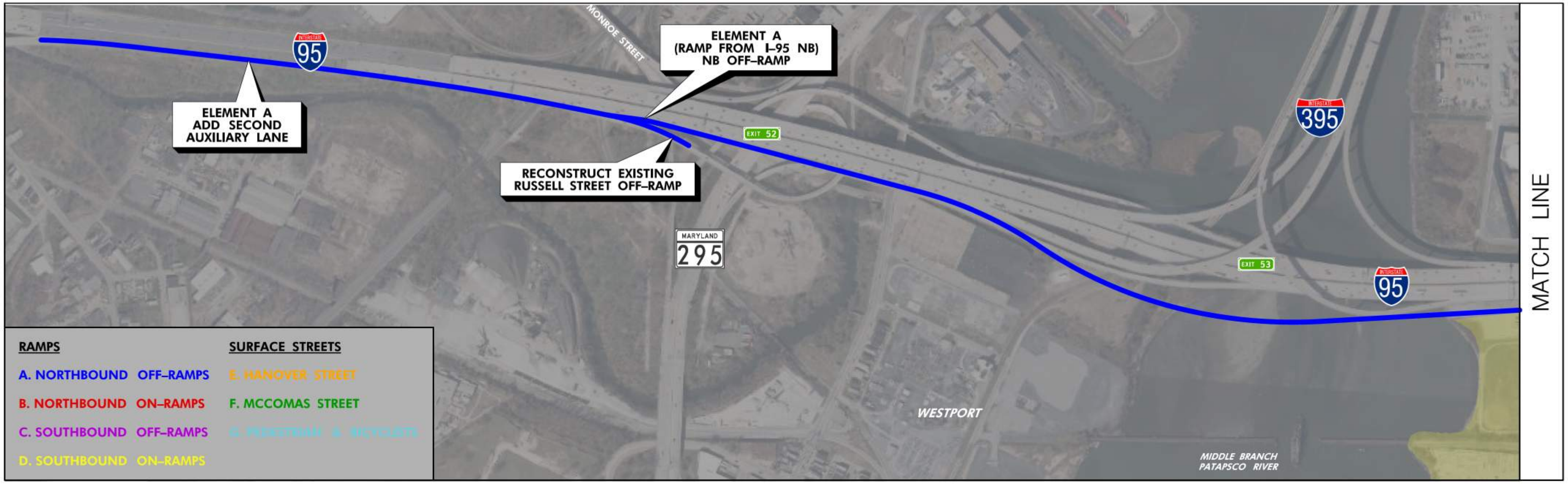
ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

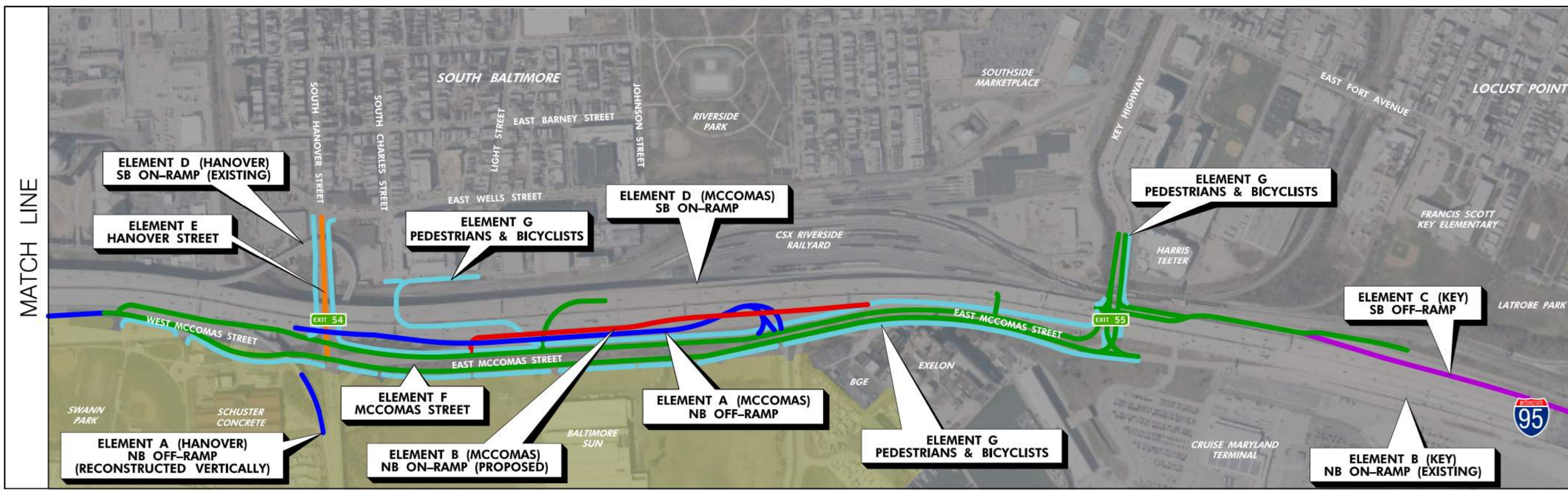
* SEE FIGURE TTR-23 FOR SURFACE STREET INTERSECTION LANE USE

NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 19D WIRING DIAGRAM - ALTERNATIVE 3





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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-20

ALTERNATIVE 3
ELEMENTS KEY MAP

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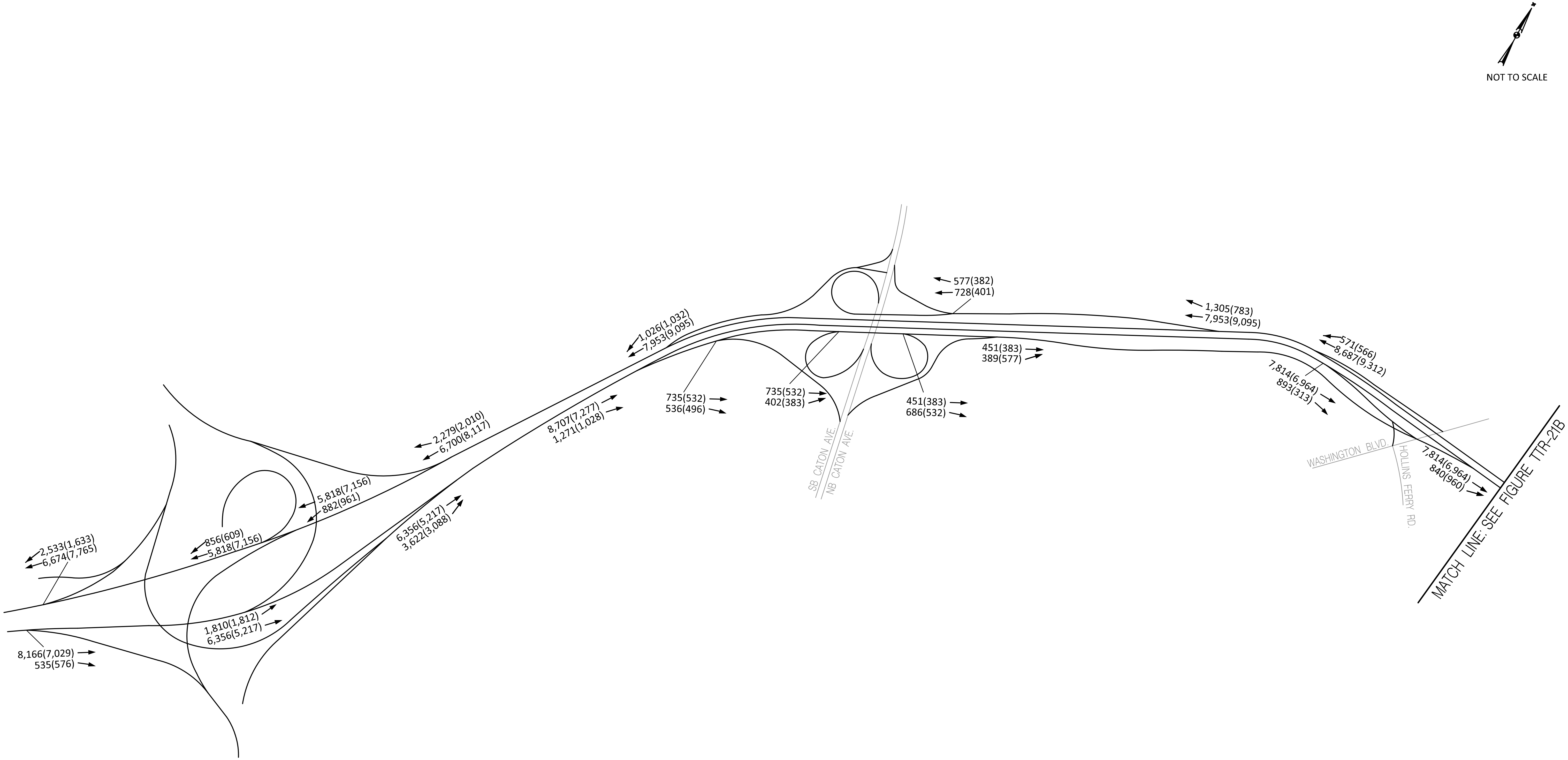
Maryland Transportation Authority



LEGEND

AM (PM)

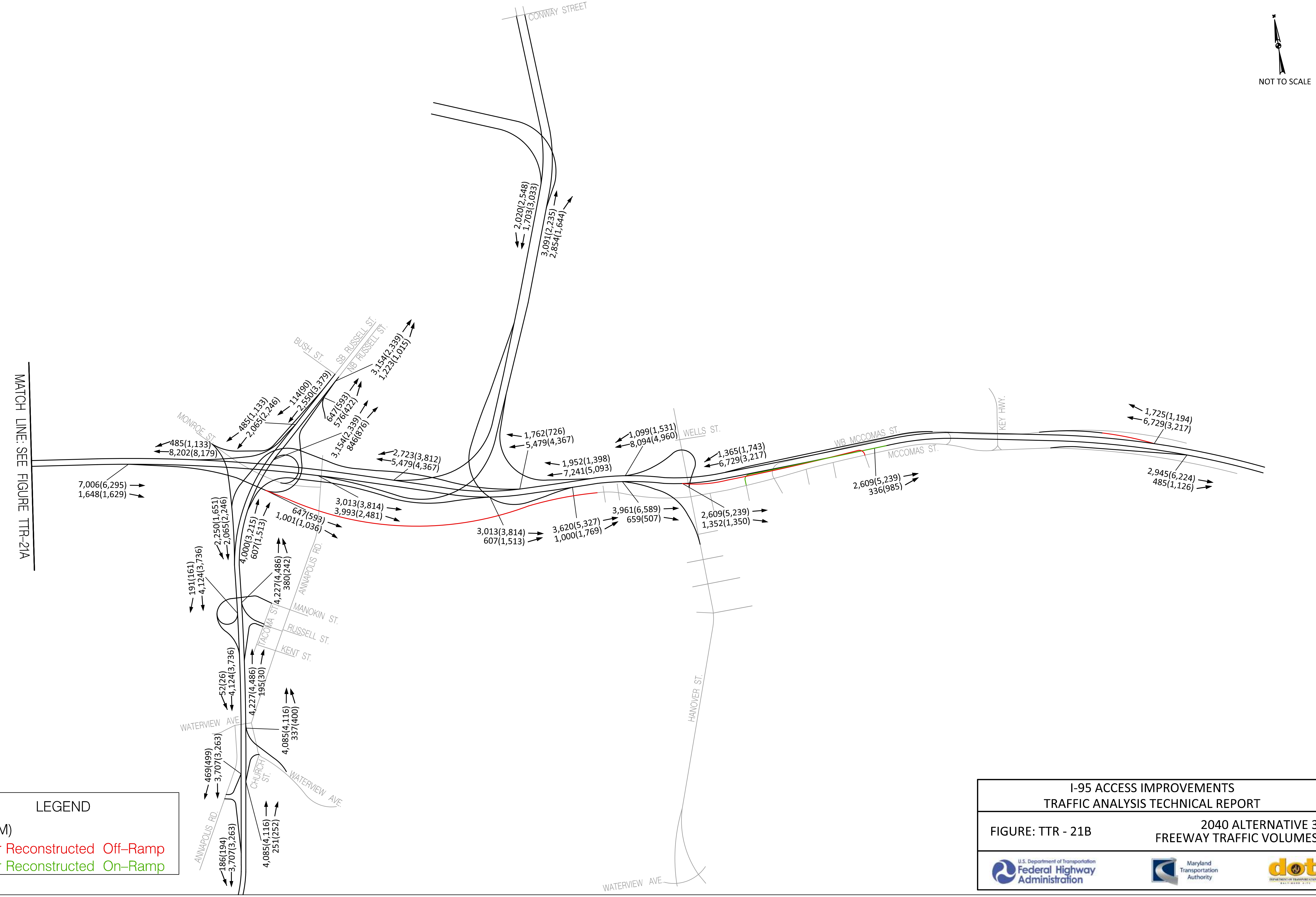
New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 21A

2040 ALTERNATIVE 3
FREEWAY TRAFFIC VOLUMES



LEGEND

AM (PM)

New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

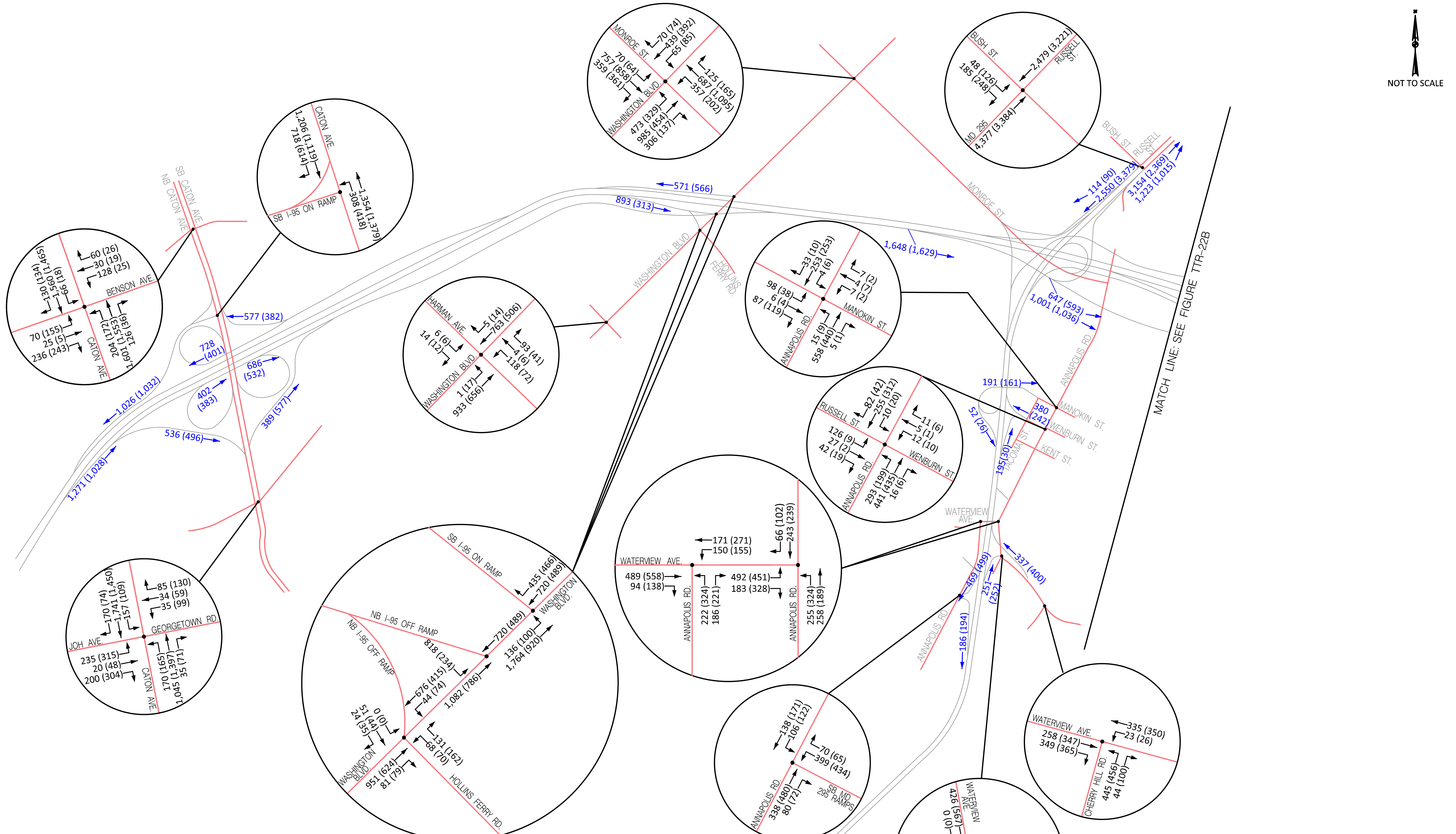
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 21B

2040 ALTERNATIVE 3
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

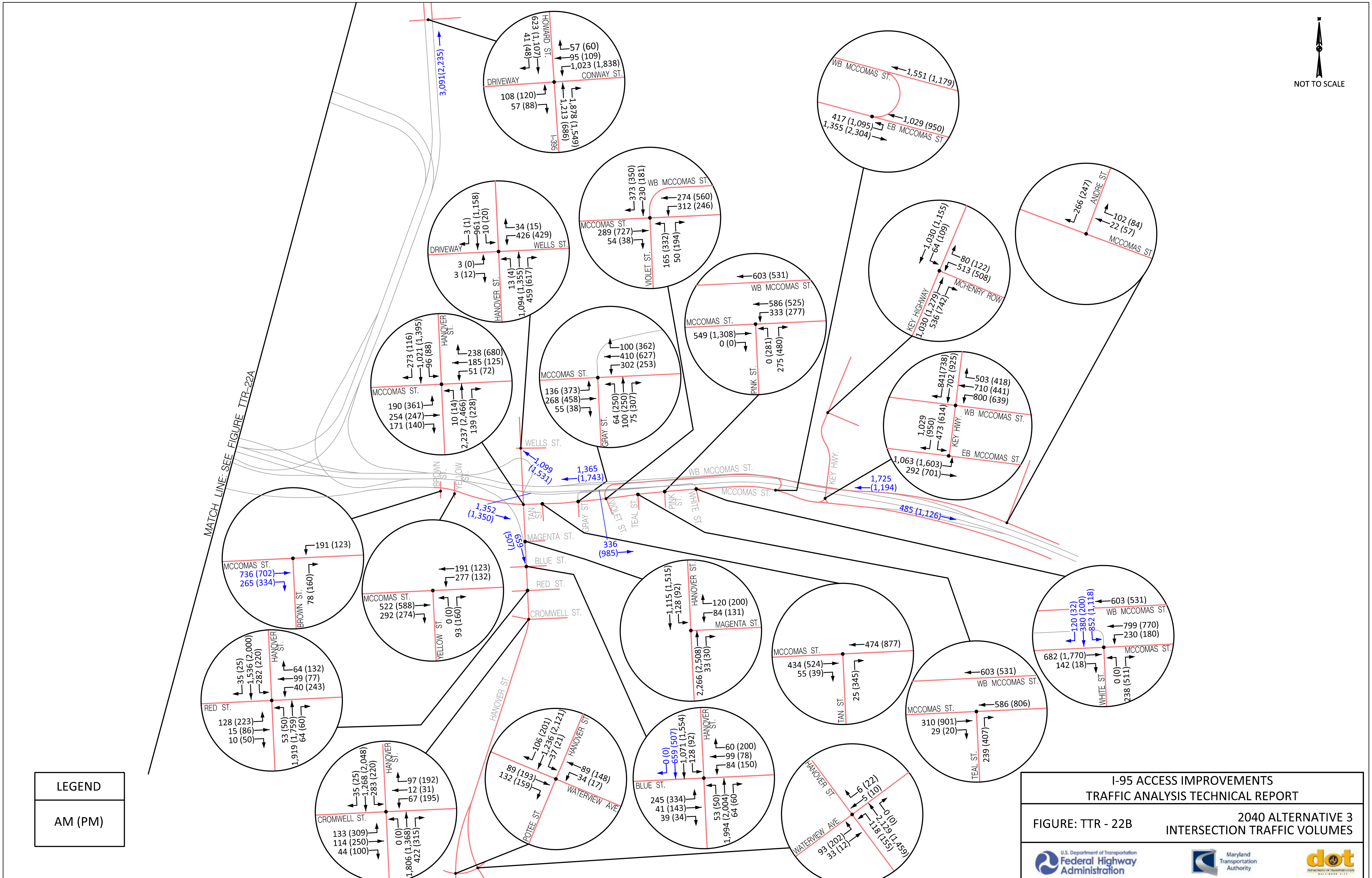
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 22A

