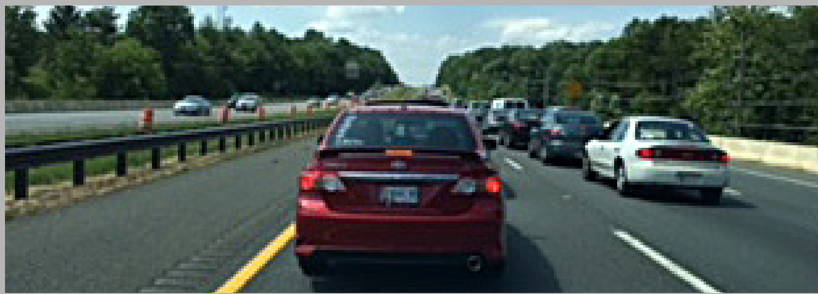


IS 270 – Innovative Congestion Management Contract

MONTGOMERY AND FREDERICK COUNTIES

CONTRACT # MO0695172 | JANUARY 19, 2017

TECHNICAL PROPOSAL

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS


HOV
HOV LANE
JCT 8
N Virginia 11
Washington 17
270 SOUTH
Washington
NO TRUCKS LEFT LANE

2. MOBILITY

2. Mobility

Introduction

Wellington Power Corporation and Jacobs Engineering Group Inc. (Wellington/Jacobs) brings the experience, skill and services to ***effectively meet the project goals of Mobility, Safety, Operability/ Maintainability/Adaptability and a Well Managed Project***. Our team brings a well-vetted plan to design, construct and implement cost effective solutions addressing current ***and*** future congestion on I-270. Our experience and personnel were presented in the Statement of Qualifications. We will present other Key Team members in his proposal and demonstrate our team's ability to deliver a sustainable, adaptable, and maintainable I-270 project.

Our proposal is to create a smart and self-evident highway through ***strategic civil improvements to the existing roadway overlaid with an Active Transportation and Demand Management (ATDM) System.*** We believe that restructuring the manner in which the driver interacts with the roadway creates an operating environment that promotes safe and efficient travel, and is a significantly innovative approach to corridor revitalization. Our proposed improvements and traffic management systems will improve mobility and throughput, while addressing safety, predictability and operations. It will promote congestion-reduction, is flexible and provides for future operational demands and technology.

Our solutions to improve both mobility and safety along the I-270 corridor focus on:

- Throughput
- Travel time reduction and reliability
- Crash reduction

We will implement these solutions and meet the project goals through the following strategies:

- Civil Improvements to alleviate bottlenecks
- Speed Harmonization
- Lane Management
- Queue Warning - incident detection and management
- Traveler Information

Wellington Power and Jacobs Engineering have worked together on multiple design-build contracts. The team has provided and is providing services for the Maryland Department of Transportation State Highway Administration (SHA), the Pennsylvania Department of Transportation (PennDOT), and other state agencies. Additionally, Wellington and Jacobs have worked together on SHA's Intercounty Connector, Contract A, Woodrow Wilson Bridge; PennDOT Harrisburg Area ITS DB and the Chesapeake Bay Bridge and Tunnel Sign Control and Data Acquisition System (SCADA) project. These projects were highly successful, and this relationship ensures that the I-270 project will be as well. Wellington/Jacobs have also worked on numerous projects with our other major subconsultants / contractors of Century Engineering, Skyline Technologies, Turnkey Systems and Fay, an i+icon USA Company (Fay) – all of whom have worked on SHA projects.

We have added a major subconsultant of Cubic Transportation Systems, Inc. (Cubic) to provide its proven ATDM software system. Cubic is currently under contract with Maryland Transit Administration (MTA) to provide an electronic fare payment system. Our established and cohesive team will provide SHA with solid communications, sound design solutions, and quality construction and installation.

i. Improvements for maximizing throughput and minimizing travel times

Our Vision: Our vision for the corridor is one of a smart and self-evident highway outfitted with sophisticated technology to assist Coordinated Highways Active Response Team (CHART) operators in effectively managing the corridor; that informs and guides travelers and improves their trip experience; and is adaptable now and for future additional deployment of advanced technologies. We achieve this through:

- Peak period capacity improvements using part-time shoulder use along mainline I-270
- Full-time capacity improvements using added lanes and improved ramp geometry
- ATDM in the higher density, more-congested area of I-270 to improve congestion management
- Additional surveillance through the implementation of additional Closed Circuit Television (CCTV) coverage along the corridor to improve incident detection, verification and diagnosis

- Additional vehicle detection along the corridor to improve incident detection
- Additional traveler information to provide real-time traffic conditions
- Improved incident response through better collaboration and cooperation
- Provision of a robust communications network and supporting infrastructure

Wellington/Jacobs is proposing to create this smart and self-evident highway with ATDM tools in concert with civil capacity improvements tailored for the specific needs of each section of the corridor. These ATDM tools will supplement the existing Intelligent Transportation Systems (ITS) infrastructure, expand on strategies already deployed, and introduce new strategies. Additional ITS assets such as CCTV cameras and vehicle detection equipment will be deployed as well. The high level of traffic demand along I-270 presents significant challenges to SHA that the current ITS deployment cannot effectively manage.

Members of the Wellington/Jacobs Team have deployed ATDM technologies and applications around the world to alleviate high-volume congested corridors like the I-270 corridor. Our proposed improvements to the physical roadway infrastructure will relieve capacity constraints at primary locations. When combined with ATDM technologies these improvements will achieve improved throughput, travel time reliability and overall operations along the heavily congested segments of I-270 as well provide improved incident management.

Our Plan: Wellington/Jacobs' proposed strategic civil improvements supported by ATDM tools for maximizing vehicle throughput, and improving travel times and travel time reliability encompasses:

- Strategic civil capacity improvements
- Roadway communications
- Accurate and timely data gathering and use
- Comprehensive traffic control and response procedures
- Minimization of differential speed conditions
- Improved incident management
- Minimization of maintenance activities that impact traffic flow

All of these improvements are geared to providing the structure and flexibility for future growth. Our plan includes:

> Wellington/Jacobs chose Cubic as our ATDM provider due to their proven design and implementation on multiple systems that are similar to I-270 and their easily integrate-able platform into CHART.

Traffic-flow strategies intended to maximize vehicle throughput through strategic geometric improvements, such as extension of acceleration lanes to facilitate merges, provision of auxiliary lanes to improve lane balances, and realignment of lanes at critical merge points, combined with pre-emptive real-time automated and manual traffic control strategies based upon real-time traffic flow and incident data and images.

Data gathering and analysis procedures to enable immediate response to incidents, the provision of travel operation information along the corridor, collaboration with local governments and law enforcement, and promotion of uniform travel speeds along the corridor, that are expandable to other automated solutions such as traffic violation enforcement through ATDM strategies.

Traffic control technologies such as lane-use control signals (LCS) to communicate dynamic speed limits and dynamic lane assignments, detection options, and continuous surveillance throughout the corridor that will continue to serve the highway well into the future.

Wellington/Jacobs is proposing Cubic Transportation System's (Cubic) Surface Transport Management Solution (STM) as the central management software. STM is a computing system that monitors, manages and controls the ATDM strategies and tools and is a cloud-based platform. It is a highly configurable Commercial-Off-The-Shelf (COTS) product that supports a wide variety of operational needs associated with transportation management within a freeway or urban environment. (More detailed information on STM and how it will be integrated into SHA's CHART system can be found in the Appendix under PTC 1 and Concept of Operations (ConOps); and under Sections 2. Mobility, ii; 3. Safety ii; and 4. Operability iii.)

The STM System is Cubic's next-generation traffic and transportation management and control platform providing ATDM strategies based on over 25 years of relevant experience with systems similar to that proposed for I-270. STM will provide SHA a flexible platform to integrate many other transportation management systems (e.g., ramp metering and traffic signals) giving potential for further improved incident management and decision support capability as well as significant future flexibility to SHA.

A CHART / STM Web Interface component developed by Turnkey Solutions will allow the STM to link into the CHART processing environment. This coupling allows STM to function as a component underneath CHART providing support for the ATDM functions while coordinating event and response plan actions with CHART.

Cubic brings substantial experience in ATDM planning, design, system integration into existing environments, system testing and validation, commissioning, training, education and outreach, and on-going support. International deployments of solutions similar to I-270 include UK Highways England, Transport Scotland, the Welsh Assembly Government, and Transport for New South Wales. Innovative use of advanced technologies such as cloud hosting and the ability to easily integrate into the CHART processing environment provides for a less disruptive and more flexible deployment approach when compared to other systems. The wealth of relevant cumulative experience will ensure our proposed solutions will be implemented successfully.

Our team has arrived at a design that blends civil and technological ***solutions that can be implemented within the existing right-of-way (ROW)*** and can be constructed with very little disruption to traffic when compared to other build-out options. We will implement a series of solutions that utilize both technology (ATDM) and strategic civil improvements.

Active management of transportation includes multiple approaches spanning demand management and traffic management. The ATDM tools are:

- Dynamic Speed Limits (DSpeed)
- Queue Warning (QW)
- Dynamic Lane Assignment (DLA)
- Dynamic Shoulder Lanes (DShoulder)
- Advance Traveler Information (ATI)

Civil improvements proposed are best categorized into six basic concepts:

- Part-time Shoulder Use (PTS)
- Lane Reassignment
- Collector Distributor (CD) and Auxiliary Lane Modifications
- Mainline Modifications
- Interchange/Ramp Junction Modifications
- Off-Corridor Improvements

The Wellington/Jacobs team has assembled our system of civil and ATDM strategies in such a manner to re-invent the I-270 corridor as a smart and self-evident highway. Our solutions are developed with ***an eye to the future*** so that envisioned needs that are not fully justified at this time may be planned (e.g., autonomous/connected vehicle operations, automated enforcement, High Occupancy Tolls).

This proposal shows that by implementing a new ATDM system that is compatible with the existing CHART system, and incorporating civil improvements to the existing roadway network, SHA will have a greater dollar-for-dollar maximized throughput and minimized travel time than could otherwise be obtained by solely constructing more lanes or implementing other static solutions alone.

Figure 2.1 at the end of this tab is a comprehensive graphic that identifies all Wellington/Jacobs proposed civil and ADTM improvements along the I-270 corridor. Design plans, PTCs and the ConOps are provided in the Appendix and provide additional detail to our proposal.

A. Concept Development

The key activities for Mobility include strategic civil improvements, roadway communications, accurate timely data gathering and use, comprehensive traffic control and response procedures, minimization of differential speed conditions, improved incident management and minimization of maintenance activities that impact traffic flow. Combined, these activities achieve SHA's project goals and address the Key Issues of this project.

The I-270 corridor ranks as the most congested corridor in the state, with traffic volumes reaching up to 250,000 vehicles per day. Land for new highway construction and/or widening existing facilities is limited, massive road projects are

Table 2.1: *2015 Maryland State Highway Mobility Report* for the I-270 Corridor

Categories	AM Peak (8-9 AM)	PM Peak (5-6 PM)
Most Congested Freeway/ Expressway Segments (Average Weekday)	***SB I-270 – Shady Grove Road to Montrose Road (#10, 17, 21, 24, and 29)**	***NB I-270 – Shady Grove Road to Middlebrook Road (#9, 15, 21, and 25)**
Most Unreliable Freeway/ Expressway Segments (Average Weekday)	***SB I-270 – Father Hurley Boulevard to MD 189 (#17, 19, 22, and 29)**	SB I-270 – Democracy Boulevard to I-495 (#1, 3, 12) ***NB I-270 – MD 124 to Middlebrook Road (#19)**
Bottlenecks	***SB I-270 at I-270 Spurs (#4)** SB I-270 at MD 109 (#24) ***SB I-270 at end of SB CD (#29)**	***NB I-270 at MD 124 (#13)** NB I-270 at MD 80 (#20) NB I-270 at MD 109 (#25) NB I-270 at I-70 (#28)
# - Ranking of the top 30 locations in each category * - Locations addressed in this proposal		

extremely expensive, and the potential for environmental impacts makes it very difficult to build new highways in Maryland. With traffic congestion continuing to grow, effective planning, design, implementation and operation of new technologies is required to significantly improve the movement of people and goods across the State.

The ***2015 Maryland State Highway Mobility Report*** identified multiple portions of the I-270 corridor in its presentation of the top 30 most congested and most unreliable freeway/expressway segments during the AM and PM peak hours and the worst bottlenecks in the State and is shown on ***Table 2.1 above.***

The ***2015 Maryland State Highway Mobility Report*** further states that strategies for improving the existing roadway network will focus on maximizing the existing network through the latest advances in ITS technology, including implementing ATDM strategies, making more efficient use of existing pavement and implementing geometric improvements at critical locations to address congestion hotspots. ***This is precisely the approach employed by the Wellington/Jacobs team for improving the I-270 corridor.***

Our concept development to address recurring congestion along the I-270 corridor began with a thorough review of existing traffic operations to identify locations where congestion originates during the peak periods. Sources considered include:

- The calibrated VISSIM model files for the existing AM and PM peak hours provided by SHA
- Aerial photos provided by the Metropolitan Washington Council of Governments (MWCOG), which provide multiple images at roughly 0.67-mile increments along the I-270 and I-495 corridors during the AM and PM peak periods,
- Travel speed data available from RITIS.org

The flown images and the travel speed data were used to validate traffic flow patterns observed in the VISSIM models, and to provide additional insight into the nature of the congestion along the corridor. When identifying a congested section, these data sources were used to verify the precise location of the bottleneck, and how that bottleneck affects the surrounding roadway network. These locations included items such as intersections at a ramp terminus, a merge point along the I-270 mainline, and the location of a lane drop along the corridor.

Each source was used in combination to identify where congestion first begins during each peak period, and how congestion expands throughout each segment of the corridor during each peak period. Once the ***primary constraint*** locations were identified, further analysis was conducted including detailed review of the traffic volume data provided by SHA, the existing lane configurations, interchange and ramp geometry at each location, and the role traffic operations plays at each location and the surrounding network. Review of these data identified the cause of the congestion at each location, whether it was high weaving volumes, insufficient acceleration or deceleration lane lengths, or high levels of demand.

Once the sources of congestion were understood, our team began to identify civil improvements to alleviate the localized congestion points. Each concept was developed with the intent of minimizing overall impacts while optimizing the efficiency of the existing roadway network. Improvements ranged from implementing part-time shoulder use to maximize roadway capacity during the peak periods; to modifying the lane balance along the CD system to better meet the needs of the roadway's current use; to extending acceleration lanes to improve merging opportunities; and reassigning lanes at critical bottlenecks to maximize throughput. Once developed, each improvement concept was programmed into the VISSIM models for evaluation and refinement. As improvements were added, and congestion within the models began to clear, ***secondary constrained locations*** were revealed, and were addressed in a similar manner (***Table 2.1***).

At each stage of concept development, using the information gleaned from the available data, as well as our team's vast experience and thorough knowledge of traffic operations among a variety of facility types, consideration was given to how each improvement will operate in the real world, and not just within the VISSIM model. The civil improvement concepts were sketched onto the network, overlaid with the ATDM solutions, and cost estimates were developed. Improvements were prioritized based upon their anticipated benefit to the I-270 corridor and the feasibility and cost of construction.

In this manner, concepts were developed that will require little additional pavement (1,133 SY) and no new ROW. These concepts shape the existing roadway to match evolving traffic patterns and meet the unique needs of each segment of the corridor. The modeling data used for the Wellington/Jacobs proposed solutions can be found in the Appendix under *VISSIM Traffic Model* tab and AM and PM Peak Period output summaries can be found on ***Tables. 2.4 and 2.5 on page 14.***

Figure 2.1 at the end of this tab details the specific ATDM tools and locations of civil improvements we are using to maximize throughput, reduce travel times and improve recurring and non-recurring congestion along the corridor. While the above section (Section A) details the methodology used for our concept development, the following Section B–Proposed Solutions shows how Wellington/Jacobs will ***maximize vehicle throughput and improve travel times***, and our methodology for our concept development, our ATDM solutions and our civil improvements. We will demonstrate how Wellington/Jacobs will ***reduce recurring congestion in terms of travel time, vehicle throughput, density, intersection operations, queues, and vehicle network performance*** for I-270 and along the connecting ramps and arterial roadways. We also provide specific data on how each of our recommended solutions have performed in other states and counties.

B. Proposed Solutions and Improvements

The Wellington/Jacobs team's traffic-flow plan maximizes vehicle throughput through strategic civil improvements overlaid with ATDM tools. Our proposed civil concepts will greatly improve throughput and minimize travel times by increasing capacity and providing the tools to immediately respond to congestion and traffic incidents, and collaborate with local governments and emergency responders.

B.1 – ATDM Solutions

Our solutions to improve both mobility and safety along the I-270 corridor, focus on throughput, travel time reduction and reliability and crash reduction by implementing the successful strategies of civil improvements to alleviate bottlenecks, and ATDM strategies including speed harmonization, lane management, queue warning and traveler information.

These strategies are flexible and adaptable to future corridor needs. They work hand-in-hand while bringing the corridor to a new level of throughput and travel time reduction. The ATDM tools we will employ to are described below and discussed in greater detail in PTC 1 and 2.

- Dynamic Speed Limits (DSpeed)
- Queue Warning (QW)
- Dynamic Lane Assignment (DLA)
- Dynamic Shoulder Lanes (DShoulder)
- Advance Traveler Information (ATI)

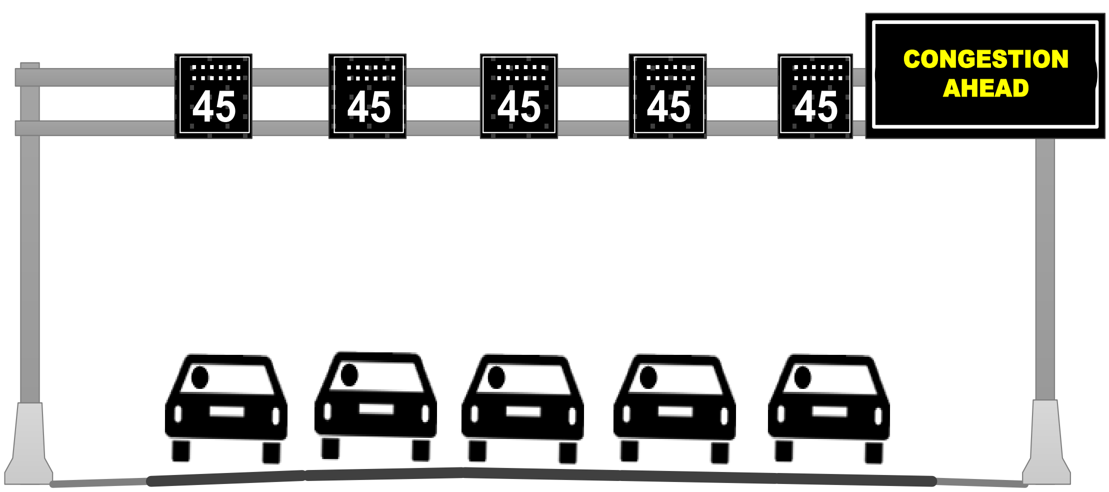
A Draft I-270 ATDM ConOps document is located in the proposal Appendix. It contains operational scenarios that describe and illustrate how these tools will operate and how they are integrated into the CHART environment. The ConOps will be finalized at project onset as part of the systems engineering process in collaboration with CHART representatives and other stakeholders.

Dynamic Speed Limits (DSpeed): This tool will be applied along southbound (SB) I-270 from Quince Orchard Road to the I-270 Split, and along SB I-270Y (the western Spur) from the I-270 Split to the merge with I-495. We are proposing to apply DSpeed to the entire roadway cross-section of the I-270 corridor. DSpeed meets SHA's Mobility Goal of maximizing throughput by achieving speed harmonization and hence greater throughput and diminished primary crashes due to congestion (rear end collisions). DSpeed posts speeds based on real-time traffic, roadway, and/or weather conditions. Dynamic speed limits can either be enforceable (regulatory) or advisory speeds. The system's final configuration will be an outcome of the I-270 ATDM ConOps. DSpeed uses LCS to inform travelers of the advisory speed. The LCS are full-color, full-matrix signs, and display either regulatory or advisory speeds.

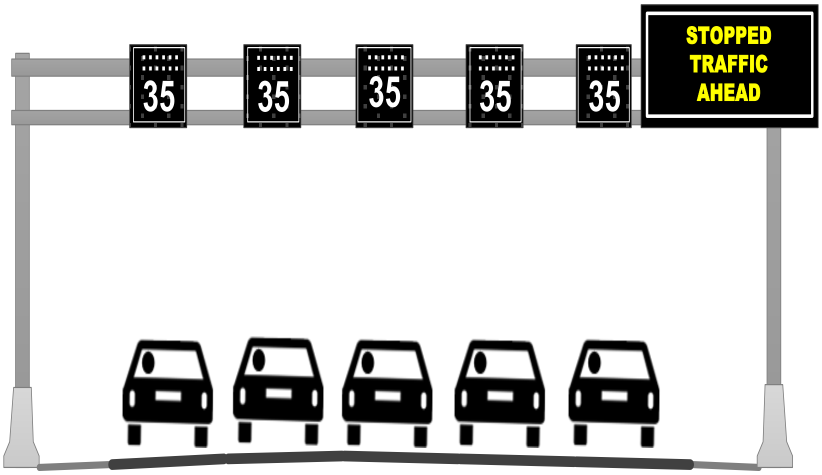
Benefits: Real-time and anticipated traffic conditions are used to adjust driver speeds dynamically to ***improve safety and mobility***. Consistent travel speeds – speed harmonization - reduce the number of unnecessary lane changes by drivers seeking a faster path while reducing differential speed conditions. Reduced numbers of lane changes allows for overall faster and safer progression of traffic along a corridor. These benefits were demonstrated and documented in a Highways England report, where a 55.7 percent reduction in personal injury crashes on the M42 Managed Motorway was realized in the 36 months that the variable speed system was installed. A variable speed limit system studied along I-270 in St. Louis saw reductions in total crash rate of as much as 8.0 percent. These crash reductions will advance the quality of mobility and provide shorter and more predictable trips.

Queue Warning (QW): Wellington/Jacobs will implement QW along SB I-270 from Quince Orchard Road to the I-270 Split, and along SB I-270Y (the western Spur) from the I-270 Split to the merge with I-495, as shown on Figure 2.1 at the end of this tab. QW is ***beneficial for both recurring congestion and non-recurring congestion,*** which results from lane reductions due to work zones or incidents. This strategy provides real-time displays of warning messages as well as lane status or speed advisory via dynamic message signs mounted on the LCS along the corridor, to alert motorists that significant queues or congested areas are ahead.

Benefits: Used in conjunction with DSpeed, this strategy reduces rear-end crashes and ***improves safety***, and is a significant contribution in ***creating predictable trips*** along the corridor. As the traffic conditions are monitored continuously, the warning messages are dynamic, based on the location and severity of queues and congestion. QW is a proven



Dynamic Speed Limits (DSpeed)

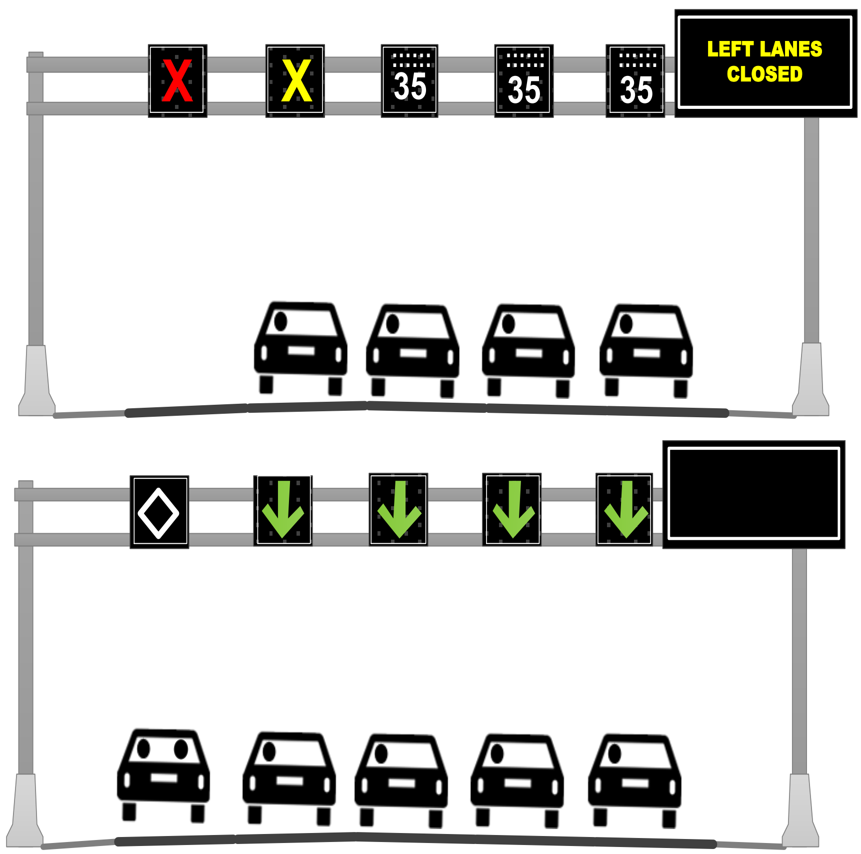


Queue Warning (QW)

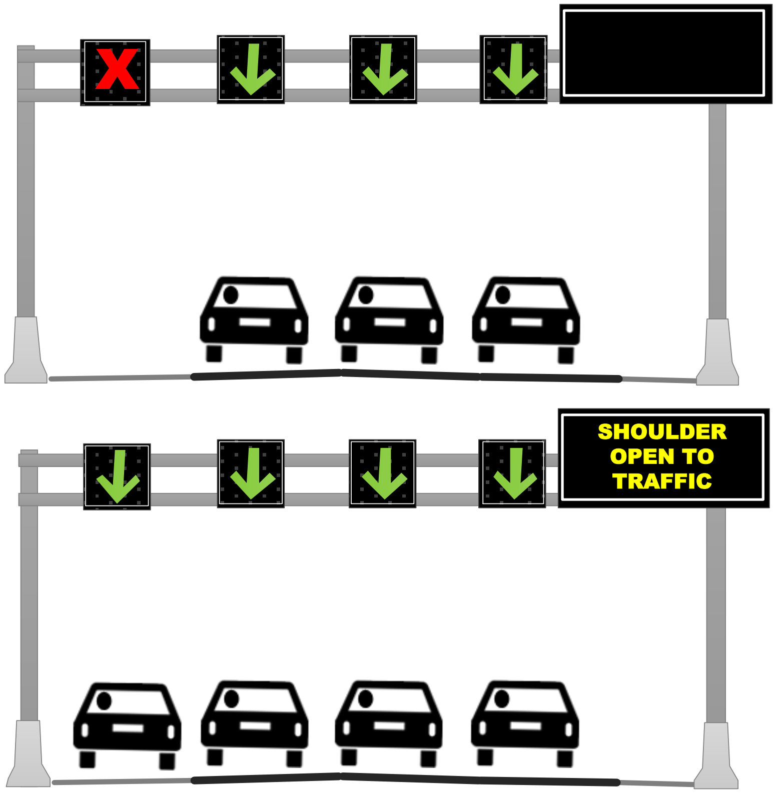
strategy in this country. Throughout 2012 and 2013, Caltrans utilized a QW system to alert motorist to backups resulting from heavy traffic attempting to enter a mall facility during peak holiday travel. Compared to the prior years, Caltrans documented a 66% reduction in the number of queue-related crashes after installing the system. Further, in 2010, Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable dynamic message signs (DMS)) up to six miles in advance of the work zone. Over the two years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system. Similar to DSpeed, the reduction of crashes has a direct correlation with improved mobility in work zones and in regular traffic.

Dynamic Lane Assignment (DLA): We will apply DLA along SB I-270 from Quince Orchard Road to the I-270 Split, and along SB I-270Y (the western Spur) from the I-270 Split to the merge with I-495. Our Team believes this tool enhances mobility and safety throughout the corridor and thereby ***improves throughput***. DLA involves dynamically closing or opening individual traffic lanes as necessary, and providing advance warning of the closure(s) using LCS, to safely merge traffic into adjoining lanes. As the network is continuously monitored, real-time incident and congestion data is used to control the lane use ahead of the lane closure(s), and dynamically manage the corridor to reduce rear-end and other secondary crashes.

Benefits: Use of DLA reduces last minute lane changing and the associated breaking. Additionally, worker and responder safety is improved by moving traffic away from work zones or incidents earlier, reducing the potential for a worker to be struck by a vehicle. The increased response times of the system to lane blockages through the use of higher density of detection means that traffic is moved away from the blockage more readily during an incident resulting in quicker incident response and enables steady state conditions to be restored much faster.



Dynamic Lane Assignment (DLA)



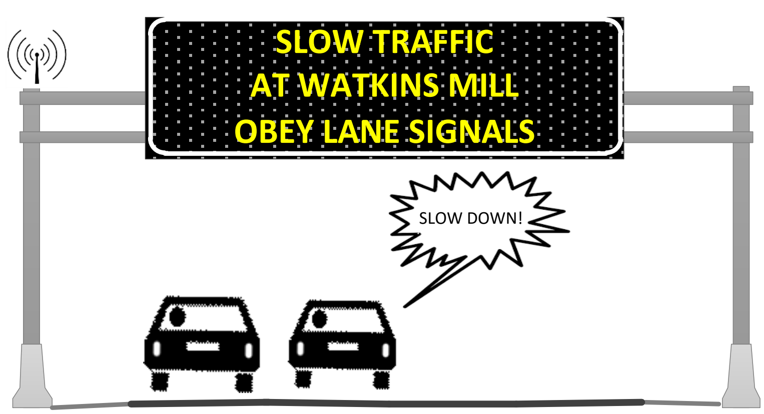
Dynamic Shoulder Lane (DShoulder)

Dynamic Shoulder Lanes (DShoulder): This tool will be applied along SB I-270Y (the western Spur) from the Westlake Terrace to the merge with I-495. DShoulder is an economical solution to utilize existing pavement when needed. This tool enables the use of the shoulder as a travel lane based on congestion levels, and in response to incidents or other conditions. DShoulder is also known as Part-Time Shoulder use.

Benefits: In contrast to a static time-of-day schedule for shoulder lane use, DShoulder allows for ***better throughput and decreases recurring and non-recurring congestion.*** Our approach continuously monitors conditions and uses real-time and anticipated congestion levels to determine the need for using a shoulder lane as a regular or special purpose travel lane (e.g., HOV only). A secondary benefit of our approach to DShoulder is that we will be able to use the shoulder as an additional general purpose lane during planned events, such as road construction or maintenance, or unplanned events such as crashes. These uses contribute greatly to ***increasing throughput and reducing congestion.***

Advance Traveler Information (ATI): ATDM-specific information will be applied along SB I-270 from Quince Orchard Road to the I-270 Split, and along SB I-270Y (the western Spur) from the I-270 Split to the merge with I-495, while general purpose ATI will be applied throughout the entire corridor. Traveler information is a key tool in ensuring improved mobility. This tool of effective dissemination of traveler information supports many types of information requests and categories of travelers, and communicates relevant information to the public so they can make more informed travel choices. This is accomplished by displaying traffic and roadway conditions on small DMS on the gantries along the ATDM-deployed network and on full DMS at critical decision points along the corridor. By integrating STM with CHART, the existing full DMS, Maryland's 511 system, the Web and other outlets are also available to the I-270 corridor.

Benefits: Properly communicating with motorists is critical to successful freeway traffic management and operations. Motorists rely on a wide variety of information to properly accomplish the control, guidance, and navigational aspects of the driving task. The roadway alignment and general terrain itself provides a great deal of this information through visual "cues;" sources such as pavement markings and regulatory, warning, and guide signs also contribute greatly to the overall information system. ***Mobility and predictability is improved*** by conveying information to motorists or travelers to influence traveler behavior (by



Advance Traveler Information (ATI)

recommending diversion routes around an incident, for example).

The ATDM solutions discussed above all contribute to a self-evident and smart highway, providing real-time adaptive controls and civil solutions which are developed specifically for the purpose to improve mobility, and create satisfying travel experiences.

Ramp Metering (RM): Along with the tools discussed above, we also examined ramp metering along the corridor. Ramp meters were applied to ramps along the project corridor in the 2040 AM and PM peak hour VISSIM models, with the civil improvements described below. Traffic operations were assessed to see what effect the application of ramp meters would have on the network. The analyses revealed that while some improvement in throughput and travel time could be gained, the improvements would be relatively minor compared to the expense of adding ramp metering to the system. Additionally, review of the model outputs showed that several affected corridors would experience significant increases in queues in delays in the vicinity of the I-270 interchanges due to the application of ramp meters. It was therefore determined that ramp metering would not be applied as part of this project. If desired, our proposed ATDM system is adaptable for SHA to implement ramp metering along the corridor at a later date.

B.2 – Civil Improvements

In addition to the ATDM tools discussed above, we are proposing a number of civil improvements. The types and locations of civil improvements are based on the bottlenecks identified in the traffic model and by the anticipated increase in throughput and reduced travel times once the ATDM tools are implemented. The civil improvements will provide road users with a more reliable system and, when combined with the ATDM solutions, will help to more fully address both the recurring and non-recurring congestion experienced along the I-270 corridor today. Our civil improvements are:

- Part-Time Shoulder Use
- Lane Realignment
- CD and Auxiliary Lane Modifications
- Mainline Modifications
- Interchange/Ramp Junction Modifications
- Off-Corridor Improvements

Table 2.2 on the following page summarizes our proposed civil improvements.

Part-Time Shoulder Use: (PTC #2) This strategy utilizes the existing inside shoulder along SB I-270 Y to provide an additional lane to increase capacity along the corridor. The Wellington/Jacobs team will convert the inside shoulder from just south of the Westlake Terrace overpass to just north of Bradley Blvd. overpass to a part-time lane. The shoulder will be used both during the current AM, HOV defined period and for incident or event management as determined by SHA based on management procedures to be developed during final design and integration of our proposed ATDM solution defined in this proposal.

Benefits: The addition of a dynamically controlled part-time shoulder lane will ***assist the predictability*** of the commuter trip in two distinct ways: first it will provide additional capacity during peak travel hours; and second it will provide an additional managed lane to utilize to address non-recurring congestion during both peak and off-peak hours. Utilizing existing pavement, as opposed to widening I-270Y to provide an additional lane, minimizes environmental and utility impacts, stormwater management and erosion and sediment control requirements, as well as shortens the time required for design and construction. It also reduces construction costs so that improvements can be implemented faster, at a lower cost and with reduced impacts to the user during construction. Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along SB I-270 will increase by 17 percent for the base year and 23 percent in 2040 during the AM peak hour, and that travel time along SB I-270, in the vicinity of this improvement, will decrease 1.3 minutes in the base year and 0.7 minutes under 2040 conditions during the AM peak hour.

Lane Reassignment: (PTC #3) Wellington/Jacobs proposes to modify the lane assignment at the SB merge of the western spur of I-270Y and I-495. The lane reassignment will consist of assigning three of the five receiving lanes for I-270Y traffic and the remaining two lanes to I-495. Under existing conditions, WB I-495 carries three travel lanes, all of which are maintained after the merge, and SB I-270Y carries three travel lanes, one of which drops

Table 2.2: Summary of Wellington/Jacobs Civil Improvements to Reduce Recurring Congestion

Primary (P) & Secondary (S) Congestion Locations	Description	Major benefit	Figure ID	PTC
SB I-270Y, from South of Westlake Terrace Overpass to North of I-495 (P)	***Part-time inside shoulder use***	Add capacity & manage incidents	A	PTC 2
SB I-270, from North of Montrose Road to I-270 Split (P)	***Mainline Improvements*** Full time outside shoulder use	Add capacity through weave section & manage incidents	B	PTC 5
SB I-270Y at Merge with WB I-495 (P)	***Lane reassignment***	Alleviate bottleneck for SB I-270Y	C	PTC 3
SB I-270 CD, between Shady Grove Road and MD 28 (S)	***CD auxiliary lane***	Alleviate bottleneck & improve merge condition	D	PTC 4
SB I-270 CD, between MD 189 and Montrose Road (S)	***CD auxiliary lane***	Alleviate bottleneck & improve merge condition	E	PTC 4
SB I-270, from MD 124 to I-370 (S)	***Mainline Improvements*** Convert acceleration lane to auxiliary lane	Alleviate bottleneck & improve capacity through weave section	F	PTC 5
NB I-270, from end of CD to Middlebrook Road (P)	***Mainline Improvements*** Convert acceleration lane to auxiliary lane	Complement future Watkins Mill project with capacity & bottleneck improvement	G	PTC 5
SB I-270 CD at Ramp from WB MD 28 (S)	***Interchange Improvements*** Extend length of acceleration lane	Improve merge condition	H	PTC 6
SB I-270 CD at Ramp from EB Montrose Road (S)	***Interchange Improvements*** Extend length of acceleration lane	Improve merge condition	I	PTC 6
MD 117 from MD 124 to I-270 (S)	***Off-Corridor Improvements*** Signal timing & offset modifications	Eliminate queues from exit ramp along NB I-270 CD	J	PTC 7

at the merge point, resulting in only two lanes entering SB I-495 from the SB I-270Y approach. Traffic volume data provided by SHA shows that the SB I-270Y approach contributes higher traffic volumes to this merge than the WB I-495 approach during both the AM and PM peak hours.

Benefits: Utilization of the lane reassignment, and allocating more lanes (3 lanes) to the approach with higher traffic volumes (I-270Y) will ***decrease the travel time and increase the throughput*** along the I-270 corridor. Better lane allocation will improve traffic flow through the merge and decrease congestion along the I-270 lanes as it does in the existing configuration. Decrease in congestion along the I-270 lanes will ***improve predictability*** of the commuter trip. Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along SB I-270 in the vicinity of this improvement will increase by 18 percent for the base year and 25 percent in 2040 during the AM peak hour, and that travel time along SB I-270 Y will decrease 3.9 minutes in the base year and from 2.6 minutes under 2040 conditions during the AM peak hour.

CD Auxiliary Lane Modifications: (PTC #4) We are proposing to modify the configuration of two locations of the CD road by adding/continuing auxiliary lanes along the SB I-270 between interchanges at the following locations:

- Between Shady Grove Road and MD 28
- Between MD 189 and Montrose Road

The improvements consist of adding an auxiliary lane between entry and exits points along the CD road. These locations can be characterized by a merge followed quickly by a diverge, where maneuvering between two successive high-volume ramp junctions results in congestion and slowing. At these locations, provision of an auxiliary lane between the merge and diverge points eliminates the primary constraints, and allows for significantly improved traffic flows.

Benefits: Implementation of the CD and Auxiliary Lane Modifications will assist ***throughput and predictability*** of the commuter trip in two distinct ways: first it will provide additional capacity along the CD lanes by providing additional lane in the evaluated CD sections; and second it will provide an extra lane to be managed and to be utilized to address non-recurring congestion. Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along the SB I-270 will increase by 13 percent for the base year and 33 percent in 2040 during the AM peak hour, and that travel time along SB I-270 CD will decrease from 73.2 minutes to 7.6 minutes in the base year and from 33.4 minutes under 2040 conditions during the AM peak hour.

Mainline Modifications: (PTC #5) Wellington/ Jacobs proposes to modify the lane configuration along I-270 in three locations:

- Along SB I-270 between the MD 124 and I-370 interchanges
- Along NB I-270 between the proposed Watkins Mill Road interchange and Middlebrook Road
- Convert the shoulder along SB I-270 from just north of Montrose Road to the I-270 Split

This work involves converting the ramp lane from MD 124 from an acceleration lane to an auxiliary lane, which, rather than ending north of the railroad overpass, will continue through the MD 117 interchange and exit at I-370. Traffic from the north, destined for I-370, will be able to enter an exiting lane farther north and access I-370 with fewer lane changes. This enhancement ***improves capacity*** south of MD 124 and reduces pressure to weave south of MD 117. The cross section at the ramp junction to I-370 will remain the same, but the source of the exiting lanes will provide significant improvement to vehicle throughput and minimize travel times through this section of the corridor.

Additionally, along NB I-270, the NB CD road is proposed to merge into mainline I-270 within the Watkins Mill Road interchange. Wellington/Jacobs proposes to convert the lane at the end of the CD road from an acceleration lane to an auxiliary lane that will drop at the loop ramp to WB Middlebrook Road, providing much needed capacity at this critical bottleneck location.

We are also proposing to convert the right shoulder along SB I-270 from just north of Montrose Road to the I-270 Split to a permanent use shoulder. This modification will provide much needed capacity along this section of roadway.

Benefits: The addition of an auxiliary lane along SB I-270 from MD 124, and maintenance of the auxiliary lane originating from MD 117, will improve reliability by significantly ***reducing local congestion*** and address reduced speed areas approaching those interchanges. The continuous lanes will alleviate the speed differential between vehicles on the ramps and vehicles in the general purpose lanes, as well as provide better access for SB vehicles approaching I-370. Provision of an auxiliary lane along NB I-270 between Watkins Mill Road and Middlebrook Road will provide additional capacity at the end of the NB CD road.

Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along SB I-270 will increase by 11 percent for the base year and 17 percent in 2040 during the AM peak hour, and that travel time along SB I-270, will decrease by 7.2 minutes in the base year and by 8.3 minutes under 2040 conditions during the AM peak hour. Additionally, these analyses show that throughput

Table 2.3: Results of Mobility Improvements Similar to the Proposed I-270*	
Shoulder Running - Add 11 ft. HOV inside shoulder	
California 101	10% increase throughput and 5% decrease in travel time
US 2, Washington State	Peak period, peak direction delays on the 1.55-mile segment with part-time shoulder use decreased from 8-10 minutes to 1-2 minutes
M42 Managed Motorway, England	Average travel times increased because the speed limit was reduced, however, the variability of travel times was decreased 27-34%.
Netherlands	Part-time shoulder use increased capacity by 7- 22%, decreased travel times from 1-3 minutes, and increased through traffic volumes up to 7% during congested periods
Munich, Germany	Part-time shoulder use created a 20% increase in peak hour capacity
Hessen (State), Germany	Part-time shoulder use reduced congestion by 30%.
Dynamic Speed Limits	
OR 217, ODOT	Lane flow distribution improvement 1-3%, overall travel time and variability decreased, throughput increased 1-3%, wet weather travel times variability decreased (predictability),
Queue Warning	
CA 805, CA 163, California 2012, 2013	Caltrans utilized a QW system to alert motorist to backups resulting from heavy traffic attempting to enter a mall during peak holiday travel. Caltrans documented a 66% reduction in the number of queue-related crashes after installing the system
I-55, Illinois 2010	Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable DMS) up to six miles in advance of the work zone. Over two years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system.
Advanced Traveler Information	
I-5, WS 512, Washington	WSDOT placed data collection devices on SR 512 and I-5 in the Olympic Region and displayed in two places on WSDOT's website: on the state's 511 system and through the mobile phone application. The information was also distributed to private sector firms that distribute their own travel information via platforms ranging from conventional radio broadcasts to smart phone applications. 84% of survey respondents found traveler information provided by WSDOT useful, with 95 % saying it should continue to collect and distribute travel congestion information.
Minneapolis-St Paul, Seattle-Tacoma	When link travel times posted on DMS are twice as long as typical travel times, drivers began to favor alternate routes. In Minnesota, drivers surveyed favored alternate routes when posted travel times were 5-10 minutes longer than typical travel times. In Washington, drivers favored alternate routes when posted travel times were 15-20 minutes longer than typical travel times.
**Study sources can be found under the Reference Tab in the Appendix.*	

along NB I-270 will increase by 3 percent for the base year and 27 percent in 2040 during the PM peak hour, and that travel time along NB I-270, from Cabin John Parkway to I-70, will decrease from 49.2 minutes to 45.8 minutes in the base year and from 53.7 minutes under 2040 conditions during the PM peak hour. The analyses also show that travel time along the NB I-270 CD will decrease

from 20.0 minutes to 12.6 minutes in the base year and from 59.2 minutes to 16.6 minutes under 2040 conditions during the PM peak hour.

Interchange Modifications: (PTC #6) Our Team is proposing to extend the existing acceleration lanes at the merge from WB MD 28 (loop ramp) and the merge from EB Montrose Road along the SB I-270 CD, which are high volume merges.

This improvement consist of upgrading the geometry of existing acceleration lanes to reduce speed differentials between entering traffic and through traffic, and improve merging opportunities at critical locations.

Benefits: Updates to acceleration lane lengths increases reliability by removing localized congestion caused by entering vehicles to adjust their travel speeds as required for travel along the interchange ramps without conflicting with higher speed through traffic, as well as provide additional merge opportunities at congested locations and ***improve predictability and reliability*** of I-270 corridor in the vicinity of those interchanges. Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along the SB I-270 CD will decrease from 20.7 minutes to 7.6 minutes in the base year and from 33.4 minutes to 8.6 minutes under 2040 conditions.

Off-Corridor Improvements: (PTC #7) Wellington/Jacobs is proposing to alleviate the queues along the exit ramp to MD 117 by adjusting signal timings at the intersection of MD 117 and MD 124, and by modifying offsets for the traffic signals along MD 117 to promote clearing of WB MD 117 during the PM peak period. This improvement will reduce queueing along the exit ramp to MD 117, which will increase the mobility and reliability along the NB CD and along the NB I-270 corridor. Under existing conditions, traffic flow along the NB I-270 CD road is restricted by queues along exit ramps at both MD 124 and MD 117. We anticipate the congestion along the ramp to MD 124 to be alleviated by redistribution of local traffic with the construction of the Watkins Mill Road interchange.

Benefits: The off-corridor improvements will increase mobility and reliability by removing queues that spill onto the CD lanes, eventually impacting the I-270 mainline lanes, resulting in slower speeds, delays, and un-safe conditions along NB I-270. Traffic operations analyses performed for the base year and 2040, using the VISSIM models provided by SHA, show that throughput along NB I-270 CD will increase by 2 percent for the base year and 39 percent in 2040 during the PM peak hour, and that travel time will decrease from 20 minutes to 12.6 minutes in the base year and from 59.2 minutes to 16.6 minutes under 2040 conditions during the PM peak hour.

The Wellington/Jacobs proposed civil improvements, combined with the ATDM solutions will provide the following:

- Improve the overall throughput along I-270 during the AM peak hour by 11 percent in the base year and 19 percent in 2040
- Improve travel times between I-70 and Cabin John Parkway from 73.2 minutes to 43.6 minutes in the base year and from 89.5 minutes to 68.1 minutes in 2040
- Improve throughput along NB I-270 by 3 percent in the base year and 27 percent in 2040
- Improve the travel time between Cabin John Parkway and I-70 from 49.2 minutes to 45.8 minutes in the base year and from 53.7 minutes to 50.9 minutes in 2040

These improvements and their locations are shown on ***Figure 2.1*** at the end of this section. ***Table 2.3 on the previous page*** provides examples in the US and Europe of similar Mobility solutions we are proposing on the I-270 corridor.

Maintenance of Traffic (MOT): As in all projects along busy corridors, maintenance of traffic is a critical component to satisfying public perception of the project and providing a safe work zone. Each work location was assessed, taking into consideration the high traffic volumes in addition to:

- Location within the corridor
- Type of work
- Duration of the work

Wellington/Jacobs anticipates performing most of the construction activities at night due to the high volume of traffic on I-270 and I-495. We will coordinate with the Districts' 3 and 7 Traffic Engineers to agree on lane closure hours, however we anticipate closures from 8:00 P.M. to 4:00 A.M. in SB direction and 9:00 P.M. to 5:00 A.M. in NB direction. Based on these criteria, the final design will dictate the number of phases for each work area. We will follow SHA MOT standards.

Table 2. 4: VISSIM Model Outputs – AM Peak Period

	Southbound		***Northbound***	
	Change in Throughput	Travel Time*	Change in Throughput	Travel Time*
Base Year				
Mainline				
No Build	0%	73.2 min	0%	32.8 min
Build	11%	43.6 min	0%	32.7 min
CD				
No Build	0%	20.7 min	0%	8.5 min
Build	13%	7.6 min	0%	8.6 min
2040				
Mainline				
No Build	0%	89.5 min	0%	34.6 min
Build	19%	68.1 min	20%	33.0 min
CD				
No Build	0%	33.4 min	0%	22.1 min
Build	33%	8.6 min	37%	9.2 min
Note: Travel time is between I-70 and Cabin John Parkway				

Table 2. 5: VISSIM Model Outputs – PM Peak Period

	Southbound		***Northbound***	
	Change in Throughput	Travel Time*	Change in Throughput	Travel Time*
Base Year				
Mainline				
No Build	0%	44.6 min	0%	49.2 min
Build	2%	37.0 min	3%	45.8 min
CD				
No Build	0%	7.1 min	0%	20.0 min
Build	0%	7.0 min	2%	12.6 min
2040				
Mainline				
No Build	0%	48.7 min	0%	53.7 min
Build	4%	38.7 min	27%	50.9 min
CD				
No Build	0%	7.3 min	0%	59.2 min
Build	6%	7.2 min	39%	16.6 min
Note: Travel time is between I-70 and Cabin John Parkway				

Temporary concrete barriers will be utilized to protect areas where full depth reconstruction, median reconstruction, excavations or obstructions occur. Channelizing devices will be used for temporary lane closures or other work not involving drop-offs or obstructions. Generally, temporary pavement markings will be placed prior to applying final surfacing and pavement markings.

Project specific MOT plans will be prepared for each work area to account for unusual traffic patterns.

Tables 2.4 and 2.5 show the results of our VISSIM modeling and the basis for our concept and solution development.

The results provided in the tables indicate substantial improvement for both the NB and SB commuters in throughput and travel time. Most significant is the SB travel time reduction from I-70 to Cabin John Parkway in the AM peak hour, which decreases from approximately 73 minutes to 44 minutes. Throughput in 2040 significantly improves by 19 percent AM peak hour and 27 percent PM peak hour.

Also significant are the improvements for the SB CD lanes, which are used as ingress and egress to many Montgomery County areas. These will experience significant improvements to both travel time and throughput with travel times along the SB I-270 CD being reduced from approximately 33 minutes to 9 minutes during the AM peak hour. Allowing better flow off and on the CD lanes significantly improves traffic operations along I-270.

ii. Improvements for a more predictable commuter trip, including innovative technologies

A self-evident and smart highway is a predictable highway. As explained in detail in the previous section of this proposal, the Wellington/Jacobs team has proposed a complement of ATDM solutions, overlaid on multiple strategic civil improvements, to provide a more predictable commuter trip. Each of the ATDM solutions and civil improvements have multiple benefits. They improve throughput, enhance safety and provide a more predictable commuter trip. Specifically, the civil improvements provide additional capacity which reduces congestion which, in turn, reduces crashes and improves travel time predictability.