2040 ALTERNATIVE 3
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



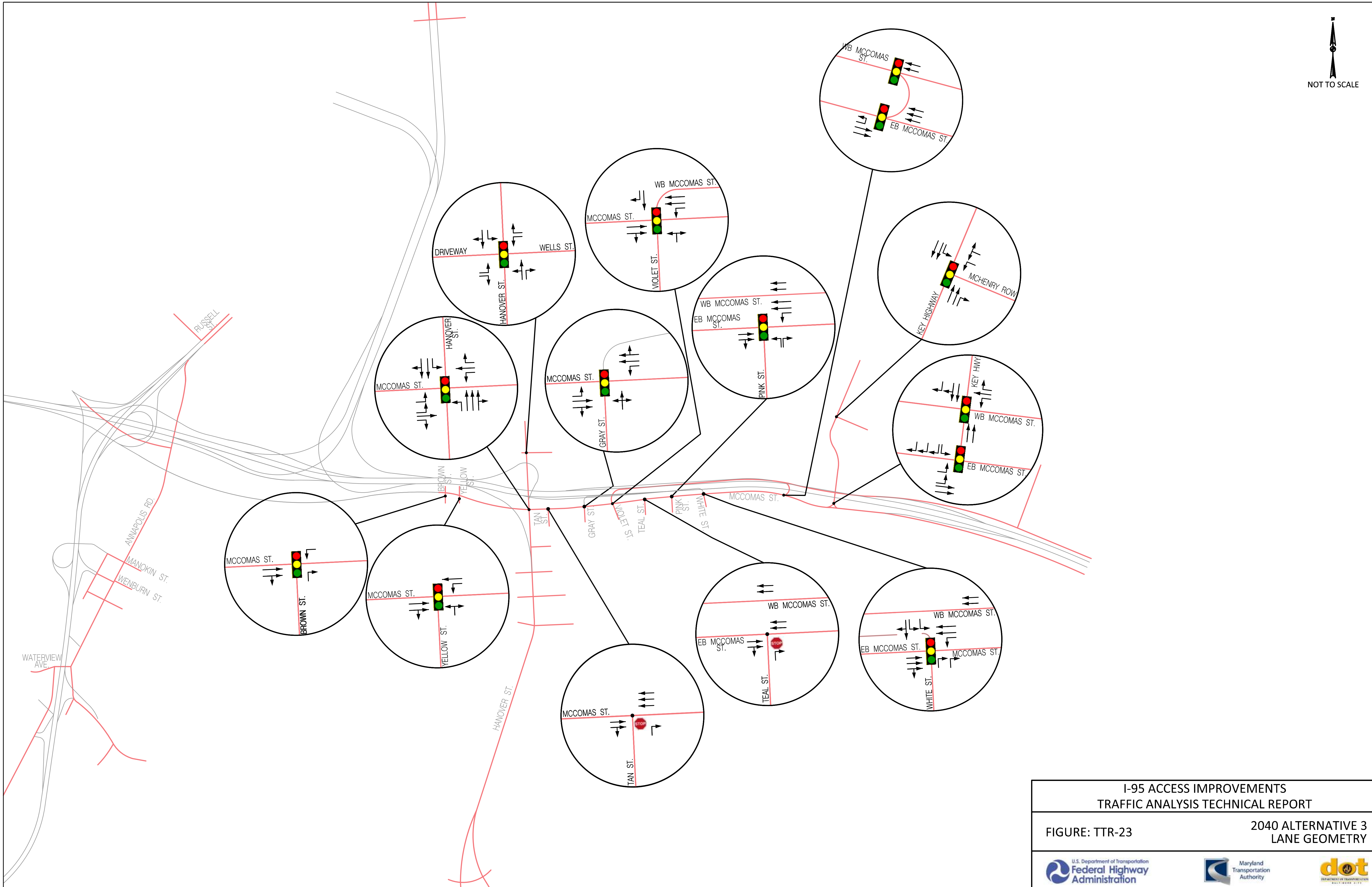
LEGEND
AM (PM)

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 22B

2040 ALTERNATIVE 3
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



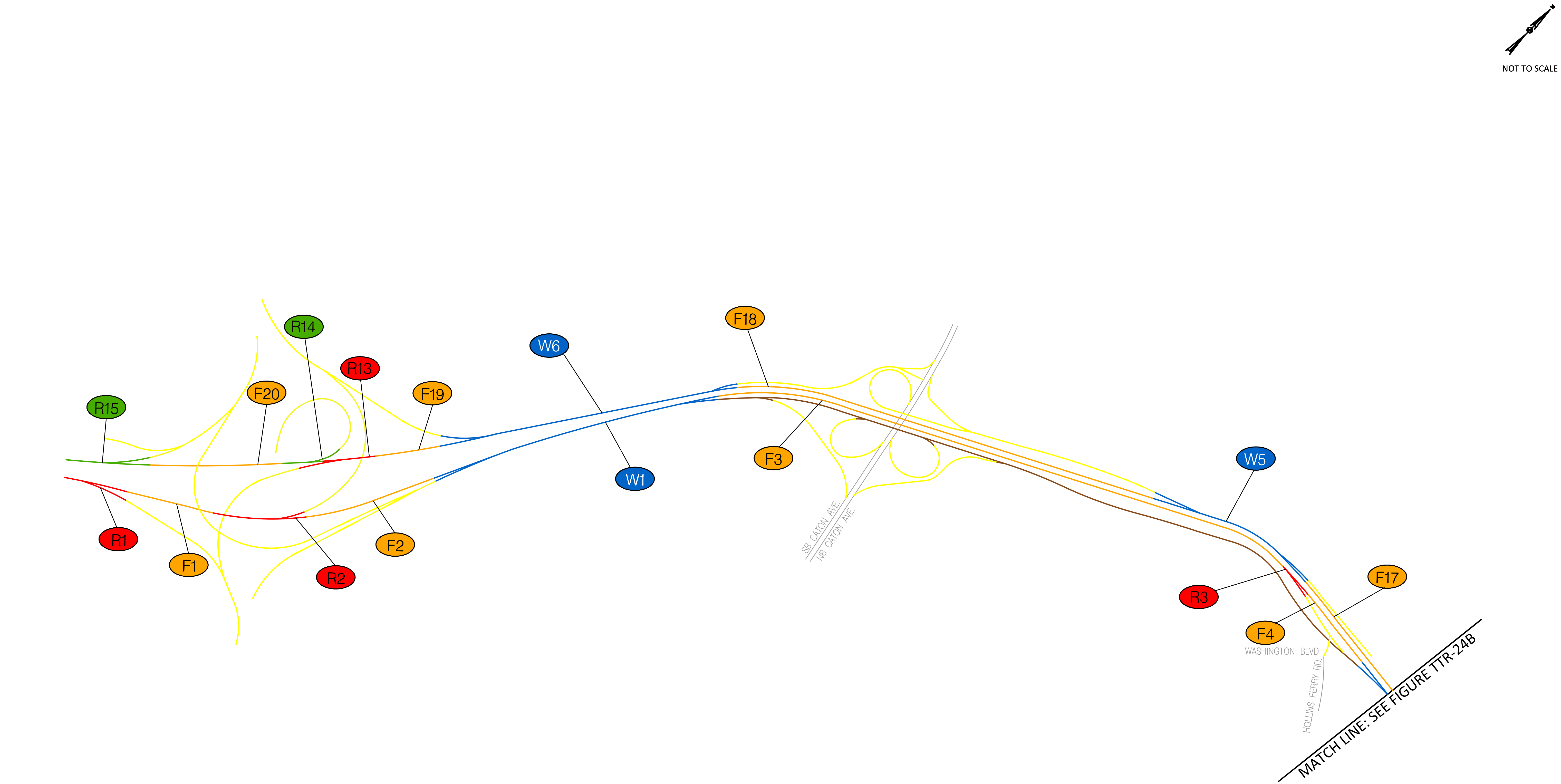
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-23

2040 ALTERNATIVE 3
LANE GEOMETRY

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

BASIC FREEWAY SEGMENT:		FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:			
DIVERGE SEGMENT:		RX	RAMP SEGMENT ID NUMBER
MERGE SEGMENT:			
FREEWAY RAMP:		WX	WEAVING SEGMENT ID NUMBER
LOCAL RAMP			

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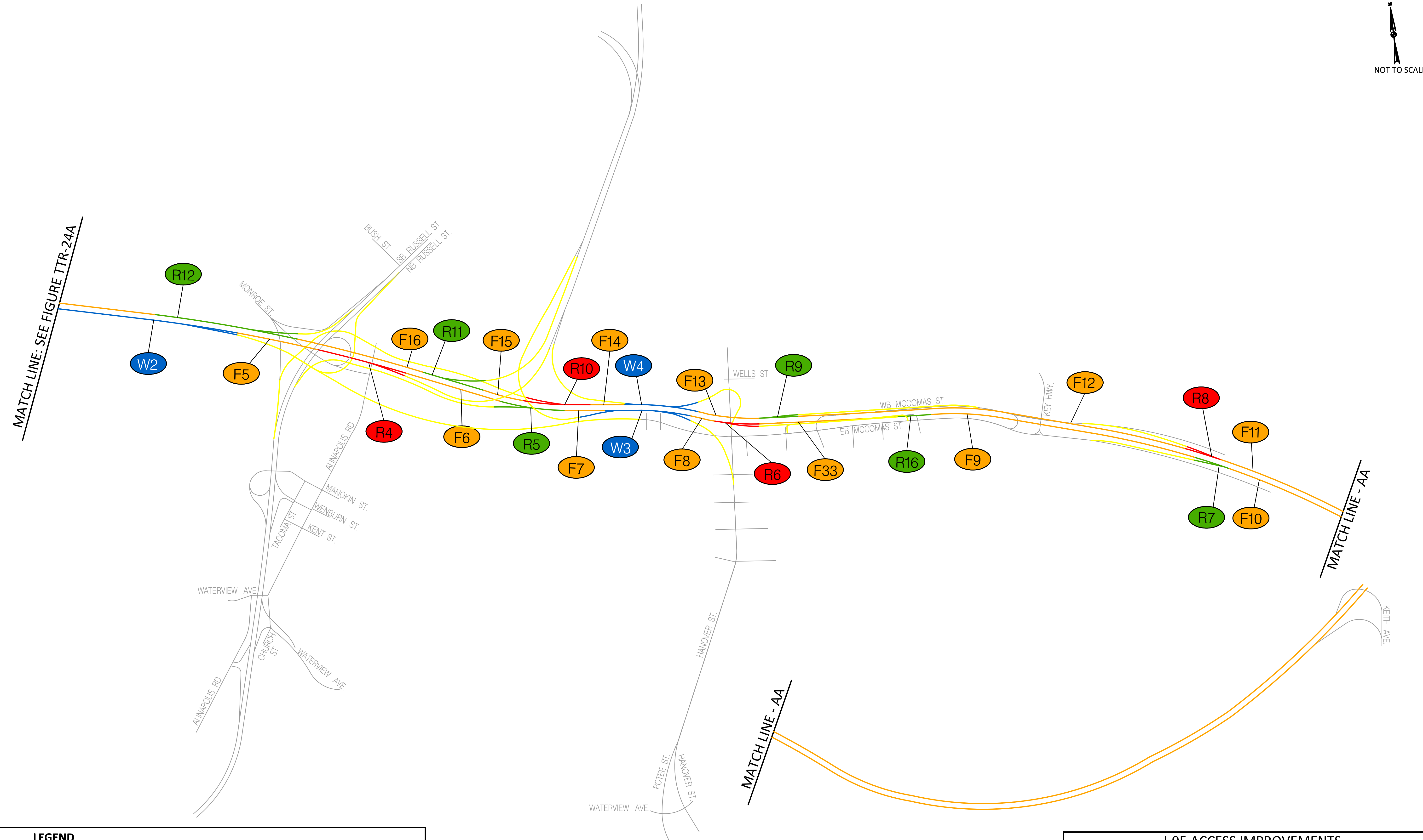
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 24A

2040 ALTERNATIVE 3 FREEWAY ANALYSIS SEGMENT LOCATION

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

BASIC FREEWAY SEGMENT:	(orange line)	FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:	(blue line)	RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:	(red line)	WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:	(green line)		
FREEWAY RAMP:	(yellow line)		
LOCAL RAMP	(brown line)		

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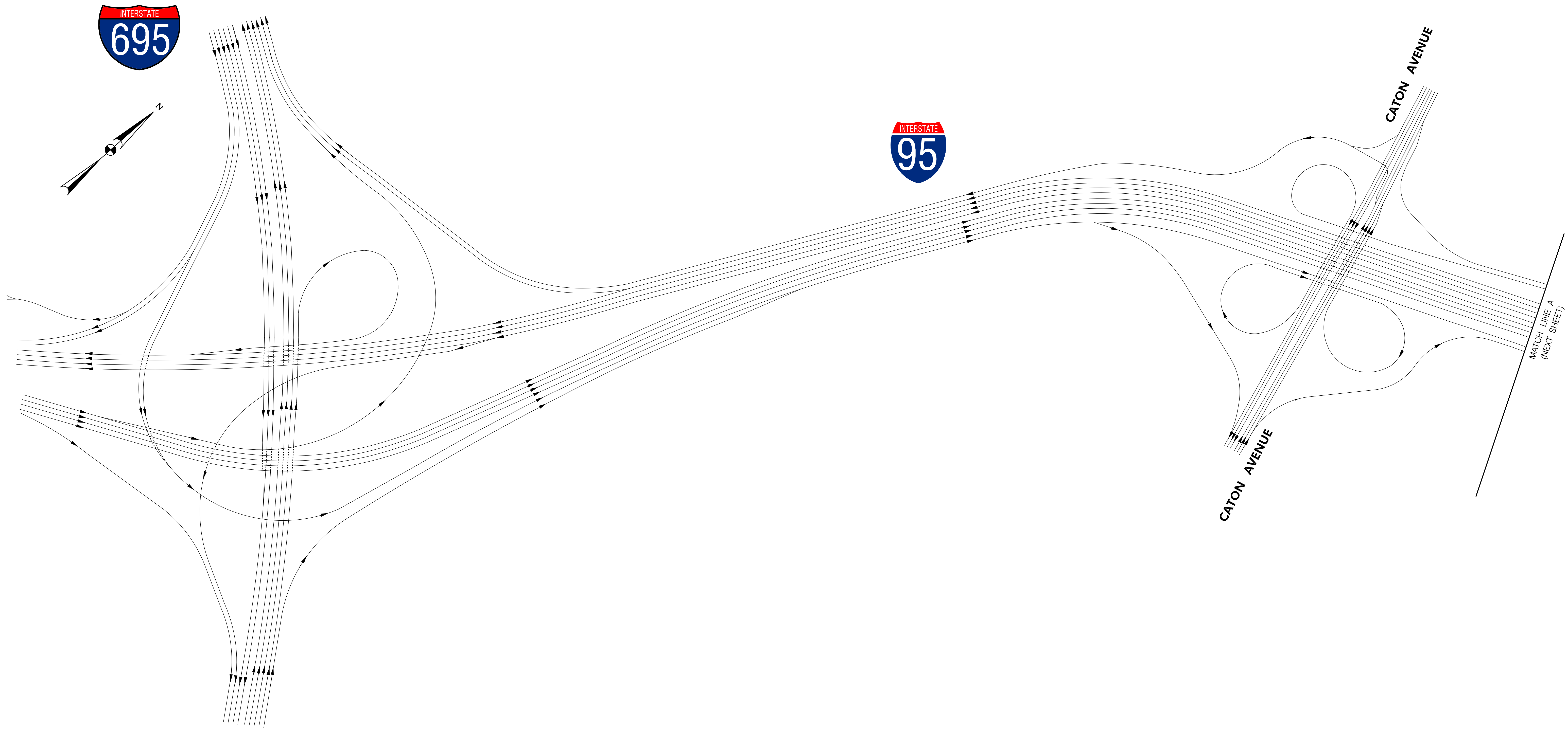
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 24B

2040 ALTERNATIVE 3 FREEWAY ANALYSIS SEGMENT LOCATION

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 25A WIRING DIAGRAM - ALTERNATIVE 4

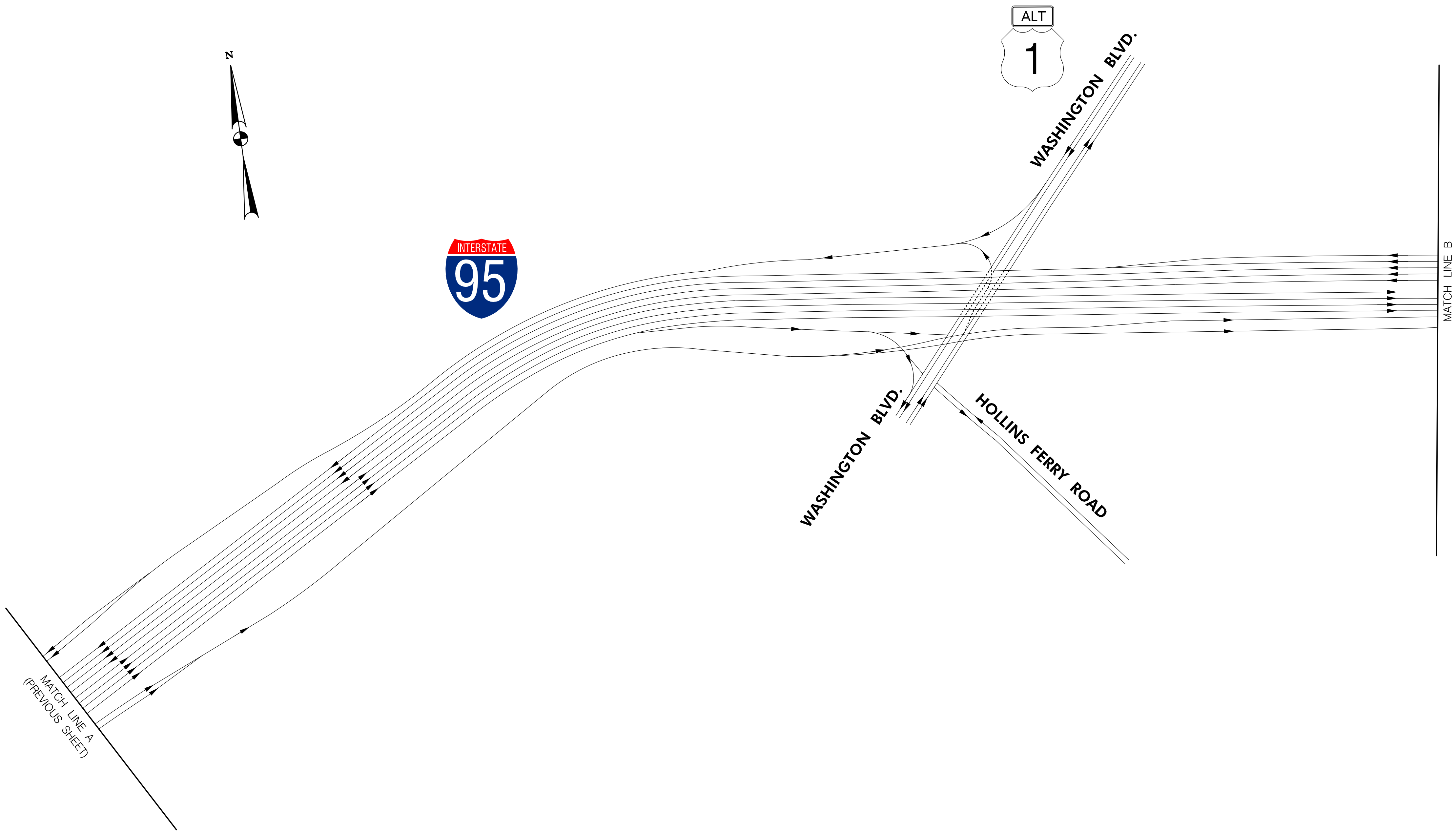
U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

NOT TO SCALE

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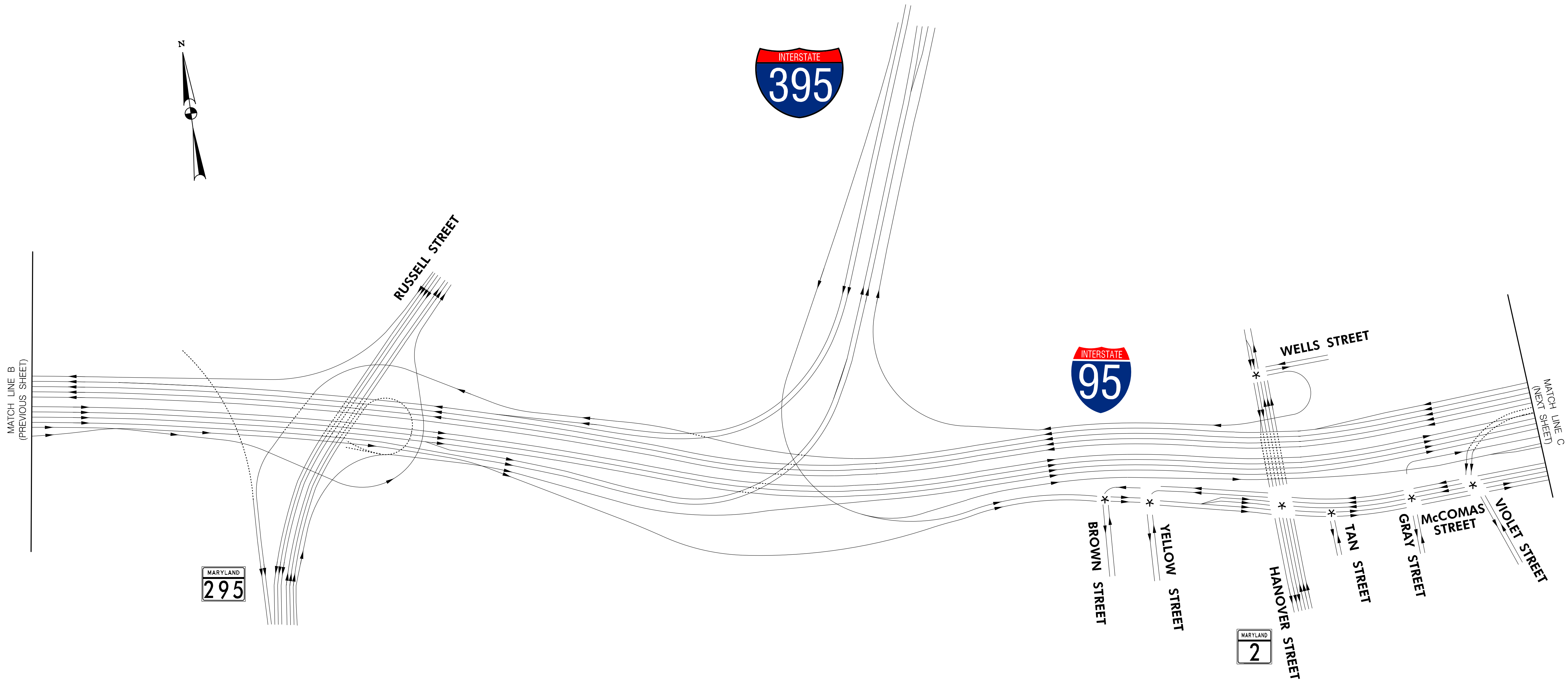
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 25B WIRING DIAGRAM - ALTERNATIVE 4

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

dot



NOT TO SCALE

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 25C WIRING DIAGRAM - ALTERNATIVE 4

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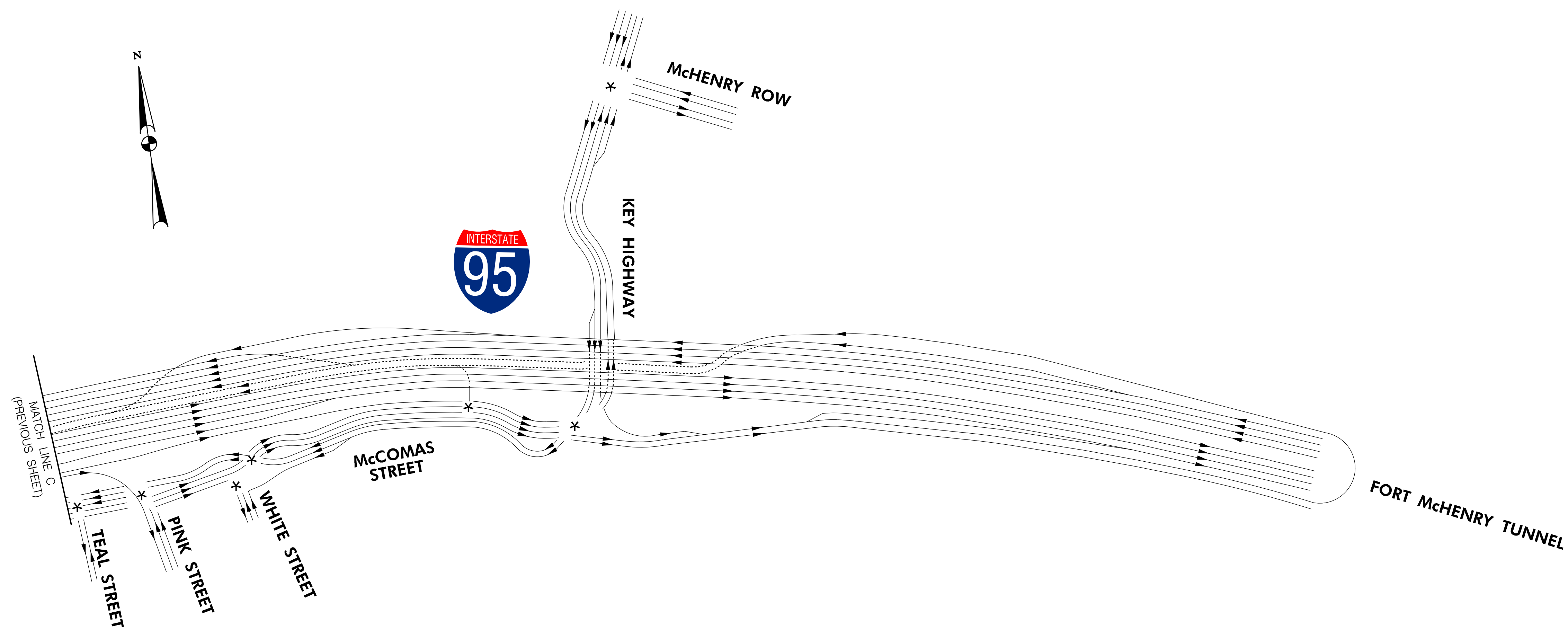
LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR–29 FOR SURFACE STREET INTERSECTION LANE USE



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-29 FOR SURFACE STREET INTERSECTION LANE USE

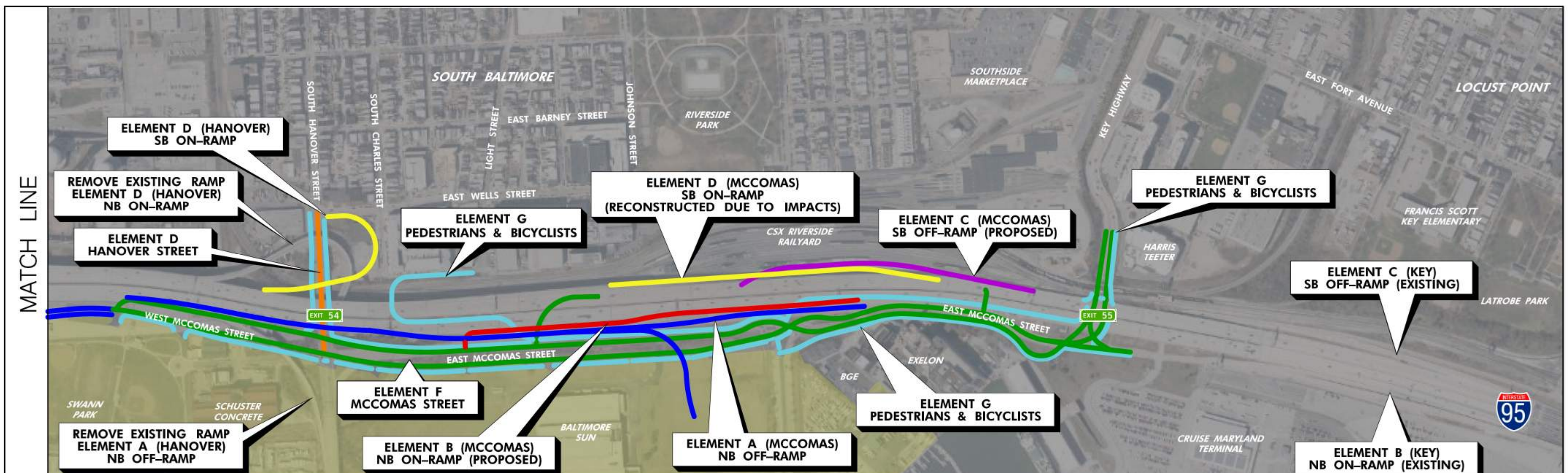
NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 25D WIRING DIAGRAM - ALTERNATIVE 4

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-26

ALTERNATIVE 4
ELEMENTS KEY MAP

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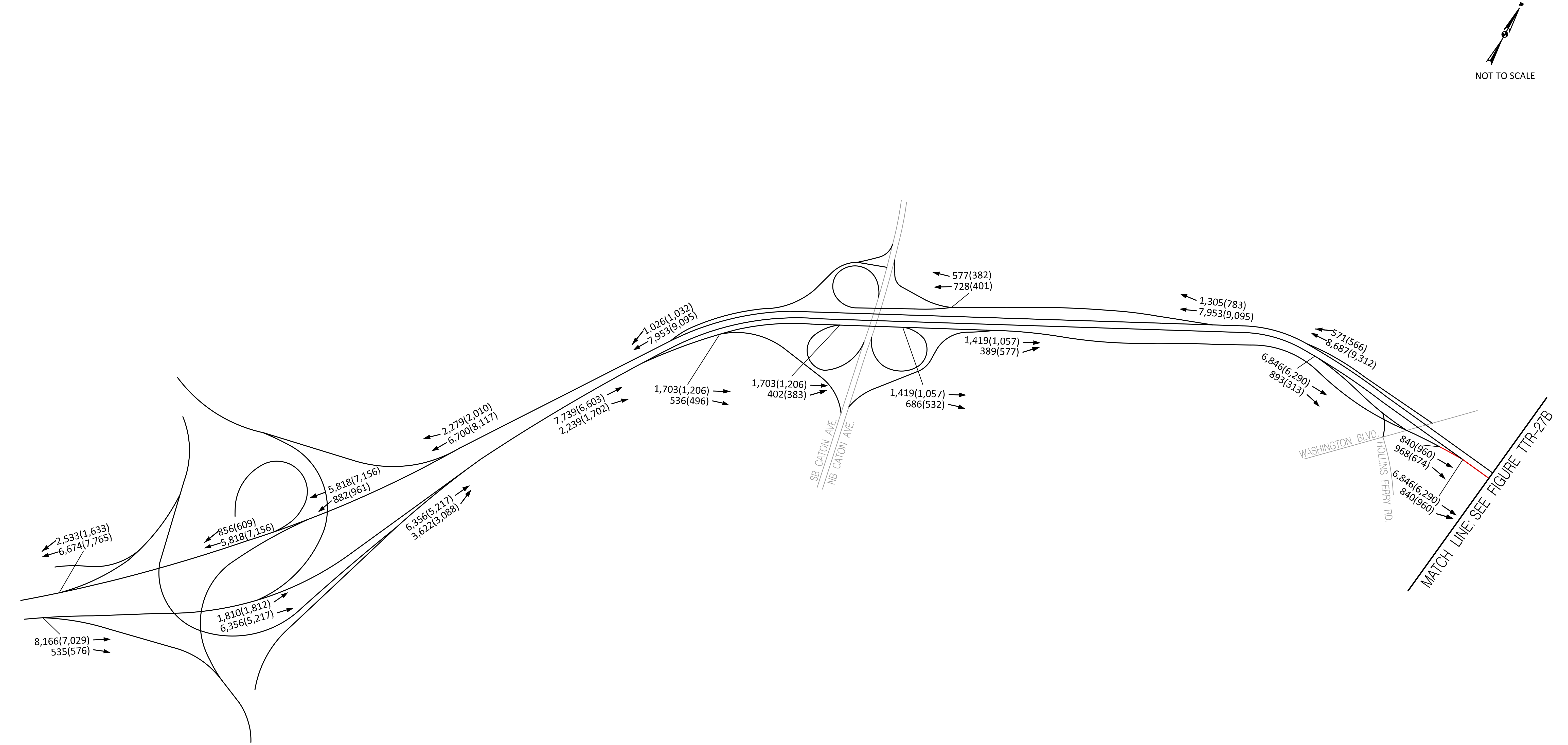
Maryland Transportation Authority



LEGEND

AM (PM)

New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

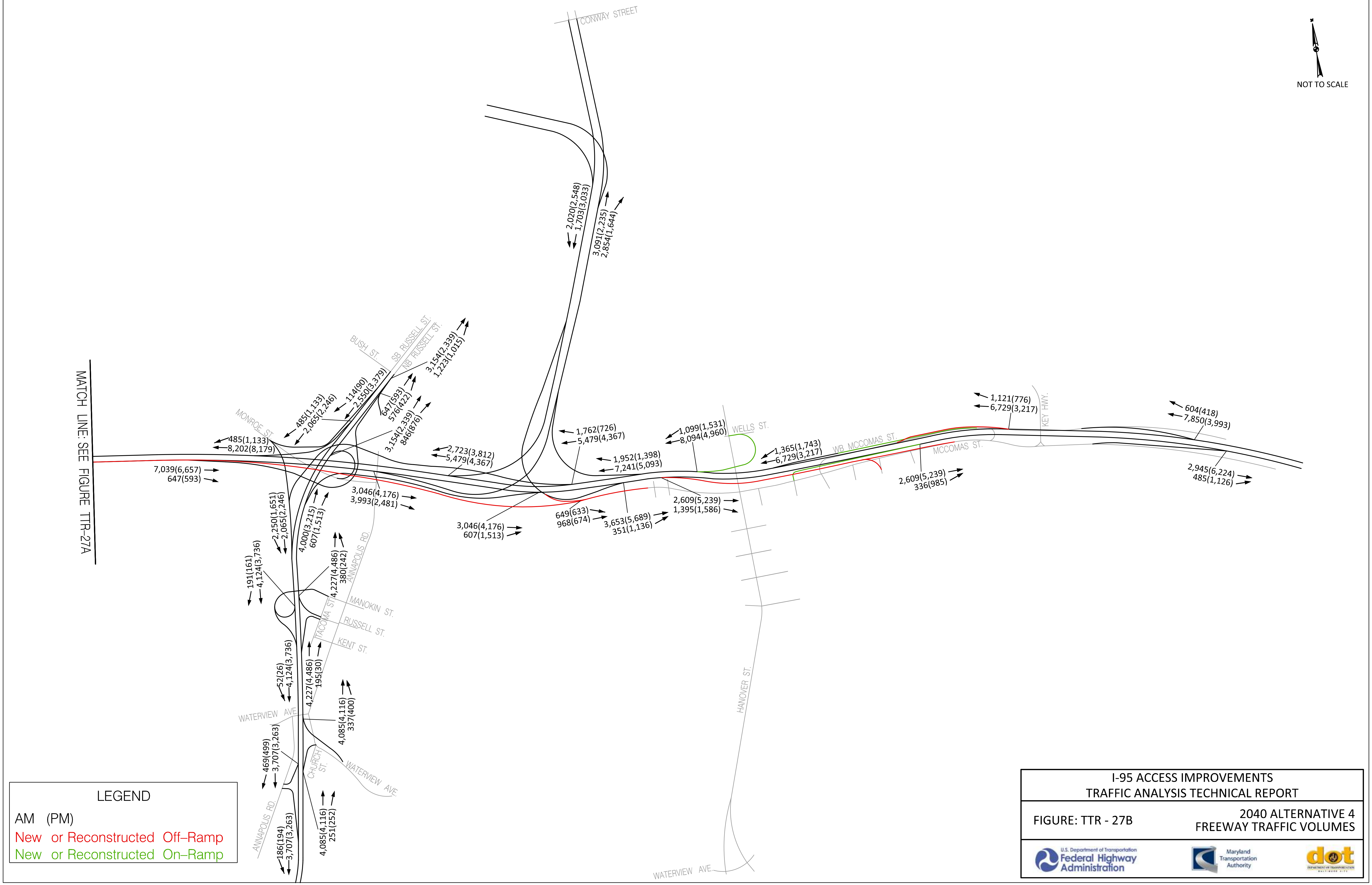
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 27A

2040 ALTERNATIVE 4
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



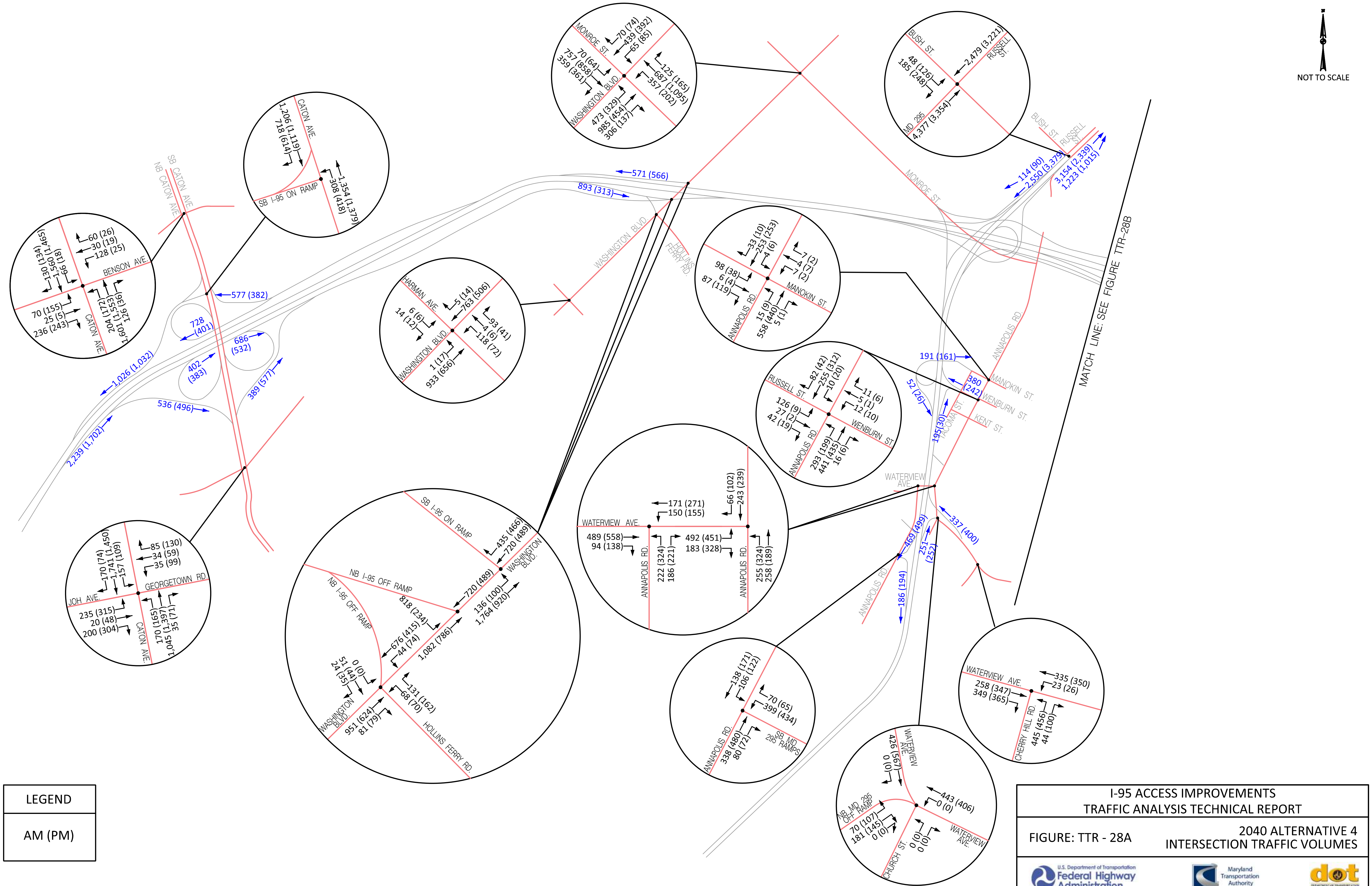
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 27B