Our ATDM tools of DSpeed, QW, DLA, ATI and DShoulder all provide improvements on throughput and travel time by providing a much safer corridor through enhanced traveler information, speed harmonization and lane management abilities. All of our solutions identified work hand in hand for a more predictable trip. The ATDM tools are all innovative uses of technology. The approach we are using to integrate the system with CHART is also very innovative as explained below.

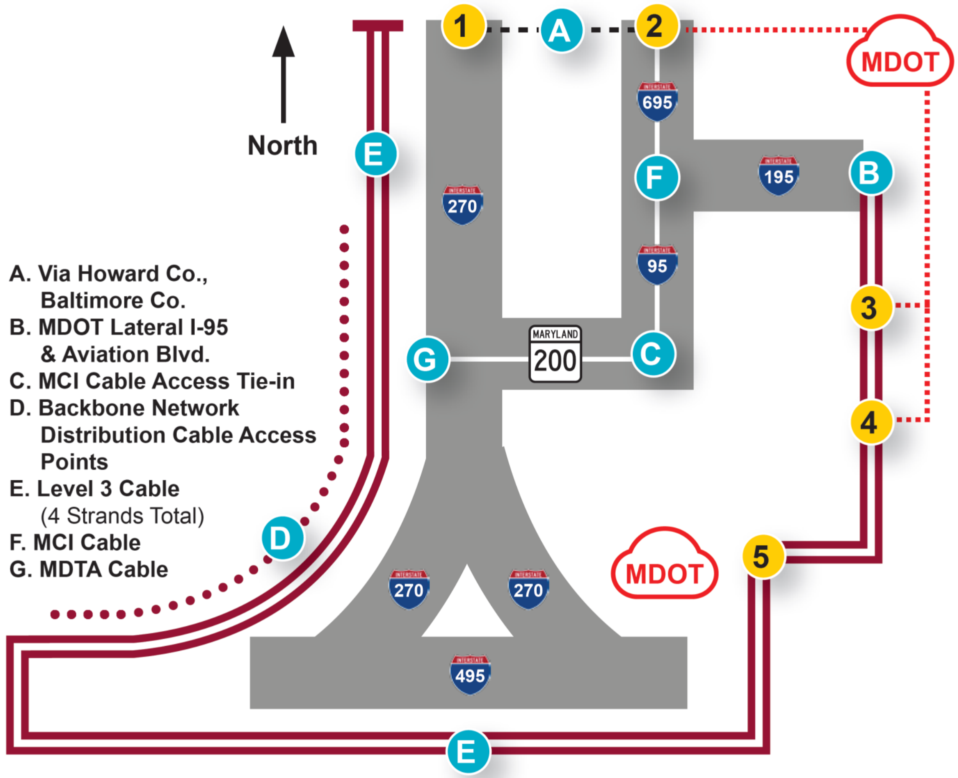
Innovative Technologies

The Wellington/Jacobs solution complements and enhances what SHA's CHART program already provides in areas of traffic monitoring, incident management and traveler information. CHART uses a combination of advanced vehicle detection sensors, CCTV cameras, third party data, communication systems, and data processing to help identify incidents quickly and aid in implementing responses to minimize traffic effects. CHART also uses a combination of DMS, Traveler Advisory Radio (TAR), a 511 traveler information system and CHART Web for real-time information to pre-trip and en-route travelers.

Surface Transport Management Solution (STM): As briefly discussed in the previous section, Wellington/Jacobs is proposing Cubic's STM as the central management software to complement CHART in the areas of ATDM. STM is a cloud-based transport management platform. It is a highly configurable COTS product that supports a wide variety of operational needs associated with transportation management within a freeway or urban environment. The software utilizes a high-density deployment of vehicle detection sensors to provide high fidelity traffic condition assessment; video image detection (VIDs) to support automated incident detection for part-time shoulder operation; additional traffic surveillance CCTV cameras for condition verification and incident management; and DMS and LCS mounted on overhead gantries for traffic control and driver information.

Overall STM will be an operational extension of CHART where CHART continues to serve strategic and regional Incident Management functions as it does today, and STM serves the tactical Traffic Management functions of I-270. When identifying

Figure 2.2: I-270 Fiber Backbone Network System Diagram



1. **Frederick Co. Law Enforcement Center** (DOIT & MDOT POP)
2. **MSHA I-695/US 40 Radio Shop** (MDOT POP)
3. **SHA Chart SOC** (MDOT POP)
4. **MSHA D5 Office, Annapolis, MD** (MDOT POP)
5. **MSHA D3 Office, Greenbelt, MD** (MDOT POP)

the configuration required for the STM product, the operational approach currently used on CHART system has been taken into account to ensure we deliver an approach that is compatible and similar enough to minimize operator workload. The STM platform use has been designed to ensure that the management of the new ATM elements does not add to the pressure operational staff can be under when dealing with major events on the road network. Key operational status data will be shared by STM with both CHART and the Regional Integrated Transportation Information System (RITIS). Use will be made of existing CHART data sources available from third parties. We will use the same GIS data source for the road network model feeding back any identified updates and enhancements to that data set. CCTV cameras and large roadway DMS installed as part of the I-270 project will also be available via CHART.

STM provides additional capabilities not yet supported in CHART. STM will work within the CHART framework as an add-on software module that will share and coordinate information with CHART. Integration will take place in such a way so as not to impact the CHART development roadmap. In the future, SHA can incorporate the STM functionality into CHART or continue with STM separately, however, at this point in time, ***STM provides the least risk with regard to implementation and is less impactful to existing systems.***

We believe that the STM system is the best alternative given the time and budget to implement these improvements. The operational approach and overall architecture of the solution has been developed to ensure close cooperation between the CHART and STM systems. The STM solution is a set of tools that manages a subset of the overall road network, the I-270, and as such can be treated as a subsystem of CHART.

Cubic's platform supports transportation management through three key capabilities:

- At the ***integration level***, the platform supports interfacing with field equipment.
- The platform supports ***interoperability*** at a data level between third party systems.
- As a ***tactical traffic management system***, the platform supports domain specific road traffic management for the I-270.

> The ***2015 Maryland State Highway Mobility Report*** states that strategies for improving the existing roadway network will focus on maximizing the existing network by using the latest advances in ITS technology, including implementing ATDM strategies.

Integration Level : The STM system will deliver Active Traffic Management capability within the overall road network structure for the I-270. Currently, CHART provides traffic management through incident management. ***STM will deliver additional traffic management and provide functionality and predictability*** for drivers using the following tools:

- ***Dynamic Speed Limits (DSpeed)*** delivers motorists with advisory speed limits using individual signs installed above each lane within the ATM section.
- ***Queue Warning (QW)*** uses the same lane use signs to set speed restrictions as traffic approaches areas of congestion.
- ***Dynamic Lane Assignment (DLA)*** informs drivers where they should move out of the current lane they are in as they approach a lane blockage.
- ***Dynamic Shoulder Lanes (DShoulder)*** is the use of the shoulder as a part-time lane during the period when the additional capacity is required.
- ***Advanced Traveler Information (ATI)*** is on-road signs to provide details of road conditions and the exporting of data to external systems delivering traveler information to the public.

Data Level: Integration of STM utilizes both Collaborative Support Logic and Data Integration.

Collaborative Support Logic enables SHA to define how the system responds to multiple situations, i.e., times when there are several separate but linked issues present in the same road section, that occur on the road network. This capability will be configured to implement automated responses reducing the load on operational staff ensuring faster responses and reduced impact of unplanned situations. The system will analyze current conditions and propose the most appropriate actions to minimize the impact of an event. The logic is fully configurable within the platform.

Data integration is supported at two levels. System-to-system integration allows the platform to exchange data with other software, including CHART, through various interfaces and protocols. System-to-device integration allows the platform to communicate directly with equipment such as road signs and monitoring sensors. The open, flexible nature of the platform architecture facilitates extension to include additional protocols and interfaces for new or legacy systems.

The platform has a comprehensive ***data storage*** facility, where data received from the individual sensors is stored alongside incident data and their associated strategic responses. Over time this builds into a rich store of data to which ***advanced analytics*** can be applied, to gain real-time insight into the current situation, as well as predict future circumstances within the road network. The data storage also provides a basis for a comprehensive ***management reporting facility*** which includes dashboard functionality as well as pre-configured performance reports as outlined in MAP-21 .

Tactical Traffic Management System: Using the flexibility of its modular architecture, ***Cubic's STM platform can adapt and evolve with SHA's needs over time.*** For example, once STM is implemented on this I-270 corridor, SHA can expand it onto I-495 and other congested interstate areas. The same is true about the implementation of the system. STM can be rolled out gradually and the individual elements of functionality "joined up" when the time is right. ***This incremental expansion capability ensures investment and return go together.***

Integration of the STM system into the CHART program will be coordinated by ***Turnkey Technology Corp.*** Turnkey has been a key member of the CHART development team as the system has evolved, working on key features such as the field device communications framework, travel times, field device additions and enhancements, and the integration with the Lane Closure Permit (LCP) system.

Skyline Network Engineering, LLC (Skyline) is a key team member and their familiarity with existing resource sharing agreement (RSA) fiber cable (i.e., Level 3), MDOT fiber and network assets, and MSHA network administrative and maintenance support staff will help facilitate the design, deployment, and commissioning of the I-270 network. Skyline will be assisting Wellington/ Jacobs in the communications network design, assist in CCTV camera design (final sighting design) and video sharing design within CHART. During construction, Skyline will perform the fiber installation into Level 3 backbone fiber; the communications equipment configuration, the VID server deployment, configuration and testing; and the communications network testing, commissioning, acceptance and monitoring.

Wellington/Jacobs' wide range of incremental improvements allows road users to experience an increase in vehicle throughput and reduce delays due to congestion. This will entail a 24 hour-a-day, seven days-a-week, 365 days-a-year operational plan consisting of continuous traffic flow detection and evaluation, immediate response to issues and incidents, automatic traffic control and information implementation, instantaneous communications between operating agencies and, as the case may require, a quick restoration of highway operations giving due regard to medical and hazardous material emergencies.

Sample Implementations: The following Scenarios illustrate how STM and CHART will work under different roadway conditions (details are provided in the ConOps).

Scenario 1: I-270 Congestion Events: STM automatically opens STM events for detected congestion and starts DSpeed and QW operations. When this occurs, STM will notify the STM / CHART ATMS Interface Web Service which will automatically open a congestion event within CHART ATMS. If the STM response includes messages for any of the Full Sized DMS, the web service will add response plan items to the new CHART ATMS event and execute the response. Similarly, if any cameras are identified to be of interest by STM, they too will be added to the CHART ATMS event response plan and be executed.

This automatic congestion event creation feature allows the event to be exported to RITIS, appear on the CHART website, and to be exported to the 511 system. Also, it is an indication to CHART ATMS operators that speed and queue management operations are active within STM. CHART

Operators can further manage the event as needed.

Scenario 2: I-270 Incident Events: Similar to congestion events, STM can detect incidents automatically. Unlike congestion, however, an operator must confirm the incident before STM opens an event for managing it. When an incident event is opened in STM, STM will notify the STM / CHART ATMS Interface Web Service, which will automatically create an incident event in CHART ATMS. If the STM response includes messages for any of the Full Sized DMS, the web service will add response plan items to the new CHART ATMS event and execute the response. Similarly, if any cameras are identified to be of interest by STM, they too will be added to the CHART ATMS event response plan and be executed. This is the same process as described above for congestion events. Like congestion events, having the system automatically create an event in CHART ATMS ensures the incident appears on the CHART website, and is exported to the 511 and RITIS systems. STM also allows the operator to further manage the event using existing CHART ATMS event management features. This includes the ability to add HARs and cameras to the response plan, add DMS to the response plan that are outside the I-270 corridor (for major events), manage participants, and send notifications.

The standard operating procedure (SOP) for incident management of the I-270 corridor is for the operator to use STM as the primary system to verify and confirm the incident before managing the incident in CHART ATMS. If, however, the operator enters the event in CHART ATMS first and still wishes to create an event in STM to take advantage of lane use signals and gantry signs, STM will provide the option for the user to disable the automatic creation of a CHART ATMS event to prevent duplicates. This may occur if initial incident notification is via #77 or 911 call and the event is first entered into CHART.

Scenario 3: I-270 Planned Roadway Closure Events: Planned roadway closure events are different than congestion and incident events. CHART ATMS is tightly integrated with the LCP system. This integration allows permits to be queued and activated automatically, with their associated CHART ATMS pending planned closure event being opened automatically when the permit is activated. Likewise, CHART ATMS automatically closes (or reverts to pending) the associated planned closure event when the LCP system automatically deactivates the permit at its scheduled end time. For this reason, CHART ATMS will continue to drive the creation, opening, and closing of planned roadway closure events for the I-270 corridor.
The use of STM for planned roadway closures will be optional. Initially this is envisioned to be performed manually via standard the SOP that requires the operator to utilize STM to activate lane use signals at the time a contractor begins closing lanes, and to use STM to deactivate the use of lane use signals when the contractor has reopened lanes.

To make the process more streamlined, a new CHART ATMS response plan item type will be created and used to coordinate this operation with the STM. Changes will be made in CHART ATMS to make the use of STM for lane use signals an available option as part of managing a CHART ATMS planned closure event via a proposed new type of response plan item. This new type of response plan item, when activated, will send a message to STM via the STM / CHART ATMS Interface Web Service that will cause an alert in the STM system. This STM alert can be used by an operator to create an STM event that can be used to activate lane use signals and gantry signs at the time they confirm the contractor will actually begin closing lanes. When the CHART ATMS response plan item is deactivated, which occurs automatically when the planned roadway closure event is closed, the response plan item will send a message to STM to indicate any STM event associated with the CHART ATMS planned roadway closure event should be deactivated. Again, the operator would only deactivate lane use signals and gantry signs in STM after confirming with the contractor that the lanes are indeed opened.

Center-to-center data exchanges with other jurisdictions, such as Montgomery County, can be supported through RITIS consistent with the ITS regional architecture. Although Montgomery County does not currently support a center-to-center interface it may in the future.

iii. Performance life of the improvements

Well-designed interchanges and ramp junctions, which the proposed lane balance modifications and extension of acceleration and deceleration lanes will provide, improve maneuverability, allowing exiting vehicles to leave the traffic stream with little disruption, through traffic to accommodate entering vehicles safely and efficiently, and all vehicles to reach their destinations with minimal lane changes, regardless of congestion levels.

Additionally, because the primary capacity improvements proposed involve managed lanes, the additional capacity afforded by part-time shoulder use may be extended to additional hours of the day, as needed. As a result, the civil improvements recommended by our team, supplemented by the ability for SHA to actively monitor and manage congestion and incident response through much of the corridor, will provide improved operations along the I-270 corridor well beyond 2040.

The VISSIM model results (Tables 2.4 and 2.5) show that operations along both NB and SB I-270 will improve significantly over the No Build condition under both the base year and 2040 conditions. Based on the VISSIM model outputs, total throughput volumes along both NB and SB I-270, from I-70 to the I-270 Split, will increase during the AM and PM peak hours between the base year and 2040 in both directions of travel.

Additionally, post improvement travel time along SB I-270 from MD 121 to the I-270 Split will only increase by 1 minute between the base year and 2040 and travel time along NB I-270 from the I-270 Split to MD 121 will only increase by 3 minutes, which means that the improvements to travel time that are gained by the civil improvements (reduction in travel time through this section of the corridor during the base year, from 46.9 minutes to 18.6 minutes along SB I-270 and 20.7 minutes to 7.6 minutes along the SB I-270 CD during the AM peak hour, and from 20.7 minutes to 17.1 minutes along NB I-270 and 20.0 minutes to 12.6 minutes along the NB I-270 CD) will be maintained as traffic volumes increase through 2040.

Throughput will be significantly improved along both NB and SB I-270. In 2040, during the AM peak hour, throughput will increase by 19 percent and 33 percent, respectively for the SB mainline lanes and CD lanes, and during the PM peak hour, throughput will increase by 27 percent and 39 percent, respectively.

The proposed civil improvements are shown to significantly improve operations during the AM and PM peak hours of a typical travel day, under both base year and 2040 conditions. The improved lane balances and geometry provided by the civil improvements will also help to reduce crashes along the corridor. However, the primary benefits to safety will be achieved through the ATDM solutions, which will improve driver awareness of congestion and slowing ahead and reduce the occurrence of crashes. The ATDM solutions also provide information and lane management tools to enable SHA to identify incidents and clear them much more quickly and safely, and thereby restoring “normal” function to the corridor more faster. In other words, the civil improvements will significantly improve reliability and address recurring congestion issues, and the ATDM solutions will significantly improve safety and address non-recurring congestion issues. ***Combined, the proposed solutions will make I-270 a much more pleasant corridor to travel for commuters and non-commuters alike.***

The combined civil improvements and ATDM solutions will provide optimum traffic operations under base year conditions and will function well beyond 2040.

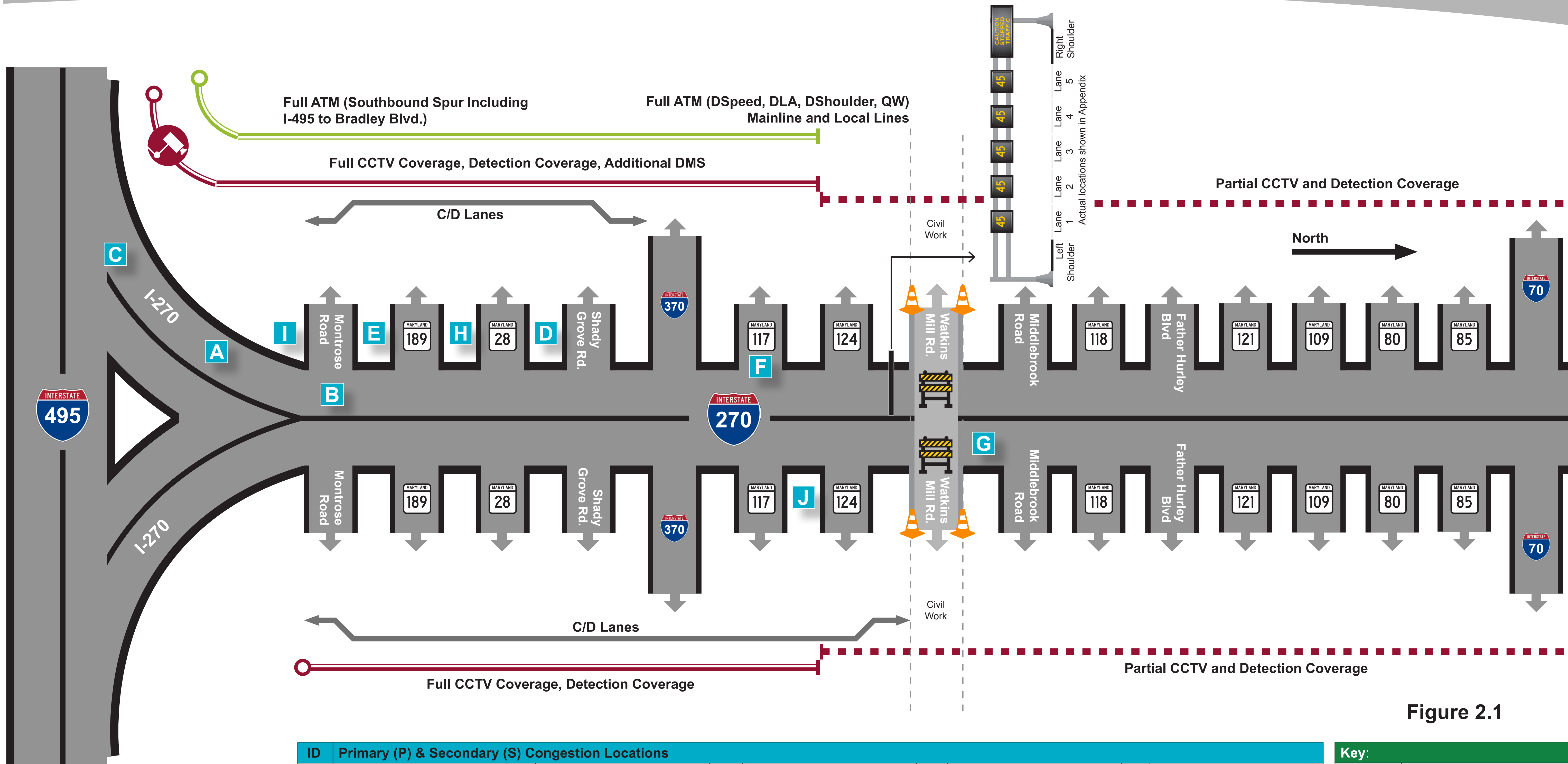


Figure 2.1

ID	Primary (P) & Secondary (S) Congestion Locations								
A	SB I-270Y, from South of Westlake Terrace Overpass to North of I-495(P)	C	SB I-270Y at Merge with WB I-495(P)	E	SB I-270 CD, between MD 189 and Montrose Road(S)	G	NB I-270, from end of CD to Middlebrook Road(P)	I	SB I-270 CD at Ramp from EB Montrose Road(S)
B	SB I-270, from North of Montrose Road to I-270 Split(P)	D	SB I-270 CD, between Shady Grove Road and MD 28(S)	F	SB I-270, from MD 124 to I-370(S)	H	SB I-270 CD at Ramp from WB MD 28(S)	J	MD 117 from MD 124 to I-270(S)

Key:	
DLA	Dynamic Lane Assignment
DShoulder	Dynamic Shoulder Lane
QW	Queue Warning
DSpeed	Dynamic Speed Limits


HOV
HOV LANE
JCT 8
N Virginia 11
Washington 17
270 SOUTH
Washington
NO TRUCKS LEFT LANE

3. SAFETY

3. Safety

i. Reducing the number, duration & severity of incidents & approach to facilitate incident management after construction

The I-270 corridor ranks as the most congested corridor in the state, with traffic volumes reaching up to 250,000 vehicles per day. Road user understanding and their resultant behavior is of paramount importance along a highly active freeway such as I-270. ***Figure 3.1 at the end of this section*** details our proposed solutions to improve safety.

Crash data for the corridor provided by the MDSHA Office of Traffic and Safety for January 1, 2013 through December 31, 2015 shows that 2,056 crashes were reported along I-270 from the I-270 Split to I-70. While a significant portion of the reported crashes are relatively minor in severity (80 percent resulting in minor injury and/or property damage), their impact on the mobility of the system is dramatic. Reducing the number of these crashes through improved roadway geometry, reduction of congestion, and active traffic management of the corridor will help to improve both safety and mobility throughout the network.

A. Reducing Number of Incidents/ Incident Duration & Incident Severity

Freeway incidents contribute to approximately 60% of all traffic delays. The Coordinated Highways Active Response Teams (CHART) program was founded on the principle of restoring normal traffic flow as quickly as possible after every incident using all available resources. Dating back to the *Reach the Beach* program of the mid-1980s, incident management has been, and continues to be, the cornerstone of CHART. CHART's incident management program depends heavily on the cooperation and teamwork developed among the State Highway Association (SHA), Maryland State Police, and Maryland Transportation Authority, as well as local police and fire departments. Tools used by CHART for incident management include Emergency Traffic Patrols (ETP), Emergency Response Units (ERU), Freeway Incident Traffic Management (FITM) trailers, "Quick Clearance" policy, a variety of tools used at the scene to manage traffic and help clear the travel way, and multi-agency training and training exercises to maintain high competency levels. Alvin Marquess of the Wellington/Jacobs Team has been deeply involved with the CHART Incident Management Program through the development of corridor-specific FITM plans and evacuation plans. These plans document procedures to be followed in the event of an incident, either natural or man-made.

Our proposal is to improve mobility and throughput, while addressing safety and operations. These improvements focus on crash reduction and include:

- Civil improvements to alleviate bottlenecks
- Speed Harmonization
- Lane Management
- Queue Warning - incident detection and management
- Traveler Information

Our proposal is to create a smart and self-evident highway through ***strategic civil improvements to the existing roadway overlaid with an Active Transportation and Demand Management (ATDM) System.*** We believe that restructuring the manner in which the driver interacts with the roadway creates an operating environment that promotes safe and efficient travel, and is a significantly innovative approach to corridor revitalization. The civil improvements and ATDM solutions were detailed in Section 2, Mobility. While mobility and safety often go hand-in-hand, the following concepts specifically address safety concerns on the I-270 corridor.

- Part-time Shoulder Use (PTS)
- Lane Realignment
- Collector Distributor (CD) and Auxiliary Lane Modifications
- Mainline Modifications
- Interchange/Ramp Junction Modifications
- Off-Corridor Improvements

The above civil improvements will be overlaid with ATDM tools of:

- Dynamic Speed Limits (DSpeed)
- Queue Warning (QW) - incident detection and management
- Dynamic Lane Assignment (DLA)
- Dynamic Shoulder Lanes (DShoulder)
- Advance Traveler Information (ATI)

We will meet with SHA through final design to ensure our solutions maximize the goals of Safety and Mobility. Below we present our solutions of civil improvements and ATDM solutions, and detail how each helps with respect to incident numbers, duration and severity as applicable.

A.i - Civil Improvements

Wellington/Jacobs is proposing the following civil improvements that work in conjunction with the ATDM to meet the project safety goals. Locations of these improvements can be found on Figure 3.1.

Part-Time Shoulder Use : (PTC #2) One of our Team's proposed improvements reduces lane widths by a few inches, and reduces shoulder widths for short sections along the roadway to provide an additional lane on either the inside or outside shoulder. These adjustments to the existing roadway will not necessarily be consciously noticed by drivers, and based on American Association of State and Highway Transportation Officials (AASHTO) anecdotal data, will have a subtle traffic calming effect, resulting in somewhat lower, more uniform travel speeds and less erratic lane changes, and subsequently, improves the safety for all drivers, during both peak and off-peak hours. However, with narrower lanes, vehicles are traveling in closer proximity to each other, increasing the likelihood of lower speeds and helps to reduce rear end crashes.

By definition, adding a travel lane – whether permanently or part-time – will increase overall roadway capacity, thereby reducing recurring congestion and improving operations.

For the HOV in the shoulder, the Wellington/Jacobs team is proposing to add a part-time travel lane with a minimum lane width of 11 feet for general purpose and 11 feet for the PTS HOV lane. In general, the greater the average daily traffic, and presumably the greater level of congestion during the "before" conditions, the more likely the safety benefits from reduced congestion (resulting from an additional lane) will outweigh the potential safety issues associated with narrower lanes and shoulders.

Studies in California have revealed that shoulder widths of 2 to 3 feet when converting to shoulder use for a lane have not detrimentally impacted safety. AASHTO anecdotal data indicate that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet. This data shows that the free flow speed for a 75 MPH by only 1.9 MPH and reducing the inside shoulder width has no measurable decrease of free flow speed. The study also found that any safety degradation from the slight reduction in lane width for several lanes is offset by the increase in safety from the added capacity and reduced overall predicted crashes.

Lane Reassignment: (PTC #3) The lane reassignment consists of assigning three of the five receiving lanes for I-270Y traffic and the remaining two lanes to I-495. Under existing conditions, WB I-495 carries three travel lanes, all of which are maintained after the merge, and SB I-270Y carries three travel lanes, one of which drops at the merge point, resulting in only two lanes entering SB I-495 from the SB I-270Y approach. This lane reassignment will improve mobility and congestion along the I-495/I-270Y merge resulting in decreasing congestion-related crashes.

CD and Auxiliary Lane Modifications: (PTC #4) Implementing a 3-lane continuous section along the CD lanes will improve mobility and congestion along the CD lanes and the I-270 mainline lanes resulting in potential decrease of congestion-related crashes. AASHTO anecdotal data indicate that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet as discussed earlier.

Mainline Modifications: (PTC #5) Jacobs proposes to modify the lane configuration along I-270 in three locations

- Along SB I-270 between the MD 124 and I-370 interchanges
- Along NB I-270 between the proposed Watkins Mill Road interchange and Middlebrook Road
- Convert the shoulder along SB I-270 from just north of Montrose Road to the I-270 Split

This work involves converting the ramp lane from MD 124 from an acceleration lane to an auxiliary lane, which will continue through the MD 117 interchange and exit at I-370 rather than ending north of the railroad overpass. Traffic from the north destined for I-370 will be able to enter an exiting lane farther north and access I-370 with fewer lane changes. The cross section at the ramp junction to I-370 will remain the same, but the source of the exiting lanes will provide significant improvement to vehicle throughput and minimize travel times through this section of the corridor.

Along NB I-270, the NB CD road is proposed to merge into mainline I-270 within the Watkins Mill Road interchange. Wellington/Jacobs proposes to convert the lane at the end of the CD road from an acceleration lane to an auxiliary lane that will drop at the loop ramp to WB Middlebrook Road, providing much needed capacity at this critical bottleneck location.

We are also proposing to convert the shoulder along SB I-270 from just north of Montrose Road to the I-270 Split, along the right shoulder as a permanent use shoulder to provide much needed capacity.

Safety evaluations of narrow lanes from the literature show the crash rate (e.g., number of crashes per million vehicle-miles) often decreases. We believe the additional throughput provided by the extra lane results in an even greater increase in the denominator of vehicle-miles of travel, resulting in a decreased crash rate.

Interchange Modifications: (PTC #6) The proposed modifications to the acceleration lanes will have a great beneficial impact on the safety along the corridor. One of the primary causes of traffic incidents is the speed differential at the merge or weave points. Without adequate length of acceleration lanes the vehicles are forced to merge with the mainline traffic before reaching the running speed of the mainline. This requires the mainline traffic to slowdown and let the merging traffic in, or swerve to avoid slower traffic entering the mainline.

In each of the above solutions above, we are reducing lane widths for 1, 2 or 3 lanes for each proposed improvement location. Additionally, the shoulder is reduced to less than a 10 foot inside shoulder, or 8 foot outside shoulder. The details of each lane width and shoulder reduction are presented in the PTCs contained in the Appendix.

Off Corridor Improvements: (PTC #7) Removal of the queues spilling onto the I-270 lanes will create safer conditions for the vehicles using I-270, and the vehicles exiting I-270 and entering surrounding traffic network. It has the potential of limiting congestion related rear-end crashes.

A.2 - ATDM Tools

Wellington/Jacobs is implementing ATDM tools to enhance the safety of our civil improvements. The locations of these can be found on the 11x17 map at the end of this tab. ATDM tools are:

- Dynamic Speed Limits
- Queue Warning
- Dynamic Lane Assignment
- Dynamic Shoulder Lanes
- Advance Traveler Information

Dynamic Speed Limits (DSpeed): DSpeed addresses traffic congestion before or during operational breakdowns. Breakdowns in traffic can be caused by high demand, weather, work zones and incidents. Dspeed reduces rear-end collisions due to speed differentials during these breakdowns. In a Highways England report, a 55.7% reduction in personal injury crashes on the M42 Managed Motorway was realized in the 36 months where a DSpeed system was installed. A variable speed limit system studied along I-270 in St. Louis saw reductions in total crash rate of as much as 8.0%.

Queue Warning (QW): QW installations support rear-end collision reduction by providing advanced warning of down-stream queues. QW is often used in conjunction with DSpeed. Throughout 2012 and 2013, Caltrans utilized QW to alert motorist to backups resulting from heavy traffic attempting to enter a mall facility during peak holiday travel. Compared to the prior years, Caltrans documented a 66% reduction in the number of queuing related crashes after installing the system. Further, in 2010, Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable Dynamic Messaging System (DMS)) up to six miles in advance of the work zone. Over two years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system. Similar to DSpeed, the reduction of crashes has a direct correlation with improved mobility in work zones and in regular traffic.

Dynamic Lane Assignment (DLA): DLA involves dynamically closing or opening individual traffic lanes as necessary, and providing advance warning of the closure(s) using lane-use control signs (LCS), to safely merge traffic into adjoining lanes. Use of DLA reduces last minute lane changing and the associated breaking. Additionally, worker and responder safety is improved by moving traffic away from work zones or incidents earlier, reducing the potential for a worker to be struck by a vehicle. As the network is continuously monitored, real-time incident and congestion data is used to control the lane use ahead of the lane closure(s), and dynamically manage the corridor to reduce rear-end and other secondary crashes.

Dynamic Shoulder Lanes (DShoulder): This tool enables the use of the shoulder as a travel lane based on congestion levels, and in response to incidents or other conditions during non-peak periods. In addition to using DShoulder to reduce recurring congestion, we will also employ DShoulder as an additional general purpose lane during planned events, such as road construction or maintenance, or unplanned events such as crashes. These uses contribute greatly to decreasing rear end crashes, increasing throughput and reducing congestion.

Advance Traveler Information (ATI): Traveler information is a key tool in ensuring improved mobility and safety. ATI supports many types of information requests and categories of travelers, and communicates relevant information to the public so they can make more informed travel choices. This is accomplished by displaying traffic and roadway conditions on small DMS on the gantries along the ATDM-deployed network and on full DMS at critical decision points along the corridor. By integrating STM with CHART, the existing full DMS, Maryland's 511 system, the Web and other outlets are also available to the I-270 corridor. Safety, mobility and predictability is improved by conveying information to motorists or travelers to influence traveler behavior (by recommending diversion routes around an incident, for example).

A.3 - Additional Hardware

Wellington/Jacobs is also adding additional hardware in the form of CCTV cameras, vehicle detection sensors and LED roadway lighting. The locations of this hardware along the corridor can be found on the 11x17 map at the end of this tab.

Detection: We are proposing additional vehicle detection throughout the corridor to improve incident detection time which results in faster response and clearance. This will reduce the number of secondary accidents due to speedier incident cleanup. Video Image Detection System (VIDS) will be installed along I-270 where part-time shoulder use is implemented. Using programmable detection zones and with full coverage, VIDS will be able to detect any stopped vehicle or debris in the shoulder. This capability can be used for verification that the shoulder is clear before opening it as well as a means to monitor its condition while in operation.

Closed Circuit Television (CCTV) Coverage: Additional CCTV coverage will serve as an additional pair of eyes for operators to see the condition of I-270. Operators can more quickly verify an incident and diagnose the incident to ensure the proper response is deployed. This will serve to reduce secondary accidents.

LED Roadway Lighting: In areas where we are replacing existing lighting, LED lighting will be deployed per current SHA design standards and criteria to improve safety and operations along the I-270 corridor. The LED lighting will be engineered for specific applications.

B. Facilitating incident management after construction is completed

Wellington/Jacobs' approach uses ATDM tools to manage lanes and alert motorists of upcoming traffic changes. This approach to safety and facilitating incident management provides for:

- More immediate response by getting emergency response vehicles to the scene faster
- Motorists move safely and efficiently past the incident.
- Safer work areas for responders, motorists and workers

Our plan to facilitate incident management after construction begins during the design phase. During design, we propose to utilize stakeholder workshops to review final Concept of Operations,(ConOps) Detailed Design, and Emergency Response Plans associated with the ATDM operation. Key stakeholders include the multiple responding agencies that monitor and respond to I-270 incidents. We will gather feedback on any operational or design concerns to ensure final implementation meets user needs.

Prior to system implementation, comprehensive system training will be provided and Standard Operating Procedures (SOPs) developed or modified to incorporate the new ATDM operating regime. The training and SOPs will focus on the inclusion of ATDM elements within the overall scope of CHART incident management. The STM will function as an extension of the CHART system by adding additional ATDM tools to help manage congestion and incidents along the controlled portion of the corridor.

From Quince Orchard Road to the Split and along I-270Y to the I-495 merge at Bradley Blvd., control will be instrumented with high density vehicle detection (about every ½ mile). The STM platform utilizes the vehicle detection data to detect congestion or possible incidents, bring these events to the attention of the operator, and offer response

plans to manage the incident. The fast detection times resulting from the high density deployment of vehicle detection means operators are notified sooner of congestion, and are able to initiate verification and response activities quicker than currently possible. STM's ability to automatically generate a response plan also reduces the time required for the operator to begin actively managing an incident and notifying emergency responders, if necessary. The overall faster response also reduces the scope, severity, and duration of resulting queues and the associated rear end crashes.

A dedicated I-270 Highway Operations Technician (HOT) position is being proposed due to the uniqueness of the ATDM operation within the context of CHART incident/traffic management. A single operator workstation may be used to operate both the STM and CHART software. Incidents and events may be initiated from and shared across either platform. Congestion events would most likely be detected by the STM based on the density of the vehicle detection deployment, although incident events may be detected by either STM or CHART. In either case, the events will be shared and linked across both platforms. The operator would use STM to manage the ATDM field elements to actively manage the traffic, while the CHART ATMS ensures the incident appears on the CHART web site and is exported to the 511 and Regional Integrated Transportation Information System (RITIS) systems. It also allows the operator to further manage the event using existing CHART ATMS event management features. This includes the ability to add Highway Advisory Radios (HAR) and cameras to the response plan, add DMS to the response plan that are outside the I-270 corridor (for major events), manage participants, and send notifications. As noted above, the integrated efficiency of this operation reduces response times and facilitates quicker recovery times.

The Wellington/Jacobs team will develop relevant materials and support SHA with outreach and educational campaigns to educate the traveling public about the corridor changes. More detail can be found under ***Tab 5, Well Managed Project.***

In the past, incident management teams were in place and the participants worked to improve incident response collaboration. Wellington/Jacobs proposes to utilize these organizations who respond to highway incidents from state and local agencies, as well as the private sector from both Frederick and Montgomery Counties to assist in formulating the response system. This group will include representatives from the agencies in both the field response and dispatch center disciplines as each will be critical in providing input into developing operational plans. State agencies include:

- Maryland Department of Transportation State Highway Administration (CHART, Construction and Maintenance Offices)
- Maryland Transportation Authority (patrols, maintenance and police)
- Maryland State Police
- Maryland Department of the Environment

Local agencies which respond to or assist with incidents and events along I-270 to include:

- Montgomery County Traffic Management Center
- Montgomery County Fire/Rescue and Police
- Frederick County Fire/Rescue and Sherriff's Office

The private sector includes local towing and recovery companies from Montgomery and Frederick Counties.

It is critical to develop this group at the onset of the project prior to the final design and construction. We recommend that a representative from the Wellington/Jacobs team be a part of the incident response team prior to and during construction.

Additional Safety Solutions: Not all solutions are electronic. Incident management along I-270 can be improved to provide better coordinated response to incidents. After this project is completed, SHA can implement a number of initiatives to provide improved incident response and reduce secondary crashes. Although the following initiatives are not funded as part of this proposal, the Wellington/Jacobs Team can lead efforts to develop them should SHA choose. These initiatives include:

- One additional Emergency Response Unit dedicated to the I-270 Corridor Monday through Friday: minimum 5:00 AM – 7:00 PM
- One additional Trooper assigned to the I-270 Corridor Monday through Friday: minimum 5:00 AM – 7:00 PM (if the trooper could be an advanced reconstructionist, hours could be saved in clearance times)
- Instant Tow Option with Maryland State Police and private tow companies

- Heavy Duty Towing certification and incentive program similar to RISC in Florida or Georgia's TRIP program
- Agreement with WAZE for customized data and ability to send alert messages to the public via WAZE including lane closures (right, left etc.) and alternate route recommendations
- Corridor Traffic Incident Management team to include all response disciplines both public and private from Montgomery and Frederick Counties
- Open Roads agreement with Montgomery County police (they currently keep more lanes closed longer than necessary when they respond to I-270)
- Enhance coordination efforts with Montgomery County
- Provide Montgomery County TMC with at least view capability of the enhanced data so they may be more responsive with signal control if there is an issue which requires motorists to exit I-270 to the surface streets
- Mobile debris clearing vehicle

ii. Innovative technologies or techniques to address project's safety goal

As discussed in the Mobility Section, our improvements related to safety focus on crash reduction using the same strategies we will implement to improve throughput:

- Civil improvements to alleviate bottlenecks
- Speed Harmonization
- Lane Management
- Queue Warning - incident detection and management
- Traveler Information

These are accomplished by strategic civil improvements overlaid with deploying ATDM tools. While the civil improvements will definitely enhance corridor safety, ***the addition of ATDM is innovative in terms of providing additional safety measures within the original footprint of the corridor*** and requires no new Right-of-Way.

Civil improvements proposed are:

- Part-Time Shoulder Use
- Lane Realignment
- CD and Auxiliary Lane Modifications
- Mainline Modifications
- Interchange Modification
- Off-Corridor Improvements

The above civil improvements will be overlaid with ***ATDM tools*** of:

- Dynamic Speed Limits
- Queue Warning
- Dynamic Lane Assignment
- Dynamic Shoulder Lanes
- Advance Traveler Information

Table 3.1 on the next page details related safety concepts and tools that have been implemented on other corridors similar to I-270.

Installing and implementing the noted ATDM tools will be coordinated with existing traffic control devices (signing, pavement marking, and roadway lighting) to provide a seamless network of motorist information. In some cases, existing signing along the corridor has remained in place since the initial inception, without revision. Existing guide and supplemental sign messages that are not current will require updating to match the proposed civil or Intelligent Transportation System (ITS)/ATDM improvements. We will conduct a supplemental review of each corridor segment during final design to define modifications, additions, or enhancements. The signage deployed will meet Federal Highway Administration (FHWA) and SHA standards using retro reflectivity, enhancing the dynamic products, and providing a fail-safe operation of the corridor, further enhancing motorist safety at all times.

iii. Techniques to mitigate conditions that may not meet typical design standards and how the mitigation will provide for a safer I-270 corridor

The Wellington/Jacobs team has utilized a number of techniques to provide a safer I-270 corridor and will mitigate the following conditions that do not meet design standards.

Lane Widths: Wellington/Jacobs is proposing to reduce lane widths from 12 feet to 11 feet throughout much of the corridor and as described in PTCs 2, 3, 4, 5 and 6. Based on the 2010 Highway Capacity Manual, reducing lane widths will reduce free flow speeds by 1.9 mph on both the mainline lanes and the CD (75 mph to 73 mph on the highway and 65mph to 63 mph on the CD). The reduction in crashes from the added capacity associated with the PTS, lengthened acceleration lanes, and added auxiliary lanes offsets the reduction in free flow speed by improving throughput and travel time with a projected reduction in crashes.

Table 3.1: Results of Safety Improvements Similar to the Proposed I-270*	
Dynamic Speed Limits	
M42 Managed Motorway, England	55.7% reduction in personal injury crashes realized in 36 months
I-270, St. Louis	4.5-8.0% reduction in crash rates
OR 217, ODOT	Lane flow distribution improvement 1-3%, overall travel time and variability decreased, throughput increased 1-3%, wet weather travel times variability decreased (predictability), crashes at VSL locations reduced 8-35%, 6% reduction in crashes occurring during AM peak
Queue Warning	
CA 805, CA 163, California 2012, 2013	Caltrans utilized a QW system to alert motorist to backups resulting from heavy traffic attempting to enter a mall during peak holiday travel. Caltrans documented a 66% reduction in the number of queue-related crashes after installing the system
I-55, Illinois 2010	Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable DMS) up to six miles in advance of the work zone. Over two years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system.
I-70/I-57, Illinois	Work zone queue warning system installed during reconstruction on the I-70/I-57 interchange in Effingham, Illinois. The system used portable dynamic message signs (DMS) mounted on solar powered trailers equipped with traffic detectors and cameras to monitor traffic conditions and warn drivers of developing queues resulting in reduced queuing crashes by 14 % and injury crashes by 11%.
I-35, Texas	TxDOT project to widen 96 miles of I-35 leg to the design of an innovative end-of -queue warning system reduced crashes by 45%.
Mainline Modifications	
Highway Safety Manual	Conversion of the acceleration lane from MD 124 to an auxiliary lane that will drop at I-370. Crash modification factor (CMF) for modifying a 2-lane change condition to a 1-lane change condition for a merge or diverge is 0.68 with a standard error of 0.04, indicating a crash rate reduction of approximately 32%.
Part-Time Shoulder Use	
California	Studies show that shoulders widths of 2 to 3 feet when converting to shoulder use for a lane have not detrimentally impacted safety.
AASHTO	AASHTO anecdotal data indicates that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet. Free flow speed for a 75 MPH corridor reduced by 1.9 MPH.
**Study sources can be found under the Reference Tab in the Appendix.*	

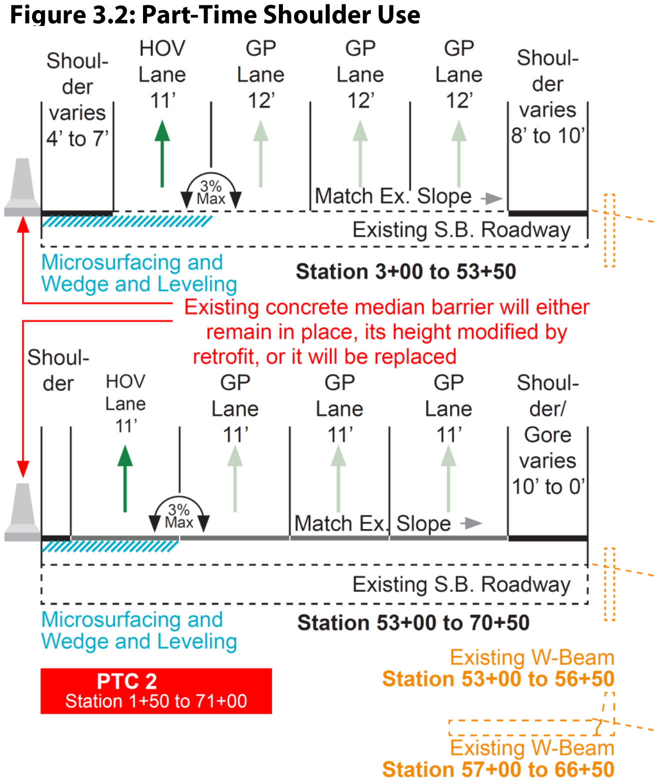
Shoulder Widths: In order to implement the proposed civil improvements, Wellington/Jacobs recommends utilizing existing shoulders, either on a part-time basis (PTC 2) or on permanent basis (PTC 3, 4, 5 and 6). Utilizing the existing shoulder per AASHTO guidelines provides an effective way of increasing capacity along the corridor without performing extensive widening to construct a new lane. AASHTO guideline shoulder widths when properly maintained, provide a space away from the traveled way for vehicles to stop because of mechanical difficulties; provide a sense of openness which contributes to driving ease and reduced stress; provide space for maintenance operation such as snow removal or storage; and provide lateral clearances for signs and guardrails/barriers.

Under the improvements proposed in PTC 2, the existing shoulders will be reduced to a minimum of 1.5 feet at pinch points to provide adequate space for the PTS lane in the following locations:

- Along the PTS lane proposed from south of Westlake Terrace overpass to North of Bradley Boulevard, the existing shoulder between Westlake Terrace and north of the I-495 flyover ramp is in excess of 14 feet and therefore, the PTS lane in that stretch of improvements will not have any pinch points that are 1.5 feet.
- In the area between the I-495 fly-over ramp and Bradley Boulevard overpass the existing shoulder decreases in width to 10 feet and the pier for the flyover ramp will create a pinch point of a minimum 1.5 feet.
- In the section north of Montrose Lane and the Split, where a full-time lane is proposed for the outside shoulder of the southbound I-270 mainline lanes and the outside shoulder of the southbound I -270 CD lanes, the 1.5-foot minimum pitch points are anticipated in the areas where the existing foundations for overhead signs/lights are and along the pier for the Montrose Road overpass.

During over saturated conditions, the operation and safety of the corridor will benefit more from added capacity than from an available full width shoulder. Travelers will benefit from a wider shoulder south of station 53+50 with the remaining shoulder being the same when the HOV lane is not in use ***(Figure 3.2).*** Additionally, the ATDM solutions allows for continuous surveillance and management of PTS lane and general purpose lanes, to safely and efficiently move the traffic the furthest distance in the shortest amount of time. The existing shoulders, PTS lanes and general purpose lanes will be managed based upon up-to-the-minute corridor operations under STM. When incidents are observed, the ATDM solutions are designed to close the necessary lanes, alert and divert the traffic around the incident zone, assist the emergency responders with getting to the incident, and open the lanes or shoulders as soon as it is deemed safe.

Figure 3.2: Part-Time Shoulder Use



Wellington/Jacobs proposes to implement permanent reduction of the outside or inside shoulders in the following locations to provide a third travel lane:

- SB CD lanes south of Shady Grove Road (outside)
- SB CD lanes south of MD 189 (outside)
- SB I-270 south of Bradley Boulevard overpass (inside)
- SB I-270 between MD 124 and I-370 (inside)
- NB I-270 between Watkins Mill Road and Middlebrook Road (outside)
- SB I-270 north of Montrose Road to north of the I -270 Y split

While the width of existing shoulder will be permanently reduced, as opposed to the part-time reduction of the PTS lanes, the ATDM solutions will provide continuous surveillance and management of the lanes and will be able to adjust lane use configuration based on the needs of the particular section of the corridor. When the shoulder is used as a lane, the corridor users will benefit from added capacity associated with the permanent third lanes. In the event one of the lanes is blocked, the corridor users will benefit from the technology provided by the ATDM solution and its effective methods of diverting traffic around an incident area. The ATDM may also be employed during periods when snow is stored next to the concrete barrier.

Acceleration Lane Lengths: The traffic modeling identified several of interchanges and the associated acceleration lanes as contributing factors to traffic

delays and difficulties with merging in and out of the I-270 traffic. Wellington/Jacobs is proposing acceleration lane modifications at the following interchanges to address the traffic concerns:

- Montrose Road
- MD 28

This work improves the ramps that cause the biggest delays in I-270 operations. In the locations where full AASTHO compliant acceleration cannot be achieved due to existing obstacles (bridge abutments/piers), the length of the acceleration lanes will be extended as much as feasible without impacting the obstacles. At MD 28 and Montrose Road, the interchange modifications will not bring the interchanges into AASHTO compliance but, due to the above conditions, will improve the traffic operations. If a minor extension of the acceleration lanes improves mobility, safety and operability (even if the minor extension does not bring it to compliance with AASTHO) the extension is recommended to address the goals of this project.

Cross-Slopes: PTS lane construction requires adjustments of the existing median cross-slopes. The superelevation of the shoulders may differ from the superelevation of adjacent general purpose lanes through the horizontal curves to facilitate drainage. In some cases, there is a cross-slope break on the shoulder, or the entire shoulder is sloped in the opposite direction of general purpose lane to direct waters to inlets. The FHWA guide ***Use of Freeway Shoulders for Travel: Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy*** (February 2016) identifies small superelevation differences of 2% or less are acceptable, with the break occurring on the edge line between the shoulder and general purpose lane. The PTS lane is scheduled for use only during the AM peak hours and Wellington/Jacobs believes that difference between adjacent lane and the shoulder of 3% or less will not have a negative impact on the mobility, safety and operability of the corridor. We have adopted this cross-slope deviation to provide cross-slope correction for these areas.

Deficient Superelevations: SHA has provided existing topographic files and Digital Terrain Model files (DTM) of the existing conditions along the corridor. The DTM files were utilized to develop cross sections showing the existing cross-slopes for the lanes and the shoulders, rollovers between lanes and shoulders, and existing superelevation rates. Wellington/Jacobs approach is that the existing deficiencies of any superelevations will not be corrected except when our primary solution is to improve mobility, throughput and safety.