2040 ALTERNATIVE 4
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

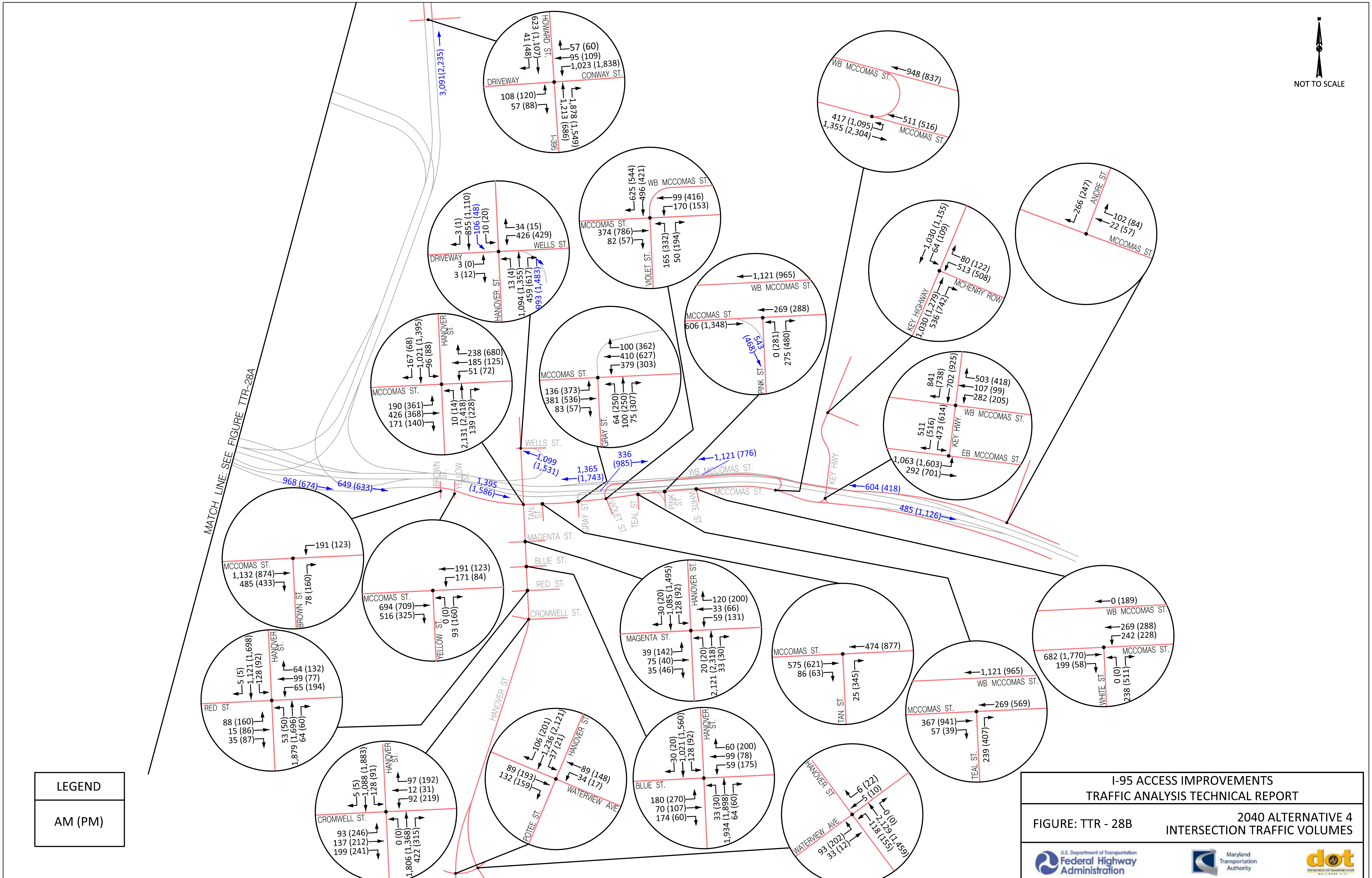
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 28A

2040 ALTERNATIVE 4
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



LEGEND

AM (PM)

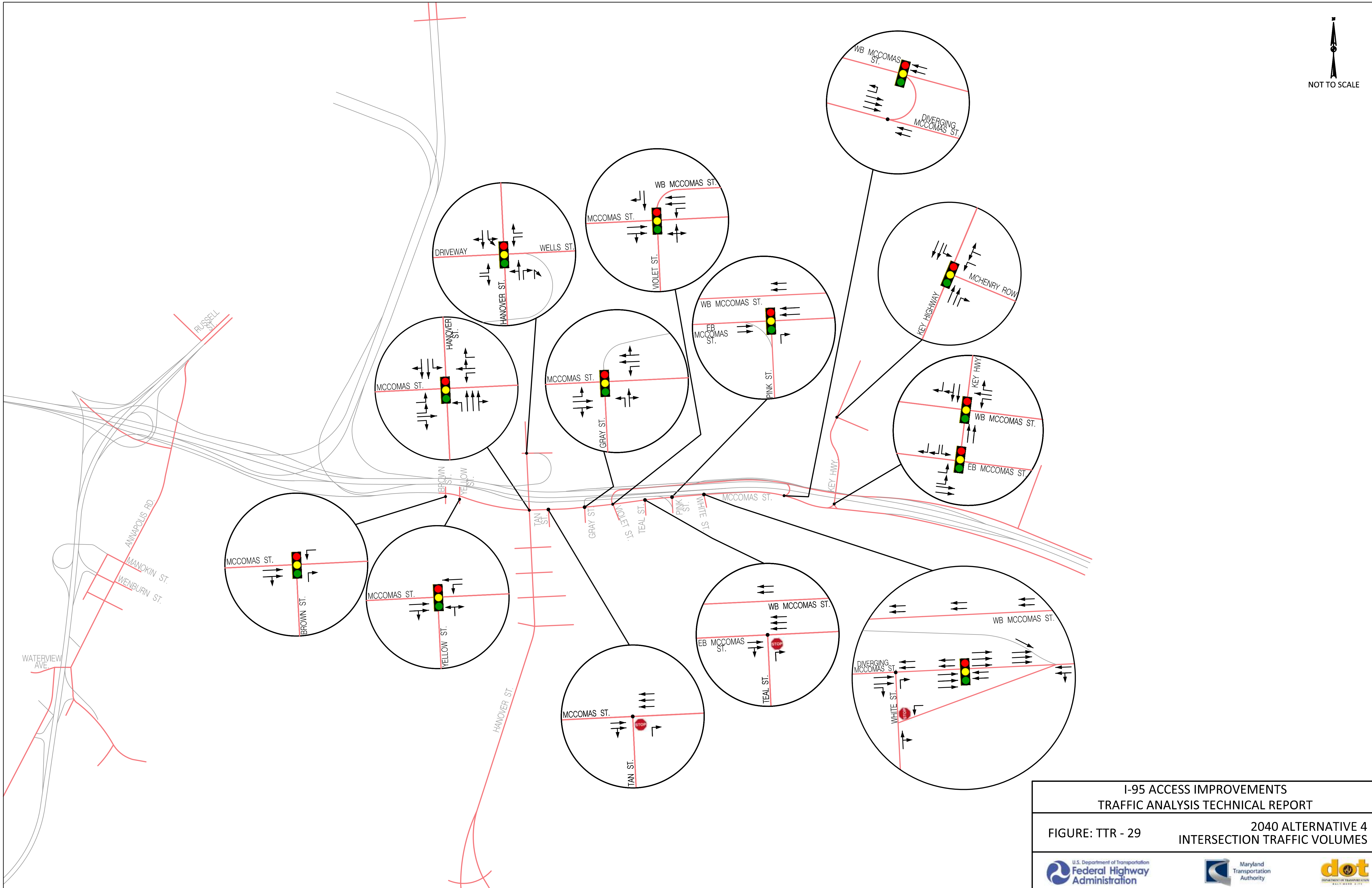
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 28B

2040 ALTERNATIVE 4
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

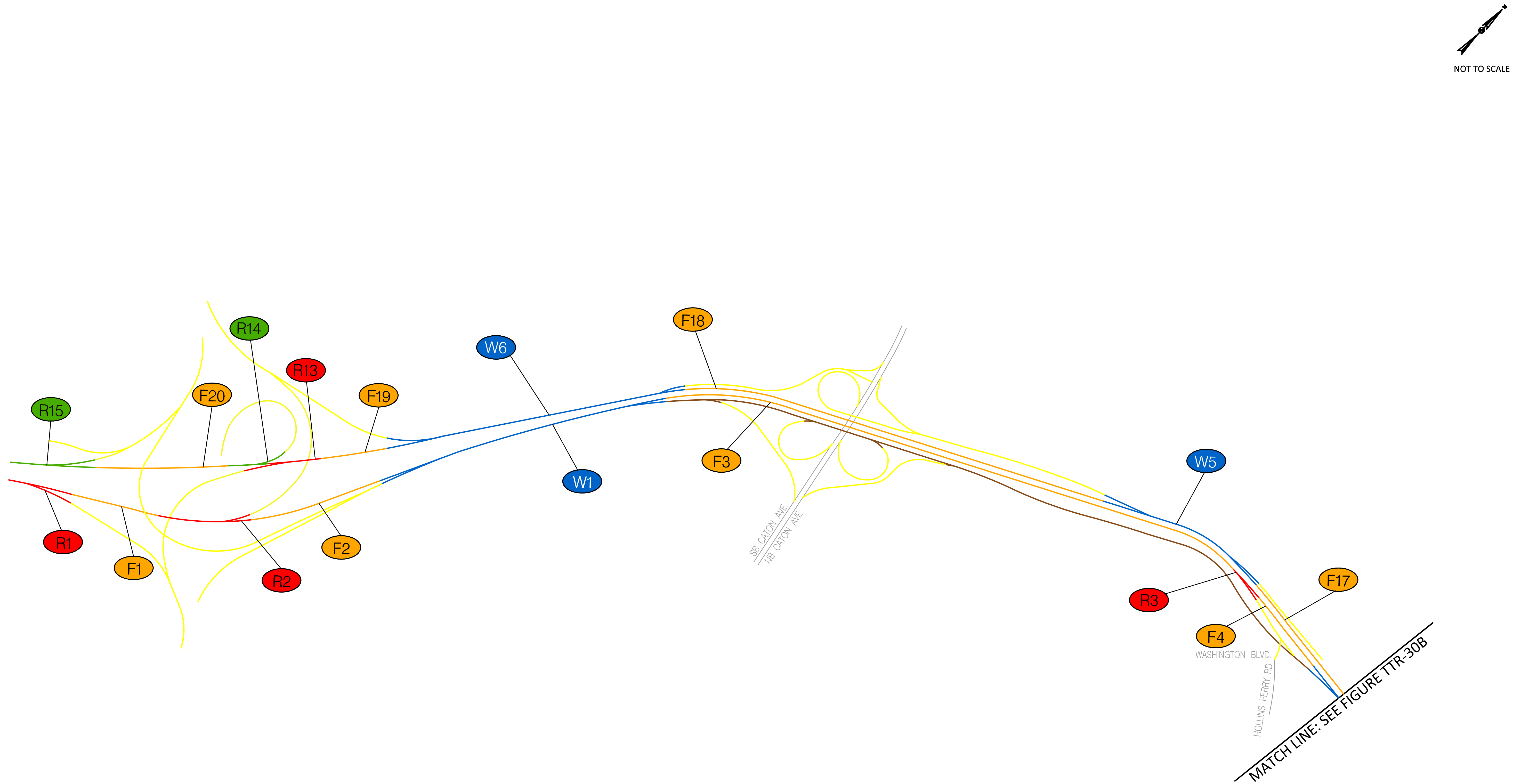
FIGURE: TTR - 29

2040 ALTERNATIVE 4
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

dot



LEGEND

BASIC FREEWAY SEGMENT:	FX FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:	
DIVERGE SEGMENT:	RX RAMP SEGMENT ID NUMBER
MERGE SEGMENT:	
FREEWAY RAMP:	WX WEAVING SEGMENT ID NUMBER
LOCAL RAMP	

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 30A

2040 ALTERNATIVE 4 FREEWAY ANALYSIS SEGMENT LOCATION

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND

BASIC FREEWAY SEGMENT:	FX FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:	RX RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:	WX WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:	
FREEWAY RAMP:	
LOCAL RAMP	

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TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 30B — 2040 ALTERNATIVE 4 FREEWAY ANALYSIS SEGMENT LOCATION

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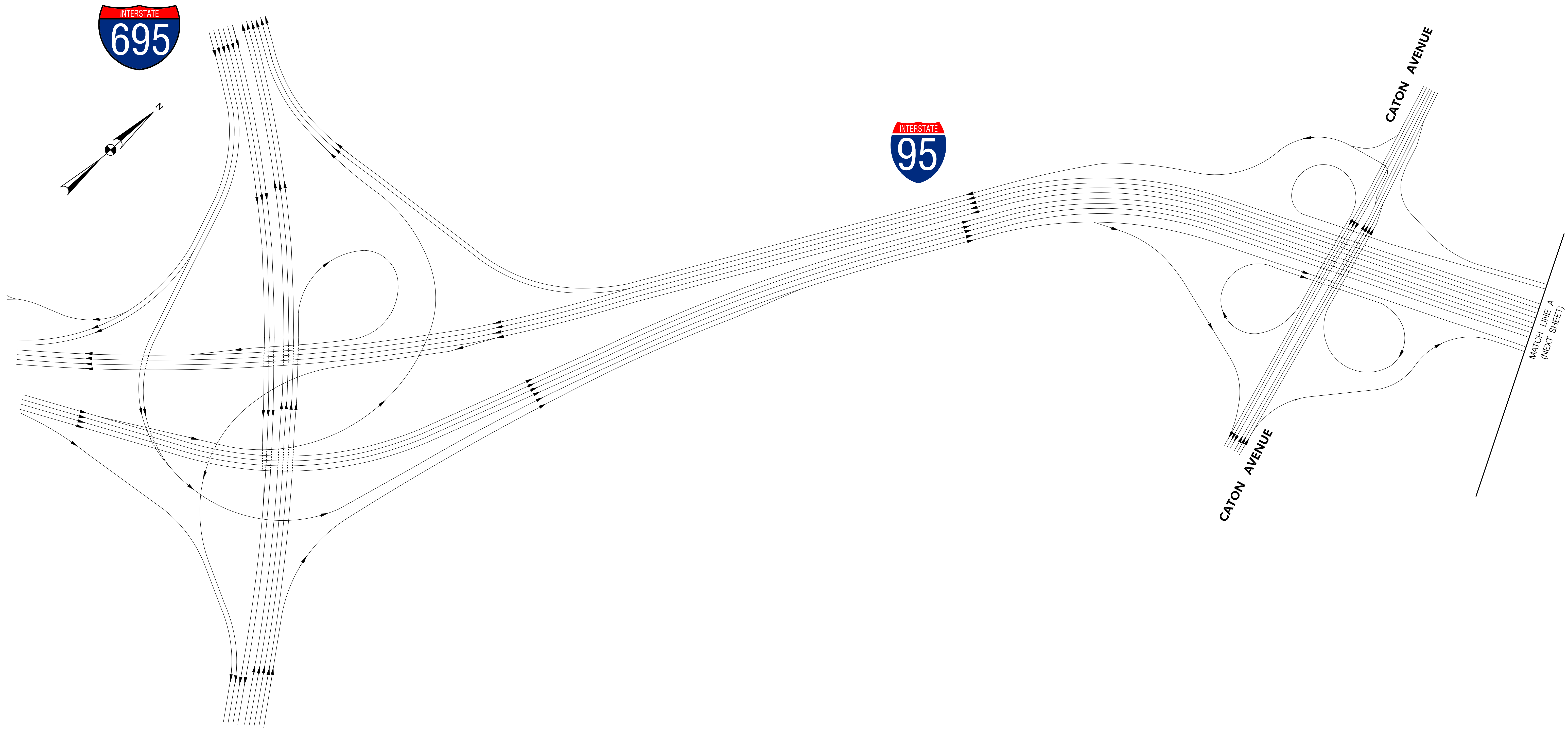


NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 31A WIRING DIAGRAM - ALTERNATIVE 5

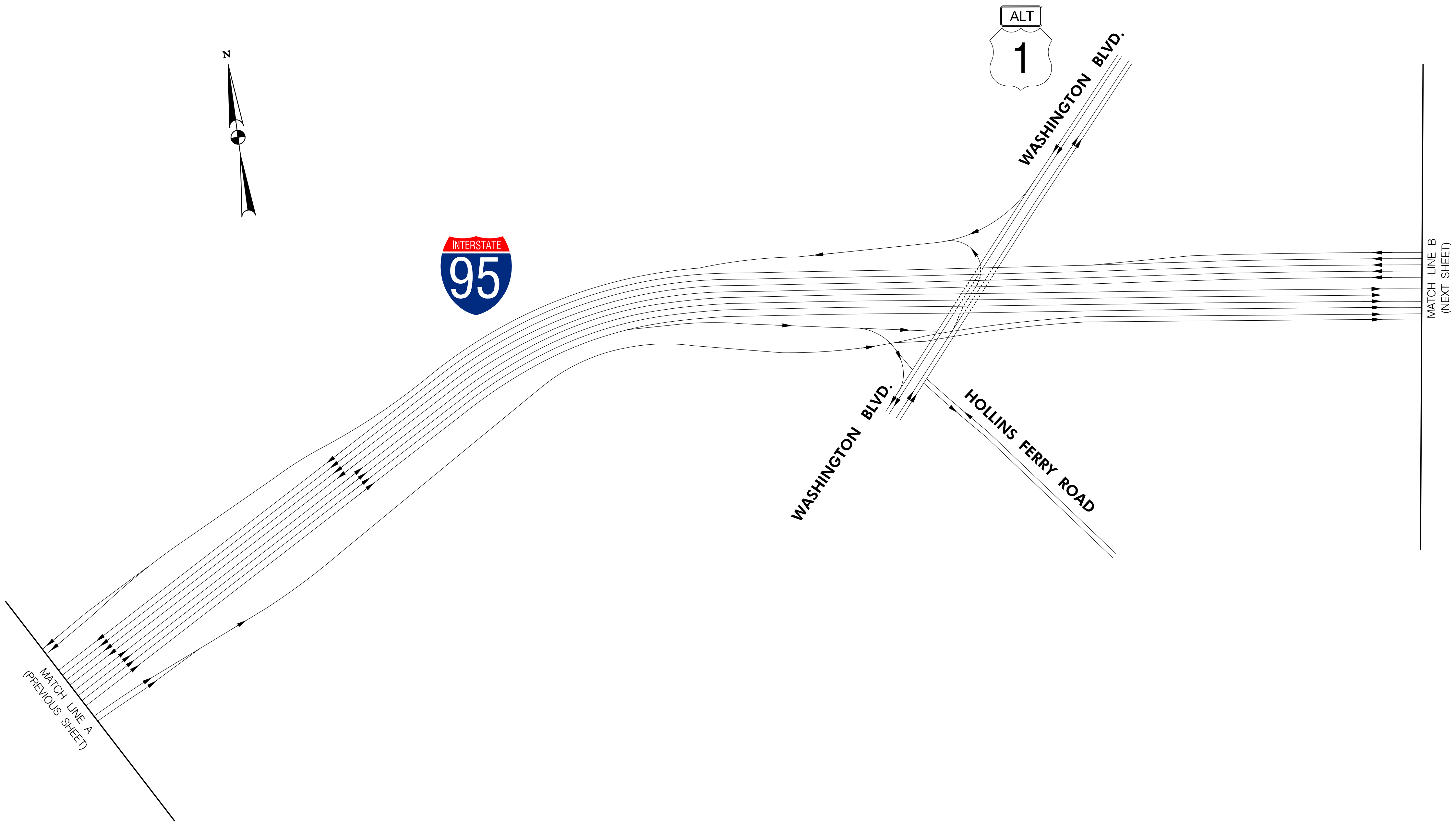
U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

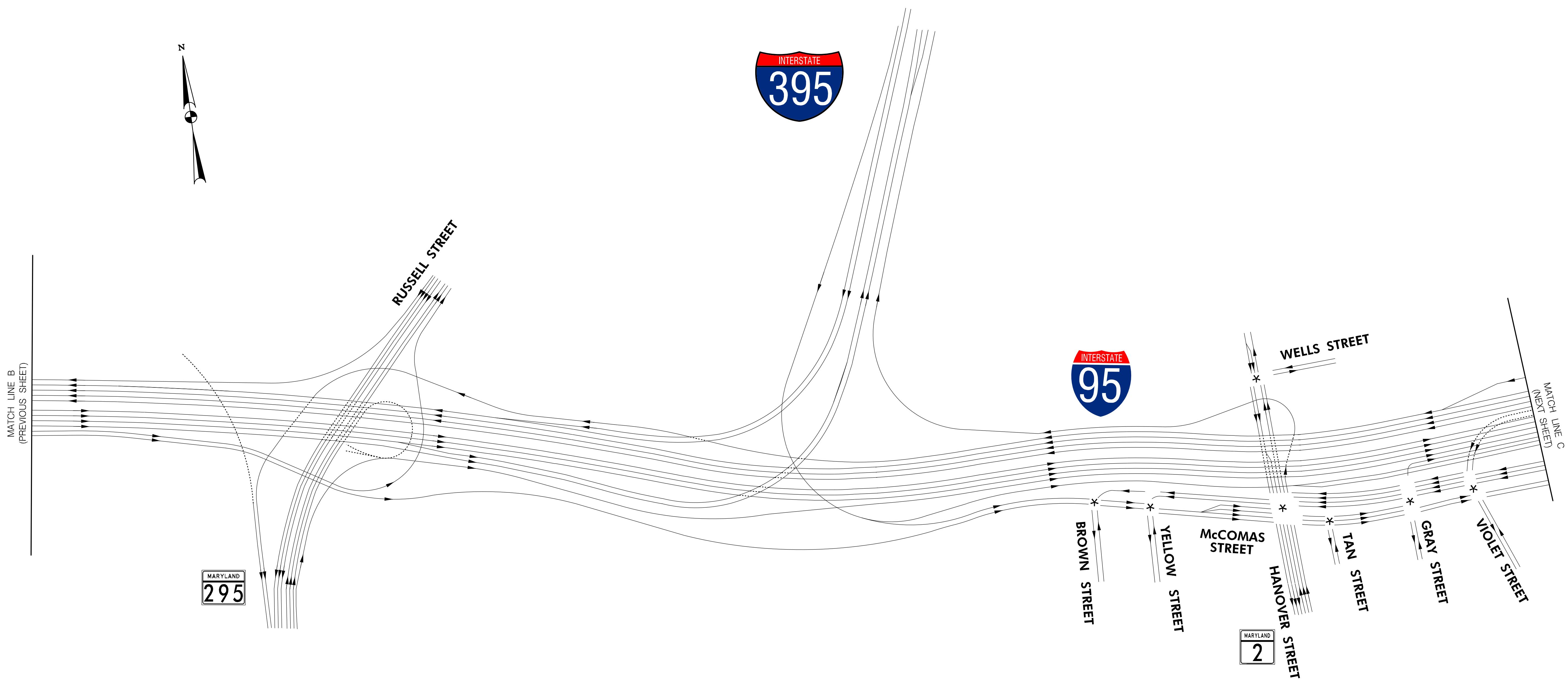
FIGURE: TTR - 31B WIRING DIAGRAM - ALTERNATIVE 5

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS



NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 31C WIRING DIAGRAM - ALTERNATIVE 5

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

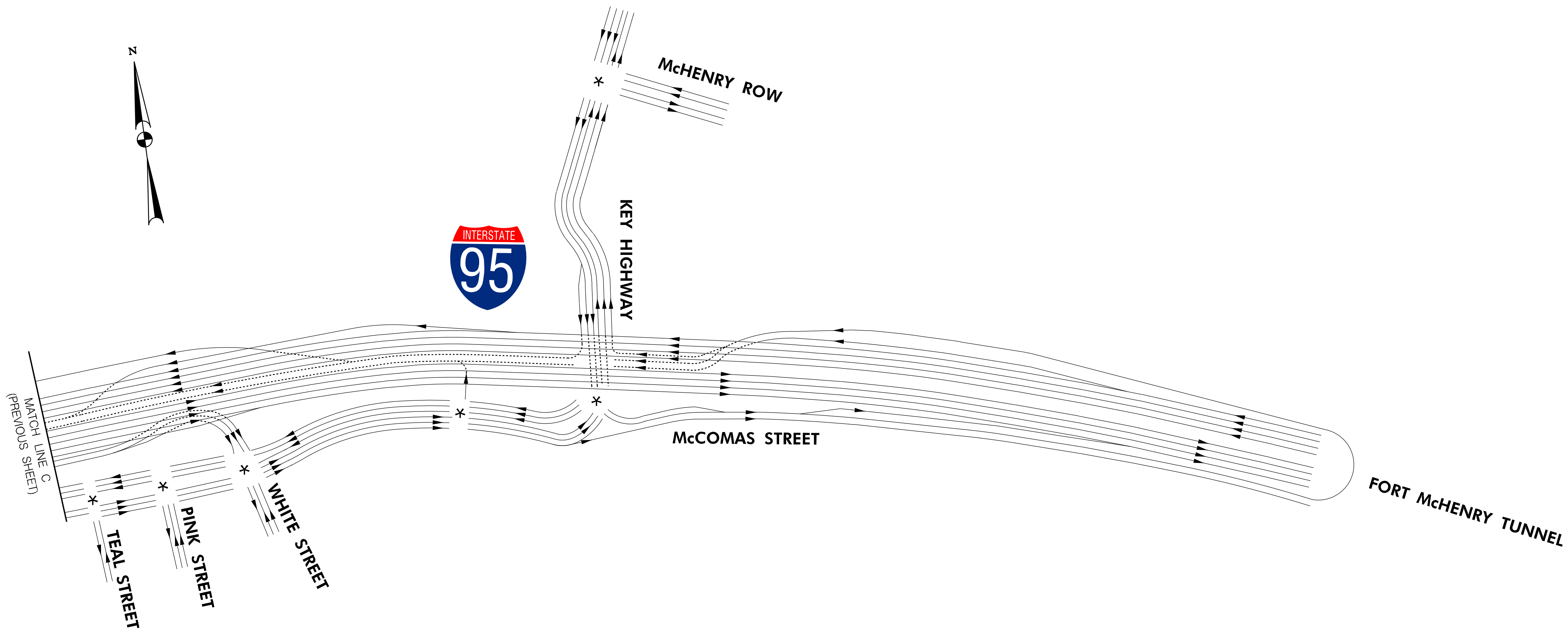
dot

LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-35 FOR SURFACE STREET INTERSECTION LANE USE



LEGEND:

EXISTING / PROPOSED TRAVEL LANES

ROADWAY / SECTIONS OF ROADWAY UNDER OTHER ROADWAYS

* SEE FIGURE TTR-35 FOR SURFACE STREET INTERSECTION LANE USE

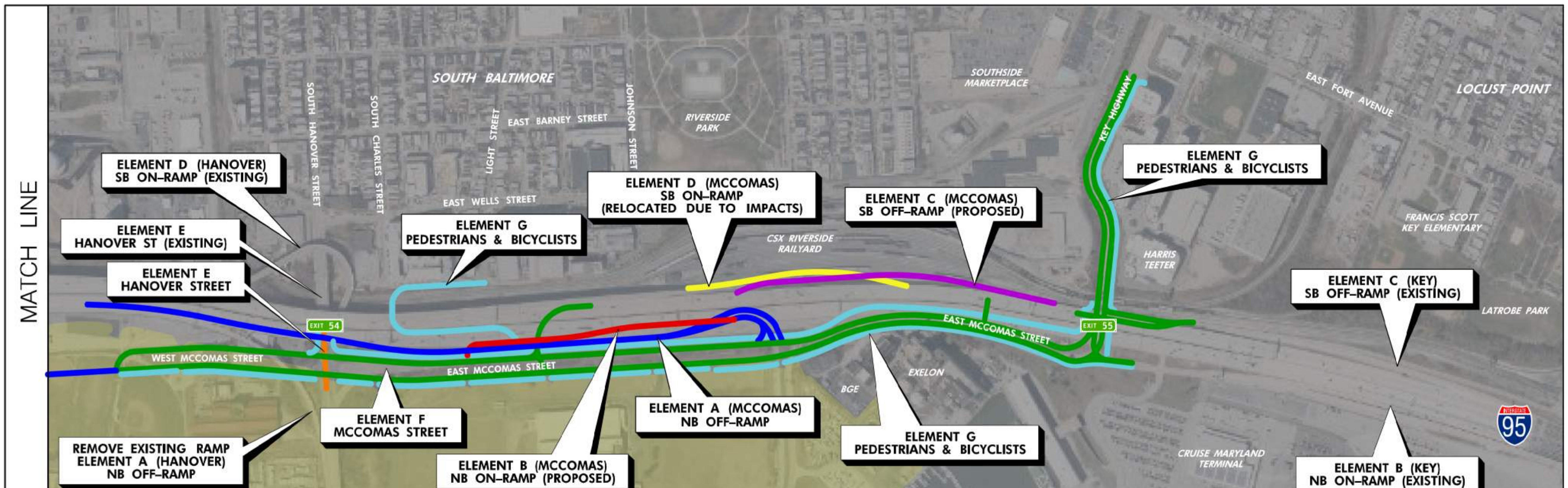
NOT TO SCALE

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 31D WIRING DIAGRAM - ALTERNATIVE 5

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority



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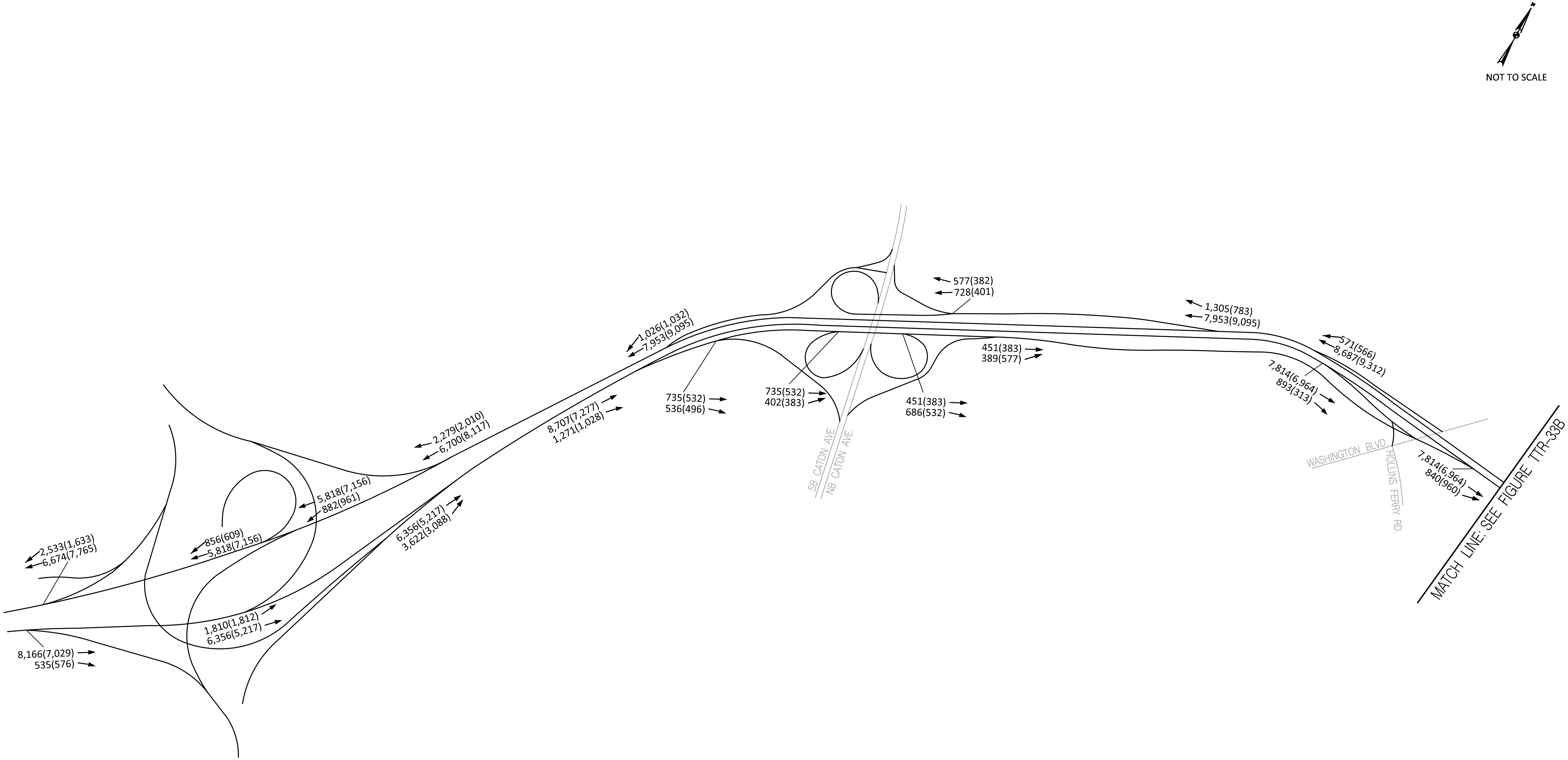
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR-32

ALTERNATIVE 5
ELEMENTS KEY MAP

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



LEGEND

AM (PM)

New or Reconstructed Off–Ramp

New or Reconstructed On–Ramp

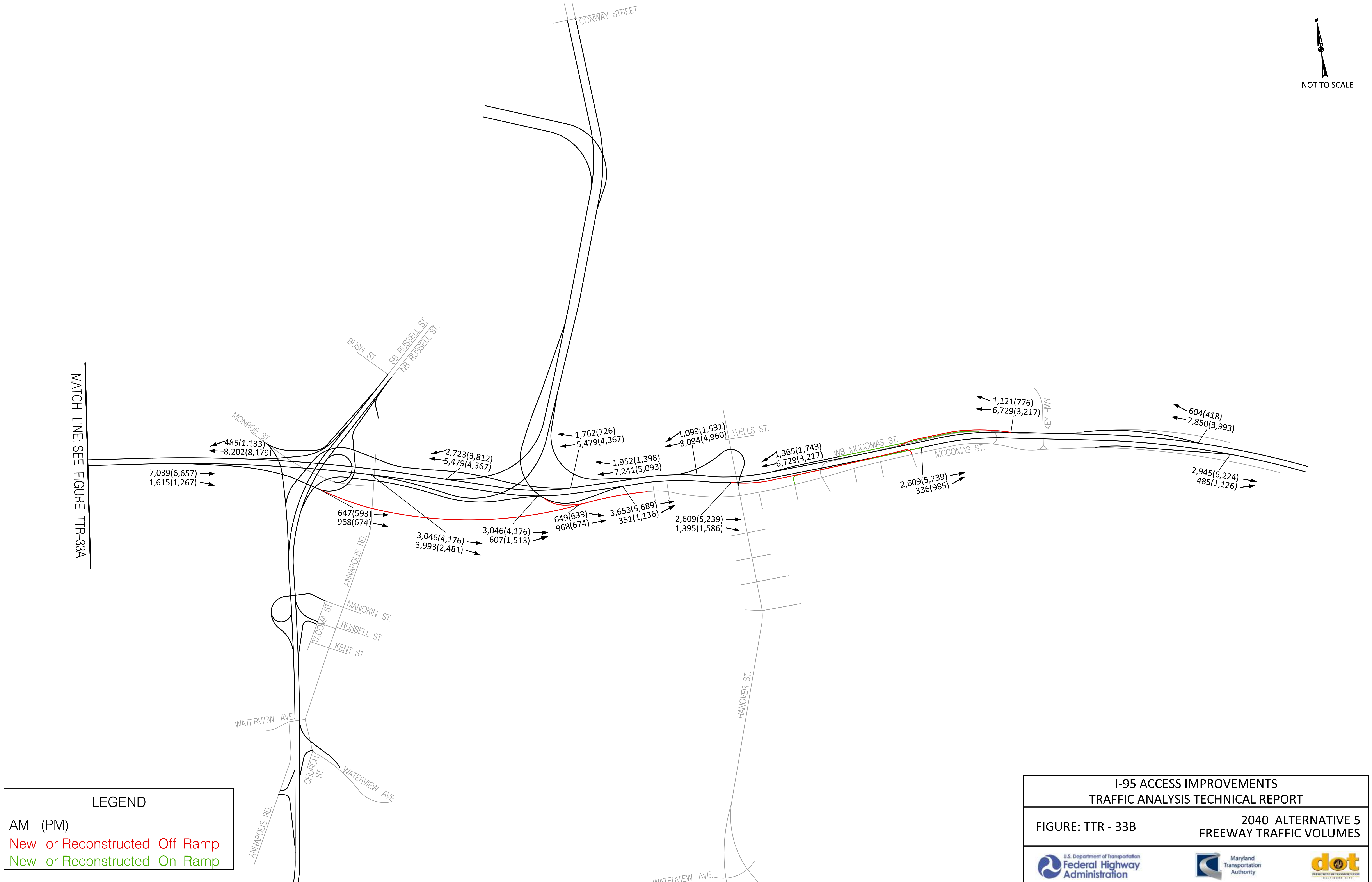
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 33A