Pavement Thickness: Wellington/Jacobs proposes utilizing the existing shoulders to provide part- or full-time lanes. SHA provided the results of the Ground Penetrating Radar (GPR) investigation performed in 2015, and as-builts/design plans for the I-270 improvements however, there was a limited number of pavement borings provided along the corridor. The paving borings provided us with the most accurate representation of the existing pavement section at each boring location. Based on the existing and proposed traffic numbers, we designed preliminary pavement sections for each improvement.

We reviewed all the as-builts/design plans provided by SHA and developed an index map showing the coverage of each of the as-built plans and how they relate to the locations of the proposed civil improvements. The GPR data was converted into a Microstation drawing which showed the locations of all of the readings and the thickness of the existing pavement at each of the test location. Graphical representation of the GPR points allowed for comparison of GPR locations and the proposed civil improvement locations.

If the GPR results of any of our civil improvements showed a limited pavement section, the as-built/design plans were reviewed to evaluate if the GPR reading was an anomaly or if the reading is in line with the pavement section shown in the corresponding as-built/design plans. If available, pavement cores were used as an evaluation tool.

Based on the pavement research, we determined whether the existing pavement area could be used as-is or if it needs to be reconstructed. In areas where GRP or as-build/design plans show insufficient pavement, a reconstruction is assumed as a way of addressing uncertainty as detailed in the PTCs. Although this is an area where we have followed standard pavement design, it is worth discussion because of the conservativeness we have assumed.

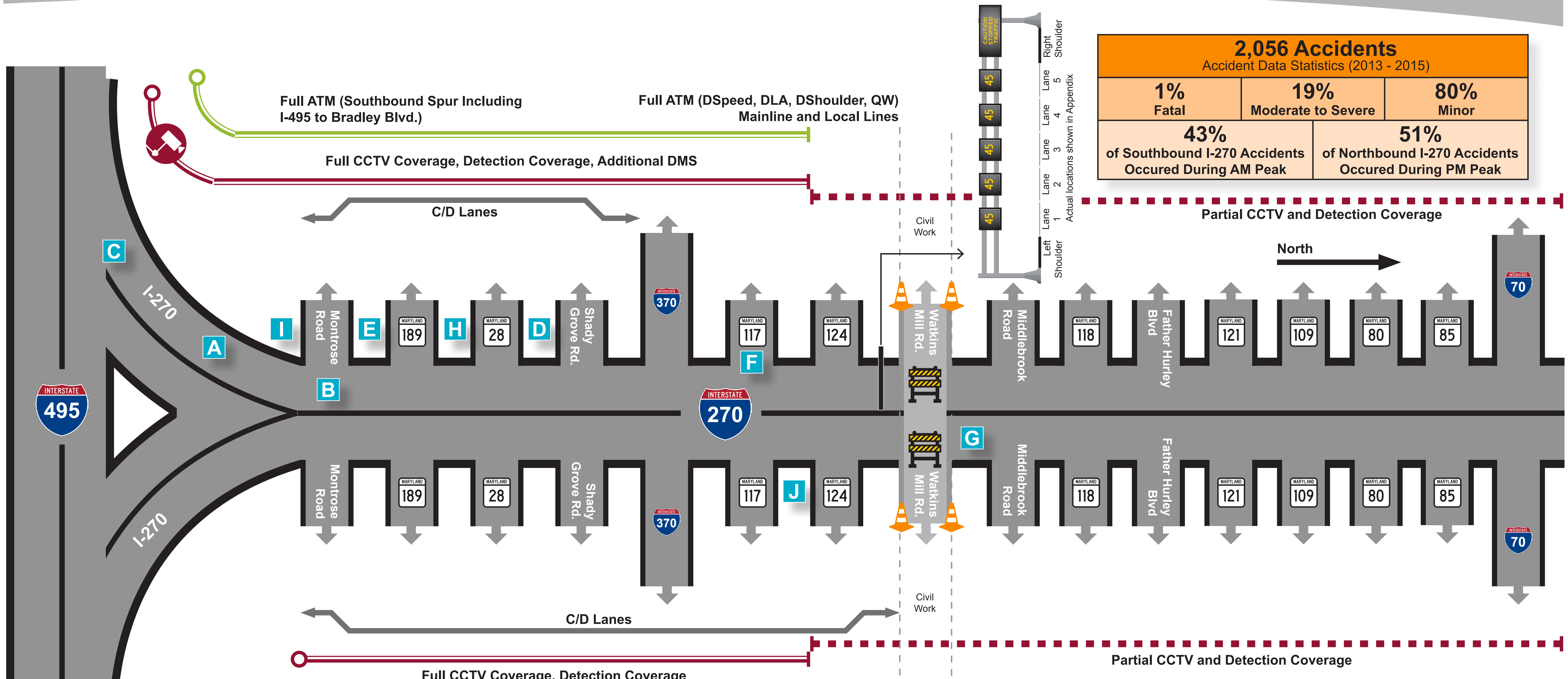


Figure 3.1

ID	Primary (P) & Secondary (S) Congestion Locations								
A	SB I-270Y, from South of Westlake Terrace Overpass to North of I-495(P)	C	SB I-270Y at Merge with WB I-495(P)	E	SB I-270 CD, between MD 189 and Montrose Road(S)	G	NB I-270, from end of CD to Middlebrook Road(P)	I	SB I-270 CD at Ramp from EB Montrose Road(S)
B	SB I-270, from North of Montrose Road to I-270 Split(P)	D	SB I-270 CD, between Shady Grove Road and MD 28(S)	F	SB I-270, from MD 124 to I-370(S)	H	SB I-270 CD at Ramp from WB MD 28(S)	J	MD 117 from MD 124 to I-270(S)

Key:	
DLA	Dynamic Lane Assignment
DShoulder	Dynamic Shoulder Lane
QW	Queue Warning
DSpeed	Dynamic Speed Limits

4. OPERABILITY/MAINTAINABILITY/ADAPTABILITY

4. Operability / Maintainability / Adaptability

i. Maintenance requirements & personnel & equipment requirements after construction

The Wellington/Jacobs team is proposing a system of improvements and installations that minimizes State Highway Administration's (SHA) operations and maintenance activities and is adaptable to future transportation technological advancements.

Our proposal is to create a smart and self-evident highway that improves mobility and throughput, while addressing safety, predictability and operations, achieved through ***strategic civil improvements to the existing roadway overlaid with Active Transportation and Demand Management (ATDM) Systems.*** These applications combine to create a congestion-reducing system that is flexible and provides for future operational demands. Our solutions to improve mobility and safety focus on:

- Throughput
- Travel time reliability
- Crash reduction

We will achieve these with the following strategies:

- Civil improvements to alleviate bottlenecks
- Speed harmonization
- Lane management
- Queue warning - Incident detection and management
- Traveler information

Our team has arrived at a design that blends civil and technological solutions that can be ***implemented within the existing right-of-way (ROW)*** and can be constructed with very little disruption to traffic when compared to other build-out options. We will implement a series of solutions that utilize both technology (ATDM) and civil improvements as shown in ***Figure 4.1 at the end of this section***.

Active management of transportation includes multiple approaches spanning demand management and traffic management. The ATDM tools we are proposing are:

- Dynamic Speed Limits (DSpeed)
- Queue Warning (QW)
- Dynamic Lane Assignment (DLA)
- Dynamic Shoulder Lanes (DShoulder)
- Advance Traveler Information (ATI)

Civil Improvements proposed are best categorized into six basic concepts:

- Part Time Shoulder Use (PTS)
- Lane Realignment
- Collector Distributor (CD) and Auxiliary Lane Modifications
- Mainline Modifications
- Interchange/Ramp Junction Modifications
- Off-Corridor Improvements

We recognize that there are emerging traffic operational concepts that are somewhat off in the future, but thought must be provided today with regard to devices and controls. The Wellington/ Jacobs proposed solutions are ***adaptable to both future needs and future technological advances, materials/equipment, and operations***.

A. Pavement Elements

The civil improvements proposed are developed to work with the existing roadway network and available infrastructure as much as possible. Therefore, operations will be as is expected on any other limited access roadway.

We based our assessment on Ground-Penetrating Radar (GPR) data, boring information, and as-built/ design plans provided by SHA. If the existing pavement is expected to be thinner than the designed new section, we identified those areas as needing reconstruction. Reconstruction will provide a functional design life of at least 15 years and minimize maintenance requirements.

For the areas where the proposed improvements require cross slope adjustments, we propose to utilize wedge and leveling to obtain desired cross slope of lanes and/or shoulders. Wedge and leveling extends the pavement life by 8-25 years and improves International Roughness Index, Functional Cracking Index, Structural Cracking Index, skid, and average rutting of the treated areas.

Wellington/Jacobs proposes to apply microsurfacing as a final course of treatment in areas of full depth reconstruction, wedge and leveling, and areas impacted by restriping the existing lanes. Although not used to prolong life, micorsurfacing will prevent/ delay oxidation of the pavement surface, seal the pavement surface and will last usually 4 to 10 years. The microsurfacing will also result in uniform feel and look for the users of the I-270 corridor.

We are proposing lane adjustments and realignments that optimize operations while fitting almost entirely within the existing paved footprint. These include minor lane width adjustments and shoulder modifications without impacting bridges or reconstructing interchanges.

With the exception of approximately 1,133 square yards (SY) of added pavement, there is very little increase in pavement maintenance cost. New pavement areas include 223 SY south of Montrose Rd. Interchange to extend the acceleration lane for the SB CD lanes; 785 SY between MD 189 and Montrose Rd. for shoulder construction along SB CD lanes; and 125 SY along NB I-270 lanes near Middlebrook Interchange to modify the gore area.

Reducing several shoulders to less than 10 or 8 feet for a PTS or adding more lanes, may increase costs for snow removal. PTS areas using the shoulder as short term snow storage will need operation procedures with regard to either sequencing snow removal vehicles to remove snow to the outside shoulders, temporarily not use the shoulder as a PTS, or increase snow removal costs to remove snow from the shoulder. Also, there will be some increased maintenance costs associated with stormwater facilities installed for the project. Final quantities will be determined during design.

Table 4.1 details the location of the civil improvements and associated maintenance.

Noise Walls: We will perform a noise analysis since our improvements include striping existing outside shoulders as additional lanes, and determine if mitigation measures are needed. Based on evaluation of existing noise reports, the following noise walls are anticipated for an upgrade or new construction.

- Extension of existing noise wall 15121NO along northbound I-270, south of Montrose Road Interchange by approximately 300 feet
- Extension of existing noise wall 15123NO along southbound I-270, just north of MD189, by approximately 600 feet
- Extension of existing noise wall 15125NO along southbound I-270, south of Muddy Branch Road by approximately 200 feet
- Construction of new noise wall along northbound I -270 from Muddy Branch Road to south of Diamond Avenue, approximately 3,000 feet long
- Construction of a new noise wall near Tuckerman Lane, along northbound lanes. The length of new noise wall would be about 1,400 feet

Table 4.1: Summary of Maintenance Impacts

PTC	New Pavement	Shoulder for Snow	Figure 4.1 ID
2	N/A	6700 lf	A
3	N/A	N/A	C
4	785 lf	2,325 lf	D & E
5	125lf	23,750 lf	B,F, &G
6	223lf	900	H & I
7	N/A	N/A	J

Maintenance of Traffic (MOT) during Construction: The ability to maintain traffic throughput and safety during the construction is critical to the success of the project. Working under heavy traffic conditions is hazardous to road users and workers. The Wellington/Jacobs design along the I-270 corridor includes techniques and strategies to minimize MOT activities within the roadway.

Our plan utilizes existing and new ATDM features to assist in traffic control operations and incident management during construction. Plans and provisions will be made to ensure a safe and efficient work zone that provides a high level of safety for workers and the public. These plans will:

- Minimize congestion and community impacts by maintaining acceptable levels of service as close as possible to preconstruction levels
- Provide a feasible design of highway traffic control during highway
- Provide work zone access that is adequate to complete the work efficiently while meeting the quality requirements of the contract

B. Non-Pavement Elements

The ATDM solutions will require increased maintenance associated the physical features including structural inspections of the gantries and regular maintenance for the Intelligent Transportation System (ITS) field equipment, data processing, network communications and associated utilities. Operation costs will also include operators. ***Table 4.2*** details the maintenance and the life expectancy of our non-pavement elements.

ATDM equipment will be housed, to the greatest extent possible, in roadside cabinets, leaving only the display devices positioned on gantries over each

lane. Power supplies, sign controllers and other hardware are located in the roadside cabinet for easy access. The LCS/DMS signs are based on color LED technology with 20mm pixel spacing. The LEDs are typically rated for 100,000 hours operation and the high density pixel pitch means that a sign message can still be legible even after some of the LED pixels have failed. The ATDM operation is expected to be active only during peak periods or during incidents, and will be dark or off the rest of the time. The life expectancy of most LED is more than 20 years. The low operational duty cycle helps to extend the expected mean time between failures of supporting components.

All systems are under constant management and monitoring control through full-time network communications to all field devices via a fiber/Ethernet backbone network. Field equipment operations and maintenance issues are detected and addressed in real-time. The fiber/Ethernet network is designed as a managed and redundant network allowing the system to continue to operate even under a single point network failure. Fiber and network equipment failures can be scheduled for routine, instead of emergency restoration.

The electrical power design uses an Uninterruptable Power Supply (UPS) at each device location equipment cabinet. The UPS are sized for four hours run time, sufficient to bridge a power outage during peak periods when the ATDM may be active. The UPS includes an intelligent controller that supports remote monitoring and management and typically operates ATDM signs at half power under battery backup to provide the necessary run time. The UPS includes an intelligent controller that supports remote monitoring and management; allowing central operations to make decisions based on extended power failures at multiple gantry locations.

C. Personnel and Equipment Requirements

There are no increased requirements for specialized equipment or personnel for the civil improvements of our proposal, with the exceptions of maintenance staff for stormwater management facilities and noise wall maintenance described above.

Wellington/Jacobs anticipates the following increase in staffing to operate and maintain the new system.

- One additional Highway Operations Technician (HOT) to monitor and manage I-270 through the Surface Transport Management (STM); 24 hours-a-day, 7 days-a-week from the Statewide Operations Center (SOC). SHA's current Office of Coordinated Highways Active Response Team (CHART) and ITS Development already has the breadth of personnel
- No additional equipment will be needed in the SOC. STM will run on the CHART workstations
- Additional servers installed in MDOT data centers will become the responsibility of the Maryland Department of Information Technology (DOIT)

ii. Compatibility & integration with current transportation infrastructure, including CHART

Wellington/Jacobs' proposed civil improvements are very compatible with the existing civil roadway network and require no new ROW. The PTS and added lanes, with the exception of 1,133 SY of widening, use the existing pavement footprint. In these areas, we maintained the opposite shoulder width for use as refuge area.

Our proposed ATDM infrastructure optimizes the existing civil assets and is easily integrated into the CHART system. The ATDM techniques discussed in this proposal are consistent with SHA's traffic management philosophy and provide additional tools to actively manage traffic conditions.

A new third party commercial-off-the-shelf (COTS) STM platform, supplied by Cubic Transportation Systems, Inc., is proposed to support the ATDM and ITS described above. Wellington/Jacobs is proposing a new STM / CHART ATMS interface Web Services component as an adaptation layer between STM and CHART. The new component allows STM integration with CHART's existing capabilities in event/incident management, DMS and Closed Circuit Television (CCTV) control, without needing to change the way CHART operates and keeps CHART as the primary "top level" tool for statewide freeway operations.

The system workstation operator interface will be located at the SOC or Traffic Operations Center (TOC) with the supporting server functionality located in a cloud-hosted facility and/or at the SHA primary and backup data centers. The system will integrate with CHART and can share information with other third party centers such as Regional Integrated Transportation Information System (RITIS). However, its operation of ATDM and ITS field elements is not dependent upon these external interfaces. ***Figure 4.2*** shows the initial conceptual

Table 4.2: Non-Pavement Maintenance Elements	
ATDM Component	**Maintenance Impacts**
Gantries Galvanized steel standard SHA gantries. Life expectancy - 50 years	SHA OOTS TEDD provides inspection of all Traffic Control Device structures on a *5- year cycle*. New structures will be inspected/accepted for maintenance and added to SHA TSIIM system inventory.
Roadside cabinets Aluminum commercial-off-the-shelf housing power and communications equipment for the ATDM/ITS. Life expectancy - 20+ years	*Every Six months,* the cabinet needs to be inspected for unusual wear and to ensure it has maintained its water and animal resistance. The status of the cabinet equipment and its contents are monitored in real-time through STM. This reduces the level of field inspection needed.
Lane-use Control Signals Front accessible, full-matrix DMS signs mounted over each roadway lane. Life expectancy - 20 years	The LCS preventive maintenance planned and coordinated with control room. *Weekly* - Check that all signal heads can be controlled from the SOC through STM. *Every Three Months* - from each control cabinet in the field (or remotely using sign vendor software), perform pixel test, verify full sign functionality.
Battery Back-up Ensures that the lane-use control signs maintain display and intelligence should power be lost. Life Expectancy – 20 years Batteries – 5	UPS preventive maintenance mainly involves monitoring battery health using the UPS controller built-in and remote monitoring tools. *Weekly* – Check/record battery voltages, and ambient temperatures. *Every Five Years (approx.)* – Batteries should be replaced approximate every 5ears. This is best performed using 20% annual replacement cycle.
DMS Front accessible, full-matrix electronic signs mounted over the roadway shoulder. Life expectancy - 20 years.	The DMS preventive maintenance requires planning and coordination with control room. *Weekly* - Check that all signs can be controlled from the SOC through STM. *Every Three Months* - from each control cabinet in the field (or remotely using sign vendor software), perform pixel test, verify full sign functionality.
Computer/Software The servers that will drive Cubic's STM will be standard Intel-based processors running Microsoft Windows software. Life expectancy – 10 years	Normal system administrator tasks should be carried out on the same schedule as other processing elements in the same facility. This may consist of checking system and event logs, running disk cleanup and optimization utilities, operating system and utility patching, database and file management. The STM cloud-hosted components will be maintained by the hosting facility.
Network The Ethernet switches and firewalls connecting field elements with the MDOT network. Life expectancy – 10 years	The network is under constant monitoring through the MDOT NOC. Normal network administrator tasks should be carried out on the same schedule as other MDOT networking elements, including checking event logs in response to system alarms and firmware version and security patching.

architecture. The final architectural decision on the external interface will be developed during design.

Integration of the STM system into CHART will be coordinated by ***Turnkey Technology Corp.*** Turnkey has been a key member of the CHART development team as the system has evolved, working on features such as the field device communications framework, travel times, field device additions and enhancements, and the integration with the Lane Closure Program system.

Skyline Network Engineering, LLC (Skyline) is a key team member. Their familiarity with existing resource sharing agreement (RSA) fiber cable (i.e. Level 3), MDOT fiber and network assets, and MSHA network staff will help facilitate the design, deployment, and commissioning of the network. Skyline will be assisting Wellington/Jacobs in the design of the communications network, CCTV camera sighting design, and video sharing within CHART. During construction, Skyline will perform

the fiber installation into Level 3 backbone fiber; the VID server deployment, configuration and testing; and the communications network testing, commissioning, acceptance and monitoring.

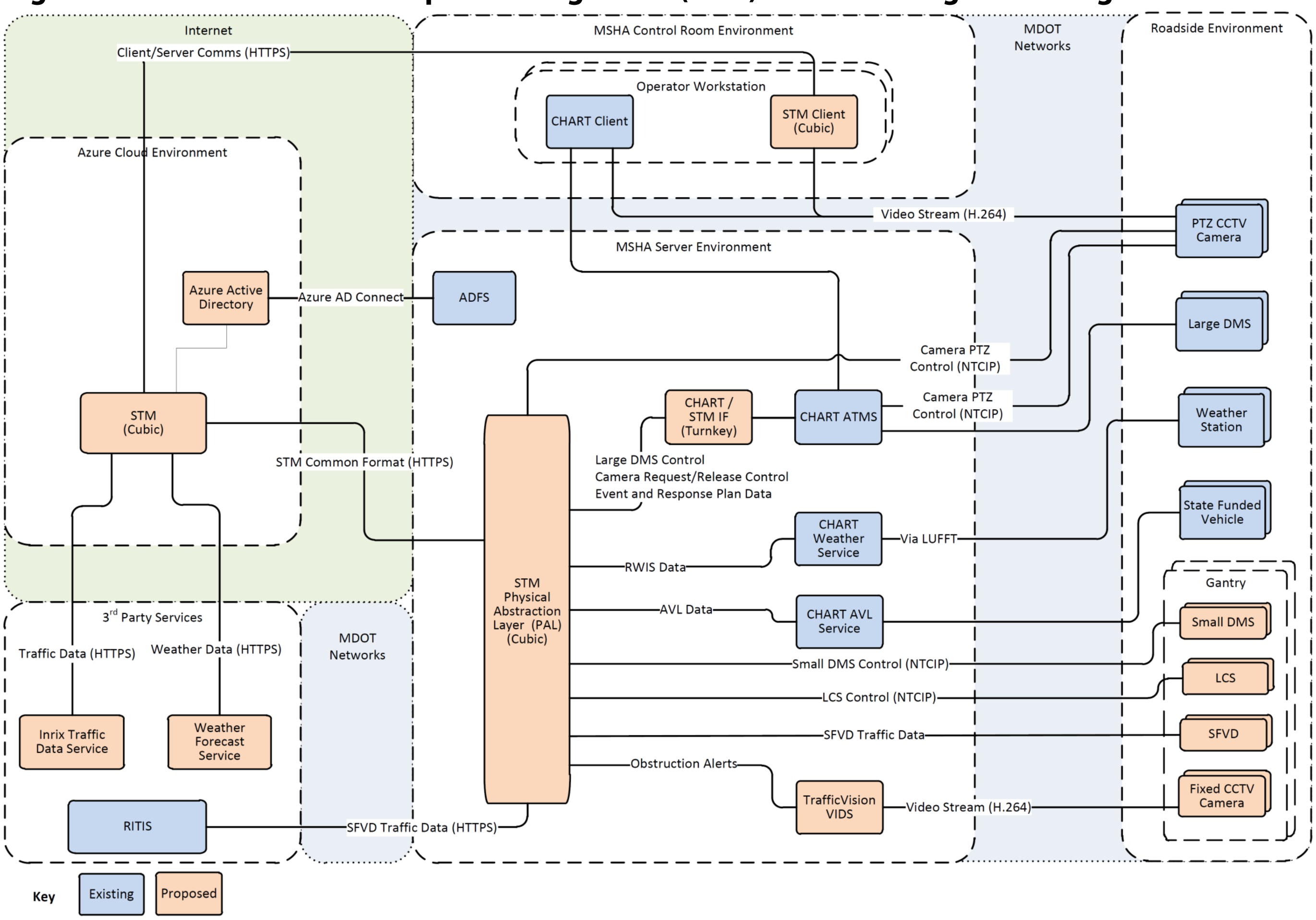
Integration of Personnel: Training will start in the design phase and continue through to full integration .

The I-270 STM application will directly control each gantry-level ATDM field component and coordinate the operation of other CHART-level components based on the current corridor conditions. The STM has the ability to operate in fully automated, semi-automated or fully manual mode, depending upon user configuration and field conditions. The details of final operating procedures will be determined collaboratively with SHA/ CHART during final design. It is likely that during initial turn-on and the system evaluation period, the system will operate in semi-automated mode with operator confirmation. Over time, as response plans are validated and operator confidence is developed, the system may be placed into more automated operations to improve control response times.

It is envisioned that for recurring congestion, the system will operate automatically, without the requirement for operator intervention. This allows variable speed limit controls to be set automatically based upon a combination of time-of-day schedule and real-time system congestion monitoring.

For non-recurrent congestion, the system will operate in semi-automated mode that will require operator confirmation of the event and response plan actions prior to activation. The system will still generate the recommended response plan once the operator confirms the event. This time saving process allows the operator to immediately implement the recommended actions or make adjustments to the response prior to activation.

Figure 4.2: Cubic Surface Transport Management (STM) / CHART Integration Diagram



Manual mode is typically used by the operator to perform real-time adjustments to an active response plan. The STM client component operates as a thin-client browser interface and therefore resides within a separate window on the same desktop computer workstation that supports the CHART Interface. The I-270 operator will have immediate access to both CHART and STM from the same operator workstation. The CHART / STM Interface - a web component developed for this project to allow STM to link into existing CHART capabilities - allows STM generated events to spawn and be linked to CHART events, and likewise for STM events to be associated with potentially already activated CHART events. ***This event linking allows STM to manage ongoing ATDM operations on the corridor while CHART continues to manage events and incidents on a larger regional scale*** while also communicating related traveler information through existing outlets (i.e., Web, MD511, TAR, larger roadway DMS). The STM may also utilize other available data such as regional weather, roadway weather information system (RWIS), automated vehicle location (AVL), and commercial probe vehicle data (i.e., Inrix) to supplement infrastructure -based vehicle detection to ascertain existing conditions for the appropriate response plans.

The STM will incorporate the following ITS components throughout the ATDM limits of the corridor from Quince Orchard Road on the northern end to I-495. Each will provide specific capabilities required to meet the operational needs of the system:

- DMS capable of displaying advisory and lane status notifications to supplement LCS status. These are traffic management specific messages displayed on smaller, gantry-mounted signs co-located with LCS
- LCS displaying lane status and speed.
- Traffic detectors gathering individual lane speed, volume and occupancy at approximately ½ - mile spacing using non-intrusive side fire radar.
- CCTV cameras providing traffic surveillance for incident verification and management, available to both CHART and STM
- Communication systems to monitor and control these devices

The STM will utilize partial vehicle detection and CCTV coverage north of Quince Orchard Road to MD85 to detect and manage incidents along this portion of the corridor.

The Scenarios below summarize the STM / CHART interface which is further described in Section 2 - Mobility.

Scenario 1: I-270 Congestion Events: STM automatically opens STM events for detected congestion and starts DSpeed and QW operations. When this occurs, STM will notify the STM / CHART Interface Web Service which will automatically open a congestion event within CHART ATMS.

This automatic congestion event creation feature allows the event to be exported to RITIS, appear on the CHART website, and to be exported to the 511 system. Also, it is an indication to CHART ATMS operators that speed and queue management operations are active within STM. CHART operators can further manage the event as needed.

Scenario 2: I-270 Incident Events: Similar to congestion events, STM can also automatically detect incidents, however, an operator must confirm the incident before STM opens an event for managing it. When an incident event is opened in STM, STM will notify the STM / CHART Interface Web Service, which will automatically create an incident event in CHART ATMS. If the STM response includes messages for any of the full sized DMS, the web service will add response plan items to the new CHART ATMS event and execute the response. If any cameras are identified to be of interest by STM, they too will be added to the CHART ATMS event response plan and be executed. This is the same process as described above for congestion events.

Scenario 3: I-270 Planned Roadway Closure Events: CHART ATMS will continue to drive the creation, opening, and closing of planned roadway closure events with the LCP system for the I-270 corridor.

The use of STM for planned roadway closures will be optional. Initially this is envisioned to be performed manually via a standard operating procedure (SOP) that requires the operator to utilize STM to activate lane use signals at the time a contractor begins closing lanes, and to use STM to deactivate the use of lane use signals when the contractor has reopened lanes.

To make the process more streamlined, a new CHART ATMS response plan item type may be created and used to automatically coordinate this operation with the STM.

Center-to-center data exchanges with other jurisdictions, such as Montgomery County, can be supported through RITIS consistent with the ITS regional architecture. Although Montgomery County does not currently support a center-to-center interface, it may in the future.

Civil Improvements Compatibility: As discussed previously, the civil improvements recommended by our team are all developed to work with the existing roadway network and available infrastructure as much as possible, proposing lane adjustments and realignments that will adapt current assets to optimize operations while fitting almost entirely within the existing paved footprint, utilizing minor lane width adjustments and shoulder modifications without impacting major structures or requiring interchange reconstruction.

iii. Innovative technologies implemented & the proposed plan & future requirements. Ensuring the newest innovations are incorporated into the design prior to agreement of a CAP

A. Innovative Technologies and Techniques

As noted in previous sections of this proposal, Wellington/Jacobs is utilizing ATDM tools combined with strategic civil improvements. Wellington/Jacobs is proposing Cubic's STM as the central management software because it lends itself to easy integration into CHART and is very adaptable to future transportation technological advancements and adaptations.

Cubic's platform achieves this through three key capabilities:

- At the ***integration level***, the platform supports interfacing with field equipment.
- The platform supports ***interoperability*** at a data level between third party systems.
- As a ***tactical traffic management system***, the platform supports domain specific road traffic management for the I-270.

These three capabilities are described in detail in Section 2. Mobility.

A CHART / STM Web Interface component developed by Turnkey Solutions will allow the STM to link into the CHART processing environment. This coupling allows STM to function as a component underneath CHART providing support for the ATDM functions while coordinating event and response plan actions with CHART. This level of integration will ease operator workload and streamline corridor operations. All of this is possible utilizing existing features within the CHART architecture thereby eliminating the need for any additional CHART software development.

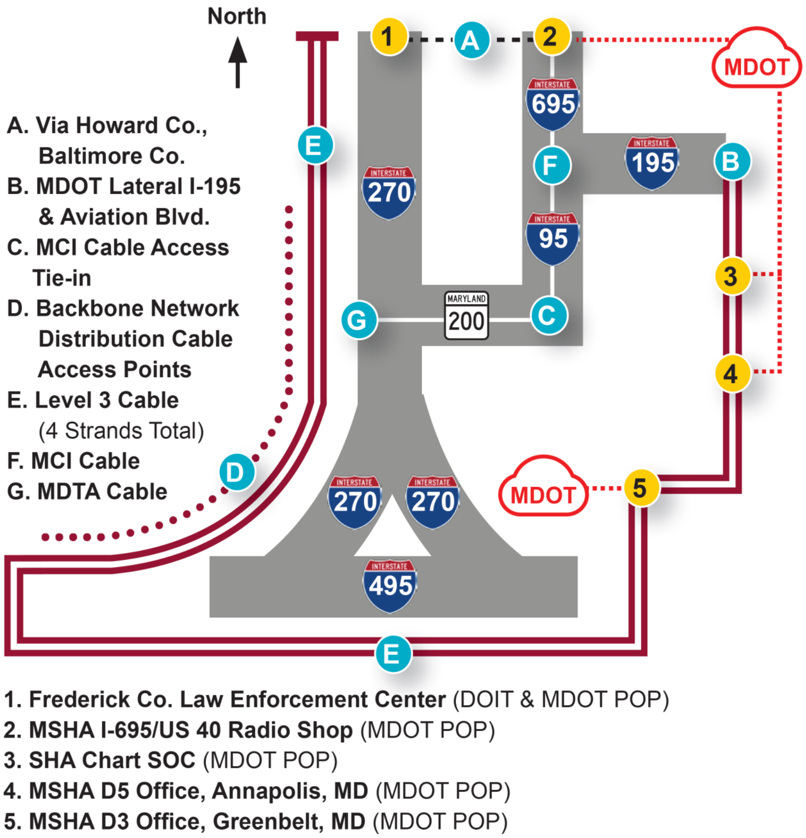
> Turnkey Technology Corp. is an exclusive subconsultant on the Wellington/Jacobs team and will ensure the CHART and STM systems are fully integrated for optimum traffic management.

STM is being deployed as a cloud-hosted service with traffic data simulation capability that will be used early during detailed design workshops. These workshops will provide stakeholder orientation, configuration and response plan development validation, and initial training opportunities. This also allows for smoother cutover to the production environment and operation of roadway devices.

The ATDM/ITS equipment will be supported by a fiber/Ethernet backbone network providing full-time and redundant communications between field elements and central data processing components as shown in the ***figure 4.3 and 4.4.*** Four fiber strands from the existing Level 3 fiber backbone cable along the I-270 corridor have been identified for use by the Wellington/Jacobs Team. The Level 3 backbone fibers terminate at MDOT network points-of-presence (POP) in Frederick, I-370 ICC, and Districts 3 and 5 as shown in the figure. Only one of these locations is necessary to provide the required connectivity; however, we are providing two for redundancy. Final selection and backend network configuration will be determined during design. These locations provide the existing MDOT network access to interconnect the I-270 backbone back to the central data processing components in the SHA primary/backup data centers and third party cloud hosting.

The backbone fiber network is extended from designated Level 3 splice access points to connect all field cabinets in a redundant ring with the backbone and distribution cable switch connections

Figure 4.3: I-270 Fiber Backbone Network System



operating at 1 Gb/s. Clustered cabinets at a single location may be connected via local fiber connections from the main cabinet Ethernet switch. Managed Layer 2 and 3 switches are being used throughout, along with firewalls at the POP locations supporting advanced network traffic segmentation, routing and security capabilities. It is anticipated that the entire field network will be managed as part of the existing MDOT Network Operations Center (NOC) at Skyline Technologies, Glen Burnie, MD.

The I-270 ATDM/ITS network will operate at less than 10% of the total allocated 4 Gb/s bandwidth ***providing enough head room to accommodate future system expansion and growth.*** The system can expand by adding devices of the same type residing on the same logical network segments and by establishing additional logical network segments to accommodate future services such as:

- Connected vehicle roadside equipment
- Other mode coordination
- Traffic violation enforcement
- Adaptive ramp metering

Configuring additional logical network segments is typically equipment configuration; not necessarily additional equipment.

B. Future Operability, Maintainability & Adaptability

The ATDM system consists of three major subsystems: central hardware/software, communications network, and field equipment. The system design provides suitable redundancy for the central processing and communications components to withstand single point failures. None of the technologies introduced system are new to MDSHA/ CHART. There may be some minor differences but the basic maintenance requirements, skills, tools and equipment required are similar.

The central hardware/software consists of both on-premise (SHA hosted) and cloud-hosted components with suitable redundancy to withstand single point failures. It is envisioned that the on-premise server hardware will be deployed in MDOT primary and backup data centers with monitoring and support capabilities similar to existing CHART systems. The cloud-hosted components are under Service Level Agreement (SLA) support provided by the cloud service provider.

The communications network subsystem will fall under the existing NOC management scheme for continuous monitoring and support. It is envisioned that the physical fiber optic cable would fall under existing SHA fiber optic cable support contracts.

The field hardware consists of DMS/LCS signs, Side Fire Vehicle Detectors (SFVD), CCTV cameras, roadside cabinets, and UPS. They are systems that are familiar to SHA/CHART maintenance personnel and will fall under the normal SHA maintenance scheme.

Wellington/Jacobs will provide sufficient operator, maintainer and administrator training prior to system handover and continue to support as personnel become more comfortable with the STM system. A system warranty will also be provided.

Monitoring proper system operations occurs at several different levels. At the application layer the STM software is continuously monitoring field equipment communication and fault alarms even when field systems are not currently active. The SHA maintenance shop may have a STM workstation with maintenance level access and STM can be configured to provide workstation level alerts, send email alerts and reports, or automatically generate scheduled reports of field system conditions. The SHA maintenance shop will have the ability to remotely interrogate, troubleshoot and diagnose most problems before needing to dispatch personnel. Field corrective maintenance is then mainly a field component replacement activity. Test cabinets on-line with the STM system and designated as "test gantries" are used to verify and validate proper equipment operation before field deployment. At the communications level, the NOC will be providing continuous monitoring support of all network elements. Since the system has been designed for single point failure redundancy, it is likely the NOC will detect the problem and coordinate the appropriate maintenance response without impacting operations.

The STM cloud-hosted environment can be easily replicated to provide an equivalent simulation/test environment without impacting the production environment. This simulation/test environment can be activated at any time providing a convenient means to support ongoing training, event and response-plan development and validation, and new software release testing.

Expandability: STM is deployed using a Platform as a Service (PaaS) model to allow computing resources to automatically scale without the need to build in specific elasticity. STM also uses Software as a Service (SaaS) as a software licensing delivery model in which software is a subscription that is centrally hosted.

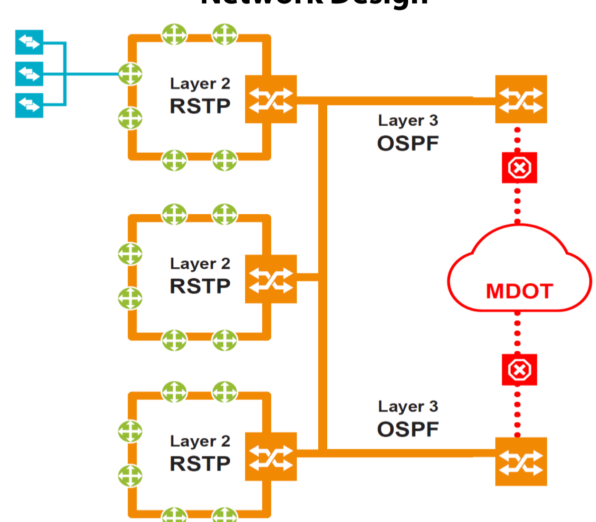
The combination PaaS and SaaS solution provides SHA with a hosted, managed and supported software that is accessed via a browser with the following characteristics:

- SHA will have their own dedicated cloud-hosted STM instance (not multi-tenant) providing maximum security, reliability and performance.
- STM is licensed at a fixed level (per instance), rather than on a variable demand or usage basis that is typical of multi-tenanted SaaS.
- STM will have some elements, such as the Physical Abstraction Layer (PAL) hosted within MDOT premises, which improves performance and is a fit better with security requirements.
- The SaaS cloud-hosted environment allows STM instances to be created and removed to provide training, testing or pre-production facilities.

B. Ensuring that the newest innovations are incorporated prior to agreement of a CAP

The proposed design offers a lot of flexibility in technology adaptation both during final design and deployment, as well as over the life of the system. Deploying the STM software in a cloud-hosted environment ensures that the computing hardware and systems environments are always up to current industry standards, and the STM application software being provided as a service is always maintained to the latest version. At the field integration level the STM software is implemented using industry standard open protocols (i.e., NTCIP, H.264) ensuring ongoing compatibility with the latest field equipment technology. STM will also be updated to adapt to newer standards (i.e., H.265) or more current versions of existing standards as they become industry accepted. This allows the system to easily adapt to the latest field equipment (i.e., NTCIP 1203 v2 DMS with color graphics support).

Figure 4.4: I-270 Fiber Distribution Logical Network Design



Key:			
	Local Ethernet Switch		Distribution Ethernet Switch
	Core Ethernet Switch		Firewall

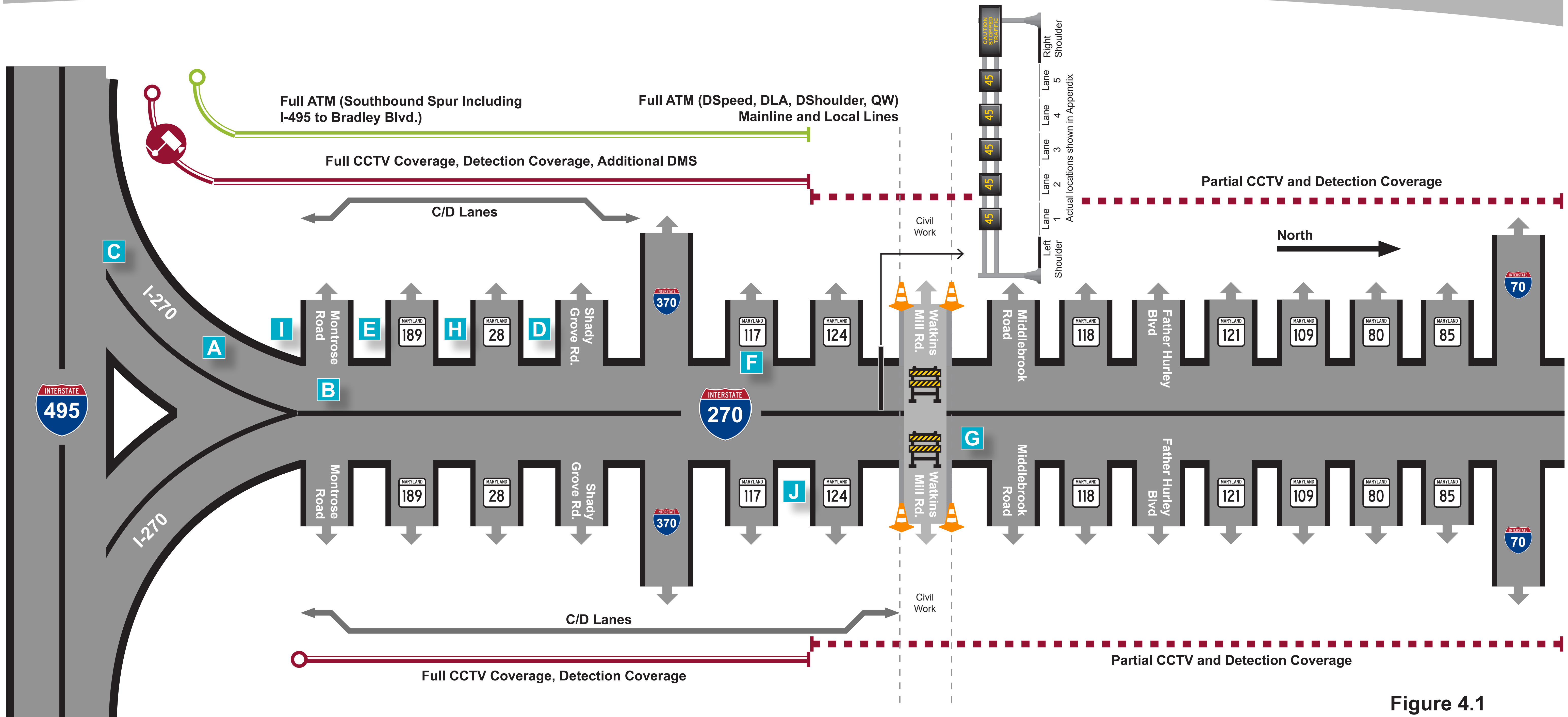


Figure 4.1

ID	Primary (P) & Secondary (S) Congestion Locations								
A	SB I-270Y, from South of Westlake Terrace Overpass to North of I-495(P)	C	SB I-270Y at Merge with WB I-495(P)	E	SB I-270 CD, between MD 189 and Montrose Road(S)	G	NB I-270, from end of CD to Middlebrook Road(P)	I	SB I-270 CD at Ramp from EB Montrose Road(S)
B	SB I-270, from North of Montrose Road to I-270 Split(P)	D	SB I-270 CD, between Shady Grove Road and MD 28(S)	F	SB I-270, from MD 124 to I-370(S)	H	SB I-270 CD at Ramp from WB MD 28(S)	J	MD 117 from MD 124 to I-270(S)

Key:	
DLA	Dynamic Lane Assignment
DShoulder	Dynamic Shoulder Lane
QW	Queue Warning
DSpeed	Dynamic Speed Limits

5. WELL-MANAGED PROJECT

5. Well-Managed Project

i. Communications, Coordination & Risk Management

The Wellington/Jacobs team is fully aware of the benefits Progressive Design-Build (PDB) brings to owners and the design-build team. ***The primary benefits after project award come from reduced risk that is manifested by project team collaboration.*** Secondary benefits come through shared cooperation by releasing work packages in a manner that optimizes the schedule while reducing risk. Our approach to PDB utilizes coordination and communication systems to achieve the project goals.

Our proposal is to create a smart and self-evident highway through ***strategic civil improvements to the existing roadway overlaid with an Active Transportation and Demand Management (ATDM) System.*** We believe that restructuring the manner in which the driver interacts with the roadway creates an operating environment that promotes safe and efficient travel, and is a significantly innovative approach to corridor revitalization. Our proposed improvements and traffic management systems will improve mobility and throughput, while addressing safety, predictability and operations. It will promote congestion-reduction, is flexible and provides for future operational demands and technology. Our solutions to improve both mobility and safety along the I-270 corridor focus on:

- Throughput
- Travel time reliability
- Crash reduction

We will achieve these goals through the following strategies:

- Civil Improvements to alleviate bottlenecks
- Speed Harmonization
- Lane Management
- Queue Warning - incident detection and management
- Traveler Information

A. Communication and Coordination

Project Management Plan (PMP): The Wellington/Jacobs team will prepare an extensive PMP and submit a draft plan shortly after project award. Our PMP includes:

- A listing of communication and coordination activities, and the associated implementation
- The approach to design and design quality
- The approach to document control
- The approach to scheduling work and updating the schedule regularly
- The approach to risk management
- The approach to construction quality

The remaining portion of the following Sections A and B detail the aspects of our PMP as they relate to communication, coordination and risk management.

Partnering and Management Meetings: The first order of business, after reviewing our PMP with State Highway Administration (SHA), is to hold a partnering meeting. The partnering meeting will include upper management, project foremen, superintendents, design leads, project management and all counterparts from SHA, as well as key stakeholders. We will hold a facilitated partnering meeting early in design, early in construction, and yearly. We will also hold a weekly, to every other week, management meeting that will serve as a management partnering meeting. We have found these meetings foster full transparency and a partnering attitude throughout the team. Going into these meetings with the attitude of resolving each other's "what keeps me up at night" concerns fosters true partnering and collaboration.

Wellington/Jacobs will use many of the traditional design-build meetings and methods of communication and coordination in our PMP. We propose several unique approaches to gain the most benefit from the PDB delivery method.

Additional Coordination and communication efforts include:

- Design Charrettes
- Traditional Design Discipline Task Force meetings
- Traffic modeling meetings
- Scope Validation meetings
- Systems Engineering Meetings
- Stakeholder meetings
- Educational meetings and materials
- Opinion of Probable Construction Cost (OPCC) Workshops
- Construction Agreed Price (CAP) Workshops
- Construction meetings
- Schedule Updates
- Document Control

Design Charrettes: Our collaboration efforts begin immediately after contract award by scheduling a

design charrette with SHA with three primary goals; 1) create a combined risk matrix, 2) review our proposal design with SHA to discuss the approach and engage SHA in final design concepts. ***This is one of the primary benefits of PDB in that the owner is more involved with design after contract award***, and 3) outline our proposed scope validation work. We anticipate several design charrettes as we progress design through the scope validation period. These meetings will be used to define the work packages that result in CAPs and the design information to be presented in each CAP.

A common mistake in design-build projects is to not fully define the scope proposed. We meet early in the project to allow for final discussions of the proposal scope intent with the full team in order to avoid misunderstandings later in design.

Task Force or Work Group Meetings: These will also begin immediately after award and are central to the progression of design. The goals of these meetings are to solicit input from other design disciplines, the construction team, SHA and key stakeholders to ensure "no surprises" late in the design stage and during construction.

Traffic Modeling Meetings: Traffic modeling is critical to the ultimate project outcome. The I-270 project requires extensive modeling and concurrence that the model is reflecting everyone's expectations to meet the project goals. We will engage SHA early to ensure the model assumptions and calibration, as presented in the proposal and being progressed, are appropriate for the solutions proposed.

Scope Validation Meetings: This meeting will take place within the first 120 days after project award. These meetings are used to disseminate both the proposed scope of work and the purpose for the work. We anticipate our scope validation work to focus on the following critical project needs:

- Survey
- Permitting
- Geotechnical and pavement

Systems Engineering Meetings: System engineering efforts will begin immediately following notice to proceed. These meetings are to ensure that the ATDM system provided meets SHA's operational needs in terms of improved mobility, safety and incident response while adequately integrating into the existing environment for operations and maintenance support. The process will be used to finalize the Concept of Operations (ConOps), the user requirements documents and the verification and validation plans.

Stakeholder Meetings: There are several key stakeholders we will engage early and consistently throughout design development and implementation:

- SHA Coordinated Highways Active Response Team (CHART)
- Montgomery County
- Frederick County

We will engage incident management/first responders throughout the design charrettes and systems engineering meetings. We will engage other stakeholders such as school districts and the traveling public, however, the above three have been identified as key stakeholders. We will hold specific stakeholder meetings several times throughout design. With regard to SHA CHART, we will also engage them through a robust educational and training program.

Educational Meetings and Materials: Our unique approach with a robust ATDM deployment will realize early and better success with an outreach and educational program. Our program will be two-fold; 1) for the end user, 2) for SHA stakeholders.

We will assist in preparing information for developing education materials about the ATDM aspects and disseminated to the public through organizations such as AAA and fix270now.org and other regional traffic-focused media outlets (i.e., TotalTraffic) before the corridor is fully integrated.

Our education will include training and education materials for CHART and other SHA stakeholders. Thorough operations and maintenance plans will be prepared. The training will focus on the new software aspects of our solution but also provide user expectancy aspirational information.

Opinion of Probable Construction Cost (OPCC) Workshops: In the spirit of PDB, we will hold OPCC workshops. We will provide assumptions made in our cost estimating to allow the SHA Independent Cost Estimator (ICE) to understand our approach. We are prepared to share our unit costs at the early OPPC workshops to ensure transparency. It is important for all parties to understand the work and what is considered as part of each element.

Construction Agreed Price (CAP) Workshops: For each CAP we will hold a workshop with the ICE and SHA and be prepared to provide transparent information as necessary to work through any potential gaps in estimates.

Construction Meetings: These meetings will be held with design, construction, owner and stake-holder team members during construction. We will discuss specific weekly construction activities and provide a 3 to 5 week look ahead schedule as well as a long lead time schedule. This ensures that the current baseline schedule is adhered to and appropriate team members can schedule resources for the upcoming work aspects. We will also implement other traditional tools to communicate and coordinate during the project. These include an accurate and updated schedule; file sharing and document control; and risk management meetings and process.

Schedule Updates: We will work with SHA to develop the final baseline schedule with a degree of detail required to properly define each party's expectations. Our schedule will include design, review, OPCC, CAP preparation and construction timelines. Each will be tied through proper Critical Path Management logic. The schedule will be updated monthly to ensure it accurately reflects progress made and upcoming events.

Our weekly construction meetings will also focus on current and look-ahead work discussions so that all team members can plan their resources aptly. These meetings will also be used as a spring board to necessary Work Activity meetings, which will take place at the beginning of each major Work Activity.

Document Control: Our document control system centers around the Aconex software which is compatible with ProjectWise. Our system will allow for easy access to design progress drawings and information, meeting minutes, design review comments, and resolution of the comments. During construction, the system will clearly identify current construction documents as well as locations of predecessor documents to allow for cross referencing. The system will also provide OPCC and CAP information for easy access.

B. Risk Management

PDB provides the best ability over any other delivery method available to reduce and mitigate project risk through transparent and open communication. The coordination and communication approaches discussed above identify many of our risk management processes. Additional aspects not already discussed regarding risk management include the following.

Risk Matrix: The risk matrix assembled at the initial design charrette provide a focal point for all team members in mitigating risk. This will be used as design progresses as well as during construction. The risk matrix helps the team properly track and update the identified project risks and approaches to mitigate each risk. As risks are realized or mitigated we will assign a final cost to them.