2040 ALTERNATIVE 5
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

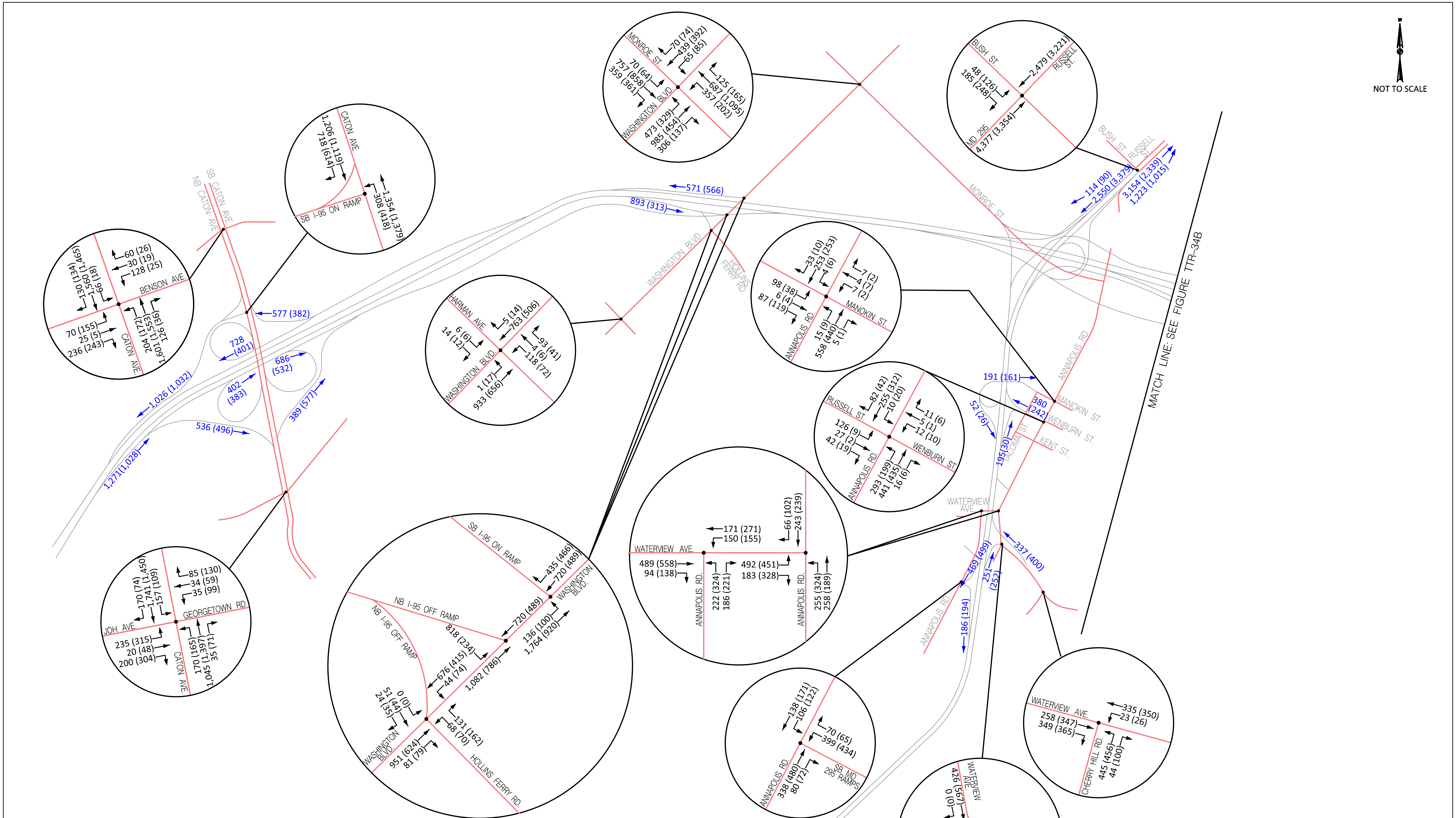


I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 33B

2040 ALTERNATIVE 5
FREEWAY TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



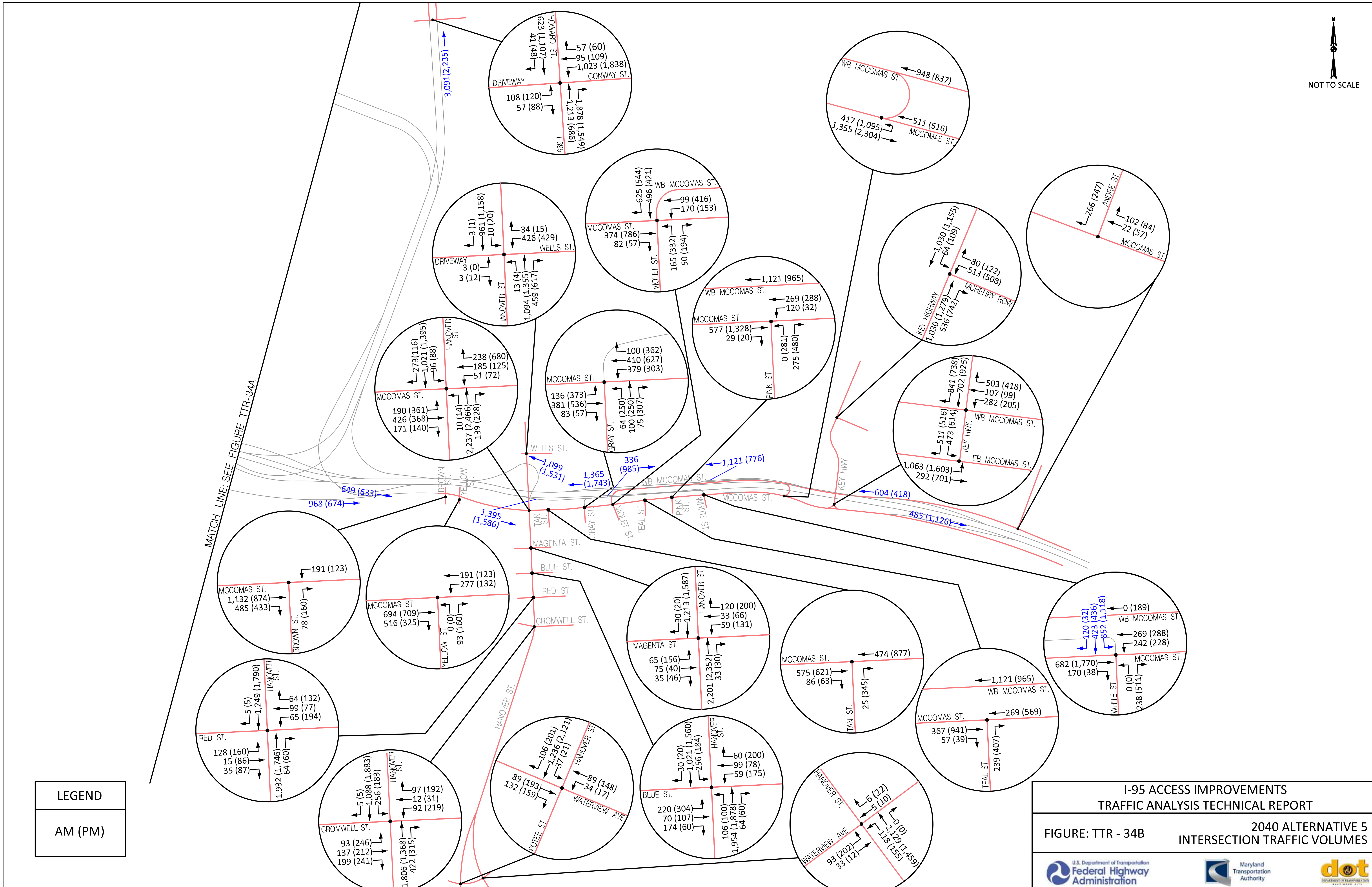
LEGEND
AM (PM)

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 34A

2040 ALTERNATIVE 5
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



LEGEND

AM (PM)

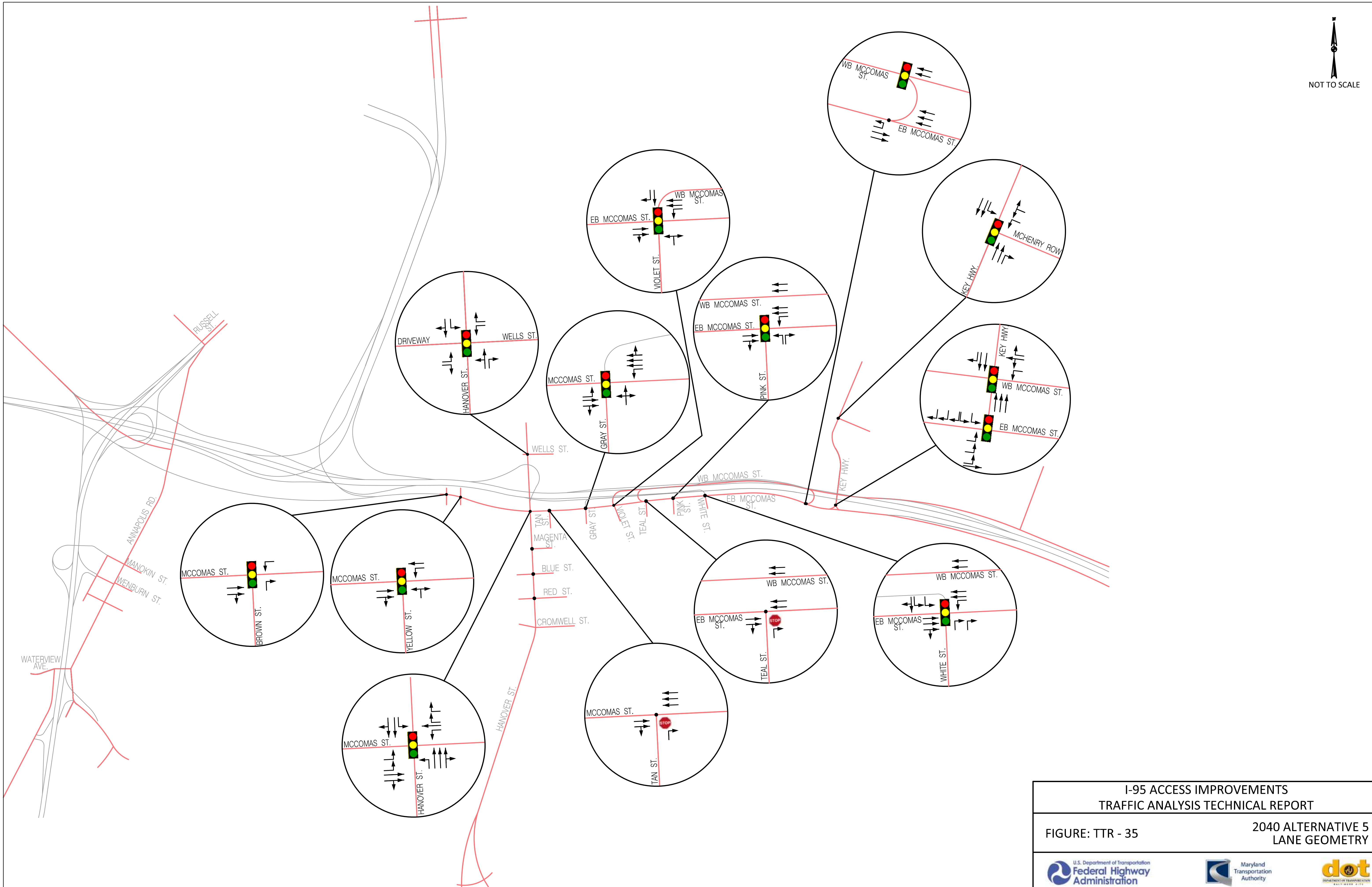
I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 34B

2040 ALTERNATIVE 5
INTERSECTION TRAFFIC VOLUMES

U.S. Department of Transportation Federal Highway Administration

Maryland Transportation Authority

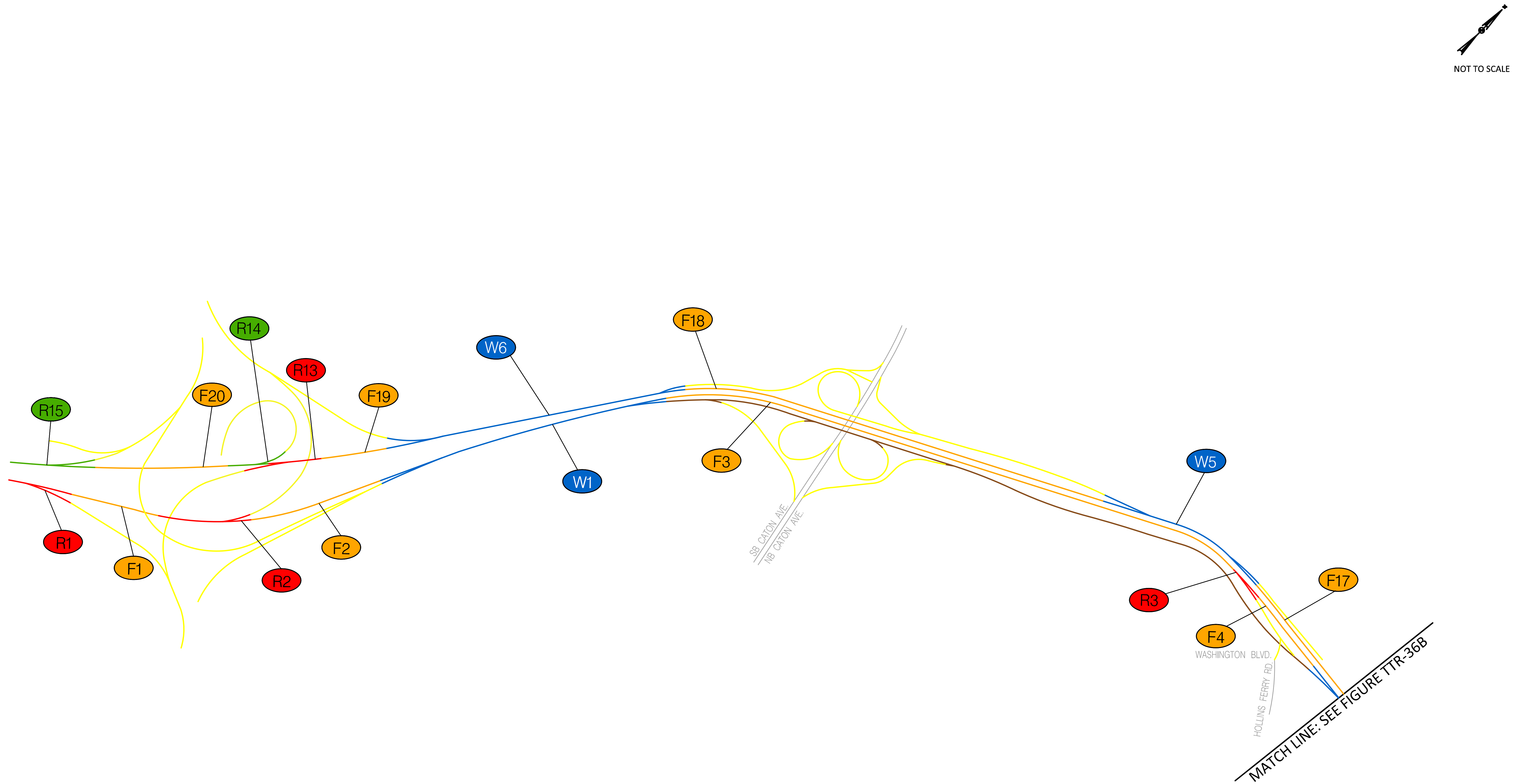


I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 35

2040 ALTERNATIVE 5
LANE GEOMETRY

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority



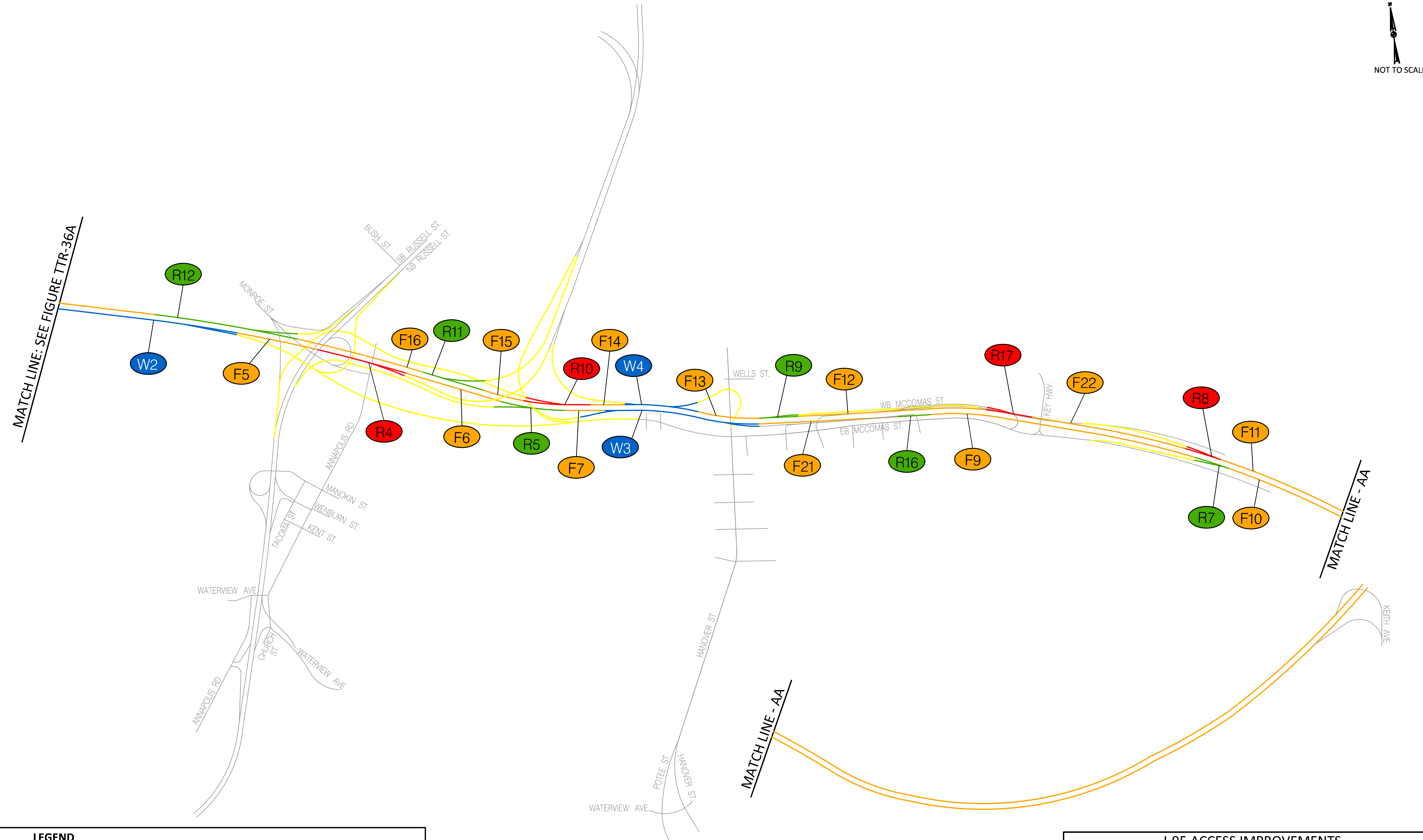
LEGEND

BASIC FREEWAY SEGMENT:		FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:		RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:		WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:			
FREEWAY RAMP:			
LOCAL RAMP			

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 36A

2040 ALTERNATIVE 5 FREEWAY ANALYSIS SEGMENT LOCATION



LEGEND

BASIC FREEWAY SEGMENT:	orange line	FX	FREEWAY SEGMENT ID NUMBER
FREEWAY WEAVE:	blue line	RX	RAMP SEGMENT ID NUMBER
DIVERGE SEGMENT:	red line	WX	WEAVING SEGMENT ID NUMBER
MERGE SEGMENT:	green line		
FREEWAY RAMP:	yellow line		
LOCAL RAMP	brown line		

I-95 ACCESS IMPROVEMENTS
TRAFFIC ANALYSIS TECHNICAL REPORT

FIGURE: TTR - 36B

2040 ALTERNATIVE 5 FREEWAY ANALYSIS SEGMENT LOCATION

U.S. Department of Transportation Federal Highway Administration
Maryland Transportation Authority

APPENDIX B: TRAVEL FORECASTING REPORT

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Port Covington

TRAFFIC FORECASTING REPORT

Prepared By:

Vision Engineering & Planning

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1. Introduction

1.1 Study Area

The Port Covington project is a mixed-use development (MXD) plan that consists of the modification of existing land use and the addition of new grids of streets as well as potential new access to I-95. The proposed change in land use and transportation infrastructure plan will certainly alter both the transportation demand and traffic flow pattern. The impact of development on the transportation network is expected to be prominent on nearby surface streets (both existing and proposed) as well as on the facilities upstream and downstream of the project area, particularly along I-95 corridor. In order to accurately model the impact of proposed changes, this study considers the influence area along I-95 from the Fort McHenry tunnel and downstream to I-695 in Baltimore County. It includes some portions of major surface streets such as McComas Street, Hanover Street, Key Highway, Washington Boulevard, Annapolis Road, and Caton Avenue. It also includes the northern extension of I-395 to W Conway Street and the extension of MD-295 from Bush Street to Waterview Avenue. Figure 1 depicts the project influence area along I-95 (within red interception line) and project area (enclosed inside rectangle).