Management Meetings: Risk and mitigation approaches will be discussed at all Management Meetings as well as our OPCC and CAP workshops. This reduces pricing risk in final OPCCs because as a team we have been open in discussing risks. It also ensures Wellington/Jacobs and the ICE are pricing the same work in multiple construction elements.

Shared Risk Pools: Shared Risk Pools allow Wellington/Jacobs and SHA to share the risk on certain aspects of the project. We believe the SHA vision of shared risk pools outlined in the RFP is a way to optimize budgetary dollars. This approach places shared money in a pool to be used toward certain risk items, and if the risk is not realized the money is either reinvested on other risk elements, additional scope, or refunded to SHA.

It is important to note that there is no funding for the Shared Risk Pool at this the proposal time. Funding comes when each priced risk is mitigated. Wellington/Jacobs has priced numerous risks and that are discussed throughout this proposal. Several of the most identifiable risks are outlined below. During the Scope Validation, final design decisions will show which priced risks are mitigated and those funds, through the OPCC and CAP process, will be placed in the Shared Risk Pool to be used against other risk, for additional scope or refunded to SHA.

B.1—Proposed Shared Risk Pools

Wellington/Jacobs is proposing the following items to be used to fund a Shared Risk Pool.

Pavement: As discussed in PTC's 2 through 6 in the Appendix, we have reviewed the available as-built/design plans for paving projects along the corridor, Ground Penetrating Radar (GPR) results

Table 5.1: Pavement Shared Risk Pool

Location	Pavement Section (HMA thickness)	Length of reconstruct	PTC
SB I-270 South of Westlake Terrace to north of I-270Y Spur	8.7" over 12" GAB	0	2
SB from north of Montrose Road to I-270 Split	9.9" over 12" GAB	6350 lf	5
SB I-270Y to Merge of I-495	9.4" Over 12" GAB	0	3
SB CD lanes South of Shady Grove Road to MD 28	11.1" over 12" GAB	2000 lf	4
SB CD Lanes South of 189 and Montrose Road	11.7" over 12" GAB	2300 lf	4
Southbound South of MD 124 to I-370	9.4" over 12" GAB	6105 lf	5
NB north of Watkins Mill Road to Middlebrook Road	11.9" over 12" GAB	4875 lf	5
SB at CD Ramp from WB MD 28	8.2" over 12" GAB	0	6
SB at Ramp from EB Montrose Road	7.7" over 12" GAB	580 lf	6
Note: preliminary pavement design was based on provided traffic data & assumptions meeting the SHA pavement guideline.			

and available pavement borings. GPR data often only reflects the latest pavement application. Only the most recent pavement application will have the same density and may be the only layer detected as asphalt by those interpreting the data. Therefore, we believe the as-built/design plan data could be just as accurate of a data point. We have conservatively assumed much of the lengths shown by as-builts/ design plans or pavement borings as adequate pavement sections to be reconstructed in favor of conflicting GPR data. In these locations, we have assumed any GPR data revealing a thickness less than our preliminary design pavement sections is proposed to be reconstructed.

Adding more conservatism, we have proposed dull depth reconstruction. We believe there budget savings using a hybrid pavement section that capitalizes on a deep Graded Aggregate Base (GAB) section in areas where the shoulders are to be used as a running lane. This involves excavating a portion of the GAB and replacing it with asphalt, thus not excavating to subgrade.

For this proposal we have assumed reconstructing anything that GPR data or as-builts reveal do not meet preliminary design pavement thicknesses (***Table 5.1***).

We have priced nearly $3 million in reconstruction for approximately 22,000 feet of alignment that did not meet the above requirements. We believe there will be less than the 22,000 feet of reconstruction actually required when considering all the pavement borings provided and many as-builts and design plans confirm thicknesses greater than GPR data was indicating.

Barrier Reconstruction: To adjust the cross slope, we are proposing an asphalt wedge and leveling by milling a minimum of 1 ½ inches and replacing with a wedge of asphalt. In the areas of wedge and leveling, the barrier will be reconstructed unless the existing shoulder has sufficient width to allow a wedge and level for the travel lane and a cross slope adjustment between there and the bottom edge of the existing barrier. Overall this is a very conservative approach because we are assuming there is no barrier lip available for overlay application of the wedge and leveling. Inspection in the field indicates there are significant lengths of barrier that have a lip ranging from partial to a full three inches to accommodate wedge and leveling. ***Table 5.2 presents*** by PTC, the length of barrier proposed to be reconstructed based on the length of wedge and leveling proposed. Table 5.2 indicates length of the individual PTCs that are wedge and leveled for asphalt placement (cross slopes are adjusted and the barrier height adjusted accordingly), length of barrier reconstruction/retrofit, pavement section reconstruction (barrier generally is not required to be reconstructed in these areas) and total length of the area. As seen by the table, there is significant opportunity to reduce the amount of barrier reconstruction utilizing the lip of the barrier as available for wedge and level filling. We have assumed no lip is available.

Microsurfacing: Wellington/Jacobs is proposing to resurface with microsurfacing in the areas we are proposing to modify lane widths to accommodate the added lanes. We do not consider this a risk, but rather a maintenance asset to be added to the maintenance schedule. Microsurfacing and associated striping has a life expectancy of 4 to 6 years based on available data. Our application of microsurfacing is not relying on the microsurface as a structural or rehabilitation improvement, rather an approach to restripe without a costly mill and overlay approach. In order to obtain any significant additional life expectancy from a mill and overlay, the thickness needs to be 3 to 4 inches, which is beyond the goals of this project. Rather, we have focused on achieving added throughput and decreased travel time, while maintaining a realistic maintenance schedule for improvements provided.

Table 5.2: Asphalt/Barrier Modifications

PTC	Length of Wedge & Level (LF)	Replacement / Retrofit Length (LF)	Pavement Reconstruction Length (LF)	Total Area Length (LF)
2	6,500	6,350	0	6,950
3	800	690	0	1,600
4	0	1500	4,300	5,500
5	9,000	15,275	17,330	28,400
6	320	0	580	1,000
Total	16,620	23,815	22,180	43,450

Foundations: No geotechnical results were provided with the RFP materials upon which to base gantry and CCTV foundations. We have used our experience in the area and with gantries of similar size to approximate foundation requirements. Our assumptions are based on conservative soil conditions.

Based on the above conservatism in our pricing for pavement reconstruction, barrier reconstruction and gantry foundations, we believe there is a significant opportunity to fund a risk shared pool as the scope validation and final design proceeds. As risk is retired we propose to first apply the risk pool to other risk, if encountered, then add scope. The addition scope we propose includes the following options along the north segment of the corridor:

- Lengthen the SB Acceleration ramp at MD 109, estimated cost of $120,000
- Lengthen the SB acceleration ramp at MD 80, estimated cost of $150,000

These two additional scope items would result in additional throughput benefits of 3 percent and travel time reduction of 3 minutes.

If additional risk is retired, as is reasonable, we would next add the NB ramps at these locations at a cost of approximately $275,000 with an improvement of throughput of 1 percent and a travel time reduction of 3 minutes.

ii. Developing the project design internally & collaboratively with SHA & stakeholders, services provided, & QC & QA

A. Design Development

As discussed in Section i above, the Wellington/ Jacobs team will provide a detailed PMP which includes the details of our design process. Our approach to ensuring a quality design and SHA satisfaction rests on four principals:

- Clearly and fully understanding SHA's expectations from the very outset of the contract
- Continually surveying SHA representatives and - with approval - stakeholders to monitor and grade our performance to ensure ongoing satisfaction
- Capturing, disseminating, and acting upon Lessons Learned
- Implementing our systematic quality process that ensures that all deliverables are subjected to objective "Second Set of Eyes" reviews

Integral to PDB is collaboration with the owner throughout the design process. In traditional design-build, the owner's ability to shape design basically ends with acceptance of a proposal. In PDB the owner's influence on final design does not end until a CAP is negotiated for a work package. Once a CAP is negotiated, Wellington/Jacobs will complete the design and prepare construction documents.

The above sections of Coordination, Communication and Risk Management detail many of the methods we will use to engage and collaborate with SHA throughout the design process. Those methods also detail the internal collaboration that is ongoing within our team. Internal collaboration began with the Statement of Qualifications (SOQ) process and we view SHA as an additional team member for internal collaboration after award.

CAPs development will be collaborative with SHA. For the purpose of this proposal, we have assumed eight CAPs that are detailed at the end of this section. After award we will engage SHA to discuss schedule goals to determine the best sequencing and grouping of work in individual CAPs.

B. Design Quality

As Lead Designer, Jacobs will employ quality procedures as described herein. This process will be used for both the civil and ATDM infrastructure design effort, as well as for the planning and configuration effort of the Surface Transport Management (STM) system.

Understanding SHA's Expectations: Immediately upon contract award, John Bale, our Project Manager will conduct an Expectation Survey with SHA to develop a full understanding of SHA's "soft" requirements in addition to the scope defined by the contract. These include such issues as:

- Safety
- Scope/Project Planning
- Communications
- Technical Services/ Engineering Design
- Staffing
- Schedule
- Cost
- Construction/Field Services
- Material Management/Contract Negotiation
- Management and Support Services
- Consulting the needs of user groups
- SHA's internal requirements
- Overall quality expectations among others

The survey has multiple goals designed to enable our team to:

- Be as responsive as possible to SHA needs
- Understand SHA's overall objectives
- Understand any issues underlying the contract or individual projects that are not explicit in the scope
- Look ahead at issues that could arise and begin to address them proactively

Quality System Planning: The high quality of design services will start with assigning qualified, experienced professionals to prepare and oversee our designs. We have assigned Mr. John Lisch, P.E. to serve as our project-level Design Quality Manager (DQM). It will be his task and responsibility to oversee our team's overall approach to design quality and meet SHA's requirements. As work under the contract progresses, he will conduct periodic audits to ensure the team is in compliance with the quality program we establish and with SHA's expectations.

The DQM will report directly to John Bale to make sure that quality receives the highest level of attention. Our DQM will:

- Develop processes to be used for a project-specific Quality Plan
- Monitor project designs for compliance with SHA and Jacobs internal quality standards
- Perform and/or monitor client satisfaction surveys and initiate corrective action as necessary

Immediately following Award, John Bale will organize a meeting to define how we will implement the project quality system. The Project Manager, Project Principal, Design Quality Manager, all discipline leads, and key subconsultants will attend. The meeting will define the components making up the plan, such as design control, document control, personnel responsible for quality, and the audit.

Design Quality: Our quality control system requires a minimum of two reviewers to participate in review of deliverables. The design quality plan sets forth a systematic procedure for checks and reviews that will provide a quality product conforming to project requirements. Our check and review procedures are applied at various and distinct stages. There are three levels of review or "Checks ."

Level 1 Check is a thorough inspection of a completed contract document performed by a technically qualified individual, other than the Originator, to verify the product meets the requirements and is ready as a deliverable. It is a complete concept suitability, theory applicability, and numbers check.

Level 2 Check is a general review of work in progress, or of a completed deliverable package. Level 2 or Peer Reviews are intended as a review by a qualified individual (or team of qualified individuals) to assess the performance, conduct and progress of a project or document during various stages of its development. The Peer Review verifies the work is complete, logical, has followed required procedures and has used the correct specifications. The intent is for the reviewer(s) to apply their accumulated experience and professional judgment to verify completion of the work according to established standards of SHA and Jacobs.

Level 3 Check is a review of the product by senior management where a signature by an appropriate authority level is required before work can proceed through the rest of the process. Similar to the Level 2 Reviews, the Level 3 Review verifies the work is complete, logical, and has followed required procedures. The type of Level 3 Review performed is dependent upon the level of authority required.

C. Project Quality

Post Design/Construction Quality Control (QC): Our design team's participation continues through construction including the following activities.

***Construction Quality Control Plan*:** The construction QC plan coordinates the construction team, the construction manager, and SHA activities. It identifies responsibilities and authorities of all parties, meeting frequencies, attendees, and agenda, status and reporting requirements, schedule and cost monitoring procedure, QC inspection procedures, site security, health and safety requirements, and testing and start-up procedures.

Constructions Inspections: While the design team will not perform construction inspections, the design staff may be requested to participate in field discussions and will be required to review shop drawings as well as perform integration of our ATDM system. During site visits, the design staff will review the progress of construction for potential conflicts with design intent. Submittals received are logged by the design team and given the highest priority to complete and returned to the field.

QC Process Control: Our DQM will implement our QC procedures for both design and any post-design activities. Any deviation will be brought to the notice of John Bale, and will be resolved in accordance with a corrective action plan. We will file and store quality records and hard copies that have undergone the QC procedures. We will accept for filing only documents that have the proper stamp and signatures of the checkers and/or originators.

Cost Control Performance: The PDB process provides a robust approach for cost controls with the uses of OPCCs and CAPs. Our design team will be integral in this by providing initial design level costing for vetting alternatives as design progresses. A major cause of cost overruns is non-adherence to project developed and defined criteria, standards, schedule, and scope. Our design team will provide estimates for alternatives and perform schedule analyses.

Schedule Compliance: We fully understand the need to meet the design schedule as the project proceeds. Our schedule includes denotations of the major events, duration, and milestone dates. The schedule is updated to assure that management has the information necessary to make effective decisions within the time period.

D. Systems Engineering

The systems engineering process ensures that the ATDM as an integrated system of components, and that operations and maintenance personnel delivers the documented function and performance capabilities. These capabilities are documented in the ConOps, detailed requirements and detailed design documents. These capabilities are then verified and validated through a series of successive tests as defined in the Test Plan.

Factory Acceptance Testing (FAT): All equipment and systems will be tested and verified at the factory level prior to on-site delivery and installation. A sample of the field hardware (i.e., LCS and DMS) will be fully tested to ensure all detailed design specifications have been met. Standard commercial-off-the-shelf (COTS) elements, such as network communications devices, will not need FAT testing. FAT will also be used to verify STM field-center communications capability with sample field devices, center-center interfaces with CHART, and final system configuration.

Field Installation Testing: Field installation will only begin following successful FAT testing. This level of testing verifies that the locally installed equipment operates correctly and is ready for system integration testing. For example, the LCS/DMS, CCTV, vehicle detection sensors, and roadside cabinet equipment will all be tested at the field level after installation and prior to communications integration.

Network Integration Testing: The entire communications network will be tested end-to-end from the field network switch through to the backend data center where the system servers reside. This testing will be performed by network segments to support the phased CAP deployments.

System Integration Testing: Following successful Field Installation and Network Integration Testing the entire system will be tested end-to-end to verify complete system functionality. This may be a combination of off-line and on-line testing in a controlled fashion to verify all system functionality has been properly delivered in an integrated system, response plans have been properly configured, SOPs have been developed and that all other elements of a fully operational system are in place.

System Acceptance Testing: Following successful System Integration Testing, the system is placed on-line for operations and enters a 30-day extended system acceptance period.

iii. Minimizing environmental impacts, right-of-way impacts, and utility impacts

Environmental: Wellington/Jacobs conducted a preliminary evaluation of the existing noise reports provided with respect to our proposed civil improvements. Nosie mitigation is expected in five locations where we are striping the outside shoulder to be a travel lane. We will conduct a noise analysis to verify exact locations and lengths during final design through.

The proposed improvements will be accomplished within the footprint of the current roadway sections with the exception of a very small area. No changes to roadway grading, or culvert extension or reconstruction are anticipated. Therefore, no environmental impacts to the 100-year floodplains, streams, wetlands, or wetland buffers are expected. For these reasons, no Joint Permit Application for the Alteration of Non-Tidal Wetlands and Waterways will be required. Similarly, because wooded areas are not impacted under this project, no Reforestation or Roadside Tree permitting is anticipated.

A comprehensive stormwater management (SWM) report for the entire work area within the project limits will be prepared and submitted to SHA's Highway Hydraulics Division (HHD) to review and provide comments before Permit Review Division (PRD) reviews the concept for approval. The Site Development approval will be received prior to construction start. Erosion and sediment control (E&SC) approval will be required for this project as part of the Site Development approval.

ROW: The majority of the improvements will be located within the existing paved footprint along the corridor. Additional widening, where necessary, will be minimal and ***will all be within the existing ROW.*** By working with the existing infrastructure, optimizing lane balances and using existing shoulders for part-time capacity enhancements, impacts to buried infrastructure, such as utilities and environmental impacts, will be minimal.

Utilities: Wellington/Jacobs has reviewed existing utility information and identified the existing roadway lighting and electrical conduit located within the median barrier as the primary utility impact that will be addressed in final design. If the existing lights and electrical conduit is located within the median/outside barrier identified for reconstruction, the lights and/or conduit will be replaced as a part of the barrier modifications.

In evaluating the potential impacts to the existing utilities, we have used the following assumptions on the standard depths of the utility lines:

- Water: 4' cover
- Fiber Optics: 2.5' cover (direct buried lines)
- Telephone: 2.5' cover (direct buried lines)
- Gas: 4' cover
- Electric: 3.5' cover
- Sewer: 5.5' cover

During the final design, utility crossings within the improvements will be test-pitted to determine exact locations. Those locations will be compared with the proposed improvements and coordinated with the contractor to identify construction methods that will minimize utility line impacts.

The improvements proposed by Wellington/Jacobs do not include new access points, revisions to existing access points, changes to configurations of existing interchanges, abandoning existing ramps or interchanges or relocating terminals of ramps to different local roads that would require an Interstate Access Point Approval (IAPA) from FHWA. Our team will coordinate proposed improvements with SHA and FHWA to confirm the improvements do not require FHWA review and action. The improvements do include additions of auxiliary lanes between access points and extensions to existing accelerations lanes. Improvements will be coordinated with SHA and FHWA. We are anticipating an IAPA will be required for improvements relating to the lane reassignment and the auxiliary lane improvements spanning more the two consecutive interchanges (PTCs 3 and 5).

iv. Approach to timely implementation of proposed improvements, including anticipated design and construction packages

SHA's approach to this PDB delivery is highly conducive for the Wellington/Jacobs team to deliver the project in an efficient manner. Timely implementation can be interpreted two ways: fast, or sequenced to minimize conflicts and mistakes. Often owners desire both.

Our approach to project delivery utilizes the CAP to maximizes efficiency of dollars spent for improved throughput and travel time reduction. Sequencing the CAPs in a manner that allows for proper design and construction sequence reduces the need to price risk in the overall project budget.

Below we provide our anticipated project sequencing along with our CAP breakdown. Our sequencing is based on early design and, as indicated above, we propose to revisit this through our design charrettes, workshops and meetings to collaboratively determine the best sequence for the project based on all stakeholders and the available budget. Working with SHA to properly identify our sequencing after award will help us deliver SHA the most effective project.

CAP 1: Video Monitoring and Surveillance: Implementing CAP 1 will provide a safer and more efficient corridor as we deliver further CAPs. CAP 1 includes design completion, procurement and installation of the video CCTV system. Installing the CCTV cameras the length of the project, as detailed in PTC 1, we will be able to enhance safety with more video coverage for CHART's use, while also monitoring traffic conditions in the vicinity of the future CAP work zones.

CAP 2: Software development/integration: We anticipate our second CAP to include final software development and integration of the ATDM software. At approximately 60 percent software development or earlier we will have sufficient design completed to identify the remaining design and development integration processes. Early development ensures software will be ready for integration as each ATDM element is deployed.

CAP 3: Civil improvement PTS use and lane reassignment: CAP 3 changes the inside shoulder to an HOV lane and reassigns lanes at the merge of I-270Y and I-495. This CAP shifts the HOV lane from the inside running lane onto the existing inside shoulder during the peak hours, and utilizes the inside running as an additional general purpose lane. As shown in PTC 2, we are proposing to convert the inside median shoulder southbound from approximate station 1+25 (south of Westlake Blvd.) to 71+00 (Bradley Blvd.) into a part-time ATDM controlled HOV lane. The lane will operate during the same times as the current static controlled HOV lane, however, when complete it will also be able to function as an incident relief general purpose lane, extended HOV-time lane and other uses through our ATDM system. Included in this work will be reconstructing and retrofitting approximately 6,350 feet of median barrier, and wedge and leveling adjacent to the barrier, to provide acceptable cross slopes. The existing pavement markings will be removed by grinding and areas restriped after a microsurface is applied.

This CAP also includes reassigning the lanes at the merge of I-270Y and I-495 through a microsurface and restripe of all lanes from approximately station 71+00 to 87+00. To maintain the same paved footprint widening will not be performed. This minimizes construction and stormwater management requirements, while achieving a critical safety and mobility improvement. Please refer to the draft design plans in the appendix.

CAP 4: ATDM remaining elements: CAP 4 includes deploying the remaining ATDM elements into the shoulder area before we implement other CAPs and allows for better managed MOT during construction of other CAP work. ATM elements include gantry installation.

CAP 5: Civil improvements for outside shoulder conversions: This CAP is anticipated to be for work along SB I-270 mainline lanes and SB I-270 CD lanes from just north of Montrose Avenue to just north of the I-270Y split. This work is separated from other CAPs and could therefore be performed in any sequence after award, if deemed necessary. The work consists of converting the outside shoulder into a full time use managed lane from approximate station 4005+00 to 4000+00 (100+00) and from

100+00 to 190+00. The acceleration lane for the on-ramp from EB Montrose Ave. to SB I-270 will be lengthened to improve merge and weave conditions from approximately station 157+00 to 159+00.

Included in this work is reconstruction of approximately 3,100 feet of median barrier; reconstruction and retrofit of approximately 4,400 feet of outside median; and wedge and leveling adjacent to the barrier to provide acceptable cross slopes. This also includes reconstruction of pavement sections with deficient pavement. The existing pavement markings will be removed for the existing shoulder and the number 1 and 2 lanes, and in some area additional lanes, and replaced after a micro-surfacing in those areas.

The widening within this CAP only includes the extended the acceleration lane along the on-ramp from EB Montrose Road to SB I-270. This minimizes the required stormwater management treatment and achieves critical safety and mobility improvements by reducing the speed difference between through traffic and those using the ramps.

CAP 6: Civil improvements for auxiliary land and acceleration lane: This CAP consist of work in several locations:
Location 1 - *From approximate station 201+00 (south of Wootton Parkway) to approximate station 230+00 (north of Wootton Parkway).* We will convert the outside shoulder to a managed full-time use lane by reconstructing pavement areas where deficient pavement exists (approximately 2,300 feet) as defined in the risk section and PTC 4.

Location 2 - *From approximate station 302+50 to 304+50.* The work includes extending the length of the acceleration lane from WB MD 28 to SB I-270 by approximately 100 feet to improve merge conditions. PTC 6 details the work in this area.

Location 3 - *Approximate station 374+00 (north of Gude Drive) to approximate station 348+00 (south of Gude Drive).* In this area, the outside shoulder will be converted to an additional managed lane with approximately 2,000 feet of shoulder reconstruction. This area includes approximately 1,500 feet of outside barrier retrofit or replacement. PTC 4 details the work in this area.

In locations 1 and 3, the existing pavement markings will be removed and replaced, after microsurfacing the three lanes for the entire length. In location 2, pavement markings for the existing acceleration lane will be removed and replaced after the extension of the acceleration lane is microsurfaced.

CAP 7: Civil Improvements for inside shoulder conversion: *Approximate station 487+00 (south of Muddy Branch Rd.) to approximate station 577+50 (north of Quince Orchard Rd.)* This work consists of adding an auxiliary lane from MD 124 to I-370 and another from MD 117 to I-370. To accommodate the auxiliary lanes, the general purpose lanes will be shifted towards the inside median. The thickness and the cross slope of the existing inside median will be addressed by pavement reconstruction (approximately 6,075 feet) that has deficient pavement thickness as defined in the risk section and PTC 5; or wedge and leveling adjacent to the barrier to provide acceptable cross slope. Included in this work is reconstructing approximately 4,700 feet of median barrier. The existing pavement markings will be removed for the existing shoulder and all of the existing travel lanes, and replaced after a micro-surfacing in those areas.

CAP 8: Civil Improvements at Watkins Mill Road: *This work extends from approximate station 602+00 to approximate station 698+50.* We are extending an extra lane from the end of Watkins Mill Road work to the Middlebrook WB loop ramp. PTC 5 defines the work in detail. Work includes reconstructing approximately 4,875 feet of outside shoulder to convert to full time use, and wedge and leveling over approximately 2,550 feet. This CAP also includes replacing approximately 1,925 feet of W-beam guardrail and reconstructing or retrofitting approximately 3,075 feet of outside concrete barrier. The existing pavement markings will be removed for the existing shoulder and three travel lanes, and replaced after a micro-surfacing in those areas.

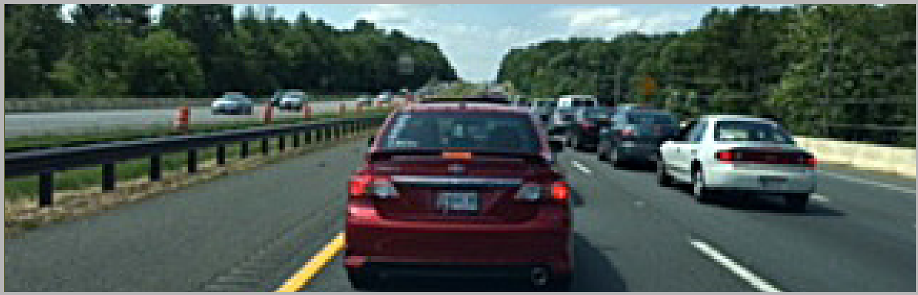
v. Modifications to the proposed Watkins Mill Interchange project

Our design provides an additional lane along NB I-270 from the end of the CD road to the loop ramp to WB Middlebrook Road. To reduce impacts and avoid widening, we propose to shift the existing lanes along mainline NB I-270 approaching, and beyond, the end of NB I-270 CD road. The Watkins Mill project will need to adjust the ramp to I-270 NB to tie to our design and coordinate construction timing to avoid the need to mill, overlay, and re-stripe a portion of mainline NB I-270 a second time.

WELLINGTON POWER CORPORATION
177 THORN HILL ROAD | WARRENDALE, PA 15086

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS




IS 270 – Innovative Congestion Management Contract

MONTGOMERY AND FREDERICK COUNTIES

CONTRACT # MO0695172 | JANUARY 19, 2017






APPENDIX

1 OF 2

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS

LIST OF ACRONYMS

List of Acronyms

AASHTO	American Association of State and Highway Transportation Officials
ATI	Advance Traveler Information
ATM	Active Traffic Management
ATDM	Advanced Transportation and Demand Management
ATMS	Advanced Traffic Management System
CAP	Construction Agreed Price
CATT	Center for Advanced Transportation Technology
CCTV	Closed Circuit Television
CD	Collector Distributor
CHART	Coordinated Highways Action Response Team
ConOps	Concept of Operations
COTS	Commercial-off-the-Shelf
COTSS	Commercial-off-the-Shelf Software
DLA	Dynamic Lane Assignment
DMS	Dynamic Message Sign
DOIT	Maryland Department of Information Technology
DShoulder	Dynamic Shoulder Lanes
DSpeed	Dynamic Speed Limits
E&SC	Erosion and Sediment Control
FAT	Factory Acceptance Testing
FHWA	Federal Highway Administration
EMS	Emergency Medical Services
ERU	Emergency Response Units
ERT	Emergency Response Technician
ETP	Emergency Traffic Patrol
FTE	Full-Time Equivalent
GAB	Graded Aggregate Base
GP	General Purpose
GPR	Ground-Penetrating Radar
GPS	Global Positioning System
HAR	Highway Advisory Radio
HHD	Highway Hydraulics Division
HOT	Highway Operations Technician
HOV	High Occupancy Vehicle
IP	Internet Protocol
IRT	Incident Response Team
ICE	Independent Cost Estimate
I-270 ICM	I-270 Innovative Congestion Management Project
ITS	Intelligent Transportation System
L3	Level 3

LED	Light Emitting Diode
LF	Lineal Foot
LCS	Lane-Use Control Signal
MCDOT	Montgomery County Department of Transportation
MDOT	Maryland Department of Transportation
MDTA	Maryland Transportation Authority
MOT	Maintenance of Traffic
MSP	Maryland State Police
MUTCD	Manual on Uniform Traffic Control Devices
NB	Northbound
NTCIP™	National Transportation Communications for ITS Protocol
OPCC	Opinion of Probable Construction Cost
O&M	Operations and Maintenance
PaaS	Platform as a Service
PDB	Progressive Design Build
PM	Preventive Maintenance
PS&E	Plans, Specifications and Estimate
PMP	Project Management Plan
POP	Point of Presence
PRD	Permit Review Division
PTC	Progressive Technical Concept
PTS	Part Time Shoulder
QW	Queue Warning
RITIS	Regional Integrated Transportation Information System
ROW	Right-of-Way
RWIS	Roadway Weather Information Systems
SaaS	Software as a Service
SB	Southbound
SFVD	Side-Fire Vehicle Detectors
SOC	SHA Statewide Operations Center
SOP	Standard Operating Procedure
SOQ	Statement of Qualifications
SOV	Single-Occupant Vehicle
STM	Surface Transport Management
SWM	Stormwater Management
SY	Square Yard
TMC	Traffic Management Center
TOC	Traffic Operations Center
UPS	Uninterruptible Power Supply
US	United States
VIDS	Video Image Detection System

REFERENCE SOURCES

Study	Source
US 2, Washington State	Use of Freeway Shoulders for Travel (page 48) Doc reference: Federal Highway Administration (FHWA). 2011. Freeway Geometric Design for Active Traffic Management in Europe FHWA-PL-110-004
M42 Managed Motorway, England	Use of Freeway Shoulders for Travel (page 48) Doc reference: Department of Transport (London, United Kingdom). 2008. Advanced Motorway Signaling and Traffic Management Feasibility Study. A report to the Secretary of State for Transport. March.
Netherlands	Use of Freeway Shoulders for Travel (page 48) Doc reference: Federal Highway Administration (FHWA). 2010. Synthesis of Active Traffic Management Experiences in Europe and the United States FHWA-HOP-10-031. March.
Munich, Germany	Use of Freeway Shoulders for Travel (page 48) Doc reference: Federal Highway Administration (FHWA). 2010. Synthesis of Active Traffic Management Experiences in Europe and the United States FHWA-HOP-10-031. March.
Hessen (State), Germany	Use of Freeway Shoulders for Travel (page 48) Doc reference: Federal Highway Administration (FHWA). 2011. Freeway Geometric Design for Active Traffic Management in Europe FHWA-PL-11-004. March.
M42 Managed Motorway, England	M42 MM Monitoring and Evaluation
I-270, St. Louis	http://www.itsbenefits.its.dot.gov/its/benecost.nsf/SummID/B2011-00735
OR 217, ODOT	TRB 16-0687
CA 805, CA 163, California	Queue Warning Systems in Work Zones, Enterprise
I-55, Illinois	Queue Warning Systems in Work Zones, Enterprise
I-70/I-57, Illinois	http://www.itsbenefits.its.dot.gov/ITS/benecost.nsf/SummID/B2014-00966
I-35, Texas	TxDOT End of Queue Warning
I-5, WS 512, Washington	http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/00D69153B125ABB985257B7B0071729B?OpenDocument&Query=Home
Minneapolis-St Paul, Seattle-Tacoma	http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/693750BE76651D2585257B6300512295?OpenDocument&Query=Home
I-435, Kansas/Missouri	http://www.itsbenefits.its.dot.gov/its/benecost.nsf/ID/A38F3AD34C9A16F285257B960062EC60?OpenDocument&Query=Home

ADDENDA LETTERS AND RESPONSES TO RFIs

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF HIGHWAY DEVELOPMENT
707 NORTH CALVERT STREET
BALTIMORE, MARYLAND 21202

September 1, 2016

Contract No.: MO0695172
F.A.P. No.: Not Applicable
Description: IS 270 Innovative Congestion Management Contract – Progressive Design-Build: Request for Proposals (RFP)

ADDENDUM NO. 1

To All Prospective Proposers:

Please be advised that the Technical and Price Proposal Submittal Date for this contract is still scheduled for **January 5, 2017**.

The attention of prospective proposers is directed to the following revisions, additions and/or deletions to the Request for Proposals (RFP).

REQUEST FOR PROPOSALS

Page No.	Description
18	ADDED "ITS Information" to the Additional Material.
Appendix	Stipend Agreement, page 2 of 6: REVISED "Alternative Technical Concept" and "ATC" to "Proposed Technical Concept" and "PTC." Also, REVISED stipend amount in section 2.2 (a) to $750,000.

NOTICE TO PROSPECTIVE PROPOSERS

The attention of prospective proposers is directed to the following revisions, additions, and/or deletions to the Additional Information on ProjectWise:

ADDED "I-270 ITS Devices.xlsx" and "ITS_I270.kmz" and "I270_FiberLine.kmz" and "I270_MH_FM.kmz" at the following location on ProjectWise:
pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\06 - ITS Information\

Questions relating to this Addendum No. 1 may be directed in writing to:

Jason A. Ridgway, P.E.
Director, Office of Highway Development
Maryland Department of Transportation
State Highway Administration
e-mail address: MO069_IS_270@sha.state.md.us

During the Technical Proposal Phase, only e-mailed inquires will be accepted. No requests for additional information or clarification to any other Department or Administration office, consultant, or employee will be considered.

GREGORY I. SLATER, DEPUTY ADMINSTRATOR FOR PLANNING, ENGINEERING, REAL ESTATE, AND ENVIRONMENT.

THIS ADDENDUM IS ISSUED TO CLARIFY, ADD TO, DELETE FROM, CORRECT AND/OR CHANGE THE CONTRACT DOCUMENTS TO THE EXTENT INDICATED AND IS HEREBY MADE PART OF THE SAID CONTRACT DOCUMENTS. COMAR 21.05.02.08 REQUIRES THAT ALL ADDENDA ISSUED BE ACKNOWLEDGED; THEREFORE, PRIOR TO SUBMITTING YOUR PRICE PROPOSAL, ATTACH THE ADDENDUM RECEIPT VERIFICATION FORM TO THE FRONT OF THE PRICE PROPOSAL FORM PACKET. FAILURE TO DO SO MAY RESULT IN THE PRICE PROPOSAL BEING DECLARED NON-RESPONSIVE.

- Watkins Mill IAPA and Permits

F. Watkins Mill Interchange Plans

G. Watkins Mill Interchange Design Files

The following materials are being provided in electronic format on Projectwise. The Administration makes no representation regarding its accuracy.

H. Additional Material

- 100-Scale Mapping
- Existing Right-of-Way mosaic file
- Inventory of Existing Structures
- Utility plans and/or as-builts
- As-builts
- 1 ITS Information

The following materials are being provided in electronic format on Projectwise, unless otherwise noted. This material is considered necessary for the Design-Build Team to submit a technical proposal and prepare a bid.

I. I-270 Concept Evaluation Templates

J. Manuals and Guidance

- VISSIM Modeling Techniques
- Manual for the Inspection of Highway Right of Way in Karst Areas

In general, the Microstation files included on the ProjectWise are in conformance with the MDSHA Microstation V8 CAD Standards Manual.

It is likely that most Proposers will use plot drivers that differ from the drivers used to produce the provided plans. Some of the drawings screen existing features through level symbology color 250. The manipulation of the drawing files to produce any requirements (as found elsewhere in the RFP) for as-built plans will be the responsibility of the selected Design-Builder.

Proposers are also provided with a file index provided on ProjectWise. The file is a Word Document describing all the files and files names as outlined above.

III. RULES OF CONTACT

The Procurement Officer is the Administration's single contact and source of information for this procurement.

The following rules of contact will apply during the Contract procurement process, which begins upon the submittal of the SOQ, and will be completed with the execution of the Contract. These rules are designed to promote a fair, unbiased, and legally defensible

1.5 shall not be entitled to use information submitted by Proposer to the SHA in which the SHA determines is exempt from disclosure under the Maryland Public Information Act ("PIA"), Title 10, Subtitle 6, Part III of the State Government Article of the Annotated Code of Maryland, unless the RFP otherwise provides.

1.6 The SHA acknowledges that the use of any of the Work Product by the SHA or the Design-Builder is at the sole risk and discretion of the SHA and the Design-Builder, and shall in no way be deemed to confer liability on the unsuccessful Proposer.

2. **Compensation And Payment.**

2.1 Compensation payable to Proposer for the Work Product described herein shall be $750,000.00 if any of the following conditions are met:

(a) The Proposer was in the competitive range and was not the most advantageous to the State or was not selected for award;

(b) The Proposer was selected for award, but the Contract was not executed or it was terminated by SHA for its convenience prior to issuance of a notice to proceed for events outside the control of the Design-Builder and the Design-Builder is not seeking reimbursement for design activities undertaken after notice of selection;

△1 (c) The Proposer was not in the competitive range, but it submitted an Proposed Technical Concept (PTC) approved by the Administration and that the Administration wishes to utilize the PTC in the final design.

2.2 In its sole discretion, the SHA may pay compensation to Proposer, in an amount to be determined by the SHA, for the Work Product described herein under the following conditions:

(a) For any Proposer meeting the criteria identified in Section 2.1, above.

△1 Any amount paid under this subparagraph (a) will not exceed $750,000.00 and will be subject to audit of the costs incurred by the Proposer in preparing its Technical Proposal and Price Proposal. Auditors shall have access to all books, records, documents and other evidence and accounting principles and practices sufficient to reflect properly all direct and indirect costs of whatever nature claimed to have been incurred. Failure of the Proposer or its team members to maintain and retain sufficient records to allow the auditors to verify all or a portion of the claim or to permit the auditors access to the books and records of Proposer and its team members shall constitute a waiver of the right to be paid a stipend and shall bar any recovery hereunder.

Any Proposer wishing to apply for a stipend under this subparagraph (a) shall submit the completed Agreement to the SHA concurrently with the price proposals being submitted. Eligibility of receipt of a stipend is dependent upon

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF HIGHWAY DEVELOPMENT
707 NORTH CALVERT STREET
BALTIMORE, MARYLAND 21202

October 7, 2016

Contract No.: MO0695172
F.A.P. No.: Not Applicable
Description: IS 270 Innovative Congestion Management Contract – Progressive Design-Build: Request for Proposals (RFP)

ADDENDUM NO. 2

To All Prospective Proposers:

Please be advised that the Technical and Price Proposal Submittal Date for this contract has been POSTPONED from January 5, 2017 to **January 19, 2017**.

The attention of prospective proposers is directed to the following revisions, additions and/or deletions to the Request for Proposals (RFP).

REQUEST FOR PROPOSALS

Page No.	Description
38	REVISED the submittal deadline for Proposed Technical Concepts to November 17, 2016.
41	REVISED the submittal deadline for the Technical and Price Proposals to January 19, 2017.
57	REVISED the submittal deadline for Proposed Technical Concepts to November 17, 2016.
57	REVISED the submittal deadline for the Technical and Price Proposals to January 19, 2017.
Appendix	Price Proposal, Page 1 of 43: REVISED the submittal deadline for the Technical and Price Proposals to January 19, 2017.

Questions relating to this Addendum No. 2 may be directed in writing to:

Jason A. Ridgway, P.E.
Director, Office of Highway Development
Maryland Department of Transportation
State Highway Administration
e-mail address: MO069_IS_270@sha.state.md.us

During the Technical Proposal Phase, only e-mailed inquires will be accepted. No requests for additional information or clarification to any other Department or Administration office, consultant, or employee will be considered.

GREGORY I. SLATER, DEPUTY ADMINSTRATOR FOR PLANNING, ENGINEERING, REAL ESTATE, AND ENVIRONMENT.

THIS ADDENDUM IS ISSUED TO CLARIFY, ADD TO, DELETE FROM, CORRECT AND/OR CHANGE THE CONTRACT DOCUMENTS TO THE EXTENT INDICATED AND IS HEREBY MADE PART OF THE SAID CONTRACT DOCUMENTS. COMAR 21.05.02.08 REQUIRES THAT ALL ADDENDA ISSUED BE ACKNOWLEDGED; THEREFORE, PRIOR TO SUBMITTING YOUR PRICE PROPOSAL, ATTACH THE ADDENDUM RECEIPT VERIFICATION FORM TO THE FRONT OF THE PRICE PROPOSAL FORM PACKET. FAILURE TO DO SO MAY RESULT IN THE PRICE PROPOSAL BEING DECLARED NON-RESPONSIVE.

A Letter of Interest (LOI), on official letterhead of the Design-Builder, notifying the Administration whether or not the Design-Builder intends to submit a Technical and Price Proposal must be delivered no later than **December 15, 2016 prior to 12 noon** (EST). The LOI must be delivered to the following email address:

MO069_IS_270@sha.state.md.us

The LOI must be signed by individual(s) authorized to represent the Major Participant firm(s) and the lead Constructor firm(s). A Major Participant is defined as the legal entity, firm or company, individually or as a party in a joint venture or limited liability company or some other legal entity, that will be signatory to the Design–Build Contract with the Administration. Major Participant(s) will be expected to accept joint and several liability for performance of the Design–Build Contract. Major Participants are not design subconsultants, construction subcontractors or any other subcontractors to the legal entity that signs the Design–Build Contract.

If the Design–Build contracting entity will be a joint venture, or some other entity involving multiple firms, all Major Participant firms involved must have an authorized representative sign the LOI.

iii. Proposed Technical Concepts Submittal and Review

Section iii through section vii sets the process for the submittal and review of Proposed Technical Concepts (PTC). The process is intended to:

- Allow Proposers to incorporate innovation and creativity into the Proposals.
- Allow the Administration to consider Proposer PTCs in making the selection decision.
- Avoid delays and potential conflicts in the design associated with deferring of reviews of PTCs to the post-award period.
- Obtain the best-value for the public.

The Proposer is also encouraged to submit standards or specifications that are approved for usage by other state Departments of Transportation as PTCs.

The Proposer may submit PTCs for review by the Administration on or before **November 17, 2016 prior to 12 noon.** (prevailing local time). Inquiries received after that date and time will not be accepted.

All PTCs shall be submitted in writing via email only to the project email address, with a cover letter clearly identifying the submittal as a request for review of a PTC. If the Proposer does not clearly designate its submittal as a PTC, the submission will not be treated as a PTC by the Administration

The Administration will review each PTC submitted to assess the implementation potential of the technical aspects of the concept and its compatibility with the project goals. The Administration will not approve PTCs but will return comments on the PTC on its implementation potential and its compatibility with the project goals. If the Administration needs more information, the Administration will submit written questions to the Proposer and/or request a one-on-one meeting in order to better understand the details of the PTC.

Proposer's Name

<u>Price Proposal</u>

Contract No. MO0695172

Container ____of____

d. Location and deadline for submittal of Technical and Price Proposals

2 Technical Proposals and Price Proposals must be delivered no later than **January 19, 2017 prior to 12 noon** (prevailing local time). The proposal must be delivered to the following location:

Office of Procurement and Contract Management
Fourth Floor, C-405
707 N. Calvert Street
Baltimore, Maryland 21202

e. Number of Copies

One original and eleven (11) copies of the complete Technical Proposal shall be submitted along with one (1) electronic copy PDF file on a CD or flash drive. A single original of the Price Proposal shall also be submitted.

f. Proposal Guaranty

The Proposal Guaranty shall be delivered with the Price Proposal in a sealed business-sized envelope clearly marked as follows:

Prospective Proposer's Name

<u>Proposal Guaranty</u>

IS 270 – Innovative Congestion Management Project

Contract No. MO0695172

4. Effect of Submitting Proposal

Signing of the Design-Build Proposal Submission Form and Price Proposal Form, and delivery of the Proposal represents (a) an offer by the proposer to perform the Work for the Price submitted within the time(s) specified in accordance with all provisions of this RFP and (b) the Prospective proposer's agreement to all the provisions of the RFP and Contract governing requirements and procedures applicable through execution of the Design – Build Contract. **The Technical Proposal will become part of the Design – Build Contract.**

By so signing the above referenced terms and by delivering the Proposals, the Prospective Proposer makes the following affirmative representations.

XVII. PROPOSED PROCUREMENT SCHEDULE

	Issue RFQ/RFP	June 7, 2016
	Final Date for RFQ Questions	July 11, 2016
	SOQ submittal to MSHA	July 25, 2016
	Reduced Candidate List (RCL) Notified	August 11, 2016
	One-on-One Meetings	August 24-25, 2016
	One-on-One Meetings	September 28-29, 2016
	One-on-One Meetings	October 26-27, 2016
2	Last Day to submit PTCs	November 17, 2016
	Final Date for RFP Questions	December 8, 2016
	Letter or Interest	December 15, 2016
2	Technical and Price Proposal Submittal	January 19, 2017
	Selection of Successful Proposer	February 2017
	Notice to Proceed (Anticipated)	March 2017

This is the proposed procurement schedule for this project as of the date of the issuance of this RFQ/RFP.

STATE OF MARYLAND
DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
PROPOSAL FORM

Proposal by____

Name

____

Address (Street and/or P.O. Box)

____

City State Zip

( ) ( ) ________________________________

A.C. Phone No. A.C. Fax No.

to furnish and deliver all materials and to do and perform all work, in conformance with the Standard Specifications, revisions thereto, General Provisions and the Special Provisions in this contract to IS 270 Innovative Congestion Management located in, Frederick and Montgomery Counties, Maryland, for which Technical and Price Proposals will be received until 12:00 o'clock noon on January 19, 2017. Technical and Price Proposals shall be submitted to:

2

State Highway Administration
Office of Procurement and Contract Management
Fourth Floor, C-405
707 N. Calvert Street
Baltimore, MD 21202

In response to the advertisement by the Administration, requesting proposals for the work in conformance with the Contract Documents, now on file in the office of the Administration. I/We hereby certify that I/we am/are the only person, or persons, interested in this proposal as principals, and that an examination has been made of the work site, the Specifications, and Request for Proposals, including the Special Provisions contained herein. I/We propose to furnish all necessary machinery, equipment, tools, labor and other means of construction, and to furnish all materials required to complete the project at the following unit price or lump sum price.

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF HIGHWAY DEVELOPMENT
707 NORTH CALVERT STREET
BALTIMORE, MARYLAND 21202

November 9, 2016

Contract No.: MO0695172
F.A.P. No.: Not Applicable
Description: IS 270 Innovative Congestion Management Contract – Progressive Design-Build: Request for Proposals (RFP)

ADDENDUM NO. 3

To All Prospective Proposers:

Please be advised that the Technical and Price Proposal Submittal Date for this contract is still scheduled for **January 19, 2017**.

The attention of prospective proposers is directed to the following revisions, additions and/or deletions to the Request for Proposals (RFP).

REQUEST FOR PROPOSALS

Page No.	Description
9	REVISED the 3rd bullet to shift the responsibility of constructing noise barriers required for the project from the Design-Builder to the Administration.
14	ADDED noise studies to the Design-Builder's services.
16	ADDED construction of any required noise abatement to the Administration's services.
45	REVISED the page limit for the Mobility goal from 16 pages to 20 pages.
Appendix	Contract Provisions: REPLACED TC-5.01.

Questions relating to this Addendum No. 3 may be directed in writing to:

Jason A. Ridgway, P.E.
Director, Office of Highway Development
Maryland Department of Transportation
State Highway Administration
e-mail address: MO069_IS_270@sha.state.md.us

During the Technical Proposal Phase, only e-mailed inquires will be accepted. No requests for additional information or clarification to any other Department or Administration office, consultant, or employee will be considered.

For/

GREGORY I. SLATER, DEPUTY ADMINSTRATOR FOR PLANNING, ENGINEERING, REAL ESTATE, AND ENVIRONMENT

THIS ADDENDUM IS ISSUED TO CLARIFY, ADD TO, DELETE FROM, CORRECT AND/OR CHANGE THE CONTRACT DOCUMENTS TO THE EXTENT INDICATED AND IS HEREBY MADE PART OF THE SAID CONTRACT DOCUMENTS. COMAR 21.05.02.08 REQUIRES THAT ALL ADDENDA ISSUED BE ACKNOWLEDGED; THEREFORE, PRIOR TO SUBMITTING YOUR PRICE PROPOSAL, ATTACH THE ADDENDUM RECEIPT VERIFICATION FORM TO THE FRONT OF THE PRICE PROPOSAL FORM PACKET. FAILURE TO DO SO MAY RESULT IN THE PRICE PROPOSAL BEING DECLARED NON-RESPONSIVE.

Act (MEPA)

- Project(s) will require NEPA approval from the Federal Highway Administration (FHWA) when federal actions will be required (e.g. design exceptions, Interstate Access Point Approval [IAPA]). If no federal action is required, then MEPA approval will be needed. Multiple environmental documents may be developed for the contract. Each separate project for an environmental document must be a standalone construction project that connects logical termini and be of sufficient length, have independent utility, and not restrict consideration of alternatives for other reasonably foreseeable transportation improvements. Any NEPA/MEPA document will be prepared by SHA. The Design-Builder will have no decision making responsibility with respect to the NEPA/MEPA process but will provide information needed about the project and possible mitigation actions.
- Public Involvement will be needed as part of NEPA/MEPA and should ensure travel shed is covered, not just the immediate project area.
- 3 The requirements of the SHA Noise Policy must be met for the Design-Builder's improvements. However, noise barriers, if required, will be excluded from any work package or CAP, and will not be paid for from the contract budget. The Administration will be responsible for the costs associated with noise barriers and the additional impacts or requirements they incur, including additional right-of-way, utility relocations, grading, drainage, stormwater management, retaining walls, etc.
- DNR managed land (Seneca Creek State Park) is within the contract limits.

5. Minimize Environmental Impacts

   - No permits have been obtained. Agency coordination will be required to secure necessary permits for any environmental impacts.
   - The Design-Builder will prepare permit applications for submittal by the Administration.
   - Environmental impacts due to Design-Builder's project should be minimized to the extent practical.
   - Mitigation may be required by permitting agencies depending on impacts to environmental features as a result of Design-Builder's project.

6. Minimize utility and property impacts and relocations

   - Utility and property impacts due to Design-Builder's project should be minimized to the extent practical.
   - All costs for third party utility relocations and property impacts will be subtracted from the fixed value contract.

E. **Project Status**

The current status of aspects of the project is as follows:

<u>Mapping and Survey</u>

- Develop any Right-of-way needs for the project(s)
- Preparation of any Design Exceptions as required for the project(s)
- Design of any surface drainage conveyances, stormwater management, and erosion and sediment control and obtain any related environmental agency approvals required for the project(s) (including NPDES and MDE Approvals).
- Hydrologic and Hydraulic analyses, Drainage and Storm Water Management (SWM) Analyses, Design, and Approvals.
- Closed-Circuit Television (CCTV) inspections of existing drainage pipes as needed.
- The pavement engineering for the Project shall include, but is not limited to, the pavement investigation, pavement type selection, new pavement design, pavement rehabilitation design, and material selection.
- Perform pavement and subsurface geotechnical investigations needed to determine subsurface features and characteristics, and properties to support pavement and geotechnical engineering functions.
- Analyze pavement performance data and existing material conditions to determine the structural and functional conditions for the development of pavement engineering recommendations;
- Analyze subsurface geotechnical field and laboratory test data to determine existing soil, rock, and groundwater conditions etc. for the development of geotechnical engineering recommendations;
- Structural design for all bridges, culverts, walls and any and all other incidental structures required for the project(s).
- Traffic engineering design of any temporary and permanent signing, lighting, traffic signals, pavement markings, and Intelligent transportation systems (ITS) required for the project(s)
- Traffic Operations Analyses including the preparation of a Traffic Operations Analysis Report
- Temporary Traffic Control Design and Implementation including the preparation of a Traffic Management Plan (TMP), red flag summary, Maintenance of Traffic Alternatives Analysis (MOTAA). Additionally, attending and running TMP meetings.
- HOV equivalency analysis and submit to FHWA for approval, if required
- Safety analysis using the Highway Safety Manual (HSM) and submit to FHWA for approval, if required
- Landscape Architecture design of any roadside landscaping and stormwater management landscaping required for the project(s)
- Forest Impact Analysis, Significant tree identification, development of forest impact plans, tree preservation plan and design of any reforestation mitigation required for the project(s)
- Preparation of any necessary documents to obtain final reforestation site review approval from the Maryland Department of Natural Resources
- Prepare and coordinate the Joint Permit Application(s) (JPA) including but not limited to preparation and submittal of the JPA application(s) to SHA with attachments including location map, impact plates, trilogy request and

3

- Complete all work related to providing a noise study(ies) that makes a final determination on reasonableness and feasibleness related to noise abatement.

- Acquisition of Environmental Permits
- Acquisition of Right-of-Way
- Review Construction CAP proposals and compare to ICE
- Reconcile Final CAP for each phase
- Construction Management and Inspection Services
- Design and construct required noise abatement, including additional impacts or requirements they incur, such as additional utility relocations, grading, drainage, stormwater management, retaining walls, etc.

3

Scope Validation and Identification of Scope Issues

A Scope Validation Period of 120 days from the date of the Notice to Proceed for Design and Preconstruction Services will be provided on this contract. During the Scope Validation Period, the Design-Builder shall thoroughly verify and validate that the Design-Builder's understanding of the scope of work and its ability to complete it within the Design and Preconstruction Services Fee. Any Scope Issues determined during this period shall not be deemed to include items that the Design-Builder should have reasonably discovered prior to submission of its Technical Proposal.

If the Design-Builder intends to seek an adjustment to the Design and Preconstruction Fee due to a Scope Issue, it shall promptly, but in no event later than the expiration of the Scope Validation Period, provide the Administration in writing with a notice of the existence of such Scope Issue and basis for such Scope Issue. Within 30 days of the notice, the Design-Builder shall provide documentation that specifically explains its support for the Scope Issue, which shall include among other things: (a) the assumptions the Design-Builder made during the preparation of its Proposal that form the basis of its allegation, along with documentation verifying it made such assumptions in developing its Proposal; (b) explanation of the Scope Issue that the Design-Builder could not have reasonably identified prior to submission of the Technical Proposal; (c) specific impact on the Design and Preconstruction Services. For the avoidance of doubt: (1) The Design-Builder shall not be entitled to raise any Scope Issues that were not previously addressed with a notice; and (2) Design-Builder shall have no right to seek any relief for any Scope Issues not identified in a notice provided to the Administration during the Scope Validation Period.

Within a reasonable time after the Administration's receipt of the documentation, the parties shall meet and confer to discuss the resolution of such Scope Issues. If the Administration agrees that the Design-Builder has identified a valid Scope Issue, a change order will be executed to increase the value of the Design and Preconstruction Fee; however, the Construction Services will be adjusted to retain the overall fixed value of the contract. Notwithstanding anything to the contrary in the Contract Documents or a matter of law, the Design-Builder shall have the burden of proving that the alleged Scope Issue could not have reasonably been identified prior to the submission of the Technical Proposal and such Scope Issue materially impacts its Design and Preconstruction Services Fee.

The parties acknowledge that the purpose of the Scope Validation Period is to enable the Design-Builder to identify those Scope Issues that could not have reasonably been identified prior to the submission of the Technical Proposal. By submission of the Technical Proposal, the Design-Builder acknowledges that the Scope Validation Period is a reasonable time to enable the Design-Builder to identify Scope Issues that materially impacts its Design and Preconstruction Fee. The Design-Builder will assume and accept all risks to complete the Design and

Proposer is alerted to their responsibility to confirm that all team members have received addenda. The Proposer is solely responsible to ensure that their team has the correct information.

i. Statement including the proposed legal structure of the Design–Builder.

j. Include a general authorization for the Administration to confirm all information contained in the Technical Proposal submittal with third parties, and indicate limitations, if any, to such authorization.

As an attachment to the cover letter and excluded from the page limitation for this section, provide documentation that the Design Team has Professional Liability Insurance.

3 **2. Mobility (20 Pages Maximum) – CRITICAL**

Goal: Provide improvements that maximize vehicle throughput, minimize vehicle travel times and create a more predictable commuter trip along I-270.

Value Statement: Effective and reliable traffic flow along I-270 is necessary for its function as a primary commuter route and for the vitality of economic development. Describe the improvements you will provide to address and manage congestion along I-270 while reducing delay and increasing reliability.

i. Provide the Design-Builder's improvements for maximizing vehicle throughput and minimizing vehicle travel times. Specifically, discuss how the Design-Builder's improvements will reduce recurring congestion in terms of travel time, vehicle throughput, density, intersection operations, queues and vehicle network performance, both along I-270 and on the connecting ramps and arterial roadways. – **CRITICAL**

ii. Discuss how the Design-Builder's improvements will provide a more predictable commuter trip, including innovative technologies or techniques that will be provided. – **SIGNIFICANT**

iii. Discuss the performance life of the improvements; that is, the time it will take for congestion levels to return to pre-construction levels and the basis for the Design-Builder's assessment of performance. – **IMPORTANT**

3. Safety (10 Pages Maximum) – IMPORTANT

Goal: Provide for a safer I-270 corridor.

Value Statement: Safer flow of traffic will increase mobility along I-270 by reducing incidents that increase delay and reduce travel time reliability. Discuss how your improvements will increase safety along I-270.

TERMS AND CONDITIONS

TC SECTION 5
LEGAL RELATIONS AND PROGRESS

TC-5.01 INSURANCE

100 **DELETE:** In its entirety.

INSERT: The following.

TC-5.01 INSURANCE FOR DESIGN-BUILD

In addition to the provisions of GP-7.14 (Liability Insurance), the following shall apply on Administration Contracts.

The Contractor shall maintain in full force and effect third party legal liability insurance necessary to cover claims arising from the Contractor's operations under this agreement that cause damage to the person or property of third parties. The insurance shall be under a standard commercial general liability (CGL) form endorsed as necessary to comply with the above requirements and the other requirements of this Section. The State of Maryland shall be listed as an additional insured on the policy. The limit of liability shall be no less than $1 000 000 per occurrence/$2 000 000 general aggregate. The insurance shall be kept in full force and effect until all work has been satisfactorily completed and accepted.

When specified in the Contract Documents or otherwise required by law, the Contractor shall carry the type and amounts of insurance in addition to any other forms of insurance or bonds required under the terms of the Contract and these Specifications.

All insurance policies required by this Section, elsewhere in the Contract Documents, or otherwise required by law, shall be kept in full force and effect until all work has been satisfactorily completed and accepted. The Contractor shall be responsible for the payment of all deductibles or self-insured retentions.

All insurance policies required by this Section, elsewhere in the Contract Documents, or otherwise required by law, (other than Workers' Compensation Policies) shall include endorsements:

(a) Stating that the State of Maryland is additional insured with respect to liability arising from the Contractor's operations under this agreement that cause damage to the person or property of third parties.

(b) Stating that such coverage as is provided by the policies for the benefit of the additional insureds is primary and any other coverage maintained by such additional insureds (including self-insurance pursuant to the Maryland Tort Claims Act) shall be non-contributing with the coverage provided under the policies.

(c) Containing waivers of subrogation with respect to all named insureds and additional insureds.

(d) Stating that the insurer has the duty to adjust claims and provide a defense with regard to such claims made against the additional insured.

All insurance policies required by this Section, elsewhere in the Contract Documents, or otherwise required by law, (including Workers' Compensation Policies) shall be endorsed to state that the insurer shall provide at least 7 days notice of cancellation or nonrenewal to:

Maryland State Highway Administration
Director, Office of Construction
7450 Traffic Drive
Hanover MD 21076

Evidence of insurance shall be provided to the Administration at the address listed above prior to the award of the Contract by means of a Certificate of Insurance with copies of all endorsements attached.

Any policy exclusions shall be shown on the face of the Certificate of Insurance or provided with the Certificate of Insurance.

Certificates of Insurance shall comply with all requirements of the Maryland Annotated Code, Insurance Article, § 19-116. Certificates of Insurance shall be on a form approved by the Maryland Insurance Commissioner (Commissioner). Standard Certificate of Insurance forms currently adopted for use by the Association for Cooperative Operations Research (ACORD) or the Insurance Services Office (ISO) are deemed approved by the Commissioner and are acceptable. Outdated ACORD or ISO forms (those with a revision date prior to the date of the form currently adopted for current use by ACORD or ISO) are not acceptable. The Contractor shall ensure that all required Certificates of Insurance satisfy all requirements of §19-116 of the Insurance Article, including the prohibition against the issuance of any certificate of insurance that contains false or misleading information or that purports to amend, alter, or extend the coverage provided by the policies referenced in the certificate.

The Certificate of Insurance shall be accompanied by a document (a copy of State License or letter from insurer) that indicates that the agent signing the certificate is an authorized agent of the insurer.

No acceptance and/or approval of any Certificate of Insurance or insurance by the Administration shall be construed as relieving or excusing the Contractor, or the Contractor's Surety from any liability or obligation imposed upon either or both of them by the provisions of this Contract or elsewhere in the Contract Documents.

The cost of the insurance will not be measured but the cost will be incidental to the Contract lump sum price.

Contractor and Railroad Public Liability and Property Damage Insurance shall be provided as specified in TC-6.05.

.01 Indemnification

The Design-Build Team shall indemnify, defend and hold the Administration and its officers, directors, employees, agents and consultants from and against all claims, actions, torts, costs, losses, and damages for bodily injury (including sickness, disease or death) and/or tangible property damage (other than to the Work itself) arising out of or resulting from the performance of the Work by the Design-Build Team, any subcontractor, subconsultant, engineer, supplier, any individual or entity directly or indirectly employed by any of them or anyone for whose acts any of them may be liable. Damages covered by the preceding sentence include, but are not limited to, all fees and charges of engineers, attorneys and all other professionals and all mediation, arbitration, court or other dispute resolution costs.

The indemnity obligation set forth in the preceding paragraph shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for the Design-Build Team or any subcontractor, subconsultant, engineer, supplier, or other individual or entity under Workers' Compensation acts, disability benefit acts, or other employee benefit acts.

.02 Additional Insurance Requirements

.02.1 Professional Liability Insurance

Professional Liability Insurance Policy, which covers the Indemnification Clause of this contract (paragraph .02 above), as it relates to errors, omissions, negligent acts or negligent performance in the work performance under this contract by the Designer, its subcontractors, employees and agents. The limitation of the Courts and Judical Proceedings Article states Annotated Code of Maryland Section 5-108(b) shall apply.

.02.2 Workers' Compensation Insurance

Workers' compensation, as required by the laws of the State of Maryland, including Employer's Liability Coverage and coverage for the benefits set forth under the U.S. Longshoremen and Harbor Workers' Compensation Act, the Jones Act, and other federal laws where applicable.

.02.3 Comprehensive Automobile Liability Insurance

Comprehensive Business Automobile Liability covering use of any motor vehicle to be used in conjunction with this contract, including hired automobiles and non-owned automobiles. Loading and unloading of any motor vehicle must be covered by endorsement to the automobile liability policy or policies.

.02.4 Administrative & General Provisions

a. Each policy, with the exception of Workers' Compensation and Professional Liability Insurance, shall name the State Highway Administration.

b. Defense of Claims

Each insurance policy shall include a provision requiring the carrier to investigate and defend all named insured against any and all claims for death, bodily injury or property damage, even if groundless.

c. Compliance

The Design-Build Team shall be in compliance with this Section provided it procures either one policy or insurance covering all work under the contract or separate insurance policies for all segments constituting the entire project. In either case, a certificate of insurance must be filed for each policy with the Administration indicating that all required insurance has been obtained.

The Design-Build Team is responsible for assuring that insurance policies required by this Contract comply with all the requirements. The Design-Build Team is also responsible to determine that all subconsultants, subcontractors, suppliers, and all other individuals or entities performing Work for the Project carry all applicable insurance coverages set forth in this section, including, in all cases, Workers' Compensation, Automobile, and Commercial General Liability Insurance. The Design-Build Team shall indemnify and hold harmless the Administration from any claims arising from the failure to fulfill said responsibilities.

d. Reporting Provisions

Any failure to comply with reporting provisions of the policies shall not affect coverage provided to the Administration, its officers, agents and employees.

e. Separate Application

The insurance provided by the Design-Build Team shall apply separately to each insured against whom claim is made or suit is brought, except with respect to the limits of the insurer's liability.

.02.5 Notice of Cancellation or Modification

All policies of insurance provided in this Section shall be endorsed to provide that the insurance company shall notify the Administration, the Design-Build Team, and each named insured at least thirty (30) days prior to the effective date of any cancellation or modification of such policies.

TC-5.03 SUBCONTRACTING AND SUBCONTRACTORS

102 **INSERT**: The following before the paragraph titled '**Subcontractors Prompt Payment**.'

Percentage of Own Workforce Required. The Design-Build Team must perform at least fifty percent of the value of the on-site construction work with its own workforce, not including the percent goal required in the contract proposal to be performed by DBE's. The Designer must perform at least fifty percent (50%) of the value of the design work with its own workforce, not including the work required by DBE's.

106 **ADD**: The following sections at the end of section **'TC-5.05 DETERMINATION AND EXTENSION OF CONTRACT TIME.'**

TC-5.06 OWNERSHIP OF DOCUMENTS

All plans, specifications, inspection records, or other documents ("Documents") generated by the Design-Build Team and all consultants, subcontractors, suppliers, manufacturers performing Work on the Project are the property of the Administration. Upon request by the Administration, the Design-Build Team or any other person or entity performing Work will produce and deliver such Documents as requested, both in hard copy and electronic format.

TC-5.07 ACCESS TO AND RETENTION OF RECORDS

The Design-Build Team and its employees and Subcontractors shall make all project records available for inspection by the Project Manager and all other persons authorized by the Administration, and shall permit such representatives to interview employees during working hours. Project records include daily time reports, records of force account work, quality control or assurance documentation, inspectors reports, employment records, payrolls, equal opportunity records, construction conference records, partnering records, and any other documents in any way related to the Project substantiating payment. These records shall be retained at least three years after final acceptance of the project.

MARYLAND DEPARTMENT OF TRANSPORTATION
STATE HIGHWAY ADMINISTRATION
OFFICE OF HIGHWAY DEVELOPMENT
707 NORTH CALVERT STREET
BALTIMORE, MARYLAND 21202

December 19, 2016

Contract No.: MO0695172
F.A.P. No.: Not Applicable
Description: IS 270 Innovative Congestion Management Contract – Progressive Design-Build: Request for Proposals (RFP)

ADDENDUM NO. 4

To All Prospective Proposers:

Please be advised that the Technical and Price Proposal Submittal Date for this contract is still scheduled for **January 19, 2017**.

The attention of prospective proposers is directed to the following revisions, additions and/or deletions to the Request for Proposals (RFP).

REQUEST FOR PROPOSALS

Page No.	Description
14	REVISED the order of the last two bullets at the bottom of the page so the language for the JPA services, which flows onto the next page, is continuous.
16	REVISED the last bullet of the Administration's Services to exclude construction, as the construction will not occur during the preconstruction phase.

Questions relating to this Addendum No. 4 may be directed in writing to:

Jason A. Ridgway, P.E.
Director, Office of Highway Development
Maryland Department of Transportation
State Highway Administration
e-mail address: MO069_IS_270@sha.state.md.us

During the Technical Proposal Phase, only e-mailed inquires will be accepted. No requests for additional information or clarification to any other Department or Administration office, consultant, or employee will be considered.

For/

GREGORY I. SLATER, DEPUTY ADMINSTRATOR FOR PLANNING, ENGINEERING, REAL ESTATE, AND ENVIRONMENT.

THIS ADDENDUM IS ISSUED TO CLARIFY, ADD TO, DELETE FROM, CORRECT AND/OR CHANGE THE CONTRACT DOCUMENTS TO THE EXTENT INDICATED AND IS HEREBY MADE PART OF THE SAID CONTRACT DOCUMENTS. COMAR 21.05.02.08 REQUIRES THAT ALL ADDENDA ISSUED BE ACKNOWLEDGED; THEREFORE, PRIOR TO SUBMITTING YOUR PRICE PROPOSAL, ATTACH THE ADDENDUM RECEIPT VERIFICATION FORM TO THE FRONT OF THE PRICE PROPOSAL FORM PACKET. FAILURE TO DO SO MAY RESULT IN THE PRICE PROPOSAL BEING DECLARED NON-RESPONSIVE.

- Develop any Right-of-way needs for the project(s)
- Preparation of any Design Exceptions as required for the project(s)
- Design of any surface drainage conveyances, stormwater management, and erosion and sediment control and obtain any related environmental agency approvals required for the project(s) (including NPDES and MDE Approvals).
- Hydrologic and Hydraulic analyses, Drainage and Storm Water Management (SWM) Analyses, Design, and Approvals.
- Closed-Circuit Television (CCTV) inspections of existing drainage pipes as needed.
- The pavement engineering for the Project shall include, but is not limited to, the pavement investigation, pavement type selection, new pavement design, pavement rehabilitation design, and material selection.
- Perform pavement and subsurface geotechnical investigations needed to determine subsurface features and characteristics, and properties to support pavement and geotechnical engineering functions.
- Analyze pavement performance data and existing material conditions to determine the structural and functional conditions for the development of pavement engineering recommendations;
- Analyze subsurface geotechnical field and laboratory test data to determine existing soil, rock, and groundwater conditions etc. for the development of geotechnical engineering recommendations;
- Structural design for all bridges, culverts, walls and any and all other incidental structures required for the project(s).
- Traffic engineering design of any temporary and permanent signing, lighting, traffic signals, pavement markings, and Intelligent transportation systems (ITS) required for the project(s)
- Traffic Operations Analyses including the preparation of a Traffic Operations Analysis Report
- Temporary Traffic Control Design and Implementation including the preparation of a Traffic Management Plan (TMP), red flag summary, Maintenance of Traffic Alternatives Analysis (MOTAA). Additionally, attending and running TMP meetings.
- HOV equivalency analysis and submit to FHWA for approval, if required
- Safety analysis using the Highway Safety Manual (HSM) and submit to FHWA for approval, if required
- Landscape Architecture design of any roadside landscaping and stormwater management landscaping required for the project(s)
- Forest Impact Analysis, Significant tree identification, development of forest impact plans, tree preservation plan and design of any reforestation mitigation required for the project(s)
- Preparation of any necessary documents to obtain final reforestation site review approval from the Maryland Department of Natural Resources

4 3

- Complete all work related to providing a noise study(ies) that makes a final determination on reasonableness and feasibleness related to noise abatement.
- Prepare and coordinate the Joint Permit Application(s) (JPA) including but not limited to preparation and submittal of the JPA application(s) to SHA with attachments including location map, impact plates, trilogy request and

- Acquisition of Environmental Permits
- Acquisition of Right-of-Way
- Review Construction CAP proposals and compare to ICE
- Reconcile Final CAP for each phase
- Construction Management and Inspection Services
- 4 3 Design required noise abatement

Scope Validation and Identification of Scope Issues

A Scope Validation Period of 120 days from the date of the Notice to Proceed for Design and Preconstruction Services will be provided on this contract. During the Scope Validation Period, the Design-Builder shall thoroughly verify and validate that the Design-Builder's understanding of the scope of work and its ability to complete it within the Design and Preconstruction Services Fee. Any Scope Issues determined during this period shall not be deemed to include items that the Design-Builder should have reasonably discovered prior to submission of its Technical Proposal.

If the Design-Builder intends to seek an adjustment to the Design and Preconstruction Fee due to a Scope Issue, it shall promptly, but in no event later than the expiration of the Scope Validation Period, provide the Administration in writing with a notice of the existence of such Scope Issue and basis for such Scope Issue. Within 30 days of the notice, the Design-Builder shall provide documentation that specifically explains its support for the Scope Issue, which shall include among other things: (a) the assumptions the Design-Builder made during the preparation of its Proposal that form the basis of its allegation, along with documentation verifying it made such assumptions in developing its Proposal; (b) explanation of the Scope Issue that the Design-Builder could not have reasonably identified prior to submission of the Technical Proposal; (c) specific impact on the Design and Preconstruction Services. For the avoidance of doubt: (1) The Design-Builder shall not be entitled to raise any Scope Issues that were not previously addressed with a notice; and (2) Design-Builder shall have no right to seek any relief for any Scope Issues not identified in a notice provided to the Administration during the Scope Validation Period.

Within a reasonable time after the Administration's receipt of the documentation, the parties shall meet and confer to discuss the resolution of such Scope Issues. If the Administration agrees that the Design-Builder has identified a valid Scope Issue, a change order will be executed to increase the value of the Design and Preconstruction Fee; however, the Construction Services will be adjusted to retain the overall fixed value of the contract. Notwithstanding anything to the contrary in the Contract Documents or a matter of law, the Design-Builder shall have the burden of proving that the alleged Scope Issue could not have reasonably been identified prior to the submission of the Technical Proposal and such Scope Issue materially impacts its Design and Preconstruction Services Fee.

The parties acknowledge that the purpose of the Scope Validation Period is to enable the Design-Builder to identify those Scope Issues that could not have reasonably been identified prior to the submission of the Technical Proposal. By submission of the Technical Proposal, the Design-Builder acknowledges that the Scope Validation Period is a reasonable time to enable the Design-Builder to identify Scope Issues that materially impacts its Design and Preconstruction Fee. The Design-Builder will assume and accept all risks to complete the Design and

Contract No. MO0695172

IS 270 Innovative Congestion Management Contract

Request for Proposals – Questions and Responses

The following questions were received on September 2, 2016.

Question 1:
Please provide the SHA I-270 accident data in Excel Spreadsheet format from SHA OOTS TDSD's ACRES system to aid with the expedited review and analysis of data during the Technical Proposal phase of the I-270 project.

Response 1:
Crash data in Excel format has been posted on ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\04 - Existing Crash Data\Accident Data\

Question 2:
Please provide Synchro files which were used to develop signal timing for signalized intersections in the VISSIM network to aid with the review and analysis of solutions during the Technical Proposal phase of the I-270 project.

Response 2:
Synchro files are not available. The existing signal timing sheets were used for 2015 design year and minor signal timing adjustments were made to traffic signals with excessive delays and queues for 2040 no-build design year.

Question 3:
Will SHA provide consistent parameters such as number of runs, seeds, seeding time for the VISSIM runs so that all teams provide comparable results for SHA to evaluate?

Response 3:
As stated on Page 48 of the Request for Proposals (RFP), "The Proposer shall use VISSIM version 7.00-13, shall follow SHA's VISSIM Modeling Techniques, shall not modify calibration parameters, such as vehicle inputs, vehicle routes, driving behavior, link behavior type, lane change distance, speed distributions and decisions without providing justification to the SHA and must use the simulation parameters and random seeds as provided in the VISSIM files when reporting results."

The following questions were received on September 7, 2016.

Question 4:
Please provide the following: schedule and plans for MD 85 at I-270 project, MD 121 at I-270 project, and schedule for I-270 at Watkins Mill project.

Response 4:
The Watkins Mill Interchange is planned to be re-advertised in 2017; however, a precise schedule is undetermined and will depend on the magnitude of the design changes (if any) that will be required to accommodate the I-270 Innovative Congestion Management (ICM) Contract.

The I-270/MD 121 Interchange Improvements Project is in the planning phase. Information can be found at the following project website:

http://apps.roads.maryland.gov/WebProjectLifeCycle/ProjectInformation.aspx?projectno=MO4261115

Final review plans for the I-270/MD 85 (Phase 1) Interchange Reconstruction Project (Contract No. FR3885171) have been posted to ProjectWise at the location below. Additionally, Plans, Specifications, & Estimate (PS&E) plans for a stream stabilization project (Contract No. MO1605174) have been posted to ProjectWise at the location below:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\11 - Other Projects\

The latest advertisement, bid, and notice to proceed (NTP) dates for these projects can be found in the Contractor's Ad Schedule on SHA's website:

http://www.roads.maryland.gov/pages/contractadschedule.aspx

Question 5:
Please provide the following: 100 scale mapping north of the Watkins Mill project.

Response 5:
The SHA will not provide additional 100 scale mapping. A planimetrics file for the area north of the 100 scale mapping has been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\07 - Planimetrics\mTO_planimetrics_I270.dgn

Question 6:
Please provide the following: crash data in MS Excel format.

Response 6:
See question 1.

Question 7:
Please provide the following: traffic counts in 15 minute increments and in MS Excel format.

Response 7:
Two MS Access databases have been posted to the ProjectWise location below, one for I-270 and one for Montgomery and Frederick Counties. A data dictionary has been included to explain

the columns in the tables. Also, the locations of the counts have been included in shape and KMZ formats.

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\02 - Existing Traffic Counts\15 minute counts\

Question 8:
Please provide the following: speed data in 15 minute increments (collected at the same time as the traffic counts).

Response 8:
Speed, Travel Time Index (TTI), and Planning Time Index (PTI) data for the I-270 mainline (from the spurs to I-70), the I-270 collector distributor (CD) lanes, and I-495 (from American Legion Bridge to the spurs) has been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\10 - 2015 Avg Weekday INRIX Data\

Question 9:
Please provide the following: Excel sheet for I-270 Concept Evaluation 042516 Final.pdf.

Response 9:
The Excel files used to generate said document had been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\I_I-270 Concept Evaluation Templates\files\

Question 10:
Please provide the following: origin-destination data and 5 year interval traffic projections through 2040.

Response 10:
Origin-destination data and land use information in 5 year increments have been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\09 - MWCOG Travel Demand Model Outputs\

Question 11:
Please provide the following: small structure inventory for Frederick County.

Response 11:
The following file on ProjectWise has been updated to include the maps for Frederick County:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\03 - Inventory of Existing Structures\Inventory Maps\Small Structures.pdf

Three additional small structures (10182X0, 10358X0, and 10359X0) have been added to the following ProjectWise folder:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\03 - Inventory of Existing Structures\Other Structures\

Question 12:
Please provide the following: utility designation north of the Watkins Mill Project, right-of-way (ROW) mosaic north of the Watkins Mill Project, pavement borings/geotech info north of the Watkins Mill Project, and wetland delineation and environmental features north of Game Preserve Road.

Response 12:
The extent of additional base information required to complete design will be highly dependent on the concept; therefore, the additional data collection needed to complete the project is included in the pre-construction services to be provided by the Design-Builder.

Question 13:
Please provide the following: pavement structure numbers of all shoulders.

Response 13:
The SHA has not performed any design to date. Pavement design is included in the pre-construction services to be provided by the Design-Builder. Prospective proposers may, at their will and discretion, perform preliminary calculations during the procurement phase.

Question 14:
Please provide the following: noise model north of Watkins Mill.

Response 14:
The SHA will not provide additional noise models. Should the project require noise analyses, the Design-Builder shall develop the required noise models, analyses and reports as part of the pre-construction services.

The following questions were received on September 12, 2016.

Question 15:
Our Team is requesting access to view and use the “Explore and Visualize Crashes” tool within the RITIS (Regional Integrated Transportation Information System). This tool will be beneficial to the project by allowing our team to view more detailed crash data to better identify the deficiencies along I-270.

Response 15:
Proposers may request one team member to be provided RITIS access. If access is desired, please submit a request to the project email address along with the name and email address of the user to whom RITIS access will be given.

Question 16:
In reference to RFQ/RFQ Article XII.B.7, is it acceptable to use VISSIM Version 8.00-10 in lieu of Version 7.00-13?

Response 16:
VISSIM version 7.00-13 shall be used. However, additional supporting information related to the technical proposal may be included in the Appendix.

The following questions were received on September 27, 2016.

Question 17:
Please provide clarification on the schedule of prices as shown in the RFP. All three bid items are shown as lump sum, but the RFP describes a design development process involving SHA, the DB team and public/stakeholders as required by SHA design development policies. Throughout the design process, it is likely that the construction scope will evolve with stakeholder and SHA input. For clarity, will the lump sum prices also evolve as the scope becomes better defined in the design period?

Response 17:
The contract budget is $100,000,000 and this budget is fixed. As noted in the question, the proposed concept and final construction scope shall continue to evolve during design, as is usual for all design processes and projects, prior to reconciliation of a Construction Agreed Price (CAP). However, the Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. It shall include all design and preconstruction services needed to deliver the scope of improvement proposed by the Design-Builder.

The Construction Management Fee shall include all profit, general and administrative costs, regional and home office overhead, and other indirect costs, as specified in Article XII.C.2 beginning on page 48 of the RFP.

The Construction Services Fee is determined by subtracting the Design and Preconstruction Services Fee and Construction Management Fee from the total contract budget. Regardless of what the final construction scope becomes, each construction package price will be reconciled and have its own agreed upon CAP. The sum of all the CAPs, any necessary right-of-way acquisition costs, and utility relocations costs will not exceed the Construction Services Fee, which is a "Guaranteed Maximum Price" or upset limit.

If there is a scope change during the design and preconstruction services, then it will be handled by the appropriate contract specifications. However, the Administration does not intend to increase the value of the contract and the Design-Builder will need to propose modifications to stay within budget.

Question 18:
What level of design and plans related to PTCs are required for the Technical Proposal submittal?

Response 18:
Per General paragraph of Article XII.B (Technical Proposal) in the RFP (page 42), "The Technical Proposal submittal shall contain concise narrative descriptions and graphic illustrations, drawings, charts, plans and specifications that will enable the Administration to clearly understand and evaluate the capabilities of the Design - Builder and the characteristics and benefits of the proposed solutions." Proposers are responsible for determining the necessary level of detail that will enable the Administration to clearly understand and evaluate the capabilities of the Design - Builder and the characteristics and benefits of the proposed solutions.

Question 19:
Since each PTC is being evaluated on its own merits, and with its own VISSIM analysis, please clarify what should be submitted with the final Technical Proposal? Is a VISSIM model for each PTC required, or one model that combines each of the PTCs selected by the DB for inclusion in their Technical Proposal?

Response 19:
One VISSIM model that combines each of the PTCs selected by the Design-Builder for inclusion in the Technical Proposal shall be submitted. Please refer to Article XII.B.7 in the RFP (page 48).

Question 20:
We request that SHA consider revising the Technical Proposal due date to either December 21st or January 18th.

Response 20:
In Addendum No. 2 the Technical Proposal due date was revised to January 19, 2017.

Question 21:
Is there any VISSIM calibration report available? If so, please provide.

Response 21:
A VISSIM calibration memorandum has been posted on ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\ 03 - VISSIM Traffic Models\I-270 Modeling Calibration Methodologies Memorandum.pdf

Question 22:
Can SHA provide any origin-destination traffic data for the GP and HOV lanes within the corridor used to develop existing and 2040 traffic volumes for the corridor?

Response 22:
See response to question 10.

Question 23:
We have been unable to locate any CAD files on PW that support the TNM validation that has been done, including Microstation files with the NSA shapes, the measured receptors and the TNM validation model layouts. Will SHA provide these files to all proposers?

Response 23:
MicroStation files with the NSA shapes, the measured receptors and the TNM validation model layouts will not be provided.

Question 24:
Special Provision Insert, TC-5.01 Insurance, page 2, 6th paragraph requires "*Any policy exclusions shall be shown on the face of the Certificate of Insurance or provided with the Certificate of Insurance.*" All policies have numerous standard exclusions which are usual and customary in the industry. Listing all these exclusions in or attached to the certificate of insurance would be an unnecessary administrative burden. Please consider the following amendment, which we believe is the true intent of this requirement, "*~~Any policy~~ Policy exclusions applicable to the requirements herein shall be shown on the face of the Certificate of Insurance or provided with the Certificate of Insurance.*"

Response 24:
This is a standard Special Provision for all Administration contracts and will not be modified.

The following questions were received on October 6, 2016.

Question 25:
If our proposed solution requires additional staff to operate, beyond the existing MDOT / CHART manpower capabilities, is the additional staffing to be included in the current $100M budget? If yes, for what period of time (years) would the staff need to be provided? Will additional staffing (temporary or permanent) be SHA employees, contract employees, or staff provided by the Design Builder? Will staff be located in an existing MDOT / CHART facility. If yes, which existing facility?

Response 25:
No, the contract budget does not include long-term Operations and Maintenance (O&M) costs. The budget does include design, construction, integration, testing, system documentation, training and anything else needed to turn over to the State a fully functional & operational system.

Though long-term O&M costs are not included in the budget, as part of their Technical Proposal Submittal, Proposers are responsible for evaluating impacts to O&M, and justifying and documenting anticipated O&M requirements. Please refer to the Operability/Maintainability/Adaptability goal in the RFP. The SHA needs to clearly understand the impacts the project will have on its O&M programs.

Question 26:
If our proposed solution requires "back-office" computers and other equipment, shall they be housed in an existing MDOT / CHART facility. If yes which one? If no, would the Design Builder be required to provide such facilities and would the cost be included in the current $100 Million budget?

Response 26:
Housing back-office computers and equipment in MDOT, SHA and/or CHART facilities is potentially feasible, but not required. Proposers would need to confirm that the proposed location would be implementable, assuring basic system support such as telecommunication connectivity, a reliable power supply, accessibility for maintenance and system redundancy.

Proposers will design the system and should propose where the best location would be. There are numerous alternatives – e.g. the Statewide Operations Center, the Hanover Traffic Signal Shop, the Glen Burnie Data Center, District 3, etc. Proposers shall determine the most practical solution that meets the goals of the project. As noted above, using a State facility is feasible.

Regardless of where the equipment is housed, the Design-Builder shall provide all required equipment and facilities to turn over to the State a fully functional & operational system, as noted in response 25, the cost for which must be paid for from the contract budget.

Question 27:
If existing MDOT / CHART facilities are being utilized for proposed operational activities, is the Design Builder responsible for any improvements to the facility (physical improvements or new equipment/connectivity) as part of the $100 Million budget? Please provide any existing plans or requirements for where equipment or staffing might be housed at the proposed MDOT / CHART facility including IT and computer facilities so we can estimate the cost of any improvements. Please arrange for access to the proposed facility for the Design Builders designers and estimators.

Response 27:
The cost of improvements to MDOT facilities shall be paid for from the project budget if the improvements are required for the Design-Builder to provide a fully functional system at project completion. The Design-Builder is not responsible for facility improvements unrelated to the project.

Your request for existing plans/information is too broad. Also, SHA does not know the equipment/staffing requirements for your proposed solutions and would be unable to determine potential housing locations. However, to help Proposers conceptualize potential housing locations, Proposers may visit SHA facilities. To make an appointment, Proposers may send an email request to the project email address, specifying which facility and potential dates.

Question 28:
Will maintenance of any new field ITS devices need to be covered in our $100 Million budget? If so, for what time period and to what extent is expected?

Response 28:
No. See response to question 25.

The following questions were received on October 10, 2016.

Question 29:
The RFP allows for resubmittal of PTC's after receiving initial feedback from SHA, but it does not specify a due date. Can a PTC be resubmitted after the 11/17 Last Day to submit PTC's, if the initial submittal was made prior to 11/17?

Response 29:
Yes.

Question 30:
We request permission to engage in joint discussions with FHWA and the SHA noise barrier team on proper implementation of Federal Highway Noise Regulations and Guidance. If you concur with this request, please provide appropriate point of contact.

Response 30:
Proposers may meet with the SHA Noise Team by sending a request to the project email address. If additional guidance from FHWA is needed, SHA will follow up and report back to the Proposer(s).

Question 31:
A fiber optic exists along I-270. Can this fiber optic be utilized for the project?

Response 31:
The Administration has determined that up to 4 fibers may be dedicated to this project.

The following question was received on October 13, 2016.

Question 32:
The RFP requests us to "*Discuss what modifications would be needed to the proposed Watkins Mill Interchange project to be compatible in a safe and efficient manner with your Innovative Congestion Management improvements.*" In order to properly reply to that question may we please have the latest Watkins Mill Interchange plans to review so the proper analysis can be made.

Response 32:
The Watkins Mill Interchange plans were previously posted on ProjectWise on June 7, 2016. The Proposer shall discuss what modifications would be needed to the proposed Watkins Mill Interchange as shown in that information.

The following questions were received on October 15, 2016.

Question 33:
Please furnish the 2015 Calibration Report for the I-270 Vissim models.

Response 33:
See response to question 21.

Question 34:
Please furnish contact information for Network Maryland.

Response 34:
Contact information for Network Maryland can be found on the Maryland Department of Information Technology's (DoITs) website.

Question 35:
Page 2 of the RFQ/RFP indicates that all costs for ROW acquisition will be subtracted from the established cost for Construction Services, and that ROW acquisition will be completed by the Administration. Please specify and generally describe applicable SHA costs related to ROW acquisition, e.g. purchase cost, legal fees, assessment fees, GEC fees, SHA staff, etc.

Response 35:
Only the final negotiated purchase cost of the ROW will be subtracted from the Construction Services Fee. All SHA labor and overhead—including that of our ROW specialists who will make first offers, negotiate, prepare documentation, etc.—will not be subtracted from the contract budget. Please note, development of ROW needs and plats are included in the Design & Preconstruction Services, and, therefore, will be subtracted from the contract budget.

The following questions were received on October 17, 2016.

Question 36:
As indicated in the RFQ/RFP, the Mobility Section in our Technical Proposal is of Critical Importance is 16 pages and will represent 50% of our Technical score The other sections representing the remaining 50% are 30 pages are rated only Important. We request that the page count for the Mobility Section be increased to accurately represent the relative level of importance and scoring of our proposal. A suggested page count for the Mobility Section is 25-30 pages.

Response 36:
The Administration will increase the page count to 20 pages for the Mobility section with a future addendum.

Question 37:
We request that full page explanatory graphics not count against the total page count of a specific section when included in the Technical Proposal (and not the appendix).

Response 37:
The specified page limits shall include full page explanatory graphics.

The following questions were received on October 18, 2016.

Question 38:
Can SHA provide GIS information for existing stormwater management BMPs, drainage areas and storm drains along the I-270 corridor in Montgomery County and Frederick County?

Response 38:
Available GIS information has been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\08 - SWM GIS maps\

Question 39:
Please confirm the IS 270 Congestion Management contract shall be all-inclusive and not rely on any follow-up SHA or County contracts, such as future overlays to repair any stripping eradication efforts, to meet SHA or RFP requirements.

Response 39:
No resurfacing projects on I-270 are funded or programmed in the near future. Proposed improvements for the I-270 Innovative Congestion Management contract shall be all-inclusive and not rely on improvements provided in other projects.

The following questions were received on October 31, 2016.

Question 40:
Please confirm that since this is not a capacity addition project, but a congestion management and reduction project of existing roadway traffic that noise analysis and potentially new noise walls, or modifications to existing noise walls or other mitigation efforts, will NOT be required.

Response 40:
Per the RFP Contract Provisions, General Provisions, Terms and Conditions and Technical Requirements, the Design-Builder shall comply with all Federal, State and local laws, ordinances and regulations applicable to the activities and obligations associated with this project. The Design-Builder is responsible for determining whether noise mitigation will be required to implement the Design-Builder’s proposed improvements. Please note that noise analysis and mitigation may be required if, based on the scope of improvements, the NEPA defined project is considered Type I. Refer to the MDOT SHA Highway Noise Policy and 23 CFR 772 for additional information related to the definition of Type I projects.

Question 41:
Please confirm that if no new full time mainline or CD lanes are added to the existing I-270 typical section, noise analysis and potentially new noise walls or modifications to existing noise walls or other mitigation efforts will NOT be required.

Response 41:
See response to question 40. Full-time use is not a consideration for the determination of a Type I project. Part-time shoulder use would fall under the definition of a Type I project. Refer to FHWA's Use of Freeway Shoulder for Travel for additional information.

Question 42:
Please confirm that if revisions to current entrances and exit ramp configurations along the I-270 corridor are proposed, noise analysis and potentially new noise walls, or modifications to existing noise walls or other mitigation efforts will NOT be required.

Response 42:
See response to question 40.

Question 43:
If a noise analysis is performed utilizing current criteria on the existing I-270 configuration and traffic, (without any or with only minor improvement such as the installation of gantry's, detection or ramp metering made by the Design Builder) and the results indicate additional noise mitigation is required, will the design builder be required to provide such mitigation as part of the $100 Million dollar budget? If so what would be the limit of the mitigation – the entire corridor from the I-495 juncture to the I-70 interchange - or other limits.

Response 43:
All costs for noise mitigation required by the Design-Builder's project(s) to comply with all applicable Federal, State and local laws, ordinances and regulations, shall be a part of the contract budget. This includes any required Right-of-way and or Utility Relocations needed as a result.

Multiple environmental documents may be developed for the contract. Each separate project for an environmental document must be a standalone construction project that connects logical termini and be of sufficient length, have independent utility, and not restrict consideration of alternatives for other reasonably foreseeable transportation improvements. If the project is determined to be a Type I project, the level of mitigation required and the limits of that mitigation would be determined based on any noise analysis done for the environmental document(s) to meet applicable Federal, State and local laws, ordinances and regulations.

The following questions were received on November 2, 2016.

Question 44:
It was noted that the wetlands and waterways shapes and delineation report were a draft. Have they been finalized?

Response 44:
The wetland delineation report has been finalized and posted to ProjectWise at the location below:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\06 - Wetland Delineations\

Also, the shape files have been updated and replaced at the location below. Included is a CAD file of the wetlands and waterways (mEF_I270_16.1019.dgn).

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\B_Survey and Topographic Files\02 - Environmental Features Files\

Question 45:
Since noise mitigation does not contribute directly to meeting the project goals, would MDOT consider utilizing a separate funding mechanism for noise barriers?

Response 45:
Yes. The Administration has decided to use another funding source(s) for the construction of noise barriers. This will be reflected in Addendum No. 3.

The Design-Builder shall identify in its proposal where noise barriers may be required, including approximate locations and areas. As part of its design and preconstruction services, the Design-Builder will be responsible to complete all work related to providing a noise study to make a final determination on reasonableness and feasibleness related to noise abatement for the Design-Builder's project(s) to comply with all applicable Federal, State and local laws, ordinances and regulations.

The SHA will be responsible for final design and construction of any required noise abatement and the additional impacts or requirements they incur, including additional utility relocations, grading, drainage, SWM, retaining walls, etc.

Please note, responses to questions 40, 41, and 42 still apply. Also note, this response (45) supersedes the first paragraph of response 43.

The following questions were received on November 14, 2016.

Question 46:
Please provide a copy of the SHA application for Federal funding under the Integrated Corridor Management (ICM) program.

Response 46:
The requested document has been posted to ProjectWise at the location below:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\09 - Integrated Corridor Management\

Question 47:
With regard to communications for ITS field devices such as CCTV cameras, message signs, and ramp meters, we understand there are four (4) existing dark fibers on the corridor that are available for use by the design-builder. If so:

a) How do we obtain the exact locations of existing fiber conduits, pull boxes, and splice vaults?
b) Are we able to break into the fiber duct at any point to add additional pull boxes and splice vaults?
c) Can we splice into existing fibers at any new/existing pull box or splice vault?
d) Can we add additional fiber within the existing conduits?
e) Are there spare conduits in the existing ITS duct bank?
f) Does SHA have any mandatory standards on communication architecture or equipment? For instance, is there a requirement for Cisco-supplied switches or for GB Ethernet?

Response 47:
There are four (4) existing dark fiber strands on the corridor that are available for use by the Design-Builder. The locations of these strands were previously posted to ProjectWise and can be found at the following location:
pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\06 - ITS Information\

These four (4) fibers are a part of the MDOT's Resource Share Agreement (RSA) with Level 3. Only these four dark fiber strands are available for the Design-Builder to use. There are no other existing strands or conduits available for the Design-Builder's use. Level 3 owns the strands and requires that any splicing of the strands be performed by Level 3's certified splicers. Any associated cost for that splicing shall be part of the project budget. The RSA does allow for the ability to add new pull boxes and/or splice vaults but does not allow adding fiber to the existing conduits. Any new pull boxes and/or splice vaults must be coordinated with Level 3, and locations must be approved by Level 3. If the Design-Builder's solutions require additional conduit/fiber, the Design-Builder will be required to construct these new resources as part of their project.

SHA does not have any mandatory standards on communication architecture or equipment. However, the Administration values a project which will provide for ease of operations and maintenance. It is the Design-Builder's responsibility, per the RFP, to describe how its approach, including communication architecture or equipment, will ensure the SHA will have a fully functional system that is easily maintainable.

Question 48:
We request the SHA re-evaluate the DBE participation goal of 25% for the Design and Preconstruction phase of the project.

The Construction portion of this phase involves only Estimating and Project Management (no construction). It is unrealistic to ask the Construction firm selected to subcontract out ¼ of its estimating and or management functions. Those two key functions are never subcontracted out by any Construction firms as no firm would allow these two key functions to be performed outside of their organizations from both a propriety and leadership standpoint. This fact is recognized in the DBE requirements included in SHA's CMAR program where DBE participation is not required for this phase of the project. The following is taken from one of the recent CMAR RFQ's. *"The overall DBE participation goal will be 0% of the total Contract price for the Preconstruction Services. Due to the nature of the Contractor's role in the Preconstruction Design phase, the Administration has determined that there are insufficient subcontracting opportunities to justify a DBE goal on the Preconstruction Design phase."*

The above will therefore require that the full 25% of Design and Preconstruction services be shifted to the Engineering portion of the fee putting a DBE component of approx. 35% to 40% on the designer. As an innovative project requiring "World Class" expertise to identify and implement new innovative solutions specialize senior staff will be required from the firms other national or international offices. That staff is generally only found in large multinational engineering and planning firms - not local small DBE organizations. There are specific areas where DBE firms can be utilized (e.g. Outreach, Survey, Subsurface investigations, etc.) but these tasks do not come close to equaling 25% of the total Design and Preconstruction fee.

We respectfully request the Design and Preconstruction DBE requirement be lowered to no more than 5% to 10% of the total Design and Preconstruction fee. If desired by SHA, the resulting decrease in DBE dollars can be shifted to the Construction portion of the project so as to provide the same total DBE participation for the full $100 million dollar project budget as previously desired.

Response 48:
On Design-Build projects, typically 30% of the portion of the contract price allocable to professional services requires good faith effort to achieving DBE/MBE participation. Understanding that, in addition to the professional services, that the Contractor's preconstruction services are included in the Design and Preconstruction Services Fee, the Administration determined that overall 25% was a realistic MBE goal contract to be in line with 30% of professional services allocable to MBE participation. This would allow all preconstruction services to be completed the Contractor with a similar level of MBE for professional services to other Design-Build contracts. We believe there are other areas for DBE participation above those identified such as highway, traffic, drainage, stormwater management, erosion and sediment control, permitting, noise analysis, etc.

Question 49:
On normal DB and CMAR projects the different sections of the technical proposal are divided between several different groups to review and score totally independently. Will that be same on this project. Will the Technical Proposal be reviewed by three independent groups, do the individual groups see the other sections, and are the given the appendix?

On this project, that is so non typical and innovative, we request SHA review the above assumed procedures and have one team review and score the entire document. As a minimum we believe, if independently scored, the teams should have access to the entire document, including the appendix.

Response 49:
Yes, the technical proposal will be broken down into individual Evaluation Factors and evaluated independently by different evaluation teams as described in the RFP beginning on page 50. This is SHA's standard evaluation process that serves the organization well, regardless of the nature of the project.

The following question was received on November 27, 2016.

Question 50:
On page 41 Item 4 of the RFP "Effect of Submitting a Proposal" it states we are to "*perform the work for the price submitted within the time(s) specified*". We have found no time to be specified in the RFP for completion and Section B on pages 42 thru 47, which details what is to be included in our technical proposal, does not request a schedule or completion date. We therefore assume individual completion dates will be assigned to each construction package at the time the CAP's are determined. Please confirm our assumption or inform us where the completion date is specified or requested.

Response 50:
The schedule for design and completion of construction for each CAP will be determined by the Design-Builder as part of the submittal of its Technical and Price Proposal. See Response 2 (R2) in the Notice to Prospective Proposers dated June 17, 2016. The completion date shall be provided on Page 41 of 43 of the Price Proposal Form Packet.

The following question was received on December 1, 2016.

Question 51:
As a follow up to question number 49: Will the reviewers of the individual sections have access to the full technical proposal, including the appendix?

Response 51:
As stated in the RFP on page 51, "Each Evaluation Team will only be given the section or sections for each specific Evaluation Factor or Factors they are rating and not the Technical Proposals in its entirety. Evaluations will be limited to the information provided in the specific Evaluation Factor section and will not consider information provided in other sections." Each Evaluation Team will have access to the appendix, which is not rated. It should be noted the Evaluation Teams determine the initial technical ratings. The Evaluation Committee, which determines the overall technical ratings, will have access to the entire Technical Proposal and appendix.

The following questions were received on December 5, 2016.

Question 52:
RFQ Article XII.B.5.ii (Page 47) requires the proposer to "Discuss the services to be provided by the Design-Builder." Please clarify what services are to be addressed in this section of the Technical Proposal.

Response 52:
Discuss the Design and Preconstruction Services, and any other services the Design-Builder will provide that will best meet or exceed the goals of the project.

Question 53:
In the definition of Construction Agreed Price on pages 3 and 4 of the RFP, it states that a CAP "shall include all final design…" Please define "final design".

- Is this the design effort required to progress the design to 100% from the 65% state used for negotiation of the CAP?
- If the cost to progress the design from 65% to 100% is included in the CAP, what further design effort, if any, is required if SHA elects to bid a package competitively?

Response 53:
Final design for a work package, the cost of which is included in the CAP, is the design effort required to complete design for that work package. For example, if the CAP is initiated at 65% design, final design is the effort required to progress design from 65% to 100% release for construction drawings, including revisions/redlines. If the CAP is initiated at 90% design, final design is the effort required to progress design from 90% to 100% release for construction drawings, including revisions/redlines. Proposers shall identify in their proposals at what percent design completion (e.g. 65%, 90%, 100%, etc.) CAPs will be initiated. If SHA rejects the Design-Builder's price and bids the package competitively, no further design effort will be required by the Design-Builder. The Administration will terminate the process and complete design by some other means for that work package.