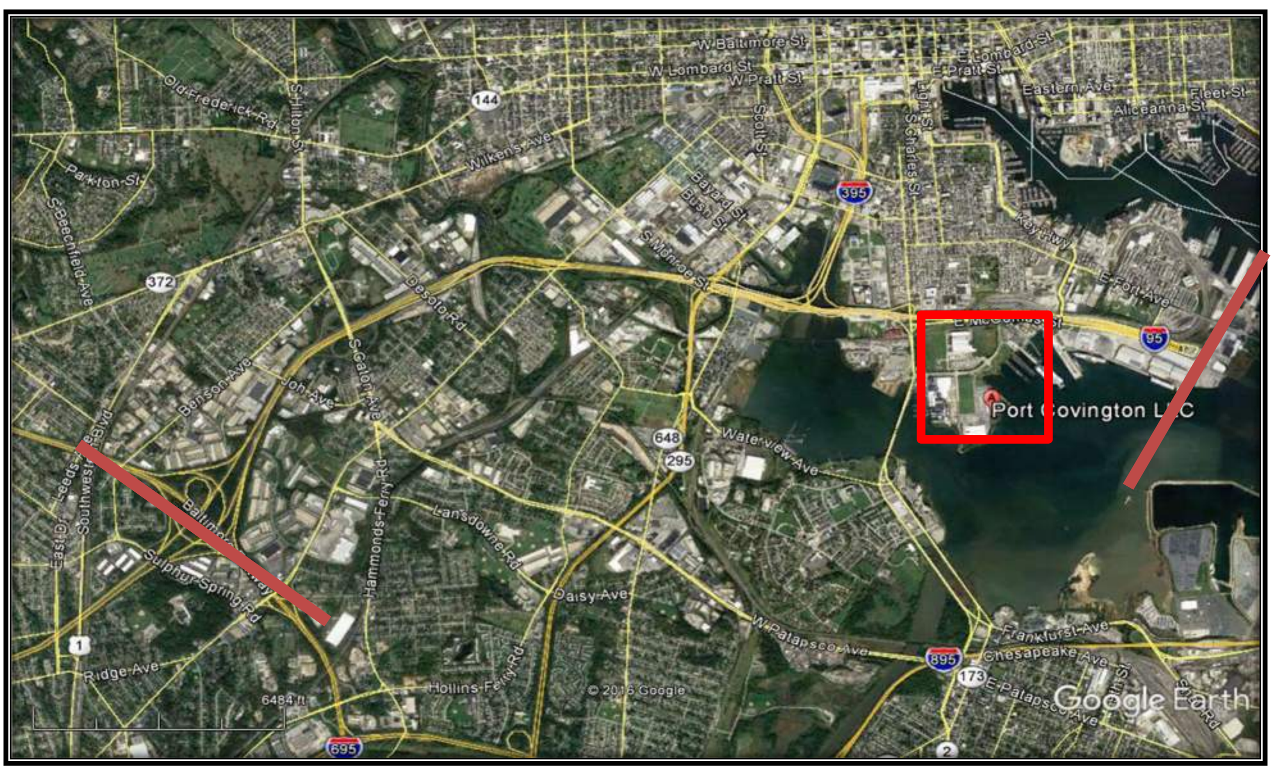

FIGURE 1 STUDY AREA

1.2 Study Intersections

Realizing the impact of proposed changes on the surrounding areas, the following interchanges and intersections were considered in the study.

I. I-95 between I-695 and the Fort McHenry Tunnel (east of Exit 55 for Key Highway). This segment includes the following interchanges:
   1. Interchanges on I-95 and I-695 [Exits: 49 A, 49 B, 11 A, 11 B]
   2. Interchanges on I-95 and S Caton Avenue [Exits: 50 A, 50 B]
   3. Exit 51: I-95 at Washington Boulevard
   4. Interchanges on I-95 and MD-295 (Baltimore-Washington Parkway)/Russell Street [Exit: 52]
   5. Interchanges on I-95 and I-395 [Exit 53]
   6. Interchanges on I-95 and Hanover Street [Exit 54]
   7. Exit 55: I-95 at Key Highway

   For opening and design year analysis, the study also evaluates new proposed ramps as alternatives (I-95 Northbound Off Ramps, I-95 Northbound On Ramps, I-95 Southbound Off Ramps, I-95 Southbound On Ramps) to provide access to and from the Port Covington development to I-95.

II. MD-295/Russell Street between the Baltimore County Line (south of the Annapolis Road/Waterview Avenue Interchange) and Bush Street, where the freeway portion of MD-295 terminates and becomes the Russell Street arterial. This segment includes the following interchanges/intersections:
   1. MD-295 at Annapolis Road/Waterview Avenue
   2. MD-295 (Baltimore-Washington Parkway) at Westport
   3. MD-295 (Baltimore-Washington Parkway) at I-95
   4. MD-295/ Russell Street at Bush Street

III. I-395 from I-95 to W Conway Street

IV. Hanover Street between Wells Street and Waterview Avenue
   1. Hanover Street at Wells Street
   2. Ramp to I-95 SB from Hanover Street
   3. Hanover Street at McComas Street
   4. Ramp from I-95 NB to Hanover Street
   5. Hanover Street at Cromwell Street
   6. Hanover Street Southbound at Waterview Avenue
   7. Hanover Street Northbound at Waterview Avenue

   The study also includes intersections of Hanover Street with proposed streets such as Magenta Street, Blue Street and Red Street inside the Port Covington development.

V. McComas Street between Hanover Street and Ramps to/from I-95 Exit 55
   1. McComas Street at Hanover Street/Ramp from I-95 NB

2. Mc Comas Street at Andre Street
3. U-Turn from westbound McComas Street to eastbound McComas Street (approximately 900 feet west of Cromwell Street)
4. McComas Street at Cromwell Street
5. U-Turn from eastbound McComas Street to westbound McComas Street (approximately 1,250 feet east of Cromwell Street)
6. McComas Street at Key Highway
7. Ramp to I-95 SB from McComas Street

The study also takes into account of the intersections of McComas Street with proposed streets such as Tan Street, Grey Street, Violet Street, Teal Street, Pink Street and White Street inside the proposed Port Covington development.

VI. Cromwell Street between Hanover Street and McComas Street
1. Cromwell Street at West Peninsula Drive
2. Cromwell Street at Driveway (approximately 1,000 ft. east of the West Peninsula Drive intersection)

VII. Washington Boulevard between Monroe Street and Hollins Ferry Road
1. Washington Boulevard at Monroe St.
2. Washington Boulevard at I-95 On Ramp
3. Washington Boulevard at I-95 Off Ramp
4. Washington Boulevard at I -95 Off Ramp and Hollins Ferry Road

VIII. Annapolis Road from MD-295 Ramp to Waterview Ave
1. Annapolis Road at MD-295 Ramps
2. Annapolis Road at Manokin Street
3. Annapolis Road at Russell Street/Wenburn Street

IX. Caton Avenue from Benson Avenue to Joh Avenue/Georgetown Road
1. Caton Avenue and Benson Avenue
2. Caton Avenue interchanges with I-95
3. Caton Avenue at Joh Avenue/Georgetown

1.3 Development Overview

The Port Covington project is a mixed-use development project undertaken by Sagamore Development Corporation. The planned development covers over 260 acres and three miles of Patapsco River waterfront (a major tributary to the Chesapeake Bay) near I-95, the Port of Baltimore's Cruise Terminal, and the Fort McHenry National Monument. The final project will add 15 million square feet of mixed-use space to the Port Covington area – 5.5 million square feet of office space, 3.9 million square feet for Under Armour's campus expansion, 1.5 million square feet of retail space, and 4.1 million square feet of hotel, park, manufacturing, and parking uses. Figure 2 depicts the overview of proposed development of Port Covington.

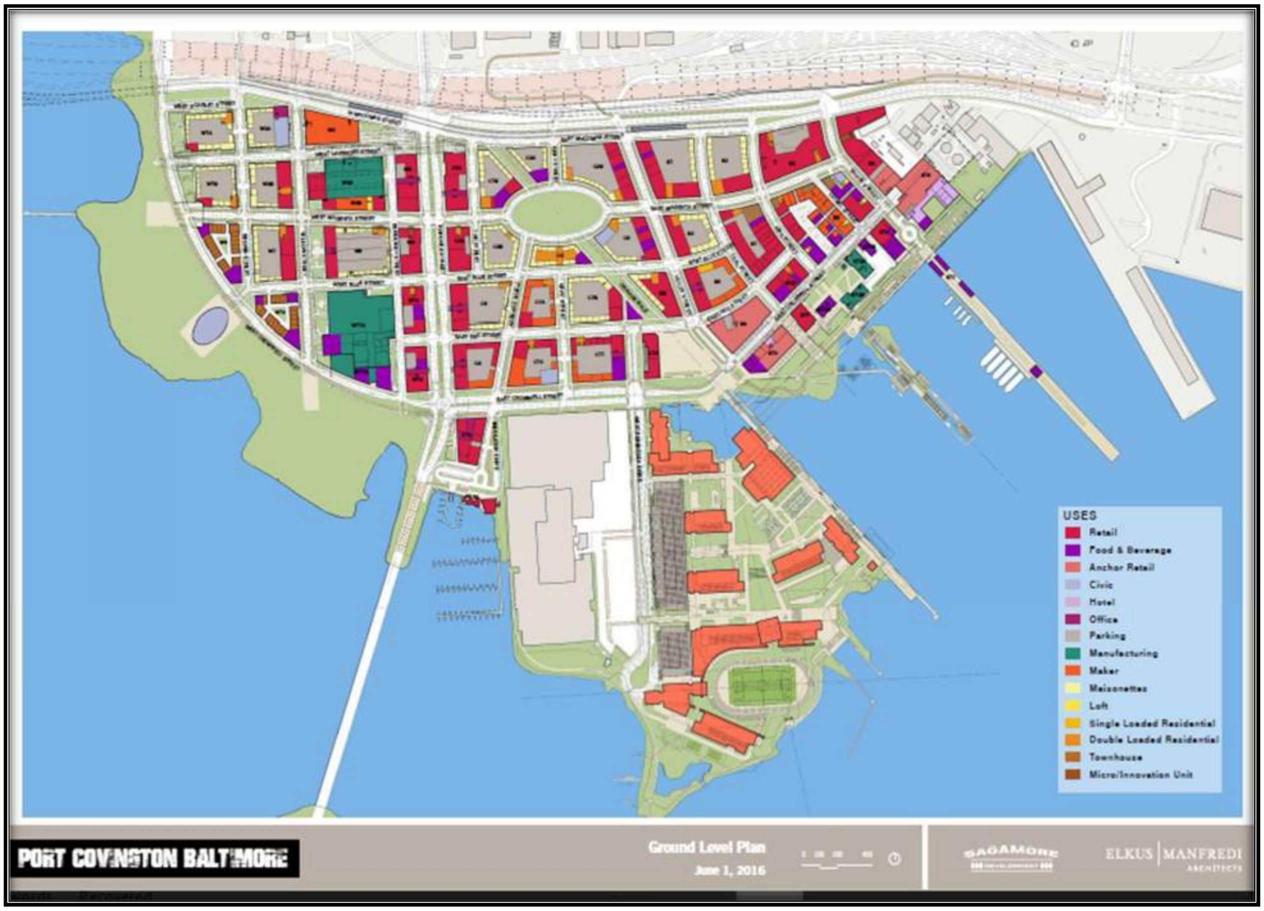

FIGURE 2 PROPOSED DEVELOPMENT OF PORT COVINGTON

The proposed development also includes transportation infrastructure plans including access improvements to I-95 and arterial roadways, transit, bicycle/pedestrian structures and facilities, and creation of a local street grid where none currently exists.

1.4 Purpose of the Study

The Port Covington development team proposes modifications in land use that is expected to have significant impacts on traffic, pedestrians, bicyclists and transit users due to resulting change in transportation demands. Furthermore, the proposed changes in transportation infrastructure will also change demand as well as travel patterns in the study area. In this regard, the transportation demand estimation is a basic and essential component of this study.

2. Baltimore Metropolitan Council (BMC) Model Overview

The BMC transportation model was developed as a four-step trip based model that runs on the Cube Voyager software platform and includes the MPO area (i.e., Baltimore City, Annapolis City, Anne Arundel County, Baltimore County, Carroll County, Harford County, and Howard County), and Montgomery County, Prince George's County, Frederick County, and Washington

D.C. In 2006, the conventional model went through a major modification with nested mode choice model and the toll choice model. The four model steps include Trip Generation, Trip Distribution, Mode Choice, and Trip Assignment. The first step, "Trip Generation" estimates the number of generated trips based on land use characteristics. It is governed by the factors such as number and size of households, automobile ownership, types of activities and density of development. These characteristics are represented by creating geographical units called Traffic Analysis Zones (TAZs). These TAZs are used to create trip generation rates. The Baltimore region has 1,151 TAZs. The second step "Trip Distribution" determines where the trips generated from each TAZ go. The distribution of the trip is based on number of attractions and the travel time from other TAZs. This is basically a creation of an Origin and Destination matrix within the region with trips between each pair of TAZs. The third step "Mode Choice" shows the modes of transportation for the trips. As an example, the modal choice could be the use of privately owned car as a single ride or carpooling, use of transit such as buses and trains, etc. The modal choice is determined based on transit capacity, schedules and fares, and also based on the real observations on how, when and where the people use transit. The fourth step "Trip Assignment" determines the routes of trips from origins to destinations. The route choice is based on quickest route from origin to destination which is governed by many factors such as actual or predicted congestion levels, road conditions, fares and schedules of transit, traffic signal systems, etc.

The model also includes a feedback loop where congested travel times are looped back into the Trip Distribution step. The purpose of the feedback loop is to capture the impacts of congested highway networks on destination (Trip Distribution) and mode choice.

This is an important detail to note as the BMC regional model was used to initially develop the background growth rates for Hanover Street, Key Highway, and McComas Street. Given the forecast growth in households in areas south of the City (such as Anne Arundel County) and forecast employment growth in downtown Baltimore (excluding Port Covington), the model illustrated significant background growth on Hanover Street which provides direct access to Anne Arundel County. However, the way the feedback loop operates within the overall BMC model chain will not yield a direct comparison of Build (with Port Covington) to No Build (without Port Covington) conditions unless the feedback loop is terminated or the portion of the Build trip table outside of Port Covington is "frozen" with only the Port Covington cells updated.

Effectively, the model assignment includes trips in the No Build assignment that are not included in the Build scenario because of differences in congestion levels between the two scenarios. The Build scenario includes fewer regional trips on Hanover Street than the No Build, because the feedback loop process redirects some of the trips originating from south of the City to work and shopping opportunities in other parts of the region because of the congestion in the Port Covington area. This modeling procedure was developed to replicate observed household survey data which illustrates that households adjust trip behavior based on congestion levels over time.

Given these factors along with the way Hanover Street is coded in the BMC model (Principal Arterial with a large capacity), the study team decided to forgo using the BMC model to develop the background growth rate and used historical traffic count data on Hanover Street, McComas Street, and Key Highway to develop background growth rates. This is the typical way background growth rates are calculated on ITE studies, and this procedure yielded a lower, more reasonable background growth rate, that obtained concurrence from MdTA and Baltimore City.

3. Trip Generation/Distribution Summary

3.1 Trip Generation

The ITE method was used to develop the intersection trip forecasts on Hanover and McComas Streets, and the BMC regional model and National Cooperative Highway Research Program Report (NCHRP) 765 methods were used to develop the future year 2040 forecasts on I-95 and the remaining study corridors. To ensure compatibility between the two forecasting methods, a test model run was conducted with the BMC regional model with the Port Covington employment and households added to the year 2040 demographic file. The results of the model run indicated that over 76,000 daily trips would be generated by Port Covington. These results were compared to existing traffic count data and the ITE peak hour forecasts.

The Trip Generation table below (Table 1) compares the daily model forecast trips with existing K-factors (that is, the percentage of daily traffic occurring during a particular peak hour) to the ITE peak hour forecasts.

TABLE 1 PORT COVINGTON TRIP GENERATION

Port Covington Trip Generation			
	Daily Trips	AM Peak Hour	PM Peak Hour
BMC Model w Existing K Factors	76371	6110	6010
ITE w 20% Transit Reduction	N/A	5614	8191
% Difference	N/A	-9%	27%
BMC Model w Adjusted PM K Factor of 0.1	76371	6110	7637
ITE w 20% Transit Reduction	N/A	5614	8191
% Difference	N/A	-9%	7%

Using the existing K-factors, the AM model peak hour forecast was within 10% of the ITE peak hour forecast, though the PM peak hour model forecast did not converge with the ITE forecast using the existing K-factor. The K-factor was increased to 0.1 for the PM peak hour, and the model peak hour forecast converged to within 10% of the ITE peak hour forecast. Given that the ITE PM peak hour forecast trips would lead to a K-factor slightly greater than 0.1 when compared to the daily model trips, the 0.1 K-factor for the PM peak hour was deemed reasonable, and the BMC model was properly capturing the future Port Covington trips.

3.2 Trip Distribution

Trip Distribution for future site developments is typically derived from existing traffic count data for the morning and evening peak hours. This approach is used for the majority of Institute of Transportation Engineers (ITE) Trip Generation Manual based traffic impact studies, and is a proven method for studying new developments that are similar in land use types as the existing land use in the study area.

In specific cases where the proposed land use is significantly different than the existing land use such as Port Covington, other trip distribution methods are recommended to substitute and/or supplement the existing traffic count distributions. These methods include surveys conducted by the site developer, or travel demand model analysis. For Port Covington, the Baltimore Metropolitan Council (BMC) regional travel demand model was used to determine the origins and destinations for the forecast Port Covington trips. This procedure, known as select link or zone analysis, uses Cube Voyager scripting to isolate the trips to and from a particular zone(s) or link(s). The benefit of a select link analysis is that the regional model includes a feedback loop that adjusts the destination choice for households that experience significant traffic congestion in their originally assigned path. For example, based on the forecast traffic congestion on I-95 in the year 2040, the model results indicated approximately half of the Port Covington trips would come from Baltimore City zones as these households had shorter paths to Port Covington when future congestion levels were considered. Moreover, the regional model includes mode choice to capture the transit usage to the site and an equilibrium assignment process that considers both regional and local highway and transit systems which the ITE method does not capture.

Existing count distributions were compared to the BMC daily model select link derived distributions, and generally the BMC model assigned more trips from Baltimore City to and from Port Covington than existing count data illustrated. The reasons for this were documented previously, however the study team wanted to develop another scenario that would shift some of the trips from Baltimore City to suburban areas of Howard, Anne Arundel, and Baltimore Counties. A test scenario was developed where the trips to these counties were increased by 10% with a corresponding reduction to Baltimore City trips. The study team developed this scenario to ensure the I-95 transportation improvements would accommodate a scenario where more of the trips used I-95 than the BMC model predicted.

Additional comparisons were also conducted between the existing peak hour traffic count distributions and BMC model peak period select link distributions. The values for the existing peak hour count distributions and peak period select link distributions were averaged as the study team determined that weight should be given to both distributions, and a cell matrix was developed comparing the various trip distributions. The green highlighted cells (Table 2) illustrate where the distributions converge within 3-4% of an average value for a particular direction to and from Port Covington. As the trip distribution table illustrates, the average of the peak hour existing count and BMC model peak period select link distributions lead to all of the directions converging within 3-4% of an average value. Therefore, the study team recommended to use these distributions for trip assignment. It should also be noted that the average peak hour/period trip distributions converge for the most part with the original daily and adjusted daily model trip distributions.