Question 54:
In the second paragraph addressing Construction Agree Price on page 4, it is noted that, "A proportionate amount of the Construction Management Fee will be included in the CAP." Is it the intent of the PDB process for the total amount of all executed CAPs to equal the sum of the Construction Management Fee bid item and the Construction Services Fee bid item, less any amount paid to third parties for ROW acquisition and utility relocation? If so, this seems inconsistent with the paragraph's first sentence that says, "A zero-dollar change order will be executed to subtract the amount of the CAP, and any associated right-of-way and utility relocation costs, from the <u>Construction services</u> costs..." (Emphasis added.)

Response 54:
Assuming the entire budget were to be spent and there were multiple independent projects, then the sum of the CAPs and amount paid to third parties for ROW acquisition and utility relocation for each project would add up to the Construction Services Fee submitted as part of the Price Proposal. Likewise the Construction Management Fee for each project would add up to the Construction Management Fee submitted as part of the Price Proposal.

Page 4 of the RFP goes on to state, "For example, if the Construction Management Fee was five percent when compared to the Construction services costs, this amount will be added to the CAP and subtracted from the original Construction Management Fee as part of the change order. Payment for the Construction of the project will be paid through an agreed upon work breakdown structure." Thus the change order pulls the CAP, ROW costs, and utility relocation costs from the Proposal Construction Services Fee, and pulls a proportionate amount from the Proposal Construction Management Fee. The purpose of the net zero dollar change order is to approve the CAP and create a pay item for it.

Question 55:
In the event that SHA executes its right to competitively bid a PS&E package, will there be any further obligation under this contract to provide design, preconstruction, or construction management services?

Response 55:
All Design and Preconstruction Services in the contract shall be provided until the Administration terminates the contract.

There is no obligation to perform Construction Management (CM) services until a CAP is accepted. If a CAP is not accepted, then the Design-Builder is not obligated to provide CM services for that work package. If a CAP is not accepted, this does not release the Design-Builder from its obligation to perform CM services for other CAPs that have been accepted.

Question 56:
On the bottom of Page 4 of the RFP in Section I.A, there is the subtitle **Design and Preconstruction Services**. The ensuing paragraph seems to be addressing the contract as a whole, including the Construction Management Fee and Construction Services Fee. Is there an inconsistency here?

Response 56:
The SHA is entering into a contract with the Design-Builder to complete the Design and Pre-Construction Services as required in the Technical Proposal. If SHA is agreeable to the CAP(s), then a net zero dollar change order will be executed for a CAP to include the PS&E package of that CAP. The Design-Builder cannot proceed with any Construction Services until SHA has approved a CAP and issued Notice to Proceed for the CAP.

Question 57:
At the bottom of RFQ page 48 in Section XII.C.2, it is noted that regional and home office overhead costs are to be included in the Construction Management Fee. No further guidance on overhead cost is provided in the ensuing table. Please clarify where to allocate the cost for establishing and maintaining a project office on the jobsite.

Response 57:
An engineer's office would be included in a CAP.

Question 58:
At the bottom of RFQ page 48 in Section XII.C.2, it is noted that general and administrative costs are to be included in the Construction Management Fee. Does this include all costs for indirect items such as Bond, insurance premiums, permits, licenses, and success fees? Might not

a separate mobilization bid item for a fixed amount of say $1,500,000.00 be appropriate for such one-time expenses?

Response 58:
If a separate mobilization item were included in the Schedule of Prices (SOP), it would apply to all work packages; however, each work package must be independent and severable. Like all other work items necessary for construction (e.g. construction stakeout, maintenance of traffic, class 1 excavation, etc.), mobilization for each work package will be included the CAP for that specific package. Permits and licenses are also included in the CAP(s). Any cost associated with providing requirements to submit a proposal, such as Proposal Guaranty for the overall $100 M contract, may be included in the Design and Preconstruction item.

Regarding Success Fees, refer to Response 4 (R4) in the Notice to Prospective Proposers dated June 17, 2016.

Question 59:
Please confirm that the "Traffic Control Plan Certification" is not relevant to this contract.

Response 59:
The Traffic Control Plan Certification Contract Provision should be completed with Option 3 checked as it is the Design-Builder's responsibility to provide any traffic control plan.

Question 60:
TC-4-02 Failure to Maintain Traffic indicates a $1,000 per day deduction for failure to maintain the project. Please clarify if this is only applicable to active work zones or if it is applicable to the entire length of I-270.

Response 60:
TC-4.02, Failure to Maintain Project, is applicable to the work as defined in GP-5.11, Maintenance of Work During Construction.

Question 61:
TC-7.05 addresses retainage on Progress Payments. Is it the intention of the Authority to hold retainage on the Design and Preconstruction Services Fee? Is this necessary when the Authority is only paying for "services actually provided and invoiced" as stated on in XII.C on page 48?

Response 61:
Retainage applies to all work under the contract.

Question 62:
Should execution of the Buy American Steel Form (Page 3 of 43 of the Contract) be deferred until CAP negotiation?

Response 62:
The Price Proposal form needs to be completed in its entirety and no portion of it can be deferred to a CAP.

Question 63:
The standard MDOT MBE Form A on Page 15 of 43 includes a certification referencing the "total dollar amount of the Contract" although the goal at the time of submission is only applicable to design work. Please clarify how this form is to be completed.

Response 63:
The form should be completed for the Design and Preconstruction Services. See response 56.

The following question was received on December 6, 2016.

Question 64:
We have had difficulty reproducing some of the results in the evaluation templates provided by SHA. We would like to be able to replicate the results to ensure the validity and comparability of all team's results.

Response 64:
The model must be run in **32-bit mode** to replicate the VISSIM model results that SHA has provided for every MOE.

The following question was received on December 7, 2016.

Question 65:
Does the Watkins Mill Interchange Project impact Level 3?

Response 65:
Yes. Design plans for the proposed relocation of Level 3 have been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\F_Watkins Mill Interchange Plans\Level 3 Relocation\

The following questions were received on December 8, 2016.

Question 66:
In the *General Requirements* on page 2 of Section I.A, it states that the Design-Builder shall complete all design and construction work in two phases, Phase IV - Final Design and Phase V – Partnering during design and construction, Review Shop Drawings, Revisions, Redesign Under Construction, As-Built Plans and provisions for expert court testimony. Please clarify the intent or significance of Phase IV and Phase V in the context of either this two-phase procurement or the two-phase contract.

Response 66:
The intent is to ensure that the consulting services provided and tasks performed by the Design-Builder during both phases of the contract comply with the Administration's policies and

procedures and the requirements set forth in "Volume II -Specifications for Consulting Engineers' Services," dated 1986.

Question 67:
A definition of *Opinion on Probable Construction Cost* (OPCC) is provided on page 3 in Section I.A. Please confirm that the OPCC is simply the aggregate construction cost of anticipated improvements and that these costs are expected to be incorporated into CAPs as the "Construction, labor, equipment, and materials and all incidentals necessary to complete the Construction of the package."

Response 67:
The OPCC is the actual Construction cost the Design-Builder estimates to build all aspects of a Construction package.

Question 68:
On page 4 as part of the definition of a CAP, it states that SHA will consider establishing a risk sharing pool with the Design-Builder during the Design and Preconstruction phase. Please clarify whether the funding for this risk sharing pool is from within or outside of the $100 million fixed value of the contract.

Response 68:
Risk sharing pools must come from the contract's fixed budget.

Question 69:
In the *General Requirements* in Section I.A and again in Section I.F *Scope of Services / Description of Work*, there are multiple references to "milestones". Please define these milestones.

Response 69:
Proposers shall determine what milestones are needed to deliver a well-managed project.

Question 70:
Section XII.C.1 defines the *Design-Builder Design and Preconstruction Services Fee*, noting that payment will be based on services actually provided and invoiced.

a. Subsequent language requires the Design-Builder to provide a fee breakdown. Is this Design-Builder requirement relevant to Proposal content or is this just guidance on how the successful proposer (the Design-Builder) is to bill for post-Award design services?
b. The final sentence of this segment indicates the Design-Builder shall provide a breakdown for each firm showing the estimated direct labor breakdown, estimated direct expenses, approved audited overhead, and profit. Is this also guidance on how the successful proposer (the Design-Builder) is to bill for post-Award design services for work performed by the Lead Designer and any subconsultants?

Response 70:
The fee breakdowns are not merely guidance. They are required of all Proposers in their Price Proposals.

Question 71:
Section XII.C.2 indicates that the Proposer will provide a breakdown of all components used in establishing the fee. Is this Proposer requirement relevant to Proposal content? If so, where in the Proposal should this information be provided?

Response 71:
This requirement shall be provided with the Price Proposal.

Question 72:
In response to Question #48, it was noted that "the Contractor's preconstruction services are included in the Design and Preconstruction Services Fee." Assuming that the table provided at the top of page 49 is applicable to the entire contract and not just to the Construction Phase, please provide guidance or examples for other types of Contractor costs that can be included in the fee for design and preconstruction services. Alternately, please confirm that the table on page 49 is only applicable to the Construction Phase thereby allowing Contractor project costs to be classified as preconstruction services during the Design Phase.

Response 72:
The table on page 49 is applicable to the Design-Builder's Construction Management services, which support the Construction Services and are not needed for nor applicable to the Design & Preconstruction Services.

Question 73:
Regarding ground mounted signs along the corridor: If a sign is proposed to be relocated without changing the content of the sign, does the sign material need to be upgraded to MUTCD standards?

Response 73:
Upgrading existing facilities to current standards when no safety or operational issues exist is not a contract goal. Existing signs that are not impacted and will remain in place do not necessarily need to be upgraded to MUTCD standards. However, once the Design-Builder changes the conditions in which that sign exists, including the sign's location or message, the sign should be upgraded to current MUTCD standards.

Question 74:
For signs mounted on cantilever or sign bridges: If a sign must be relocated to a different location without changing the content of the sign, does the sign material need to be upgraded to MUTCD standards?

Response 74:
Yes. See response 73.

Question 75:
If a sign remains in place with a different message, does the sign material need to be upgraded to MUTCD standards?

Response 75:
Yes. See response 73.

Question 76:
If a sign with the same message must be temporarily removed and replaced on a new structure in the same location without changing the message, or a different location on the same structure without changing the message, does the sign material need to be upgraded to MUTCD standards?

Response 76:
Yes. See response 73.

Question 77:
Are there any restrictions for including discussion of costs in the technical proposal?

Response 77:
No.

Question 78:
For the final proposal, can the PTC's and other Appendix data be presented in only electronic format and provide the required copies for the technical and cost proposal only?

Response 78:
Proposals shall include hard copies of the Concept Evaluation Templates. All other appendix materials may be saved onto a flash drive.

Question 79:
We would like to request the following data for six scenario years including the years 2015, 2020, 2025, 2030, 2035, and 2040:

A. Four OD trip tables for all scenarios, which are inputs to the 4th iteration highway assignment. These OD trip table names are i4_AM.VTT, i4_MD.VTT, i4_PM.VTT and i4_NT.VTT.
B. Two highway assignment loaded networks for all scenarios, which are outputs from the 4th iteration highway assignment. These loaded network names are i4_HWY.NET and i4_HWYMOD.NET.
C. The full MWCOG model transmittal folder with input files, scripts and all the supporting input data.

Response 79:
The MWCOG model input files and the documentation necessary to run the model successfully have been posted to ProjectWise at the following location:

pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\10 - MWCOG model\

Proposers can use these files to run the interim year models and generate loaded networks and time of day trip tables. This model set represents version 2.3.57a, the 2015 CLRP and Round 8.4 land use assumptions.

The following question was received on December 11, 2016.

Question 80:
We understand this is past the due date for questions and apologize for this late clarification request; however, we believe it may be in the Administration's best interest to provide additional information to the proposers on formatting of the Technical Proposal and Appendix. The only guidance provided is that the Technical Proposal (including appendix) shall be in a 3-ring binder and any "*Charts, exhibits, and other illustrative and graphical information may be on 11"-by-17" paper, but must be folded to 8.5"-by-11", with the title block showing. An 11"-by-17" sheet will be considered only one page*."

It may be inconvenient to unfold and then refold each sheet individually as your team reviews the material and we may not be able to fit, in a reasonably sized single 3-ring binder, if tri-folded. We respectfully request the appendix be allowed in its own 11"x17" binder with unfolded sheets.

Response 80:
The appendix can be in its own 11"x17" binder with unfolded sheets. Also, see Response 78.

The following question was received on December 16, 2016.

Question 81:
Question 70 addressed a cost breakdown that must be provided by the Design-Builder. Question 71 addressed a cost breakdown that must be provided by the Proposer. In both cases, the SHA response indicates that the required breakdown must be provided with the Price Proposal. It is mandated on RFP page 40 that the "Price Proposal shall be submitted on the Price Proposal Form supplied by the Administration…" Would the aforementioned Article XII.C breakdowns be a supplement to the 43-page Price Proposal Form since there does not seem to be an appropriate place for inclusion within those 43 pages.

Response 81:
Yes, the cost breakdown should be a supplement submitted with the Price Proposal Form.

The following question was received on December 19, 2016.

Question 82:
We have been unsuccessful in exporting the document "Ver2.3.57a_Conformity_2015CLRP_Rnd8_4_Xmittal.zip" located in the following folder on ProjectWise:
pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\10 – MWCOG model\

We believe this is due to the zip folders size (25.48 GB). Would you please consider breaking this folder into smaller zip files, or extracting the files into the 10-MWCOG model folder so that we can download the information and put it to use on this project?

Response 82:
The files that were in the zip file "Ver2.3.57a_Conformity_2015CLRP_Rnd8_4_Xmittal.zip" have been extracted and placed at the following location on PW:
pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\H_Additional Material\10 - MWCOG model\Ver2.3.57a_Conformity_2015CLRP_Rnd8_4_Xmittal\

The following questions were received on December 23, 2016.

Question 83:
The fifth paragraph of TC-5.01 indicates that Workers' Compensation policies are the only exceptions to an endorsement requirement. Please note that such endorsements are not commercially available on a Professional Liability insurance policy because of the nature of the coverage. Accordingly, we request listing of Professional Liability insurance as an exception.

Response 83:
Professional Liability insurance may be an exception.

Question 84:
TC Section 5 Article .02.1 is an additional requirement for the Professional Liability Insurance Policy to provide various indemnifications. Please note that such indemnifications are not commercially available because of the nature of the coverage. Accordingly, we request deletion of this requirement.

Response 84:
This is a standard Special Provision for all Administration contracts and will not be modified.

Question 85:
TC Section 5 Article 02.4a establishes a requirement to name the State Highway Administration in various insurance policies, presumably meaning that the Administration must be named as an Additional Insured. Consistent with the questions addressing endorsements and indemnifications and with the nature of errors and omissions coverage, we request that Professional Liability Insurance be listed with Workers' Compensation as an exception to this requirement.

Response 85:
The said article states, "Each policy, with the exception of Workers' Compensation and Professional Liability Insurance, shall name the State Highway Administration."

Question 86:
TC Section 5 Article 02.4b uses "named insured" as an identifier, as was the case in 02.4a. Please consider revising the reference to Additional Insureds, assuming this is the intent of the requirement.

Response 86:
The said language, "named insured," is consistent with other provisions in SHA's Standard Specifications for Construction and Materials, 2008.

Question 87:
TC Section 5 Article 02.5 requires the insurance company to notify the Administration, the Design-Build Team, and each insured about policy cancellation or modification. The industry-standard Notice of Cancellation to Others will trigger appropriate notifications if a policy is cancelled, but it will not react to modifications. We suggest that the obligation for notification of policy modifications be eliminated or assigned to the design-builder. Alternately, could the Administration provide an example Notice of Cancellations to Others endorsement that they have accepted in the past?

Response 87:
This is a standard Special Provision for all Administration contracts and will not be modified.

The following question was received on December 24, 2016.

Question 88:
A safety and resurfacing project (Contract No. MO1865177) has appeared on the contractor's advertisement schedule. It appears to be located on I-495 near the southern end of the I-270 contract. The advertisement date is 2/14/17 and the NTP date is 5/22/17. Are plans available?

Response 88:
Yes. Plans have been posted to ProjectWise at the following location:
pw:\\SHAVMPWX.shacadd.ad.mdot.mdstate:SHAEDMS01\Documents\Design-Build\MO0695172\E_Appendices\11 - Other Projects\MO1865177 - IFB_PS&E- Design Plans.pdf

The following question was received on January 4, 2017.

Question 89:
Article VIII.B on page 23 of the RFP mandates meeting or exceeding the DBE Participation Goal for work performed under the Design and Preconstruction Fee bid item. Please clarify this requirement. Does the reference to a goal only pull in the goal for 25% DBE participation, or does this reference also pull in the subgoals for 9% female participation and 6% African-American participation?

Response 89:
The Design-Builder shall meet or exceed the DBE goals, including sub-goals, required by the Contract Provision AFFIRMATIVE ACTION REQUIREMENTS UTILIZATION OF MINORITY BUSINESS ENTERPRISES FOR STRAIGHT STATE CONTRACTS (page 3 of 10).

The following question was received on January 9, 2017.

Question 90:
The RFP states that the Contract MBE goal as shown in the Appendix is only applicable to the Design and Preconstruction item in the Price Proposal. The Design and Preconstruction item includes significant cost for items such as 'costs associated with providing requirements to submit a proposal, such as the Proposal Guaranty' (per Response 58) and the contractually required ACONEX project management software. There is no ability to provide MBE participation for these items or to help meet the MBE goal via the considerable construction to be performed under the CAPS, forcing the entire MBE participation for the Design and Preconstruction to be achieved via professional services participation. Is it SHA's intent that the MBE goal be achieved on the entire value of the Design and Preconstruction item, or may the MBE goal be interpreted to apply only to those professional services being provided by the Lead Design Firm and its subconsultants?

Response 90:
25 percent of the Design & Preconstruction Services Fee provided with the Price Proposal must be MBE. As mentioned in Response 48, the MBE goal has been adjusted down from what a typical design-build project would require to account for Preconstruction Services and Aconex costs. Also note, the Design-Builder is not required to include the Proposal Guaranty in the Design & Preconstruction Services Fee. The Design-Builder may elect to include the Proposal Guaranty in the Construction Services Fee.

The following questions were received on January 10, 2017.

Question 91:
Has the Maryland State Highway Administration issued a wage determination for the project based upon the (Anticipated) Notice to Proceed Date of March 2017?

Response 91:
Prevailing wage rates will be established with the CAP.

Question 92:
Will the Maryland State Highway Administration consider establishing indexed base cost for petroleum based products (diesel fuel, hot mixed asphalt pavements and slurry seal) and structural steel?

Response 92:
Any adjustments will be included in the CAP. Depending on the scope of the CAP, typical SHA adjustments for asphalt binder, pavement density, asphalt mixture, pavement surface profile, and diesel fuel will be included. While SHA does not have a standard structural steel adjustment, this can be discussed with the CAP and potentially included in a risk sharing pool.

The following question was received on January 11, 2017.

Question 93:
Please confirm the design builder must provide Aconex project management software for this project. The cost of providing that software from March 2017 thru March 2020 is almost 1/4 of a million dollars. In addition after that date access to the data base to retrieve the project records would not be available unless additional payments are made by SHA on a yearly basis. Several members of our team have existing service agreement with other software firms for similar Project Management tools that could be made available for use on this project for no cost and would provide the SHA the availability to recover their Project Records at no cost after March 2020.

Response 93:
Confirmed. The Design-Builder is to provide Aconex project management software per the RFP.

PTCS AND ADMINISTRATION'S PTC LETTERS

WELLINGTON POWER CORPORATION
ELECTRICAL INFRASTRUCTURE | ENERGY

177 THORN HILL ROAD
WARRENDALE, PA
15086
U.S.A.
+ 1.724.779.4000 P
+ 1.724.779.5070 F

December 15, 2016

Delivered via E-Mail

Maryland Department of Transportation
State Highway Administration, Office of Highway Development
707 North Calvert Street
Baltimore, Maryland 21202

Attention: Jason A. Ridgway, P.E.
Director-Office of Highway Development

Reference: Technical and Price Proposal Submittal
Contract No.: MO0695172, F.A.P. No.: N/A
Description: IS-270 Innovative Congestion Management Contract
Progressive Design-Build

Subject: Proposed Technical Concept: Revised PTC-01-Submission

Dear Mr. Ridgway:

Wellington Power Corporation, in association with Jacobs Engineering Group, provides revisions to their original and formal PTC-01 submission for review and consideration by MDSHA for the following portion of the above referenced project:

PTC-01: Active Traffic Management

1. **Revised -Written Proposed Technical Concept - 2016-12-14**
2. **Revised -ATM Deployment Schematic - 2016-12-01**

Yours,
Wellington Power Corporation

Craig J. Robash
Director – Infrastructure

crobash@wellingtonpower.com

A) Description: Detailed descriptive information and other appropriate information and appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.

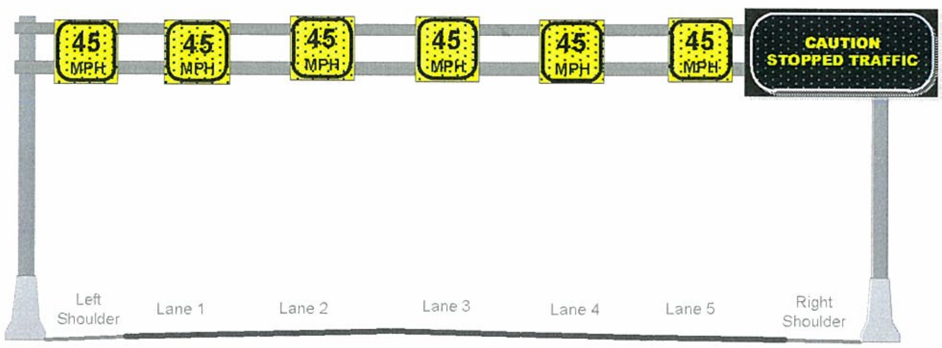
The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to implement Active Traffic Management (ATM) strategies along I-270 to improve mobility and predictability, enhance safety, reduce congestion, for the users of the I-270 Corridor and provide opportunity for a dynamically managed lanes to assist with dispersion of traffic in the event of abnormal traffic event or incident.

I-270 is one of the most travelled in the State with average daily traffic count of about 240,000 vehicles in many segments. It is one of the most congested corridors in Maryland and the Washington, DC region with strong directional peaks. It operates with over-saturated conditions and extended peak periods that greatly impacts reliability. Much of the corridor is over capacity, and operates at unacceptable levels of service. Reliability in the corridor is a significant challenge throughout the year.

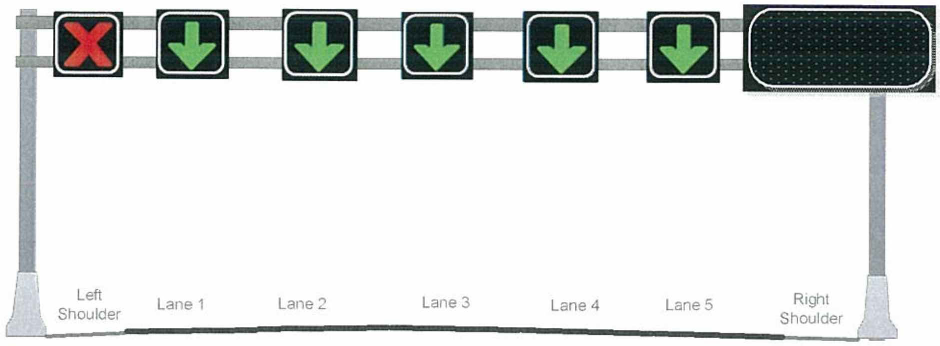
Mobility is the goal of the I-270 corridor traveler who expects a reasonably freely moving trip, predictable with minimum disruptions; rapid removal of incidents; adequate real-time communication of roadway conditions; corrective action taken at operational and safety hot-spots; the provision of alternate/bypass routes for the diverting of traffic to maintain traffic flow within the corridor; in other words, the total management of the corridor network at all times.

ATM is the ability to dynamically manage recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions. Focusing on trip reliability, it maximizes the effectiveness and efficiency of the facility. ATM increases throughput and safety using integrated systems with new technology, including automated dynamic deployment. The use of dynamic deployment optimizes performance quickly and without the delay that occurs when operators must deploy operational strategies manually. ATM approaches focus on influencing travel behavior with respect to lane/facility choices and operations. ATM strategies can be deployed singularly to address a specific need such as the utilizing adaptive ramp metering to control traffic flow or can be combined to meet system-wide needs of congestion management, traveler information, and safety resulting in synergistic performance gains.

ATM is deployed as a combination of a central computing system (advanced traffic management system software) with decision support capability along with field infrastructure of dynamic message signs and lane use signals (LUS) over the roadway to convey lane use and advisory speed.



Typical Advisory Speed and Traveler Notification



Typical Lane Use Notification

ATM is not a stand-alone system of field devices. These devices are controlled by an advanced traffic management system (ATMS). This "back-end" software manages top-down, integrating technology primarily to improve the flow of vehicle traffic and improve safety. Real-time traffic data from cameras, sensors (detectors on each gantry), etc. flows into the ATMS software where it is integrated and processed (e.g. for incident detection), and results in actions taken (e.g. traffic routing, lane closures, incident response, DMS messages, etc.) with the goal of improving traffic flow. For the ATM strategies proposed on I-270, this real-time data is processed by an ATM software solution that uses a sophisticated decision support system (DSS) to implement the ATM strategies. This DSS uses expert knowledge and predicted traffic conditions to make solution recommendations that:

- Predicts traffic issues in advance
- Responds faster to recurring and non-recurring congestion.

This results in smoother, safer and more predictable commuter experience and travel times.

We are proposing to provide Cubic Transportation System's Surface Transport Management (STM) system software as the back-end ATMS as further detailed in this PTC and the attached Concept of Operations.

Our implementation of ATM provides the following tools that the current (CHART) system does not provide:

- Mechanism to reduce mainline speeds
- Increased knowledge of traveler information
- Lane control and incident warning
- Ability to accommodate peak period capacity increases
- Constant real-time travel times at major decision points
- Flexible lane use and control that would be appropriate for the varying conditions

The following ATM concepts have been identified for implementation along the I-270 Corridor. Operationally, these concepts, when deployed will integrate and work together to form a comprehensive traffic management system that SHA can utilize to dynamically manage traffic to the benefit of motorists, commercial vehicles, and emergency responders.

Many of these concepts are conveyed via dynamic signing over each lane on gantries across the roadway.

The gantry spacing will be based on a design objective of 1/2- mile spacing (nominally). This spacing generally results in the desired 2 gantries being visible at any given time while travelling the controlled corridor. The final spacing and location of the gantries will be based on the following:

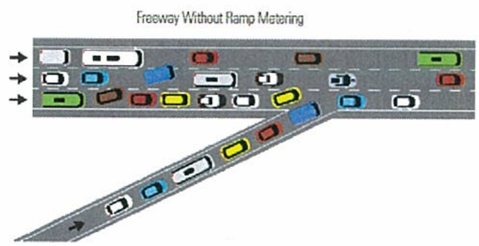
- Ability for a motorist to clearly see one and preferably two gantries in advance
- Satisfactory site distance to read and comprehend message (no obstructions from horizontal or vertical curves, other sign structures or overpasses)
- Gantries located at least 800 feet from any other guide sign, the preferred distance is 1,000 feet.
- Sight lines – vertical and horizontal visibility – 1,000 feet min sight distance
- Horizontal alignment – 30 deg cone of visibility
-
- Maximum of 19' vertical clearance required over roadway
- Collector/Distributor – Gantry/LUS location should be the same for mainline and C/D to minimize driver confusion. Locations with single barrier separation or no separation should be on same gantry.
- Downstream of interchange ramp merge – about 600-800 feet – communicate scheme to drivers entering section and after completing merge operation
- Upstream of interchange (before exit ramps and about 1800-2300 feet from interchange downstream gantry)

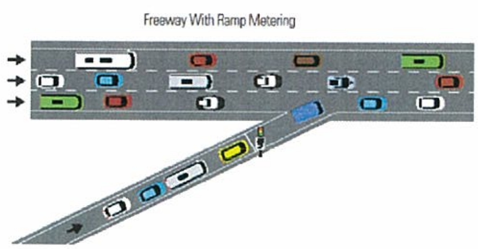
Where necessary, existing static signs have been combined on gantries with the LUS to eliminate sign congestion while ensuring that the deployment meets the five basic requirements of traffic control device implementation:

- Fulfill a need;
- Command attention;
- Convey a clear, simple meaning;
- Command respect from road users; and
- Give adequate time for proper response.

- **Ramp Metering (RM)**: This strategy consists of deploying traffic signal(s) on ramps to dynamically control the rate vehicles enter a freeway facility. This in essence, smooths the flow of traffic onto the mainline, allowing efficient use of existing freeway capacity. RM utilizes traffic responsive or adaptive algorithms (as opposed to pre-timed or fixed time rates) that can optimize either local or system-wide conditions. In an ATM approach, real-time and anticipated traffic volumes on the freeway facility will be used to control the rate of vehicles entering the freeway facility. Based on the conditions, the ramp meter rates will be adjusted dynamically. Ramp Meter Locations consist of several field devices working together to provide input to the traffic controller and back-end software to determine appropriate timings. The following items will be included in our implementation of a ramp signal deployment:
    - Metering Traffic Signal - Indicates to driver when they can enter I-270 (green ball) or to wait (red ball).
    - Ramp Meter Signage – A yellow "RAMP METERED WHEN FLASHING" light along with static signage, indicating that ramp metering is active.

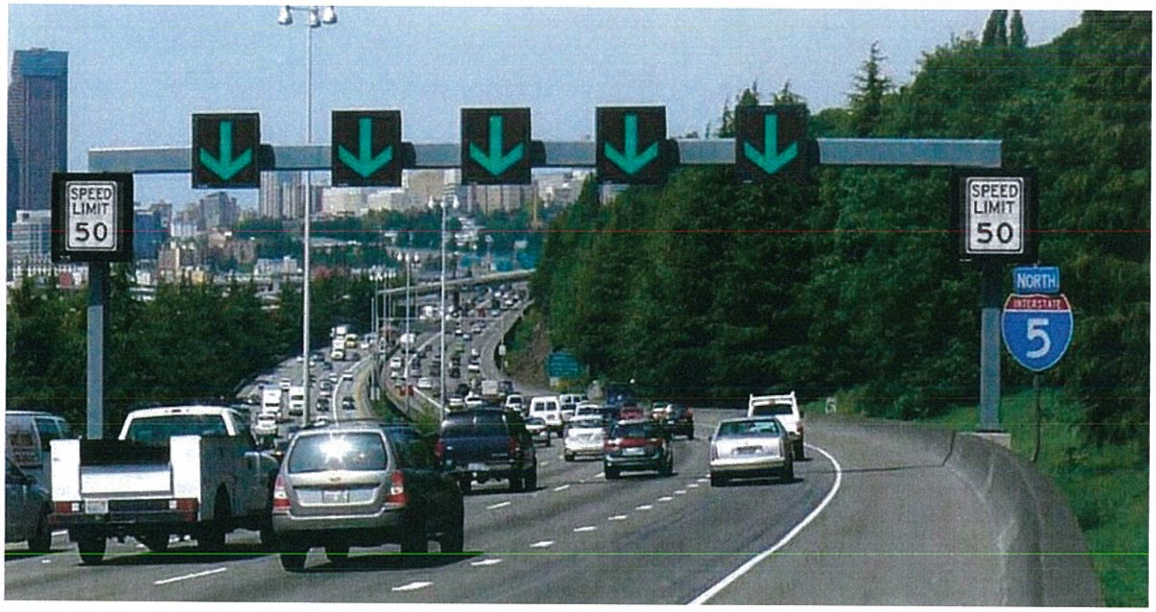
- Demand Detectors - Notifies controller that a vehicle is waiting at the meter and that the signal should be turned to green.
- Passage Detectors - Notifies controller that a vehicle has passed through the meter and that the signal should be turned to red.
- Queue Detector - Notifies the controller that there is a significant queue so that the metering rate can be adjusted to prevent spillover onto the arterial street.
- Ramp Controller - Controls the ramp metering rate.
- Lane Detectors - Measures the mainline flow volume, occupancy and speed.
- Statewide Operations Center (SOC) - Collects vehicle traffic flow and freeway condition information upstream, downstream, and at ramp entrance. The ramp metering system is automated but can be manually controlled at the SOC as necessary.





Source: Washington State DOT

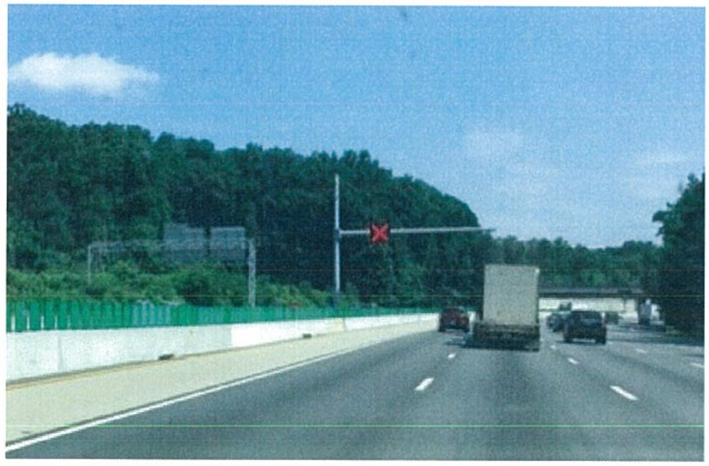
- **Dynamic Lane Assignment (DLA):** This strategy involves dynamically closing or opening of individual traffic lanes as warranted and providing advance warning of the closure(s) (typically through dynamic lane control signs), to safely merge traffic into adjoining lanes. In an ATM approach, as the network is continuously monitored, real-time incident and congestion data is used to control the lane use ahead of the lane closure(s) and dynamically manage the location to reduce rear-end and other secondary crashes.



A DLA installation consists of a series of overhead gantries or roadside signs (depending on the scope of the application) that dynamically change to indicate whether a given lane is open, closed, or about to end. Our implementation of the DLA system includes the following components:

- Vehicle Detection - DLA does not necessarily require a vehicle detection component, however a fully-automated system that we are proposing would require that some feedback on traffic conditions be provided before opening or closing a certain lane.
- Video Coverage – For safety reasons, we are proposing our DLA installations will have full camera coverage of the area of implementation so that the absence of disabled vehicles or other debris can be verified prior to opening a lane to upstream traffic.
- DLA Display Device – Typically a character-matrix dynamic message sign. These display devices will be centered over individual lanes to better notify drivers.
- DLA Support Structure – For a full roadway DLA implementation, these structures will span all lanes. For a more limited installation (such part-time shoulder running – addressed later in this document), structures will be cantilevered over specific lanes.
- Power and Communications Infrastructure – DLA devices are low-power, low-bandwidth devices so the power and communications requirements are relatively minor. DLA systems ~~can~~ will be powered by ~~either solar or~~ hard wired sources and can communicate via either Ethernet, serial, ~~cellular~~ or leased line data.
- Back-end command and control system – Typically an ATMS software application.

- **Dynamic Shoulder Lanes (DSL):** This strategy enables the use of the shoulder as a travel lane(s), also known as part-time shoulder running (PTS), based on congestion levels during peak periods and in response to incidents or other conditions as warranted during non-peak periods. In contrast to a static time-of-day schedule for using a shoulder lane, an ATM approach continuously monitors conditions and uses real-time and anticipated congestion levels to determine the need for using a shoulder lane as a regular or special purpose travel lane (e.g., HOV only). Our ATM implementation of DSL will primarily use the inside shoulder as an HOV lane during HOV regulated periods. This shoulder use will be in the sections of the full ATM deployment. PTS will also be used along I-270 northbound between MD 121 and MD 85. In this section, we will utilize PTS only (not variable advisory speed or DLA). A secondary benefit of our approach to PTS is that we will be able to use the left shoulder as an additional general purpose lane during both planned events such as road construction or maintenance or unplanned events such as crashes.



A DSL installation consists of a series of overhead gantries and roadside signs (depending on the scope of the application) that dynamically change to indicate whether the shoulder lane is open, how it is being used (e.g., HOV) or closed to traffic. Our implementation of the DSL system includes the following components:

- Vehicle Detection – DSL does not necessarily require a vehicle detection component, however a fully automated system (as we are proposing) requires that some feedback on traffic conditions be provided before opening or closing a certain lane. This will be accomplished manually by viewing CCTV cameras that will have a viewing area of the entire ATM-deployed area. An alternative is to use Video Incident Detection (VIDS) which will provide both the ability to determine if the lane is open (using presence detection) and the ability to detect when there is an incident (crash, debris, etc) in the lane while it is operating. Our system will be capable of being fully automated or manually controlled by the operator.

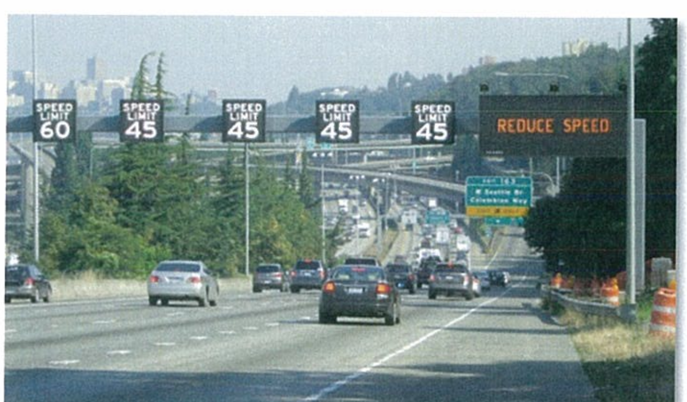
  The VIDS will use fixed cameras over the part time shoulder (PTS) areas to provide full shoulder coverage through multiple detention zones. We will be augmenting the video surveillance along the entire corridor with full PTZ CCTV cameras. These cameras will have vision of the PTS lanes in addition to the fixed VIDS.

  The camera sensor would be the only field device (located on the gantry) with all video streaming back to central processors (at the MDOT data center) for analytics based on static detection zone configurations. Location-specific alarms would be sent to STM which would then alert the operator through their personal user interface at the SOC. Operator alert configurations may be dependent upon if the lane is closed, preparing to be opened, or opened.

  All alarms will be logged/recorded by STM, and the extent of the logging is configurable by the network administrator.

- Video Coverage – For safety reasons, we are proposing our DSL installations will have full camera coverage of the area of implementation so that the absence of disabled vehicles or other debris can be verified prior to opening the shoulder to upstream traffic. Video coverage will also assist operators to determine if the shoulders should be closed due to an incident to allow passage of emergency vehicles along the shoulder.
- DSL Display Device – These signs are the same as the DLA signs described previously. These display devices are often centered over the shoulder to better notify drivers.
- DSL Support Structure – Support structures will typically span all mainline and ramp lanes if being utilized in conjunction with dynamic lane use control, variable speed limits, or queue warning. Locations where DSL is the only strategy employed will utilize a cantilever sign structure over the shoulder (see photo above).
- Emergency Refuge Areas – These are locations built outside the shoulder that provide disabled vehicles a place to pull over when the shoulder is in use. Where we utilize the right shoulder for PTS and there is not sufficient inside shoulder, we will implement emergency refuge areas at approximately half mile increments. Where we operate the left lane as the PTS and maintain the full-width right shoulder, we will not provide refuge areas. These refuge areas will be constructed with a minimum 16' width to ensure separation of a disabled vehicle or two truck rom the travel lane. Sufficient tapers (~300') will be provided as well with full-width lengths at least 110'.
- Power and Communications Infrastructure – we are proposing DSL devices that are low-power, low-bandwidth devices so the power and communications requirements are relatively minor. DJC systems ~~can~~ will be powered by ~~either solar or~~ hard wired sources and can communicate via either Ethernet, serial, ~~cellular,~~ or leased line data.
- Back-end command and control system – Typically an ATMS software application. The CHART software currently does not provide the functionality necessary for this strategy.

- **Variable Advisory Speed (VAS):** This strategy posts advisory speeds based on real-time traffic, roadway, and/or weather conditions. Dynamic speed limits can either be enforceable (regulatory) speed limits or advisory speeds, and they can be applied to an entire roadway segment or individual lanes. In our approach, we are proposing to implement advisory speed management (yellow and black), however, the signs that we are proposing are full color, full-matrix signs that will allow any display including regulatory speed limit signs (black and white) should SHA desire this control. In an ATM approach, real-time and anticipated traffic conditions are used to adjust the speeds dynamically to meet an agency's goals/objectives for safety and mobility.



Our implementation of the VAS system includes the following components:

- Vehicle Detection Device - VAS requires vehicle detection for volume, speeds and/or occupancy along the corridor to operate in an automated manner. I-270 is currently outfitted with a sampling of microwave vehicle detection devices. The density of devices and reporting frequency is not currently sufficient to meet the VAS needs. Third party probe-based data available through RIITIS does not provide the necessary temporal or spatial resolution. Additional infrastructure-based detection will be deployed as outlined in the DLA section above.

- Video coverage – Video coverage is not required, but is helpful in verifying and monitoring conditions back at the SOC. In our use of VAS we will implement full video deployment in the full ATM-deployed areas as detailed in Appendix 2. These pan, tilt, zoom cameras will be used to verify the sign displays as well as monitor traffic conditions.

- VAS Display Device – Full- color, full-matrix dynamic message sign. We propose to use these signs in conjunction with the existing ground-mounted static regulatory speed limit signs. These signs are flexible enough to display any message (within reason of the sign's size) including advisory or regulatory speed limits signs. Some agencies, such as the New Jersey Turnpike Commission utilize larger, full-matrix DMS that are configured to mimic a static sign.

- VAS Support Structure –VAS devices in our deployment will be installed on overhead gantries or sign structures – one sign per lane.

- Power and Communications Infrastructure – VAS devices that we are proposing are low-power, low-bandwidth devices so the power and communications requirements are relatively minor. VAS systems ~~can~~ will be powered by either solar or utility hard-wired sources and can communicate via either fiber network, Ethernet, serial, ~~cellular,~~ or leased line data.

- Back-end command and control system – An ATMS software application. CHART currently does not support this capability in its functional menu.

- **Queue Warning (QW):** This strategy involves real-time displays of warning messages (mounted on dynamic message signs) along a roadway to alert motorists that queues or significant slowdowns are ahead. Used in conjunction with variable advisory speed limit, this strategy reduces rear-end crashes and improves safety. In an ATM approach, as the traffic conditions are monitored continuously, the warning messages are dynamic based on the location and severity of the queues

and slowdowns.

Our implementation of a QW system includes the following components:

- Vehicle Detection Device – These devices can utilize in-pavement sensors, radar sensors, video detection, probe data, or any other source to collect lane-based vehicle presence, speed, and occupancy. Vehicle detection devices are placed in strategic locations to locate the back of a queue of vehicles upstream of an incident or bottleneck in order to warn approaching motorist. Our implementation calls for non-intrusive radar detection sensor mounted to the side of I-270.
- Video coverage – We ae proposing full video coverage for verifying and monitoring queue back at the SOC.
- Warning Display Device – We are proposing to utilize DMS on the sign gantries (see figure above) to convey the queue warning. On the same gantry, the lane control signals will advise speed changes.
- Power and Communications Infrastructure – QW detection devices are low-power, low bandwidth devices so the power and communications requirements are relatively minor. Depending on the messaging device, more robust power may be required, however many detection devices ~~can~~will be powered by ~~either~~ hard wiring ~~or solar~~. QW systems can communicate via either fiber optic, Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Back-end software is required for the operation of a corridor-wide queue warning system. Of specific importance is the algorithm used to generate the warning. The proposed ATM software will provide this capability. Existing functionality will be referenced during system design and any required modifications or enhancements to meet design requirements will be included in the capital project.

The implementation of these strategies will follow Federal and SHA guidelines and policies. We will perform all contract engineering services in accordance with the current editions of the following references, their interim specifications, their successor replacement references, and all other pertinent guidelines and memoranda as released by FHWA, AASHTO, and SHA including, but not limited to the following publications:

- The Manual of Uniform Traffic Control Devices (MUTCD);
- The Institute of Transportation Engineers (ITE);
- ITE Transportation and Engineering Handbook;
- ITE Manual of Traffic Engineering;
- ITE Manual of Traffic Signal Design;
- The Transportation Research Board (TRB);
- The Highway Capacity Manual (HCM);
- The Uniform Vehicle Code and the Model Traffic Ordinance;
- FHW A Guidelines, Practices, and Design Manuals;
- The Maryland Vehicle Law Book;

- National ITS Architecture and National Transportation Communications for Intelligent Transportation Systems Protocol (NTCIP) Standards and various communications and ITS standards of guidelines as they become available from organizations such as ITS America, the I-95 Corridor Coalition, Federal Highway Administration (FHWA), American National Standards Institute (ANSI), Society of Automotive Engineers (SAE), Federal Communications Commission (FCC) and Institute of Electrical and Electronic Engineers (IEEE)
- AASHTO: A Policy on Geometric Design of Highways and Streets; and
- SHA's "Specifications for Consulting Engineers' Services" dated April 1986.

B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.

The ATM solutions will be deployed along both directions of I-270 and along the mainline and collector/distributor lanes as depicted in Appendix 1 and below.

This PTC presents the ATM technologies and deployment methodology we will use. It also presents the maximum extent of anticipated locations of our deployment. Final locations of deployment will be based on final pricing of our proposal. As such, we have structured this PTC to have severable locations of deployment. The final PTC submitted with our proposal will present the locations included in our proposal for the $100 million contract value.

The full implementation of ATM, including:

- Ramp metering - We have identified forty-three (43) ramps that may benefit from RM. The following table identifies these ramp meter locations.

RAMP ID	Ramp Location
SB-E1	FR IS 70 EB TO IS 270 SB
SB-E2	FR MD 85 EB TO IS 270 SB
SB-E3	FR MD 80 EB TO IS 270 SB
SB-E4	FR MD 109 EB TO IS 270 SB
SB-E5	FR MD 121 WB TO IS 270 SB
SB-E6	FATHER HURLEY BLVD WB TO IS270 SB
SB-E7	FATHER HURLEY BLVD EB TO IS270 SB
SB-E8	FR MD 118 WB TO IS 270 SB
SB-E9	FR MD 118 EB TO IS 270 SB
SB-E10	FR MIDDLEBROOK RD EB TO IS 270 SB
SB-E11	FR MD 124 WB TO IS 270 SB
SB-E12	FR MD 117 EB TO IS 270 SB
SB-E13	FR IS 370 WB TO IS 270 SB
SB-E14	FR SHADY GROVE RD WB TO IS 270 SB

RAMP ID	Ramp Location
SB-E15	FR SHADY GROVE RD EB TO IS 270 SB
SB-E16	FR MD 28 WB TO IS 270 SB
SB-E17	FR MD 28 EB TO IS 270 SB
SB-E18	FR MD 189 WB TO IS 270 SB
SB-E19	FR MD 927 WB TO IS 270 SB
SB-E20	FR MONTROSE RD EB TO IS 270 SB
SB-E21	FR MONTROSE RD EB TO IS 270 SB
SB-E22	FR RAMP 10 (FR MD 187B) TO IS270
SB-E23	FR MD 187 NB TO IS 270 EB
NB-E1	FR MD 355 NB TO IS 270 WB
NB-E2	FR MD 187B SB TO IS 270 WB
NB-E3	FR MD 927 EB TO IS 270 NB
NB-E4	FR MD 927 WB TO IS 270 NB
NB-E5	FR MD 189 EB TO IS 270 NB
NB-E6	FR MD 28 EB TO IS 270 NB
NB-E7	FR MD 28 WB TO IS 270 NB
NB-E8	FR SHADY GROVE RD WB TO IS 270 NB
NB-E9	FR SHADY GROVE RD WB TO IS 270 NB
NB-E10	FR IS 370 EB TO IS 270 NB
NB-E11	FR IS 370 EB TO IS 270 NB
NB-E12	FR MD 124 EB TO IS 270 NB
NB-E13	FR MD 124 WB TO IS 270 NB
NB-E14	FR MD 118 WB TO IS 270 NB
NB-E15	FR RIDGE RD EB TO IS 270 NB
NB-E16	FR RIDGE RD WB TO IS 270 NB
NB-E17	FR MD 121 EB TO IS 270 NB
NB-E18	FR MD 109 WB TO IS 270 NB
NB-E19	FR MD 80 WB TO IS 270 NB
NB-E20	FR MD 85 WB TO IS 270 NB

- Dynamic Lane Use Control - Along I-270, this strategy will be used to close lanes for incident management, work zones, etc. along the entire length of our deployment from I-495 (Capital Beltway) ~~to north of the proposed~~ along both I-270 spurs and north of the proposed Watkins Mill interchange. When all lanes are being used (during peak congestion periods, this strategy can close a lane to provide access for emergency vehicles. In the event of a full freeway closure, this system can inform motorists well in advance to gradually close lanes. Specific areas of use are illustrated in the attached deployment diagram.
- Dynamic Shoulder Lanes- For the IS 270 ICM project, the inside shoulders will be used for additional capacity as needed. The inside shoulder will be used as a travel lane during peak periods, and will act as the HOV lane during its current regulated times in the Full ATM deployment areas depicted in Appendix 1. DSL will also be used along I-270 northbound between MD 121 and MD 85. In this section, we will utilize DSL only (not variable advisory speed or DLA). Specific areas of use are illustrated in the attached deployment diagram.
- Dynamic Speed Limits - This strategy, and queue warning, will be implemented across the entire ATM deployment area and will serve to slow traffic down in advance of congestion related to recurring congestions, work zones, incidents, etc. Specific areas of use are illustrated in the attached deployment diagram.
- Queue Warning will be deployed from I-495 (Capital Beltway) to north of the proposed along both I-270 spurs and north of the proposed Watkins Mill interchange. This is the area of most congestion and includes the area containing the collector/distributor lane. Specific areas of use are illustrated in the attached deployment diagram.

C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the existing condition using models developed in and calibrated by SHA using Vissim analysis software. These models were used to compare the No Build and Build conditions, and show that, with proposed capacity improvement in place, and in conjunction with capacity improvements along downstream sections of I-270 to facilitate operations, during the AM peak hour, travel time along southbound I-270 from I-70 to Cabin John Parkway (along I-495) would be expected to improve by approximately 14 minutes, and that throughput along southbound I-270 would be expected to improve by over 5 percent; during the PM peak hour, travel time along northbound I-270 from Cabin John Parkway (along I-495) to I-270 would be expected to improve by approximately 7 minutes, and that throughput along northbound I-270 would be expected to improve by over 3 percent.

Active traffic management (ATM) dynamically manages recurrent and non-recurrent congestion based on prevailing and predicted traffic conditions. Focusing on trip reliability, it maximizes the effectiveness and efficiency of the facility. It increases throughput and safety through the use of integrated systems with new technology, including the automation of dynamic deployment to optimize performance quickly and without delay that occurs when operators must deploy operational strategies manually. ATM approaches focus on influencing travel behavior with respect to lane/facility choices and operations.