TABLE 2 PORT COVINGTON TRIP DISTRIBUTION

Port Covington Trip Distribution							
	From I-95 North	From I-95 South	From Waterview	From Hanover Street North	From Hanover Street South	From Key Hwy/McCommas	From I-395
AM Peak Period Trips	2467	4469	50	3845	2195	2070	2030
AM Peak Period % Distribution	14%	26%	0%	22%	13%	12%	12%
AM Count	9700	9800	187	1971	2807	2384	1350
AM Count Dist	34%	35%	1%	7%	10%	8%	5%
STV Dist	35%	35%	0%	15%	10%	5%	0%
PM Peak Period Trips	3131	4766	503	4619	2946	2669	2839
PM Peak Period % Distribution	15%	22%	2%	22%	14%	12%	13%
PM Count	9600	9100	226	2217	2745	2624	1250
PM Count Dist	35%	33%	1%	8%	10%	9%	5%
AM Average % Distribution	24%	30%	0%	15%	11%	10%	8%
PM Average % Distribution	25%	27%	2%	15%	12%	11%	9%
Daily Model % Distribution	15%	25%	1%	23%	13%	13%	10%
Adjusted Model % Distribution	23%	31%	1%	15%	10%	7%	13%

4. Mode Choice Summary

Mode choice is one of the most important considerations in the context of planning for the transportation impacts of the Port Covington development. The forecast mode shares for the development determine the number of additional vehicle trips that are added to the existing roadway network. It is important that the mode choice assumptions be based on existing data in order to expedite the FHWA NEPA planning process and gain consensus with various stakeholders. Research on existing mode shares was conducted for Baltimore City and is presented in Table 3. The American Community Survey (ACS) is developed by the United States Census Bureau and summarizes household characteristics including mode of travel to work.

The ACS profile illustrates that 27% of commuting trips in Baltimore City are made by transit, walking, or other means which includes bicycling.

TABLE 3 BALTIMORE CITY ACS MODE SHARES

Subject	Baltimore city, Maryland			
	Estimate	Margin of Error	Percent	Percent Margin of Error
COMMUTING TO WORK				
Workers 16 years and over	266,684	+/-4,293	100%	(X)
Car, truck, or van -- drove alone	162,463	+/-4,883	60.9%	+/-1.7
Car, truck, or van -- carpooled	24,144	+/-2,676	9.1%	+/-1.0
Public transportation (excluding taxicab)	49,594	+/-3,955	18.6%	+/-1.4
Walked	17,671	+/-2,038	6.6%	+/-0.8
Other means	4,789	+/-1,120	1.8%	+/-0.4
Worked at home	8,023	+/-1,584	3.0%	+/-0.6
Mean travel time to work (minutes)	29.8	+/-0.8	(X)	(X)

Additional ACS analysis was conducted for census tracts in Baltimore City with similar characteristics as the completed Port Covington (Table 4). The transit/non-motorized mode shares for these tracts ranged from 10% in the existing Port Covington tract which currently has less household/employment density than the other tracts, to over 60% for the University of Maryland tract in downtown Baltimore. The average transit/non-motorized share for all of these census tracts is 31% which is higher than the citywide average of 27%.

TABLE 4 ACS CENSUS TRACT JOURNEY TO WORK DATA

	Census Tract 203, Baltimore city, Maryland	Census Tract 302, Baltimore city, Maryland	Census Tract 401, Baltimore city, Maryland	Census Tract 402, Baltimore city, Maryland	Census Tract 2201, Baltimore city, Maryland	Census Tract 2301, Baltimore city, Maryland	Census Tract 2302, Baltimore city, Maryland	Census Tract 2303, Baltimore city, Maryland	Census Tract 2401, Baltimore city, Maryland	Census Tract 2402, Baltimore city, Maryland	Census Tract 2403, Baltimore city, Maryland	Census Tract 2404, Baltimore city, Maryland
	Fells Point	Harbor East/Little Italy	Downtown	University of Maryland	Inner Harbor/Ridgely's Delight/Otterbein	Sharp Leadenhall	South Baltimore/ Federal Hill	South Baltimore/ Port Covington	Locust Point	Riverside	Federal Hill	Riverside/ Port Covington
COMMUTING TO WORK												
Workers 16 years and over	2,593	1,445	2,284	362	2,093	1,021	1,564	725	1,892	2,108	1,428	2,019
Car, truck, or van -- drove	69.3%	39.4%	39.7%	32.0%	54.2%	69.9%	81.0%	84.7%	73.3%	72.6%	65.3%	81.2%
Car, truck, or van -- carpooled	2.9%	5.8%	3.9%	6.1%	4.9%	7.1%	5.1%	5.2%	9.3%	5.7%	3.2%	5.6%
Auto	**72.2%**	**45.2%**	**43.6%**	**38.1%**	**59.1%**	**77.0%**	**86.1%**	**89.9%**	**82.6%**	**78.3%**	**68.5%**	**86.8%**
Public transportation	9.3%	8.2%	16.4%	2.2%	4.9%	4.2%	4.6%	3.7%	4.8%	3.1%	11.0%	4.3%
Walked	14.0%	39.7%	34.6%	48.6%	28.7%	10.4%	7.9%	3.3%	8.2%	12.1%	14.6%	5.6%
Other means	0.3%	1.9%	3.3%	5.2%	0.7%	1.4%	0.0%	0.0%	2.7%	2.1%	1.4%	1.8%
Worked at home	4.2%	5.0%	2.1%	5.8%	6.6%	7.0%	1.4%	3.0%	1.7%	4.3%	4.6%	1.5%
Non-Auto	**27.8%**	**54.8%**	**56.4%**	**61.8%**	**40.9%**	**23.0%**	**13.9%**	**10.0%**	**17.4%**	**21.6%**	**31.6%**	**13.2%**

The Census Transportation Planning Package (CTPP) developed by AASHTO is another useful source for researching existing modal shares and other commuting characteristics (Figure 3). The CTPP analysis for Baltimore City is consistent with the 27% in the ACS profile. When telecommuting is included, the transit and non-motorized modal shares increase to 30%. Given that Home-Based-Work trips constitute 30-40% of trips in the Baltimore region, more weight should be given to these trips when considering mode splits.

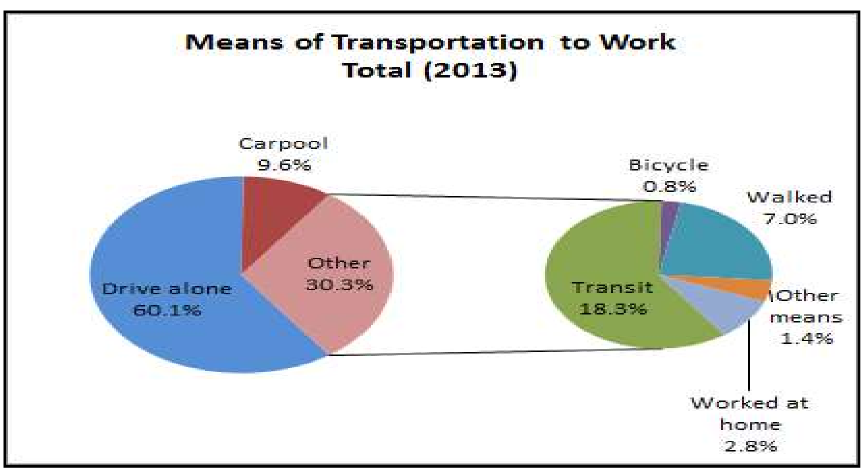

FIGURE 3 CTTP MODE SHARES

However, other trip purposes should also be considered. A limitation of the Census data is that it includes only Home-Based-Work commuting data for the census tracts in those areas. To obtain existing mode shares for regional trips to Port Covington and other trip purposes including Home-Based-Shopping, Home-Based-Other, and work based trips, additional research had to be conducted. Additional data from the Waterfront Partnership of Baltimore was obtained for the Harbor East area near downtown Baltimore. Given the proximity and similarity of the characteristics of this development to Port Covington, additional consideration was given to these mode shares. The year 2015 transit/non-motorized mode share was observed to be 20% and is estimated to increase to 22% in the year 2017.

It is important to note that the Waterfront Partnership survey focused on commuter trips from the Baltimore region to Harbor East only, though this data does give some specific insight into areas similar to Port Covington. The 20-22% transit/pedestrian/bicycle mode share is less than the 27% mode share for the City. There are a number of factors for this, including the concentration of higher paying office jobs in Harbor East which attract higher income workers from suburban areas who are less likely to use transit than lower income groups, and the lack of high quality transit service to Harbor East from the I-83 and I-95 corridors which provide regional access to Harbor East.

TABLE 5 WATERFRONT PARTNER SHIP SURVEY FOR COMMUTERS TRIP FROM BALTIMORE TO HARBOR EAST

Harbor East/Harbor Point
If no change in commuting patterns

	2015 Office Employees		Est. 2017 Office Employees	
	#	Mode Share	#	Mode Share
Total Employees	3609	100%	5200	100%
Drive Alone	2471	69%	3529	68%
Carpool	236	7%	342	7%
Walk/Bike	313	8%	497	10%
Transit	312	8%	482	9%
Harbor Connector	166	4%	167	3%
Taxicab or Other	102	3%	157	3%
Work at Home	8	0%	12	0%
Commuter Bus/Vanpool	2	0%	5	0%
Canton Harbor Connector	0	0%	0	0%

The Port Covington plans include a future high quality transit extension from downtown (Figure 4). A high quality transit connection between Port Covington and the rest of the regional transit network is critical to obtain higher transit mode shares than the observed one for Harbor East. In the context of this study, high quality transit specifically refers to transit service that is independent of roadway traffic congestion which means exclusive right-of-way or lanes and transit priority at signalized intersections. Commuter Rail, Heavy Rail, Light Rail, and Bus Rapid Transit all meet these criteria. Improved bus routing and circulation will help with these connections locally, but more reliable and faster service such as Light Rail or Bus Rapid Transit (BRT) in exclusive right-of-way has proven to increase transit mode shares beyond what traditional buses can do alone. Therefore, future consideration should be given in this regard, as Light Rail/BRT are not included in the current development plans. MTA Baltimore Link routes 67, 71, 94, and 164 currently serve the Port Covington area and provide connections to the rest of the City and region. One or more of these routes would likely be modified to provide the circulation service illustrated on Figure 4 as the Port Covington development is built out. These routes were included in the travel model runs.

Research conducted by K. Zamir, A. Nasri, B. Baghaei, S. Mahapatra, and L. Zhang in the research report "*Effects of Transit-Oriented Development on Trip Generation, Distribution, and Mode Share in Washington, D.C., and Baltimore, Maryland*", summarized the total daily modal shares for Baltimore and Washington D.C by daily trip purpose (Figure 5). The study team for this research used the National Household Travel Survey (NHTS) as their data source, and their research illustrates a total transit/pedestrian/bicycle mode share of 22.58% for Baltimore City Transit Oriented Development (TOD) and 8.7% for non-TOD for all trip purposes. Though the Port Covington Master Plan does not include rail transit or BRT, its density and proximity to downtown will likely lead to shares closer to TOD than non-TOD. For analysis purposes, an average of the two percentages was used which is 15%.

Given that the focus of the NEPA forecasting effort is the future year AM and PM peak hours, more weight was given to the commuting mode share percentages in determining the future year mode share percentage to apply to Port Covington as these trips constitute a majority of peak hour trips. The CTPP/ACS data indicated a 27% transit/pedestrian/bicycle mode share for Baltimore City overall and 31% for central city zones compared to 20-22% for Baltimore regional commuters to the Harbor East area. Factoring in the 15% transit/pedestrian/bicycle share derived from the NHTS based study, an overall transit/pedestrian/bicycle mode share for the Port Covington Study area was adopted to be 20%.

FIGURE 4 PROPOSED TRANSIT IMPROVEMENTS IN COVINGTON

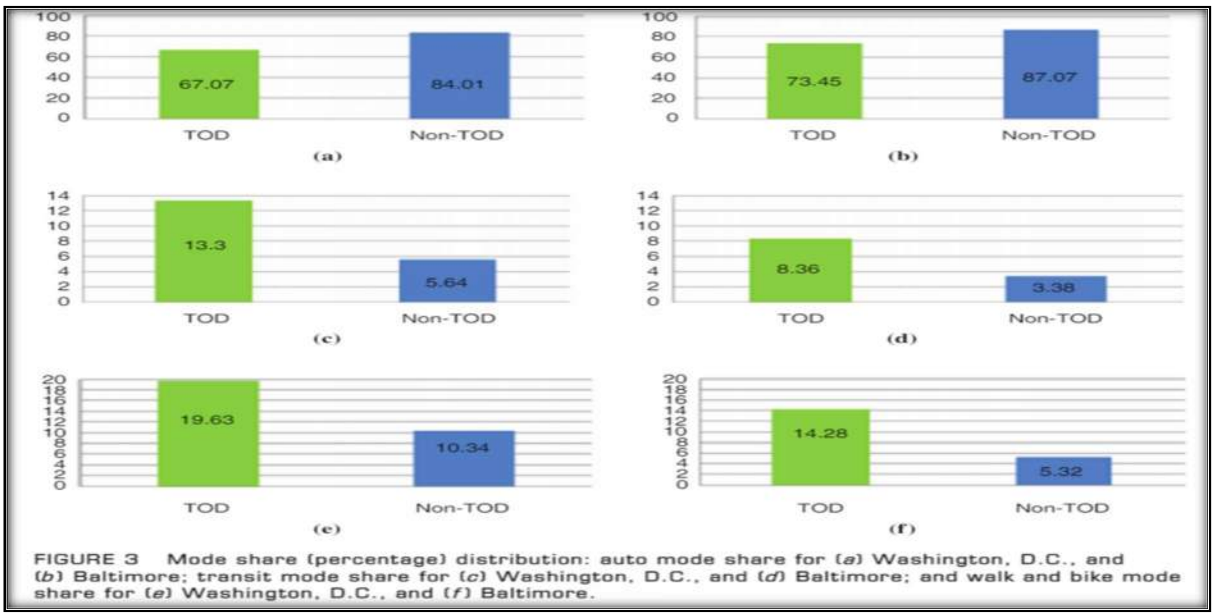

FIGURE 5 TRANSIT ORIENTED DEVELOPMENT REPORT MODE SHARES

5. Forecasting Methodology

To account for the impact of development on surrounding traffic, the transportation demand should be estimated for base year 2016 and design year 2040. Traffic forecasting was done to evaluate the future demand. To obtain the most reliable future year traffic forecasts for the Port Covington development, a hybrid approach using the ITE Trip Generation Manual and the BMC regional model was used. The hybrid approach combines the strengths of both methodologies and is summarized below by forecasting step. The first three steps are already described in the previous section of this report.

Trip Generation: The ITE method is used for Port Covington trip generation as trip generation could be estimated at the site level for specific land uses which the BMC travel demand model would not explicitly do even with modifications to the TAZ structure. However, the BMC regional model was modified as necessary to reasonably replicate the total vehicle trips estimated by the ITE method to ensure overall consistency in trip generation results which was necessary for later steps in the forecasting process. This was accomplished by adding the Port Covington households and employment to the TAZs representing the Port Covington area. The Baltimore City Department of Planning's Research and Strategic Planning Division forecasted 7050 households and 15,339 jobs for Port Covington.

Trip Distribution: The BMC regional model was used to estimate the trip distributions for Port Covington. The BMC model captures the regional impacts of Port Covington to trip distribution and destination choice. The typical ITE method of using existing traffic counts for trip distribution was not initially recommended due to the significant difference between the existing and proposed land use pattern, but was factored into the analysis to yield the most reasonable distributions and obtain concurrence from stakeholders.

Mode Choice: The ITE standard transit reduction was used as the starting point for determining transit mode shares for Port Covington; however, this estimate needed to be adjusted as existing transit ridership exceeded the ITE standard reduction for areas similar to Port Covington (i.e. Inner Harbor East, Central Business District). Moreover, given the significant pedestrian and bicycle mode shares in areas of the City similar to Port Covington, it was decided to use existing pedestrian and bicycle count data to estimate the non-motorized mode share for Port Covington. At the regional level, the BMC model includes all regional transit facilities including local bus, light rail, heavy rail, commuter rail, and managed toll lanes. The BMC model also estimates trips at the person level, with non-motorized person trips removed from the trip distribution step and subsequent steps. Therefore, the regional model intersection forecasting process also captures the effects of mode choice for the portion of the study area where the ITE methodology was not used.

Assignment: Assignment was conducted at the parcel level for the core Port Covington area including the existing and proposed intersections on Hanover Street, Key Highway, and McComas Street. This is the primary benefit of utilizing the ITE methodology for the core study area as this process yielded more realistic forecasts for the NEPA analysis and captures the impacts of the development on the new grid network more robustly than if dummy nodes were used on Hanover Street and McComas Street to load the Port Covington trips. The forecasts on Hanover Street and Key Highway were used as control points for the remaining intersection/interchange forecasts. The BMC regional model was used for the remaining forecasts using the NCHRP 765 travel demand model post processing procedures. The build runs assumed the same land use as the no-build conditions and the only difference in scenarios was the network changes to I-95.

6. NCHRP 765 Procedure

NCHRP Report 765 Analytical Travel Forecasting Approaches for Project-Level Planning and Design describes the evaluation and description of currently used methods, data sources and procedures for travel forecasting for highway project level analysis. The project level traffic forecasting steps comprised of (i) forecast preparation dealing with data collection, field observations and finding archived traffic forecasts (ii) forecast development dealing with travel demand model running, (iii) quality analysis/quality review and lastly (iv) forecast product: documentation. The volumes, turning movements, measure of effectiveness (MoEs), origin destination information and other outputs for economic and environmental impact analysis are considered as the common outputs from project level travel demand models. Most of the traditional travel demand models use generalized look up tables prepared based on facility type, functional classification, area type and other parameters to estimate the capacity for individual network elements. The Highway Capacity manual (HCM) is a definitive reference for calculating capacity. The report has documented the available procedures for travel model output refinement by grouping the outputs in four broad categories such as volume outputs, turning movements, directional splits and speed outputs.

For Port Covington, the daily link year 2010 model volumes and 2040 forecasts were used in the post processing spreadsheet along with the base year counts which were obtained from Maryland State Highway Administration (MSHA). The ADT was derived from the existing turning movement counts in the case of unavailability of data on the MSHA Website. The year 2040 intersection turning movement forecasts were developed for both the AM and PM peak hours with a Turning Movement Calculator (TMC) with the assumption of both the K and D factors remaining similar to existing conditions. However, for some intersections, the turning movement count decreased marginally from the existing condition at mostly low volumes locations. For those movements, either the existing turning movement was maintained or slight growth was added. This was done to avoid forecasting lower volume, and also the slight addition of traffic is negligible considering the total intersection volume.

7. Summary of the Results

The forecasting process ultimately yielded peak hour intersection/interchange forecasts for the year 2040. The forecasts for the year 2040 and a summary of the BMC regional model outputs is included in the Appendix along with Origin/Destination information for Port Covington.

Port Covington Travel Demand Modeling Appendix

The Baltimore Metropolitan Council (BMC) regional travel demand model was used to develop the traffic forecasts outside of the core study area. The core study area (Hanover Street, McComas Street, and Key Highway) was forecasted using ITE procedures, with the interchanges of Key/I-95, McComas/I-95, and Hanover/I-95 being used as control points for the remaining forecasts that were developed with the regional model. The Appendix includes the regional output from the BMC model, demographic inputs, as well as the results of the select link analysis utilized to estimate the trip distribution to Port Covington

Note: Traffic forecasting appendix has been omitted from the Traffic Analysis Technical Report. Outputs are available upon request.