In conjunction with capacity improvements (temporary shoulder use), ATM will address all the project's goals as follows:

i. **Mobility** – Utilization of ATM will decrease the travel time, increase the throughput and improve predictability of travel along the Corridor, as compared to existing conditions along the Corridor. The benefits to mobility for each of our proposed ATM components is described below:

- Implementation of RM- The biggest benefit of ramp metering could be a result of breaking up platoons of vehicles passing through signalized intersections to on-ramps of I-270. Controlling vehicles entering the I-270 corridor spaces the vehicles merging with I-270 traffic. This ultimately enhances travel speeds along the corridor because through traffic can space itself for singular vehicles versus platoons of vehicles.
- Implementation of DLA – DLA provides flexibility in the usage of the travel lanes (and shoulders when necessary) permitting the most efficient use of the roadway capacity. Lanes can be opened or closed to traffic to reduce congestion or manage traffic around an incident, which thereby increases throughput. Ultimately, DLA provides for a more predictable trip because capacity can be managed to maintain maximum efficiency.
- Implementation of DSL – Using shoulders on an as-needed (part-time) basis increase availably capacity of the facility, increasing throughput while reducing travel times.
- Implementation of VAS – Variable speed management serves to harmonize speed by reducing the speed differential between lanes and therefore eliminating the incentive to change lanes. Improved traffic flow gives rise to smooth transitions across time and space which result in additional throughput and reduced travel times.
- Implementation of QW – QW's primary result is one of safety, by warning vehicles of queued traffic ahead. This reduces crashes and ultimately makes for a more predictable trip.

ii. **Safety** – Utilization of the ATM has potential to reduce congestion-related crashes occurring during the hours of the most. In conjunction to adding capacity to the Corridor (See other PTCs), the through lanes will operate at more consistent speeds, decreasing stop-and-go conditions conducive to traffic incidents. The benefits to safety for each of our proposed ATM components is described below:

- Implementation of DLA – DLA, though it's provision of managing available capacity through lane assignments improves safety by closing lanes in advance of crashes or work zones, while proving the added benefit of closing a lane to provide emergency responders a lane to a crash. Implementation of DSL – similarly to DLA, DSL provides responders an access lane to respond to crashes. The sooner a responder can arrive at a crash, the sooner the lanes are re-opened, and the less time available for secondary accidents.
- Implementation of VAS – as noted in the mobility section, VAS serves to harmonize speed which reduces sudden changes in speed and abrupt lane changes (by reducing the speed differential between lanes and therefore eliminating the incentive to change lanes). Improved traffic flow gives rise to smooth transitions across time and space which result less turbulence and improved safety.
- Implementation of QW – QW has the most significant impact on safety by warning of impending queues ahead. This results in fewer crashes.

The following table illustrates the Mobility and Safety goal attainment from the implementation of the ATM strategies.

Project Goal / Application	Variable Advisory Speed	Queue Warning	Dynamic Junction Control	Dynamic Lane Assignment	Dynamic Shoulder Lane	Ramp Metering
Mobility – Maximize Throughput	**X**		**X**	**X**	**X**	**X**
Mobility – Minimize Travel Time	**X**	**X**	**X**	**X**	**X**	**X**
Mobility – Create a More Predictable Commuter Trip	**X**		**X**	**X**	**X**	**X**
Safety – Provide a Safer IS 270 Corridor	**X**	**X**		**X**	**X**	

iii. **Operability / adaptive/ maintainable** – ATM is not a stand-alone system of field devices. These devices are controlled by an advanced traffic management system (ATMS). The ATMS view is a top-down management perspective that integrates technology primarily to improve the flow of vehicle traffic and improve safety. Real-time traffic data from cameras, sensors (detectors), etc. flows into the ATMS software where it is integrated and processed (e.g. for incident detection), and result in actions taken (e.g. traffic routing, lane closures, incident response, DMS messages, etc.) with the goal of improving traffic flow. For the ATM strategies proposed on I-270, this real-time data is processed by an ATM software solution that uses a sophisticated decision support system (DSS) to implement the ATM strategies. This DSS uses expert knowledge and predicted traffic conditions to make solution recommendations that:

- Predicts traffic issues in advance
- Responds faster to recurring and non-recurring congestion.

Data integration is supported at two levels. System-to-system integration allows the STM platform to exchange data with other software, such as CHART and, through various interfaces and protocols. System-to-device integration allows the platform to communicate directly with equipment such as road signs and monitoring sensors. The open, flexible nature of the platform architecture facilitates extension to include additional protocols and interfaces for new or legacy systems.

The platform has a comprehensive data storage facility, where data received from the individual sensors is stored alongside incident data and their associated strategic responses. Over time this builds into a rich store of data to which advanced analytics can be applied, to gain real-time insight into the current situation, as well as predict future circumstances within the road network. The data storage also provides a basis for a comprehensive management reporting facility which includes dashboard functionality as well as pre-configured performance reports as outlined in MAP-21.

This results in smoother, safer and more predictable conditions.

The ATM software that will be provided for this contract will be intuitive to the operator and will follow standard ATM nomenclature and processes.

Further, the software will be expandable to allow for future ATM strategy deployment anywhere on the SHA network. The proposed software has additional features that may be valuable in the future including smart parking (to manage park & ride lots) and high-occupancy toll lanes.

The software is a mature product, having been implemented in many places around the world which makes for a reliable implementation and operation within SHA. It has been developed using standard software development tools. Further it is provided with user, administrator and maintainer documentation.

It will be implemented after sufficient training on its use, administration and maintenance. Further, it will be supported by its vendor as part of the contract.

iv. **Well managed project** – The implementation of ATM and the training of SHA users (CHART operators, system engineers, etc.) will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order to develop a facility that addresses project goals and fulfills SHA's expectations. Project success rests greatly on the planning and preliminary engineering effort up front to ensure that the system delivered is suitable to SHA, delivers the proposed functions and achieves the operational goals of SHA.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right for Way** – There are no anticipated Right of Way impacts associated with this PTC. The proposed improvements will be performed within the existing footprint of pavement.

ii. **Geotechnical** – Little geotechnical information is available for proper design of the ATM gantries and other intelligent transportation system devices (CCTV poles) foundations. For the purposes of estimating foundation costs, assumptions must be made. Upon selection, additional geotechnical borings will be taken to confirm geotechnical assumptions for structures at each gantry installed.

iii. **Utilities** – There are limited utility impacts associated with this PTS. The final location of gantries and overhead sign structures can be adjusted sufficiently to avoid any conflicts with utilities at foundation locations for lateral dry or wet utilities such as fiber or water/sewer line/drainage culvert conflicts. Review of available utility information reveals no conflicts with wet utilities such as water or sewer lines for any sufficient length longitudinal to the corridor. Review of fiber and electrical facilities indicates there are longitudinal runs of electrical lines and fiber optic, however, we do not foresee any significant conflicts.

iv. **Environmental Permitting** - There are no anticipated impacts to environmental resources which would require environmental permits.

v. **Local Community** – Utilization of the ATM and particularly the ramp metering, there may be some back-up onto local roads, however, this will be rare as the ramps will be modified to manage this issue.

vi. **Safety** – The implementation of ATM will result in the Corridor operating at more consistent speeds, will decrease stop-and-go conditions and reduce potential of rear-end crashes. During the construction, the traffic will be impacted the installation of ATM gantry foundations.

vii. **Life Cycle Project Infrastructure Cost** – The implementation of ATM will increase operating and maintenance costs to SHA with the addition of hundreds of additional signs and CCTV cameras. This investment however, will result in a safer, faster and more predictable trip along I-270. It will, however, result is decrease the life of the shoulder to that similar to a general purpose lane.

viii. **Maintenance** – ATM requires significant field infrastructure as well as complex ATMS software. These will require additional maintenance forces for the additional DMS, CCTV, detection sensors, and the new lane control signals. Further, a dedicated operator will be required in the SOC to oversee and manage the operation of the ATM software.

ix. **Education** – Most Maryland travelers, it can be assumed, are not familiar with these applications and the new signs on the road and usually have plenty of unanswered questions. Thus, it is important that agencies communicate with the public and inform them of new measures and regulations as they are put in place. Of particular note is the education and communication to explain the importance of speed compliance. Much of the success of the system is a result of speed harmonization, and travelers have to understand the importance of complying with the posted speeds. This outreach and education will come in the form of printed mailings, PSA's, and public meetings. Suffice it to say that outreach and education are paramount in achieving success.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

Much empirical data exists on the implementation of ATM. ATM strategies have a long history in Europe. Some strategies have been implemented in the US with significant results. Anecdotal evidence of their impact include:

Dynamic Shoulder Lane

In the Netherlands, a capacity increase of 7% to 22% was reported during the implementation of a hard shoulder (depending on the usage levels) along 620 miles of highway throughout the country. In addition, traffic volumes increased up to 7% during congested periods along those highways in the Netherlands.

Germany (who operates 125 miles of part-time shoulder use) reported a temporary increase of up to 25% in freeway capacity with the use of a shoulder as travel lane.

In England on the M42 Motorway from Junction 3A to Junction 7, capacity increased by an average of 7% to 9%.

A study on A4-A86 in France shows that capacity increases by about 900 vehicles per hour with the use of dynamic shoulder lanes. Compared to the capacities of regular cross sections, dynamic shoulder lanes increased capacity of the two (2) lane highway by around 30%, and the three (3) lane highway from 22% to 27%.

Queue Warning

Throughout 2012 and 2013 Caltrans utilized a QW system to alert motorist to backups resulting from heavy traffic attempting to enter a mall facility during peak holiday travel. Compared to the prior years, they documented a 66% reduction in the number of queuing related crashes after installing the system.

In 2010, Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable DMS) up to six miles in advance of the work zone. Over two (2) years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system.

Variable Speed Limits

Washington State DOT has implemented and managed variable speed limits on I-90 over Snoqualmie Pass to account for changing and severe weather conditions, one of the few variable speed limits (VSL) in the entire nation. WSDOT has found the VSL to be very effective in creating a uniform traffic speed that increases the safety of travelers going across the pass.

Highways England reported a 55.7% reduction in personal injury crashes on the M42 Managed Motorway in the 36 months that the variable speed system was installed.

A variable speed limit system studied along I-270 in St. Louis saw reductions in total crash rate of as much as 8.0%.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

ATM Software - The deployment of new ATM software presents a risk to SHA if it is not planned for properly. Risk identification and management are the main concerns in every software project. Effective analysis of software risks will help to ensure proper planning and assignments of work. We will manage schedule, technical, operational and programmatic risks.

Public Acceptance – The implementation of ATM has proven itself throughout the world as noted in the Section E. Imperative to success is the public's acceptance that the controls requested (speed advisories, lanes closures, etc.) are accurate and compliance with those requests will result in improved travel. This will require time and a significant outreach to educate the public on the system and its benefits.

SHA Reputation – Given the public acceptance risk, SHA's reputation as a traffic manager is at risk if the system isn't accepted and complied with by the public. SHA has a long history of successful delivery of traffic management, and this project, if not planned thoroughly, can damage that reputation. The Wellington/Jacobs Team will provide educational materials for SHA's and our use.

Operations and Maintenance – A crucial element of the proposed system's life cycle is operations and maintenance. ATM systems are complex, integrated amalgamations of hardware, technologies and processes for data acquisition, command and control, computing and communication. Accordingly, ATM system maintenance can be a complex proposition as well, requiring sophisticated approaches and advanced technology. Maintenance of the ATM system is a necessity to ensure reliability and proper operation, thereby protecting SHA's investment and enabling the system to respond to changing conditions. Failure to function as intended could negatively impact traffic safety, reduce system capacity, and ultimately lead the traveling public to lose faith in their transportation system. Since the ATM system is complex, we propose to provide sufficient operator, maintainer and administrator training prior to system handover. In addition, a Cubic engineer will remain on-site for the first 6 months of commissioning and operation to support the operators, maintainers and administrators as they become more comfortable with the STM system. A system warranty will also be provided as part of our proposal.

Expandability – STM uses Platform as a Service (PaaS) as an architectural paradigm that allows the platform to automatically scale without the need to build in specific elasticity. Where this does not apply, the architecture is designed in a way that will allow high volume services to be scaled both horizontally (more machines) and vertically (more powerful machines). These three approaches, of automatic scaling, vertical and horizontal scaling removes limitations that might otherwise be placed on the volumes that can be accommodated by the architecture. If high volume transactions stress any part of the platform, it is a simple task to increase the available resources to avoid situations where the SLA's are in threat of being breached.

The platform can be horizontally scaled within the MDOT data Center, or across other data centers if required

The operations and maintenance costs will include:

- Maintenance of the software (STM) through warranty and software maintenance fees
- Maintenance of field infrastructure either in-house or in service agreements with electrical contractors.
- Personnel costs for additional operator to oversee I-270

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

a. The RFP provides little geotechnical information to support the design of structures along I-270. As such, the Wellington/Jacobs team is assuming soil conditions that would be conducive for a typical full lane gantry cantilevers to be supported on individual conventional caissons of approximately 5 feet in diameter by 20 feet deep. We propose to include this size of foundation in our pricing and to risk share over and underruns of this item with SHA. The Wellington/Jacobs proposal will include geotechnical sampling and analysis for each gantry and cantilever foundation location.

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

a. ATM structural devices will have a 50 year life…
b. Electronics will have to put on the regular maintenance schedule
c. Implementing the ATM approach avoids a costly widening of the corridor potentially saving hundreds of millions of dollars
d. Improved commerce

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

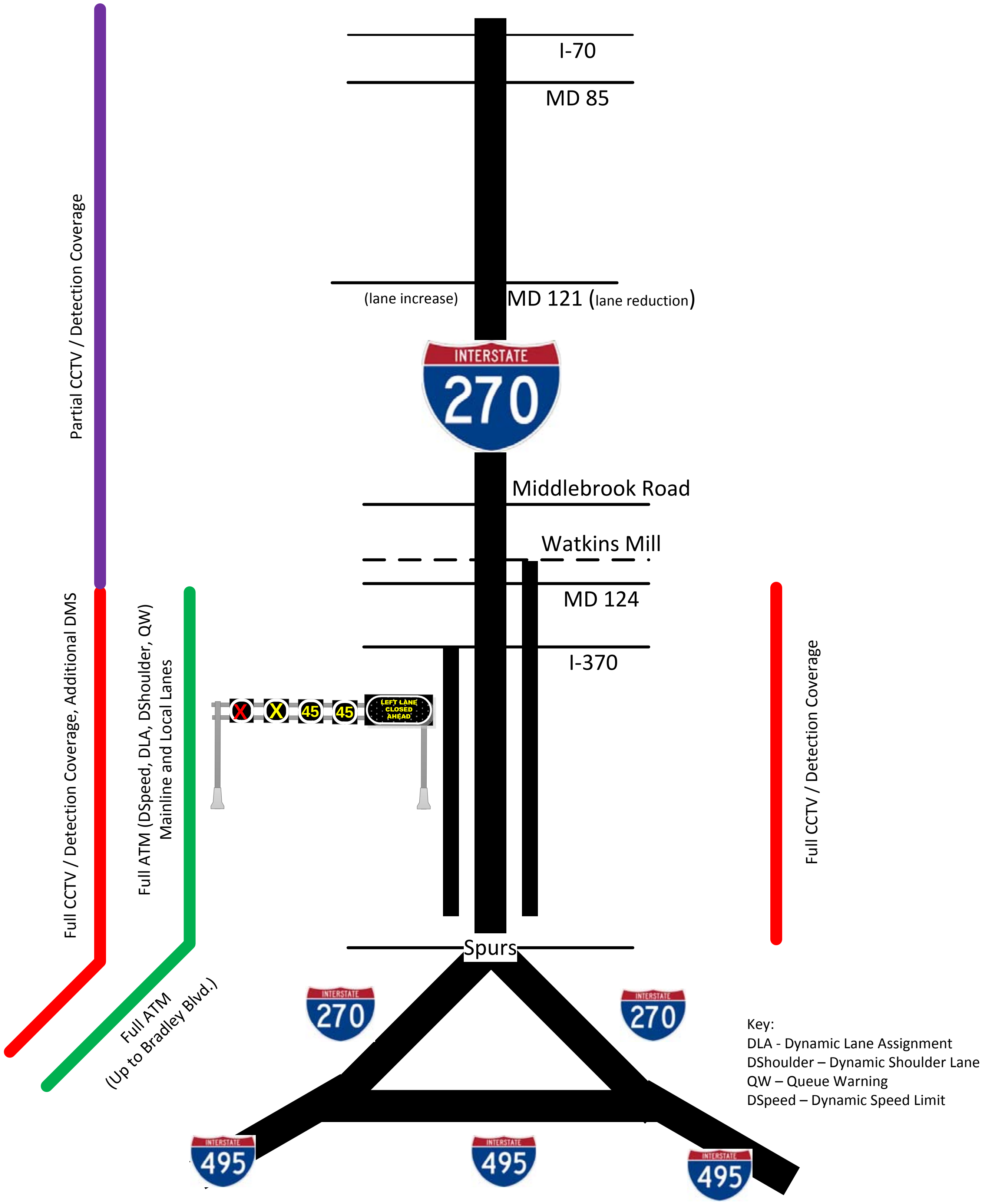
a. The Wellington/Jacobs Concept of Operations is attached.

Appendix 1

ATM Schematic.Rev.01

20161201

ATM Deployment Schematic



Key:
DLA - Dynamic Lane Assignment
DShoulder – Dynamic Shoulder Lane
QW – Queue Warning
DSpeed – Dynamic Speed Limit

Technical and Price Proposal Submittal
Contract No.: MO0695172, F.A.P. No.: N/A
Description: IS-270 Innovative Congestion Management Contract
Progressive Design-Build

PROPOSED TECHNICAL CONCEPT

PTC-01: ACTIVE TRAFFIC MANAGEMENT

APPENDIX: 01-2

JACOBS

Active Traffic Management Concept of Operations

I-270 – Innovative Congestion Management Contract
Montgomery and Frederick Counties

Maryland Department of Transportation - State Highway Administration

| DRAFT – Inclusion with PTC

November 16, 2016

Document history and status

Revision	Date	Description	By	Review	Approved
Internal Draft	10/17/16	Draft Concept of Operations for internal review	Randall		
Draft	11/16/16	Draft ConOps for submission to SHA with PTC	Randall		

JACOBS

I-270 – Innovative Congestion Management Contract

Project No:	E4X52401
Document Title:	Active Traffic Management Concept of Operations
Document No.:	
Revision:	Draft
Date:	October 17, 2016
Client Name:	Maryland Department of Transportation - State Highway Administration
Client No:	Client Reference
Project Manager:	Jeff Randall
Author:	Jeff Randall
File Name:	C:\Users\Public\Documents\Documents\Maryland\SHA\I-270 D-B\I270ICM ATM ConOps.docx

Jacobs Engineering Group Inc.

100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
United States
T +1.410.837.5840
F +1.410.837.3277
www.jacobs.com

Contents

Acronyms

ARM	Adaptive Ramp Metering
ATM	Active Traffic Management
ATMS	Advanced Traffic Management System
CATT	Center for Advanced Transportation Technology
CCTV	Closed Circuit Television
CHART	Coordinated Highways Action Response Team
ConOps	Concept of Operations
COTS	Commercial-off-the-Shelf
COTSS	Commercial-off-the-Shelf Software
DJC	Dynamic Junction Control
DMS	Dynamic Message Sign
DSL	Dynamic Shoulder Lanes
FHWA	Federal Highway Administration
ERU	Emergency Response Units
ETP	Emergency Traffic Patrol
FTE	Full-Time Equivalent
GP	General Purpose
GPS	Global Positioning System
HOV	High Occupancy Vehicle
HSR	Hard Shoulder Running
IP	Internet Protocol
IRT	Incident Response Team
I-270 ICM	I-270 Innovative Congestion Management Project
ITS	Intelligent Transportation System
LCD	Lane Control Display
LED	Light Emitting Diode
LUS	Lane Use Signal

MCDOT	Montgomery County Department of Transportation
MDOT	Maryland Department of Transportation
MDTA	Maryland Transportation Authority
MSP	Maryland State Police
MUTCD	Manual on Uniform Traffic Control Devices
NTCIP™	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
PM	Preventive Maintenance
PS&E	Plans, Specifications and Estimate
QW	Queue Warning
RITIS	Regional Integrated Transportation Information System
RM	Ramp Metering
RWIS	Roadway Weather Information Systems
SFVD	Side-Fire Vehicle Detectors
SOC	SHA Statewide Operations Center
SOP	Standard Operating Procedure
SOV	Single-Occupant Vehicle
STM	Surface Transport Management
TAR	Traveler Advisory Radio
TMC	Traffic Management Center
TMS	Transportation Management System
UPS	Uninterruptible Power Supply
US	United States
VAS	Variable Advisory Speed

Executive Summary

Page intentionally left blank

1. Purpose of the Document

1.1 Identification

This document is the Concept of Operations Report (Con Ops) for the Maryland State Department of Transportation - State Highway Administration (SHA) Active Traffic Management (ATM) Proposed Technical Concept (PTC) for the I-270 – Innovative Congestion Management Contract, Montgomery and Frederick Counties (I-270 ICM). Specific revision information can be found in the *Document history and status* Table at the front of this document.

1.2 Document Overview

This document provides a description of ATM and its initial goals, vision, and high-level concepts. This document is written for readers of all levels and provides information on the project justification, stakeholder and operational needs, system overview, operations and maintenance budgeting and an overall concept of operations for the ATM program. The purpose of this document is to communicate the current understanding of the user needs associated with ATM and to provide insight into how these systems might be implemented and procured for the I-270 ICM Project. The descriptions contained within this document are at a high-level and do not include system details that will be provided by systems designers. System details will be captured and documented in the appropriate phases of the project. At the current time, there are no known security or privacy issues associated with the contents of this document. This document contains the following sections:

- **2.0 Scope of the Project** This section gives a brief overview of the I-270 system to be built. It includes its purpose and a high-level description. It describes what area will be covered and which agencies will be involved, either directly or through interfaces.
- **3.0 Referenced Documents** This section contains a list of any supporting documentation used and other resources that are useful in understanding the operations of the system.
- **4.0 Background** This is a brief description of the current system or situation, how it is used currently, and its drawbacks and limitations.
- **5.0 Concept for the Proposed System** This section describes the concept exploration including a list and description of the alternative concepts examined, and the evaluation and assessment of each alternative for justification. The operational concept for that selected approach is described here.
- **6.0 User-Oriented Operational Description** In this section, the document focuses on how the goals and objectives are currently accomplished. It includes who users are and what the users do. Specifically, it covers when, and in what order, operations take place, personnel capabilities, organizational structures, personnel & inter-agency interactions, and types of activities.
- **7.0 Operational Needs** Here is a description of the vision, goals & objectives, and personnel needs that drive the requirements for the system. Specifically, this describes what the system needs to do that it is not currently doing.
- **8.0 System Overview** This is an overview of the system to be developed. This describes its scope, the users of the system, what it interfaces with, its states and modes, the planned capabilities, its goals & objectives, and the system architecture.

- **9.0 Operational Environment** This section describes the physical operational environment in terms of facilities, equipment, computing hardware, software, personnel, operational procedures and support necessary to operate the deployed system.
- **10.0 Support Environment** This describes the current and planned physical support environment. This includes facilities, utilities, equipment, computing hardware, software, personnel, operational procedures, maintenance, and disposal. This includes expected support from outside agencies.
- **11.0 Operational Scenarios** Each scenario describes a sequence of events, activities carried out by the user, the system, and the environment. It specifies what triggers the sequence, who or what performs each step, when communications occur and to whom or what [e.g., a log file], and what information is being communicated.
- **12.0 Summary of Impacts** This is an analysis of the proposed system and the impacts on each of the stakeholders. It is presented from the viewpoint of each, so that they can readily understand and validate how the proposed system will impact their operations.
- **13.0 Appendices** This contains background material for any of the sections.

2. Scope of the Project

The section will present the purpose of the system being proposed, a brief overview of the system and its anticipated benefits, and a summary of the agencies involved.

2.1 Problem Statement

I-270 is the most congested freeway in the State. The I-270 Corridor links significant suburban residential concentrations with the major employment regions of Northern Virginia, downtown Washington, D.C., the Capital Beltway, and along the I-270 Corridor itself. As with most urban areas in the United States, the trend in the Metropolitan Washington, D.C. area has been that development expands outward from the city. However, most commuters in the I-270 Corridor are not heading into Downtown Washington, but to other suburban locations. Because of high-traffic volumes in the corridor, and the impact that incidents even outside the corridor can have on I-270 conditions, congestion has become a monumental problem. Further, it is brought to a complete stop in areas during an incident.

2.2 I-270 Innovative Congestion Management Project

The project is intended to address the following transportation goals:

- **Mobility** – Provide improvements that maximize vehicle throughput, minimize vehicle travel times, and create a more predictable commuter trip along IS 270.
- **Safety** – Provide for a safer IS 270 corridor.
- **Operability/Maintainability/Adaptability** – Provide improvements that minimize SHA operations and maintenance activities while being adaptable to future transportation technological advancements. [1]

This will be accomplished by improving the incident detection infrastructure with more detection to augment that which already exists, to provide better surveillance by providing full video coverage, and to implement Active Traffic Management strategies to reduce congestion and accidents. These strategies include dynamic shoulder use to improve capacity, and variable speed limits, dynamic junction control, dynamic lane use control, and queue warning to reduce congestion, delay and accidents.

The strategies, or subsystems, will include:

- Freeway management system
- Traveler information system
- Traffic surveillance and monitoring system

The components of these systems and their anticipated benefits are illustrated in the Table below.

[1] IS 270 – Innovative Congestion Management Contract, Request for Qualifications/Request for Proposals, Maryland State highway Administration, June 7, 2016

System	Components	Anticipated Benefits
Freeway Management System	Adaptive ramp metering; closed-circuit television, lane control signals, advisory speed signs, dynamic message signs; travel time signs	Reduced delay; provide smoother flow; larger pace population; fewer accidents, reduced travel time; queue warning; merge control
Traveler Information System	Dynamic message signs; in-vehicle information from Connected Vehicle system	Enhanced traveler information; reduced delay during incidents; inform motorists of expected travel time
Incident Management System	Vehicle detection on mainline; presence detection on temporary use shoulder; automated incident management	Reduced delay during incidents; faster detection of, diagnosis of, and response to incidents
Connected Vehicle System	DSRC radio transmitters; in-vehicle receiver	Reduce accidents; improve mobility; incubate CV system for future expansion

Table 1: I-270 Corridor Subsystems

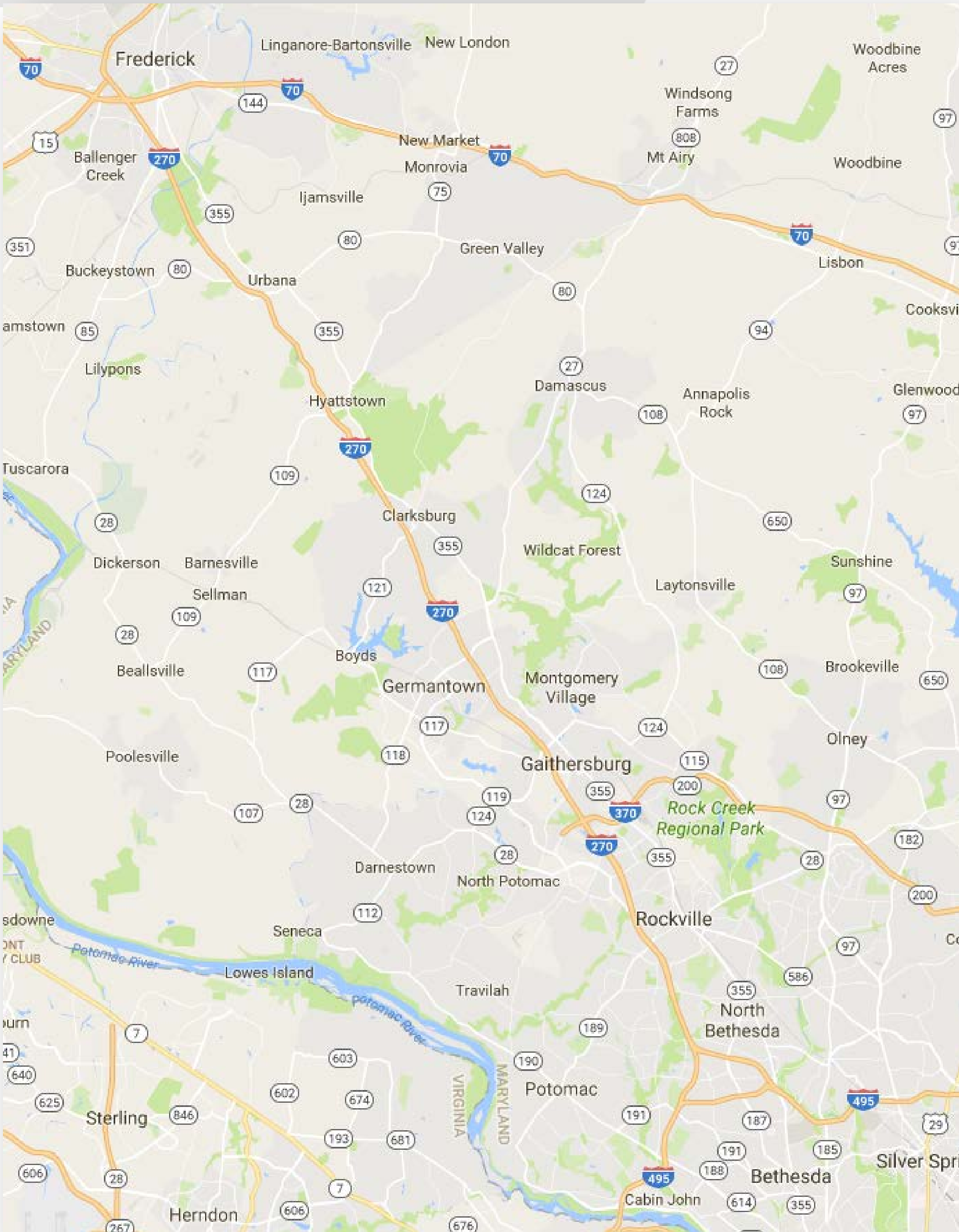
2.3 Project Limits

There are no defined project limits for the contract to improve I-270. The strategies, however, will be implemented along most of I-270 from I-70 to the north through the spurs and include the outer loop of I-495 to the American Legion Bridge.

2.4 Project Stakeholders

The users of the I-270

- Maryland State Highway Administration — Management of I-270 network and Park-n-Ride facilities along I-270.
- Montgomery County Department of Transportation (MCDOT) — Management of the county's arterial network, as well as the Ride On bus service.
- Maryland State Police — Enforcement, security, and accident investigations on I-270.
- Montgomery County Police — Enforcement, security, and accident investigations on I-270 and Montgomery County arterials.
- City of Rockville — Management of the arterial network in Rockville.
- City of Gaithersburg – Management of the arterial network in Gaithersburg.
- University of Maryland's Center for Advanced Transportation Technology (CATT) — Maintenance and operation of the Regional Integrated Transportation Information System (RITIS).


Frederick
Linganore-Bartonsville
New London
Woodbine Acres
Windsong Farms
Mt Airy
New Market
Monrovia
Woodbine
Ballenger Creek
Ijamsville
Green Valley
Lisbon
Buckeystown
Urbana
Lilypons
Hyattstown
Damascus
Annapolis Rock
Glenwood
Tuscarora
Clarksburg
Wildcat Forest
Dickerson
Barnesville
Sellman
Laytonsville
Sunshine
Boyds
Beallsville
Germantown
Montgomery Village
Brookeville
Poolesville
Gaithersburg
Olney
Rock Creek Regional Park
Darnestown
North Potomac
Rockville
Seneca
Potomac River
Lowes Island
Travilah
North Bethesda
Potomac
Sterling
Bethesda
Cabin John
Herndon
VIRGINIA
MARYLAND

3. Reference Documents

1. Request for Qualifications (RFQ) / Request for Proposals (RFP), I-270 – Innovative Congestion Management Contract - Montgomery and Frederick Counties, Contract, Contract No. MO0695172, Maryland Department of Transportation – State Highway Administration, June 2016
2. Systems Engineering for Intelligent Transportation Systems – An Introduction for Transportation Professionals, US Department of Transportation, January 2007.
3. Congestion Management Process: A Guidebook, US Department of Transportation, April 2011
4. Use of Freeway Shoulders for Travel – Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy, US Department of Transportation, January 2016
5. "Long Range Strategic Deployment Plan", Office of CHART and ITS Development, Maryland Department of Transportation - State Highway Administration, 2013
6. Concept of Operations for the I-270 Corridor in Montgomery County, Maryland, USDOT Integrated Corridor Management (ICM) Initiative, Maryland Department of Transportation, March 2008
7. 2014 Performance Evaluation and Benefit Analysis for CHART, University of Maryland, 2015
8. Maryland Transportation Systems Management and Operations (TSM&O) Strategic Implementation Plan, Maryland Department of Transportation - State Highway Administration, 2016

4. Background

4.1 Existing Conditions

I-270 runs north-south with two connections to I-495 at the south end; I-270 proper connecting to I-495 to the east in the Bethesda area at the MD 355 interchange, and the I-270 Spur connecting to I-495 to the south/west to and from the American Legion Bridge/Northern Virginia area. The east connection serves Washington DC, Bethesda, College Park, the I-95 corridor, US 50/Annapolis/Eastern Shore and Andrews AFB/Southern Maryland locales, while the south/west connection serves the Clara Barton and George Washington Parkways, Dulles Airport, I-66 and I-95 toward Richmond.

I-270, and the network of area arterials and major streets that serve as parallel routes and feeders that complement and support the I-270 function, is the economic life-stream of the businesses and communities that lie along the Washington-to-Frederick corridor. The Quality-of-Life for the 1.5 million residents of the affected corridor is hugely dependent upon effective/efficient highway transportation operations, accomplished in concert with ample, interconnected mass transit opportunities.

4.2 Traffic Management Program

The Coordinated Highways Action Response Team (CHART) is Maryland's operations element for the state's transportation program. Its mission is *to improve mobility and safety for the users of Maryland's highways through the application of ITS technology and interagency teamwork.* CHART is a joint effort of the Maryland Department of Transportation (MDOT), Maryland State Highway Administration (MDSHA), Maryland Transportation Authority (MDTA), and the Maryland State Police (MSP), in cooperation with federal, other state, and local agencies.

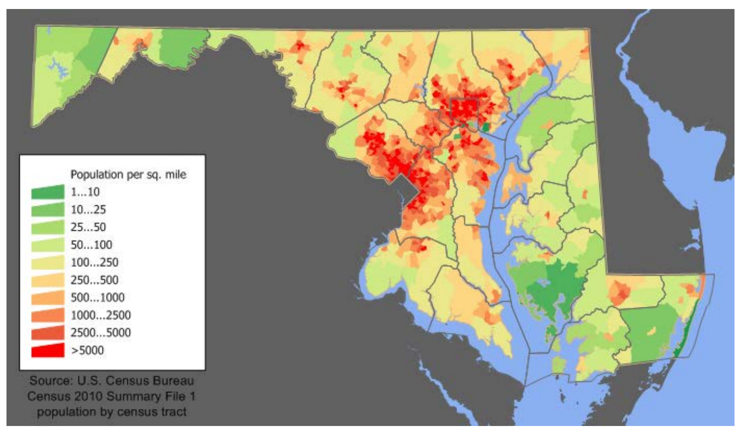


CHART accomplishes its mission by focusing on mitigation of non-recurring congestion that occurs due to events such as crashes, breakdowns, construction, weather, etc. According to the FHWA, non-recurring congestion is the cause of about 50 percent of highway congestion. Recurring congestion – generally caused by high volumes on highways with limited capacity – accounts for the other fifty percent[2].

At the heart of CHART is the Statewide Operations Center, which houses the central computing system that monitors the state highways in real-time, including I-270, and monitors and controls the ITS devices including detectors, closed circuit television cameras (CCTV), traveler advisory radios (TAR), dynamic message signs (DMS), and road weather information systems (RWIS). CHART's current functionality is in incident detection and management. It doesn't possess active traffic management functionality.

[2] CHART Long Range Strategic Deployment Plan, Maryland State Highway Administration, 2013

4.2.1 ITS Infrastructure

Given the importance and operating condition of I-270 more ITS field infrastructure is necessary. The density of detection deployment is lacking to provide the level of incident detection necessary. Similarly, CCTV coverage leaves many gaps along I-270. Most notable is the fact that along the Spurs, only one CCTV camera exists.

There is much more CCTV coverage in the Montgomery County portion of I-270 although, it is still lacking. Further complicating the traffic management capabilities is the fact that these cameras are the property of Montgomery County DOT. While the images are shared with SHA - and they provide reasonable views of I-270 – SHA has not control. Should the SOC require a different view with the camera at any given time, they must contact MCDOT via telephone and request them to make the change.

4.3 Current Operating Conditions

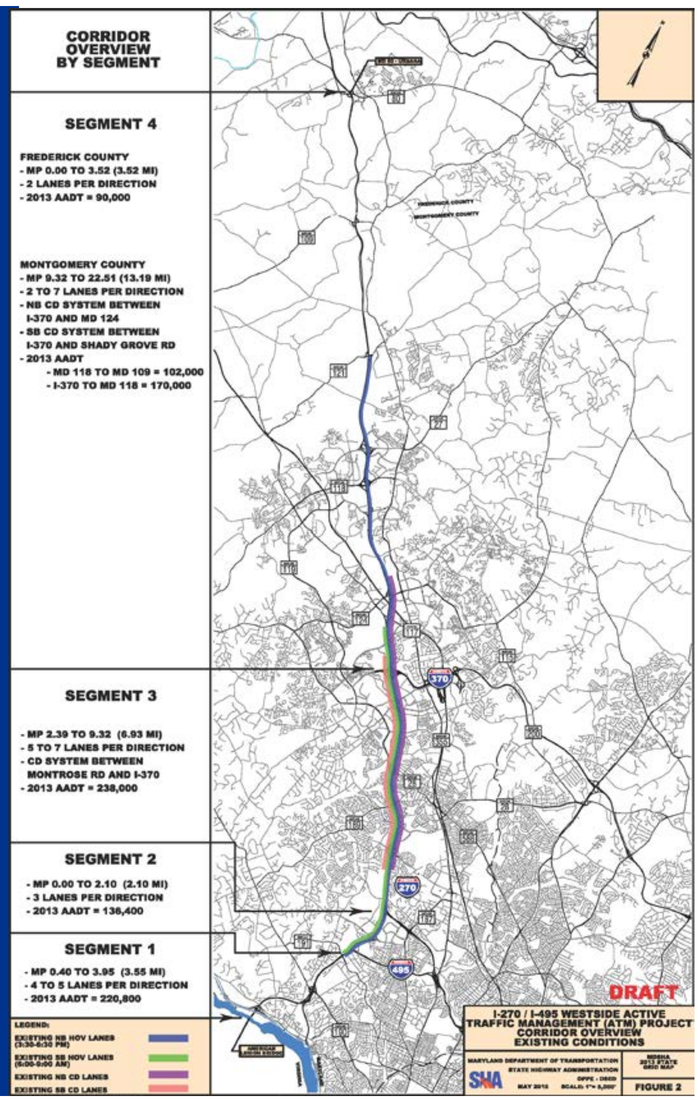
I-270 is one of the most travelled highways in the State with average daily traffic of about 240K in many segments. It is one of the most congested corridors in MD and the Washington, DC region with strong directional peaks. It operates with over-saturated conditions and extended peak periods that greatly impacts reliability. Much of the corridor is over capacity, and operates at

Segment 1: VA to I-270 Y
- 3.5 miles
- 4-5 lanes per direction
- 220,800 AADT

Segment 2: I-270 West Spur
- 2.1 miles - Existing HOV
- 3 lanes per direction
- 136,400 AADT

Segment 3: I-270 Y to I-370
- 6.9 miles - Existing HOV
- 5-7 lanes per direction - Existing CD
- 238,000 AADT

Segment 4: I-370 to MD 80
- 16.7 miles - Existing HOV (to MD 121)*
- 2-5 lanes per direction - Existing CD (to MD 124)*
- 90,000 to 170,000 AADT



unacceptable levels of service as shown in the following LOS stick maps of existing (2014) and future 2040 volumes.

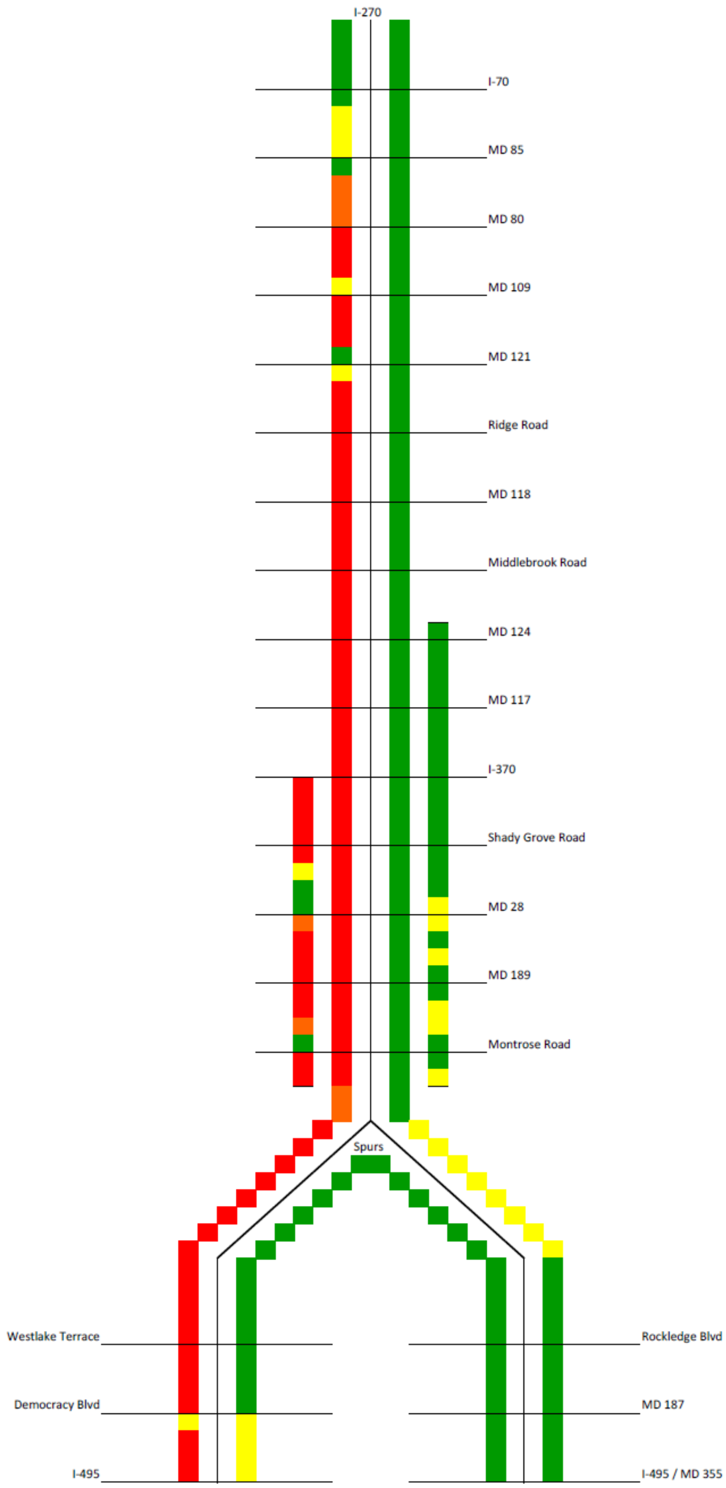


Figure 2: Existing 2014 AM Peak Hour Level of Service Along I-270

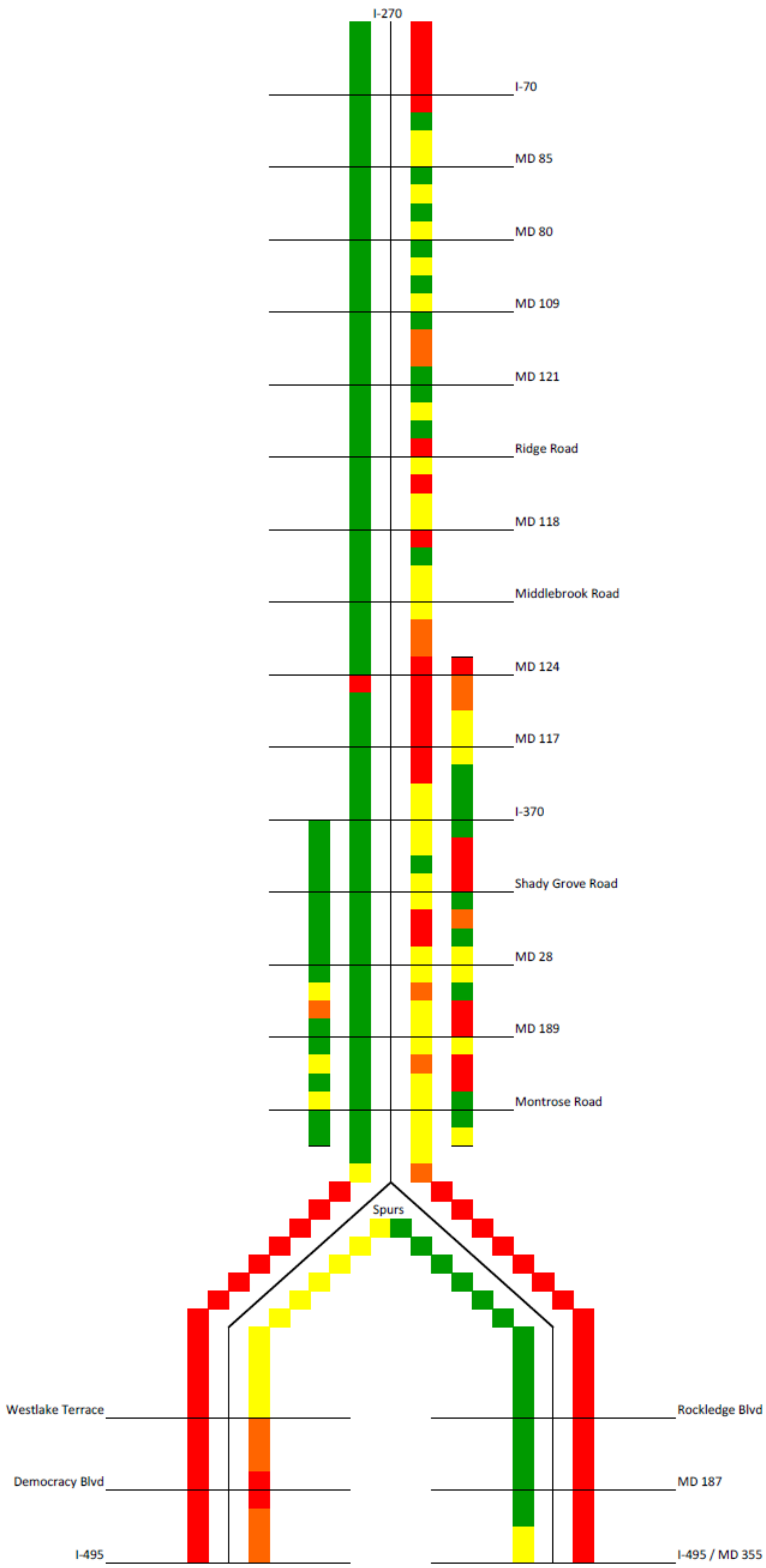


Figure 3: Existing 2014 PM Peak Hour Level of Service Along I-270

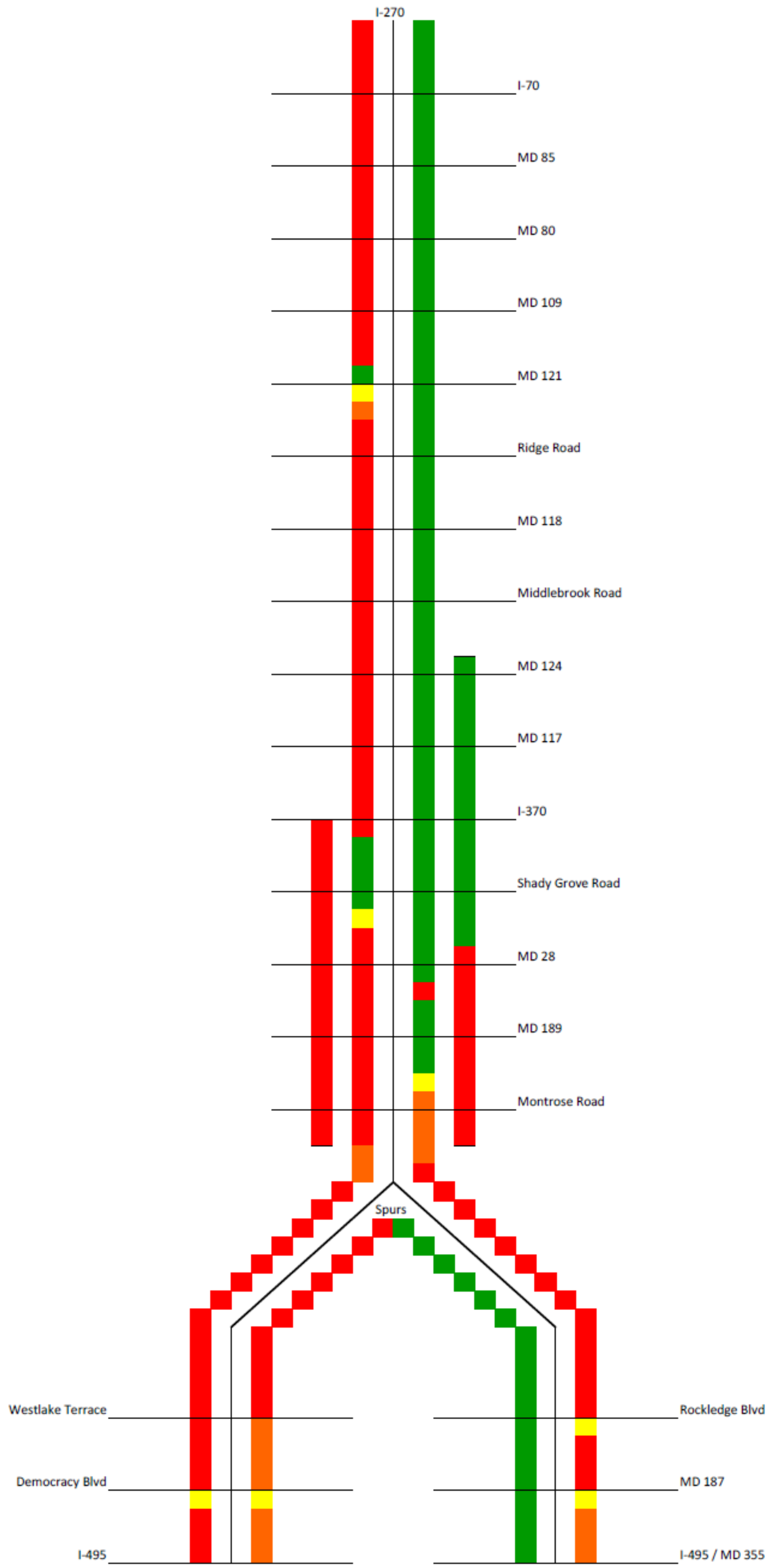


Figure 4: Projected 2040 AM Peak Hour Level of Service Along I-270

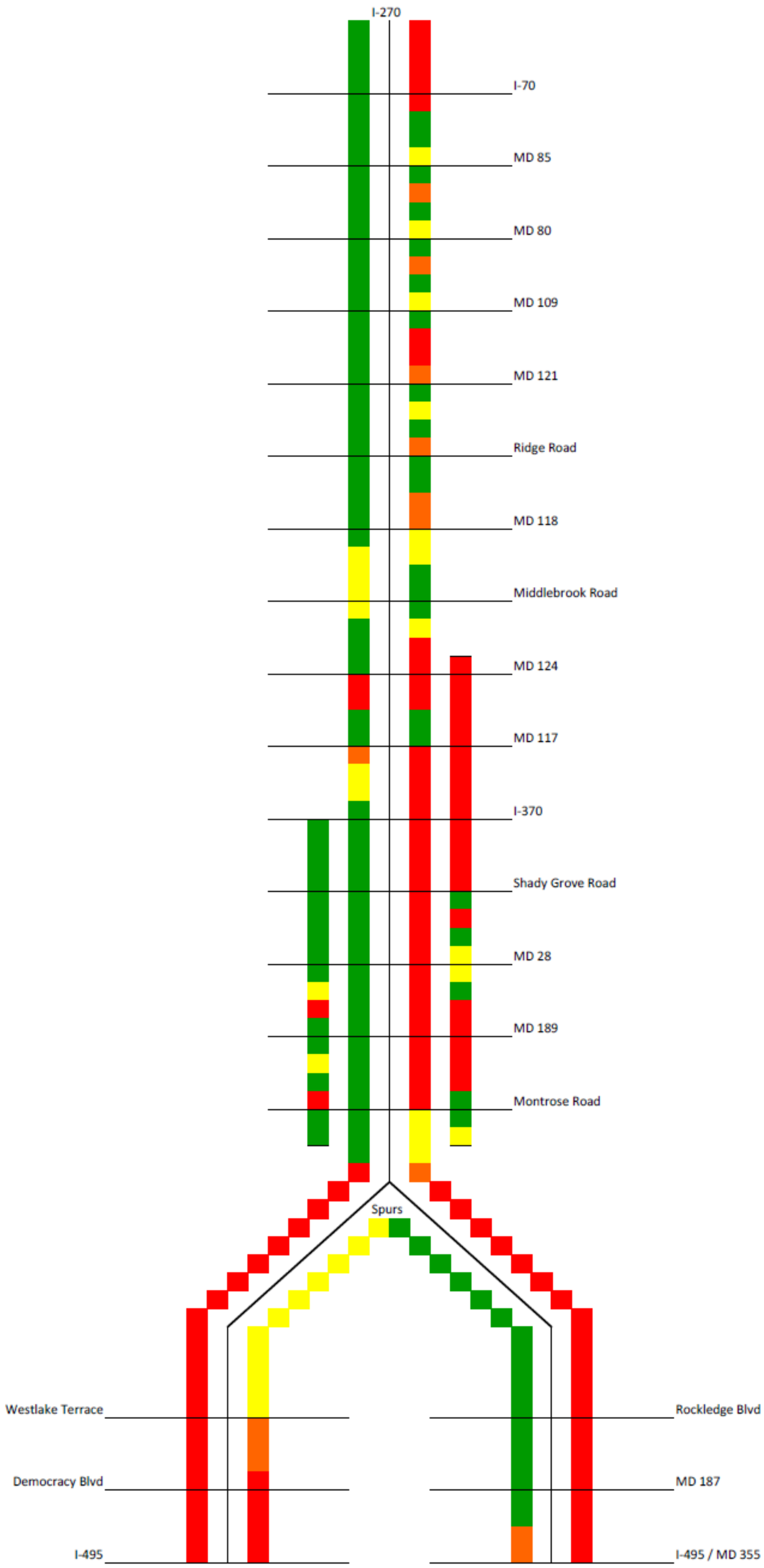
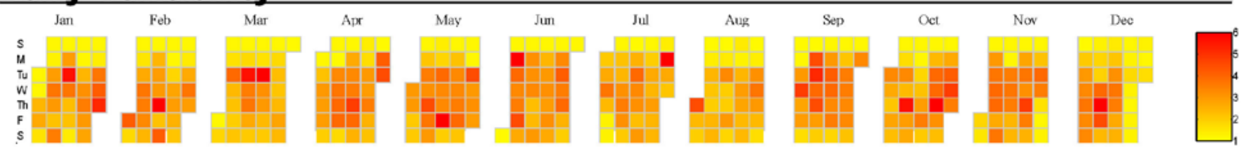


Figure 5: Projected 2040 PM Peak Hour Level of Service Along I-270

Daily Variability[e]



Top Bottlenecks[f]

2013 Rank	LOCATION	Direction	Number of Occurences Q1	Q2	Q3	Q4	Average Duration (minute)	Average Length (mile)	Impact Factor	2012 Rank	Change
6	I-270 Spur S @ I-270	Southbound	182	251	210	241	101	7.4	**5.9**	3	3
9	I-270 N @ MD-80/Exit 26	Northbound	64	90	127	76	101	9.8	**3.0**	2	7
10	I-270 Local N @ I-270/Washington National Pike	Northbound	162	156	128	159	126	4.3	**2.5**		10
14	I-270 N @ I-70/US-40	Northbound	85	106	81	128	83	8.1	**2.3**	7	7
15	I-270 S @ MD-109/Exit 22	Southbound	126	178	156	118	84	4.6	**2.1**	15	0
25	I-270 N @ Middlebrook Rd/Exit 13	Northbound	98	91		83	104	6.0	**1.4**	11	14
46	I-270 N @ I-270	Northbound	138	155	151	120	120	1.6	**1.0**		46
67	I-270 N @ MD-85/Exit 31	Northbound	26	32	21	29	85	10.2	**0.8**	32	35
70	I-270 N @ MD-109/Exit 22	Northbound	288	263	213	190	41	3.0	**0.8**	62	8
77	I-270 S @ MD-121	Southbound	23	20	17	26	111	9.6	**0.7**	56	21

Figure 6: I-270 Daily Variability and Top Bottlenecks

Reliability in the corridor is a significant challenge throughout the year. Segments along I-270 are some of the most congested in the State. In the 2013 AM Peak Hour, 7 locations along I-270 are in top 30 most congested freeway segments, and 6 in the PM Peak Hour.

4.3.1 Traffic Analysis

Southbound I-270

The following discussion is based upon traffic operations observed during the AM peak period.

I-270 Spur at Democracy Blvd:

The first place where the I-270 corridor begins to break down during the AM peak is along the I-270 Spur approaching the Democracy Blvd interchange. On its departure from SB I-270, the Spur is comprised of 3 general purpose (GP) lanes. An HOV lane joins the Spur just north of the Westlake Terrace / Fernwood Road overpass. Approaching Democracy Blvd, the right-most GP lane along the Spur departs to Democracy Blvd, leaving 2 GP lanes and 1 HOV lane along the Spur. At this point the volumes are (AM Peak):

- 630 vehicles exit (1 lane)
- 4320 vehicles in 2 GP lanes (2160 per lane)
- 575 vehicles in the HOV lane

South of the Democracy Blvd overpass, a 2-lane ramp from Democracy Blvd adds 540 vehicles to the SB lanes, resulting in:

- 4860 vehicles in 2 GP lanes (2430 per lane)
- 575 vehicles in the HOV lane

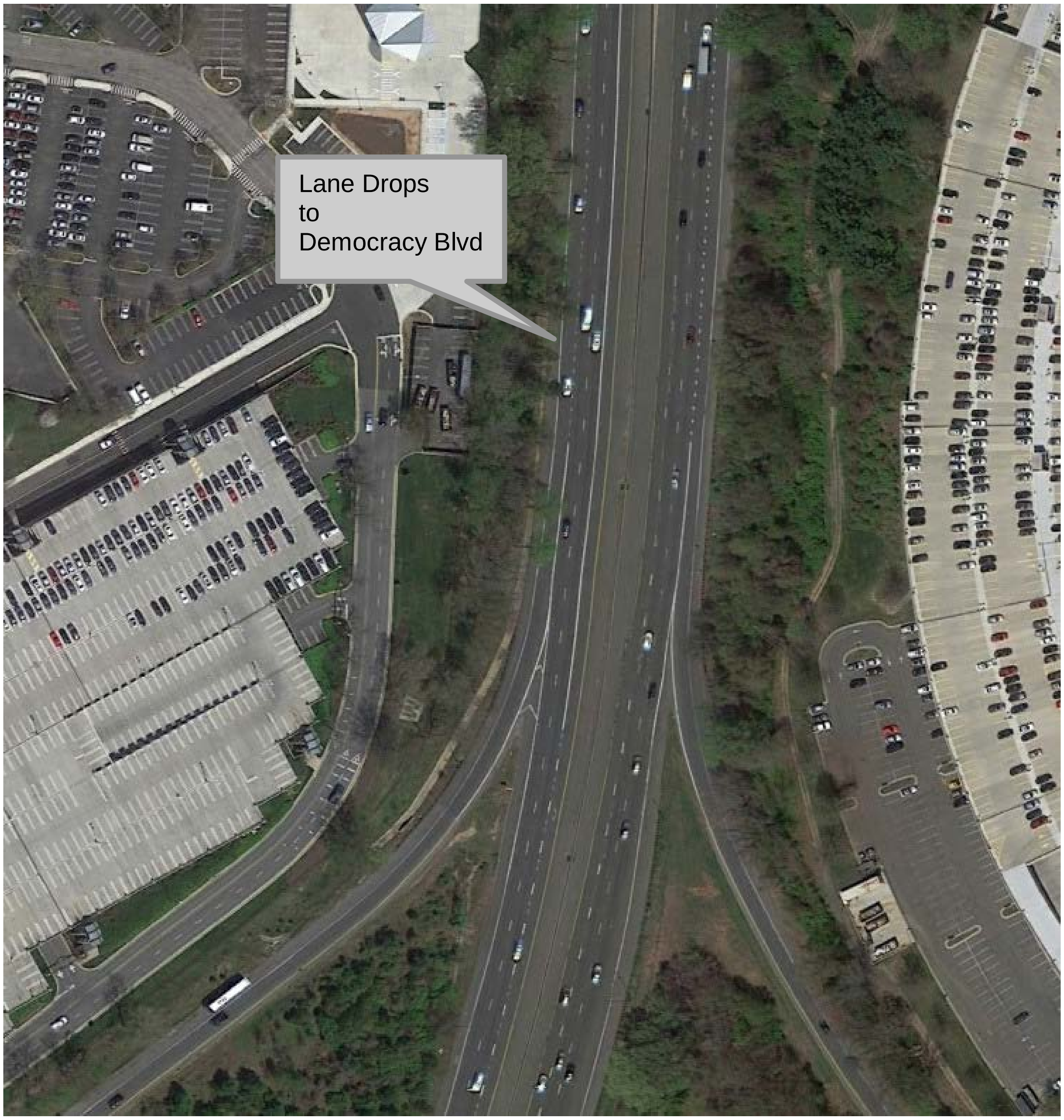


Figure 7: I-270 Spur, Just North of Democracy Blvd

I-270 Spur at I-495:

As the Spur approaches I-495, signs and pavement markings advise that the HOV lane traffic must merge into the GP lanes. The lane drop officially occurs exactly at the point that the Spur lanes meet the lanes from WB I-495. So, technically, at this point there are:

- 5435 vehicles in 2 GP lanes from the SB I-270 Spur (2718 per lane)
- 4480 vehicles in 3 lanes from WB I-495 (1494 per lane)

The SB I-270 Spur, approaching the WB I-495 lanes, begins to demonstrate congestion and delays just a few minutes after issues begin north of Democracy Blvd.

As the morning peak progresses, conditions worsen along the SB I-270 Spur long before issues begin along the WB I-495 approach to the merge.

Once congestion begins along SB I-495, south of the I-270 Spur / I-495 merge, congestion grows ever worse along the SB Spur, but never really emerges along the WB I-495 approach. This section of the I-270 corridor is also the last to clear at the end of the AM peak period.

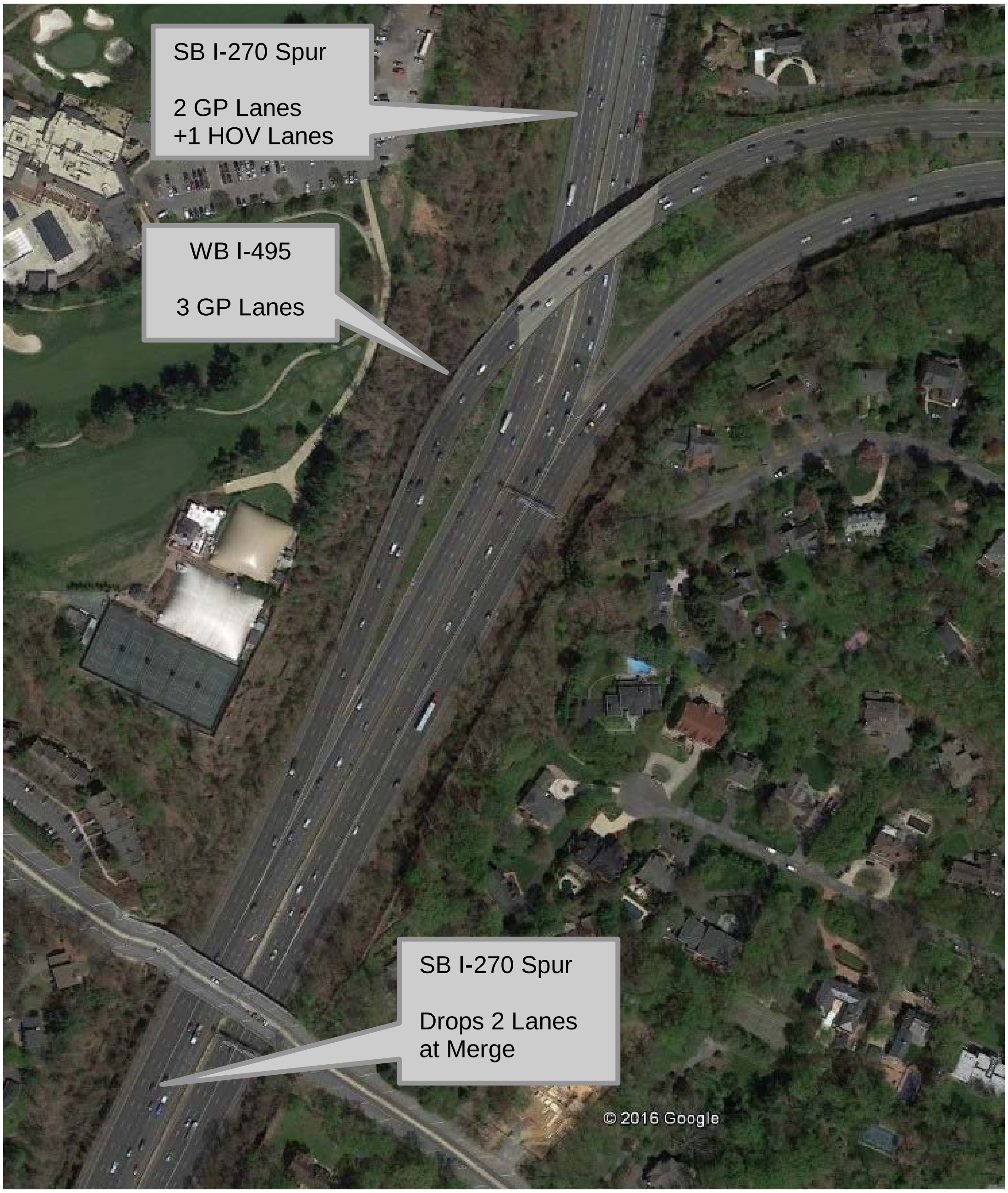


Figure 8: I-270 Spur at Merge with I-495

<u>MD 80 and MD 109 Interchanges</u>:

Even before the SB I-270 Spur begins to experience congestion, towards the north end of the corridor, where it is only 2 lanes wide, SB I-270 experiences significant congestion.

North of MD 80:

- 3120 vehicles in 2 lanes (1560 per lane)
- 250 vehicles depart to MD 80 (via a very low-speed ramp with less than 250 feet of decel)
- 670 vehicles almost immediately merge from MD 80 (likely at a relatively low speed and with less than 200 feet of accel lane)

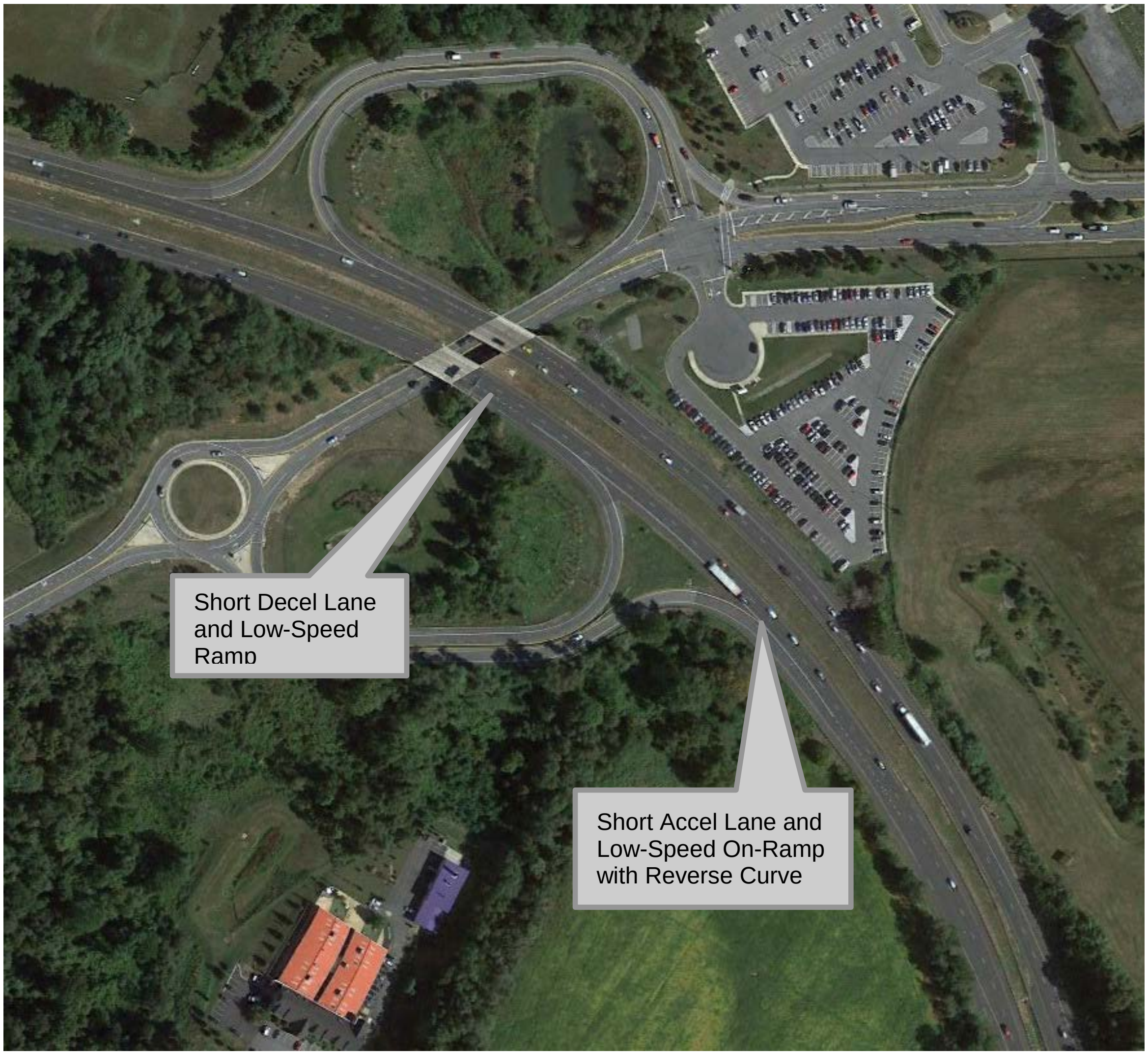


Figure 9: I-270 at MD 80 interchange

South of MD 80:

- 3520 vehicles in 2 lanes (1760 per lane)
- 55 vehicles depart to MD 109 (tight ramp, but reasonable decel distance)
- 465 vehicles merge from MD 109 (tight ramp and less than 300 feet of accel)

South of MD 109:

- 3930 vehicles in 2 lanes (1965 per lane)

A 2-lane cross section does not provide a lot of ability to maneuver, and the ramp speeds are likely very low, so there is no ability for mainline vehicles to bypass merging/diverging vehicles when volumes are relatively high. This results in congestion both approach and departing each interchange, as vehicles struggle to maneuver into desired lanes, and to accelerate after merging. And, per lane volumes are increasing as traffic moves south.

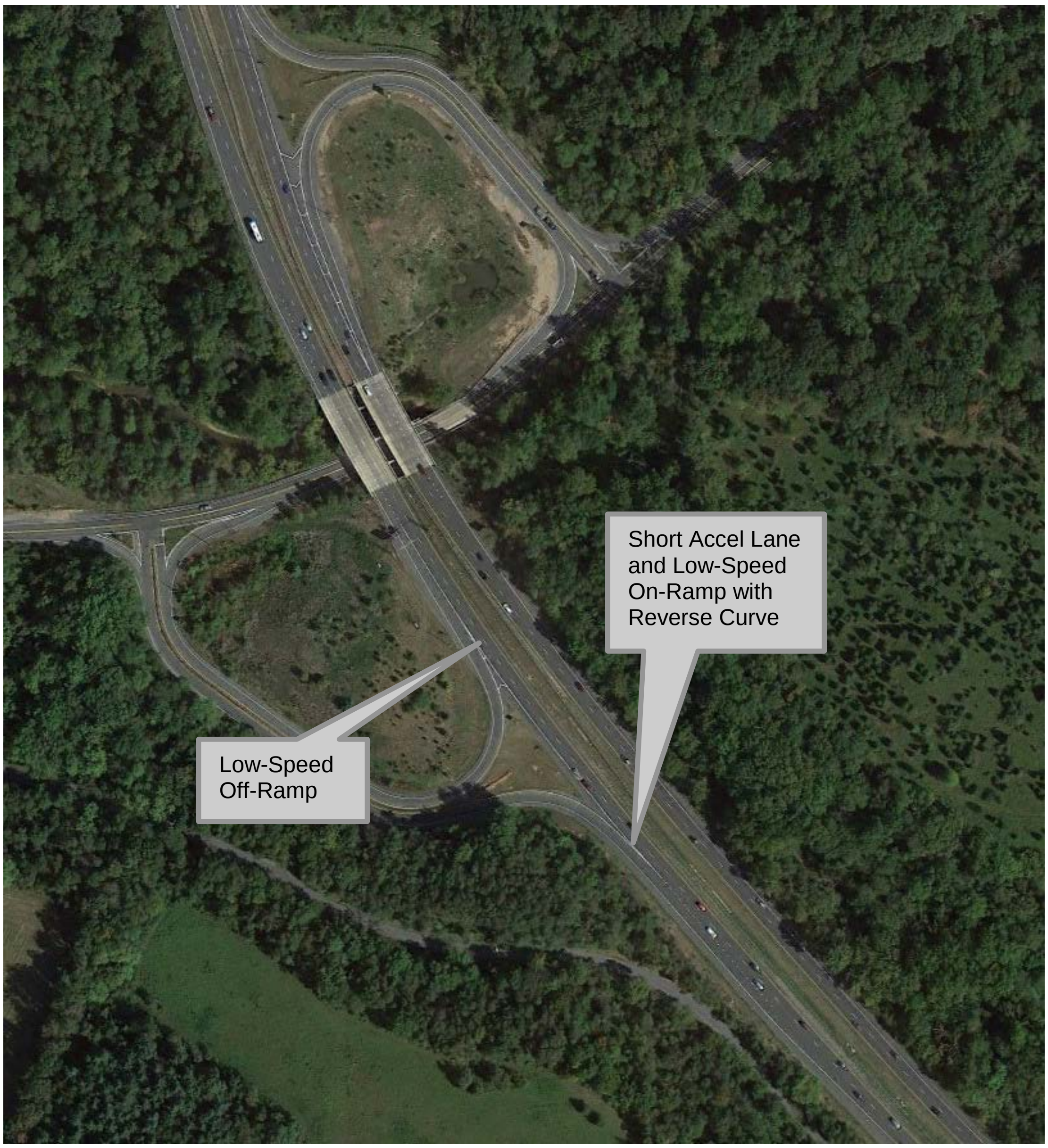


Figure 10: I-270 at MD 109 Interchange

Father Hurley Blvd / Ridge Road and Germantown Road (MD 118) Interchanges:

Also early in the AM peak period, vehicle speeds decrease significantly in the vicinity of the Germantown Road (MD 118) and the Father Hurley Blvd / Ridge Road interchanges.

Approaching the exit to Father Hurley Blvd:

- 4610 mainline vehicles in 3 lanes (1537 per lane)
- 1025 vehicles exit onto Father Hurley Blvd (decel is less than 450 feet long)
- 915 vehicles add from WB Father Hurley Blvd via a loop ramp with an accel lane less than 350 feet long
- Then another 440 vehicles add from EB Father Hurley Blvd via a directional ramp that becomes an auxiliary lane, dropping at Germantown Road, carrying 445 vehicles
- 300+590=890 vehicles enter SB I-270 from Germantown Road via 2 on-ramps, with approximately 250 feet of accel lane provided for each
- South of MD 118, SB I-270 carries 5385 vehicles in 3 lanes (1795 vehicles per lane)

The ramp volumes and interchange configurations would not necessarily be expected to result in poor operations. However, with a series of on and off ramps in relatively quick succession, and relatively short accel lanes (which may result in through vehicles being required to reduce speed to allow entering vehicles to merge), this section of roadway does experience poor operations through much of the AM peak period.

I-270, North of the Split:

As congestion and slowing occur along the SB I-270 Spur, the effect of that slowing shifts north, spreading along SB I-270 north of the Split. According to the Vissim model, the primary source of SB congestion in the AM peak period lies along SB I-270 between the end of the CD lanes and the I-270 Split. A significant weave occurs at this location.

The HOV lane, carrying 1800 vehicles, provides direct access to both SB I-270 (to the east) and the SB I-270 Spur (to the south), without requiring lane changes. These vehicles are therefore of no concern.

Just prior to the end of the CD system, volumes are as follows:

- 3645 vehicles in 2 CD lanes (1823 per lane)
- 5625 vehicles in 3 mainline lanes (1875 per lane)

After the end of the CD lanes, volumes are:

- 9270 vehicles in 5 GP lanes (1854 per lane)

This volume isn't horrible. However, of these 9270 vehicles:

- 4950 vehicles are destined for the SB I-270 Spur (3 lanes – 1650 vehicles per lane)
- 4120 vehicles are destined for I-270 to the east (2 lanes – 2060 vehicles per lane)

And, they aren't necessarily in the proper lanes to reach these destinations, so weaving will occur. With just over a mile between the end of the CD system and the split, sufficient distance is available, but if vehicles are moving slowly due to volumes near capacity, weaving becomes that much more difficult.

Montrose Road Interchange:

Because of the proximity of the Montrose Road interchange to the end of the CD system and the I-270 Split, vehicles originating from Montrose Road will have less time to position for the I-270 split.

- 1695 vehicles enter the SB CD system from Montrose Road. Any of these vehicles destined for the east must weave across a minimum of 2 lanes once the CD system ends.
- Of the 5625 vehicles in the mainline lanes, any destined for the south must weave right, against vehicles already in the right-most lanes who may wish to weave left.

Figure 11: I-270 at Montrose Road Interchange

Slip to Mainline, North of Montrose Road:

Approaching the Montrose Road interchange:

- The CD road carries 4325 vehicles in 2 lanes (2163 per lane)
- The mainline carries 4485 vehicles in 3 GP lanes (1495 per lane)

Then 940 vehicles exit the CD onto Montrose Road and 1695 vehicles enter the CD from Montrose Road.

Figure 12: I-270 North of Montrose Road Interchange

The CD road is already close to overloaded at this point, and won't be able to handle the net increase of755 vehicles. So, a slip lane allows 1435 vehicles to depart the CD and enter the mainline lanes prior to the interchange. This slip lane provides approximately 530 feet of accel lane. The resulting mainline volume is:

- 5920 vehicles in 3 GP lanes (1974 per lane)

This volume is not beyond capacity. But the merge distance is short. And, it's likely that, due to the upcoming end of the CD lanes and weave prior to the I-270 split, this merge may be more complex. Traffic slows substantially along the mainline lanes at this point, and the effects move north, extending beyond I-370.

I-370, MD 28 and Shady Grove Road Interchanges:

This section of SB I-270 experiences traffic operational issues a little later in the AM peak period, as congestion is building in the network at locations both north and south of this section.

The first locations within this section to experience slowing vehicles are the 2 SB slips from the CD to the mainline lanes between Shady Grove Road and MD 28.

Once it begins, congestion and slow travel speeds become systemic. The mainline lanes show slowing from I-495 to I-370. The CD lanes experience areas of slower speeds mixed with areas of better operations.

This section of the corridor experiences high ramp volumes and numerous slips both to and from the mainline lanes. However, mainline volumes appear to be within capacity. Review of the data seems to suggest that the slip connections are the primary source for localized congestion and slowing, primarily along the mainline sections of SB I-270 within this portion of the corridor.

Slips from the mainline lanes to the CD lanes include almost no deceleration lanes. Additionally, slips to the mainline lanes from the CD lanes include very short acceleration lanes (less than 300 feet).

South of Shady Grove Road, I-270 provides 3 slip lanes; 1 from the mainline to the CD followed by 2 from the CD to the mainline. The slip from the mainline to the CD occurs first, adding 780 vehicles to the CD lanes, increasing the volume on the CD to 3870 vehicles in 2 lanes (1935 per lane).

Along the CD lanes between Shady Grove Road and MD 28, a slip lane from the mainline lanes adds 550 vehicles, bringing the volume along the CD lanes to 3920 vehicles in 2 lanes (1960 vehicles per lane), which results in some slowing and congestion.

Figure 13: I-270 from Shady Grove Road to MD 28

MD 117 and MD 124 Interchanges:

The MD 117 interchange is partial, only providing access to and from the south along I-270.

The SB on ramp carries 1665 vehicles in a single lane, but adds that lane to the SB I-270 GP cross section, and should therefore have a minimal effect on traffic flow. Even so, speeds along that ramp, and the section immediately following the junction, are shown to be slow early in the AM peak period. Perhaps the nature of the junction makes drivers wary of sideswipes.

Figure 14: I-270 at MD 117 Interchange

The MD 124 interchange, located just north of the MD 117 interchange, includes a diverge that removes980 vehicles from the SB lanes, then a merge via a loop ramp that adds 1430 (probably slow moving) vehicles. The merge distance is approximately 700 feet long. Prior to the interchange the mainline volume is relatively high:

- 7165 vehicles in 4 lanes (1792 per lane)

After the interchange the mainline volume is:

- 7615 vehicles in 4 lanes (1904 per lane)

In theory, the departing 980 vehicles should leave good gaps for the acceptance of the 1430 merging vehicles. However, data shows early peak period slowing along SB I-270 both approaching and following the interchange. The heavy merging volume, approaching at relatively low speeds due to the loop ramp, is resulting in slowed operations along SB I-270, extending north beyond Father Hurley Blvd.

This condition may be helped by the addition of the Watkins Mill Road interchange to the north.

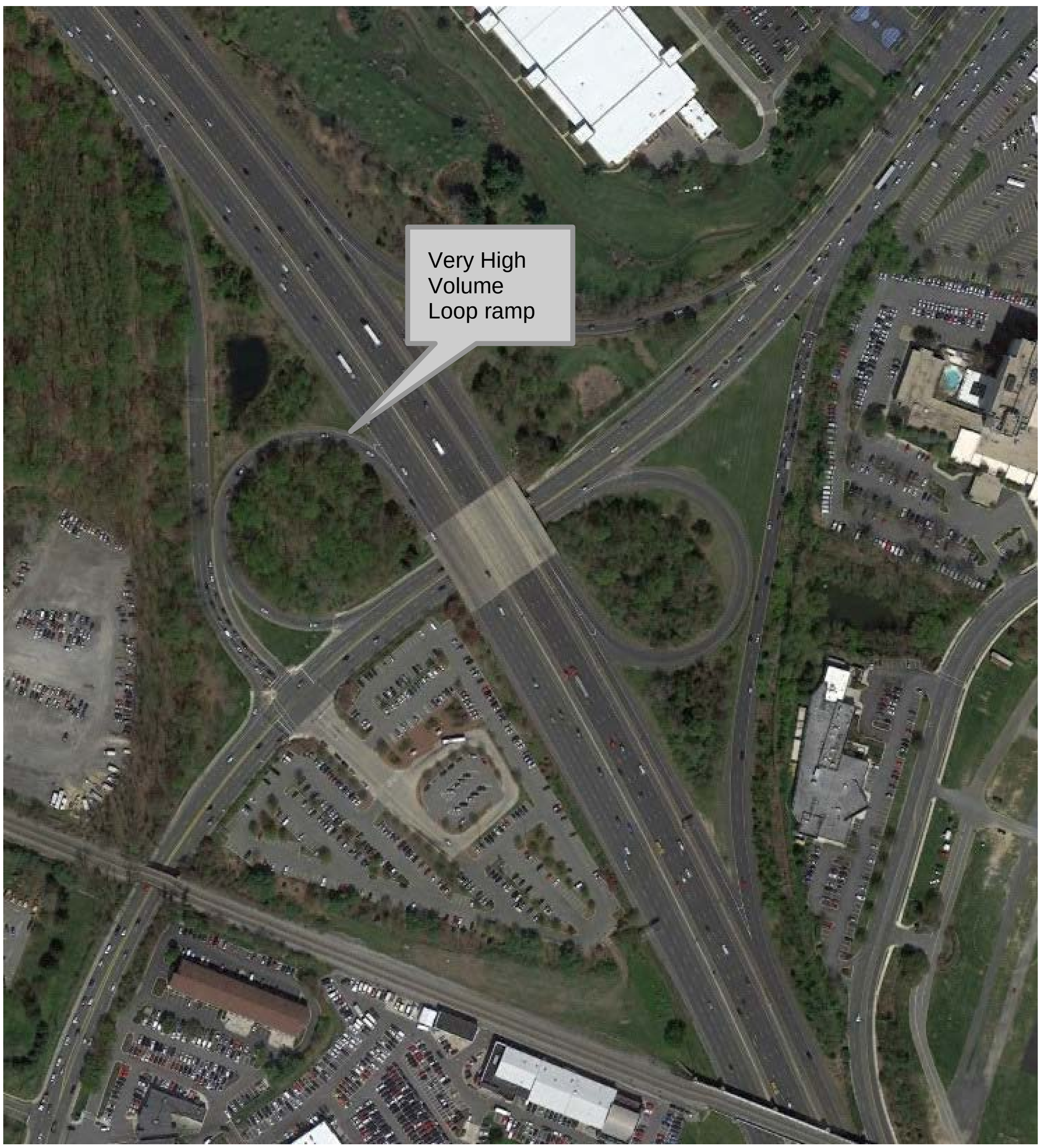


Figure 15: I-270 at MD 124 Interchange

The Corridor, in General:

As the AM peak period continues, and traffic volumes increase, congestion originating from each of the locations discussed above spreads along the corridor.

Northbound I-270

The following discussion is based upon traffic operations observed during the PM peak period.

North of MD 121:

NB I-270 drops from 3 lanes to 2 just north of MD 121. The spot where the lane drop occurs is the first location along the corridor to experience congestion / slowing during the afternoon peak period. The HOV lane also ends shortly before the lane drop, so that when the lane drop occurs, the merge / lane change behavior is that much more pronounced (1045 in the HOV lane versus 3620 in the other 2 lanes).

As the PM peak period continues, effects of the lane drop are felt at Father Hurley Blvd, and then back beyond Middlebrook Road. As the PM peak period progresses, congestion and slowing are experienced along the 2-lane section approaching the MD 80 interchange, and for a portion of the mainline roadway north of MD 80.

Within the 2-lane section, from north of MD 121 to the MD 85 interchange, the NB I-270 PM peak hour volume ranges from 4435 to 4665 vehicles per hour (2218 to 2333 vehicles per lane per hour), which is LOS E/F conditions.

I-270 Spur:

The next place to experience slowing is the I-270 Spur, from Democracy Blvd to the I-270 Split. Approaching Democracy Blvd the Spur is carrying:

- 4165 vehicles in 2 GP lanes (2083 vehicles per lane)
- 1100 vehicles in 1 HOV lane
- 535 vehicles exit to Democracy Blvd
- 2 successive merges add 225 vehicles then another 500 merges from Democracy Blvd

Just north of Democracy Blvd, Westlake Terrace adds 625 vehicles to the left side of the Spur; into the HOV lanes. Resulting volumes are:

- 4355 vehicles in 2 GP lanes (2178 vehicles per lane)
- 1725 vehicles in 1 HOV lane (while this is under capacity, it is almost the highest HOV lane volume seen)

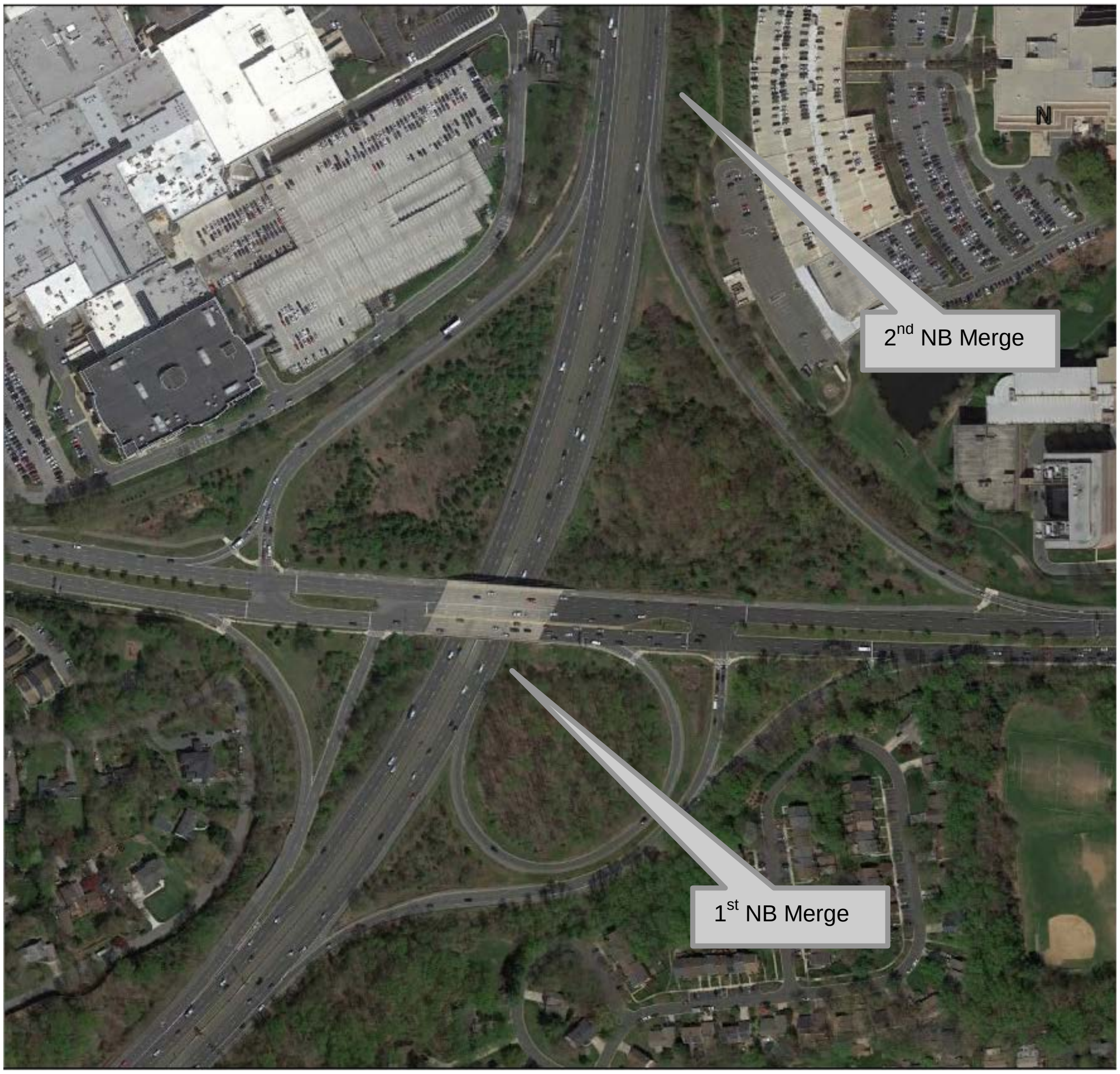


Figure 16: I-270 Spur at Democracy Blvd Interchange

As time passes, the congestion along the Spur intensifies at Democracy Blvd, and begins to extend back along the Spur to I-495 and along NB I-495 approaching the Spur.

Shady Grove Road and I-370 Interchanges:

The next place congestion / slowing is seen is along the NB CD lanes in the vicinity of Shady Brook Road.

Approaching Shady Brook Road:

- The CD Road is carrying 2315 vehicles in 2 lanes.
- The right lane, carrying 1515 vehicles, drops to Shady Grove Road, leaving 800 vehicles in a single lane along the CD.
- Shortly after the lane drop to Shady Grove Road the remaining 1 CD lane is joined by 2 lanes from the mainline on the left carrying 2280 vehicles

- And has to accept 675 vehicles merging along the right from the loop ramp from EB Shady Grove Road.
- Another merge occurs just beyond, adding 825 vehicles from WB Shady Grove Road resulting in 4580 vehicles in 3 lanes (1527 vehicles per lane)
- Then the 3rd CD lane slips back to the mainline carrying 515 vehicles, resulting in 4065 vehicles in 2 lanes along the CD road (2033 vehicles per lane).

To add complexity to the situation, many of the vehicles desiring to slip to the mainline are the 675+825=1500 entering the CD System from Shady Grove Road. Less than 1000 feet exists between where the 2nd ramp from Shady Grove Road enters on the right and the slip to the mainline departs on the left.

After about 600 feet without a ramp junction, the CD road widens to 3 lanes, with the center lane becoming a choice lane in the diverge to I-370

- 2810 vehicles exit via 1 ½ lanes
    - 1510 want to stay right to access EB I-370
    - 1300 want to stay left to access WB Sam Eig Highway (these vehicles will likely use the choice lane when exiting the CD road)
- 1255 vehicles will stay on the CD road in 2 lanes; although many will likely be in the left-most lane due to the heavy choice lane usage.
- The merge of 950 vehicles from EB Sam Eig Highway should be accepted into the CD lanes with relatively little strife

This is a lot of lane changing and weaving in a relatively short section of the CD road. As slowing along the CD road spreads, slowing begins to affect the mainline lanes approaching the slip to the CD road.

Figure 17: I-270 at Shady Grove Road Interchange

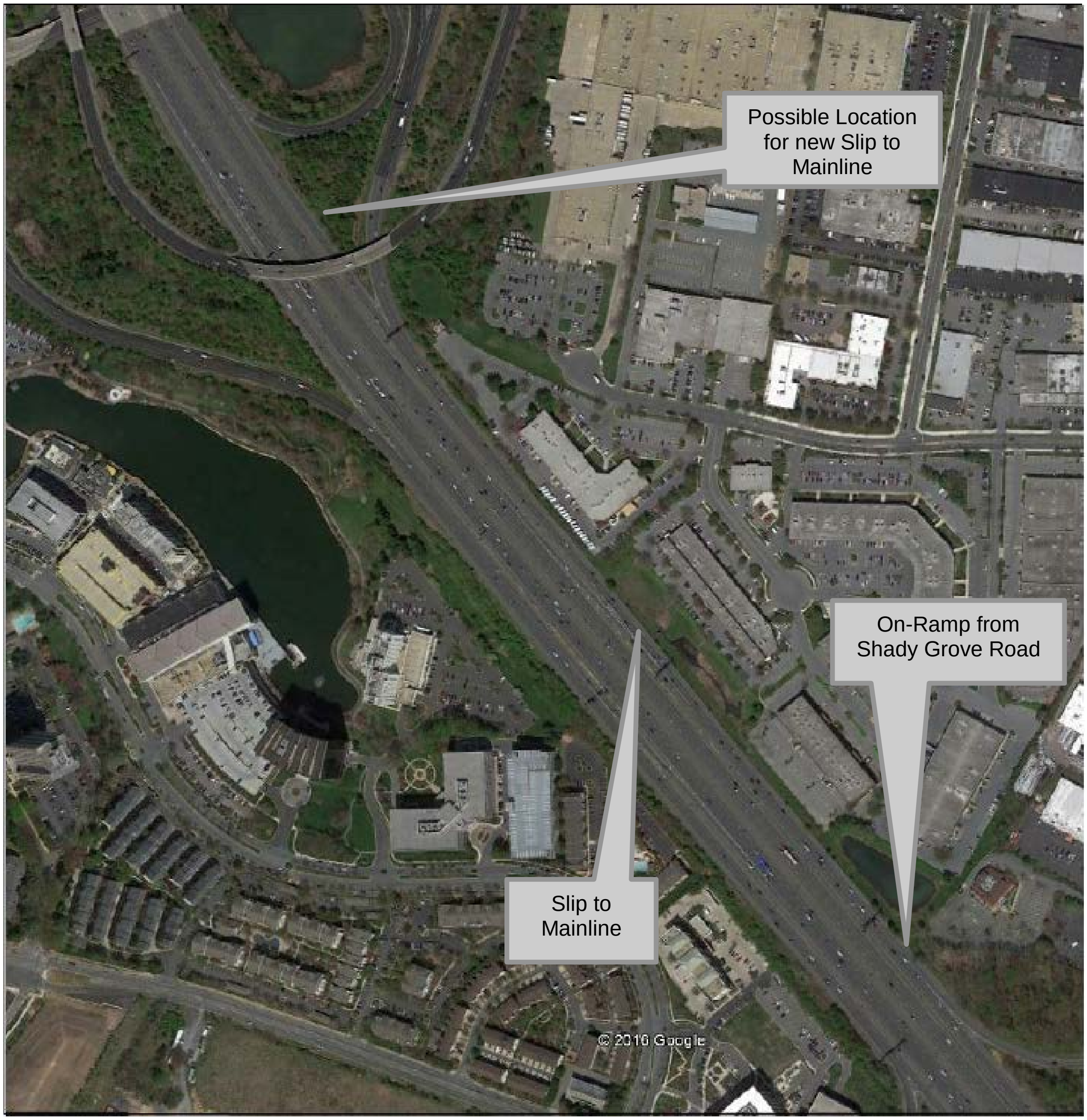


Figure 18: I-270 between Shady Grove Road and I-370 Interchange

MD 124 Interchange and the End of the NB CD System:

Before the CD System ends, just north of MD 124:

- 1200 vehicles in 1 HOV lane
- 5450 vehicles in 3 GP lanes (1817 vehicles per lane)
- 1600 vehicles in 1 CD lane

At its end, the CD System is given about 300 feet in which to merge, at which point there is

- 1200 vehicles in 1 HOV lane

- 7050 vehicles in 3 GP lanes (2350 vehicles per lane)

As the PM peak period progresses, congestion along this section encounters congestion originating to the north at the lane drop (3 to 2), then congestion originating from the south at Shady Brook Road, and operations along the overall corridor slow.

The I-270 Split:

At the Split:

- From I-270 (from the east)
    - 4250 vehicles in 2 GP lanes (2125 vehicles per lane) along the far right side
        - 1345 of these vehicles just merged in via 2 lanes from MD 187 / Rockledge Blvd
    - 1000 vehicles in 1 HOV lane along the left side
- From the I-270 Spur (from the south)
    - 4355 vehicles in 2 GP lanes (2178 vehicles per lane) along the middle/right side
    - 1725 vehicles in 1 HOV lane along the middle/left side

There is likely a lot of lane changing at this point, which is the cause for the slowing.

- Any HOVs from the Spur must move left 1 lane to merge into the new HOV lane, added from WB/NB I-270.
- Any vehicles from the Spur lanes that want to enter the CD system to access Montrose Road must weave right, and vehicles from I-270 that don't want to access the CD system must weave left.

Montrose Road Interchange:

At the north end of the interchange:

- 2065 vehicles in 2 CD lanes merges with
- 1480 vehicles in 1 ramp lane in about 300 feet

Shortly thereafter,

- 300 vehicles slip from the mainline lanes (accel lane is less than 300 feet long)

Figure 19: I-270, North of the Montrose Road Interchange

Between the MD 189 and MD 28 Interchanges:

At this location, along the CD:

- 3990 vehicles in 2 CD lanes (1945 per lane)
- 770 vehicles slip from the mainline via an auxiliary lane
- The auxiliary lane slips back to the mainline after 800 feet, carrying 1015 vehicles

Of the vehicles that may wish to slip to the mainline are 900 vehicles that just entered the CD System from MD 189 on the right side of the CD, which will need to move left to slip to the mainline lanes.

This is a high volume weave along the CD.

Along the mainline:

- 5765 vehicles in 3 lanes (1922 vehicles per lane) after the departure of 770 vehicles
- Then 1015 vehicles slip from the CD System
- Resulting in 6780 vehicles in 3 mainline lanes (2260 vehicles per lane)
- 2000 feet farther north 935 vehicles slip to the CD
- Resulting in 5960 vehicles in 3 lanes (1987 vehicles per lane)

Volumes throughout this section are at the limits of capacity, with high volume merges/diverges/slips.

Meanwhile, between MD 189 and I-370 the HOV lane carries less than 1100 vehicles.

MD 118 Interchange:

The lane configuration along the GP lanes from MIddlebrook Road through Father Hurley Blvd is somewhat complex, but does seem to meet the volume needs along almost every section of roadway. The one exception lies within the MD 118 interchange.

NB MD 118 provides 1 HOV lane and 3 GP lanes approaching the MD 118 interchange. The right-most lane is essentially used an exit staging area, providing access first to the directional ramp in the SE quadrant, then dropping at the loop ramp in the NE quadrant.

Volumes are as follows:

- 1085 vehicles in 1 HOV lane
- 5810 vehicles in 3 GP lanes (1937 vehicles per lane)
- 450+735=1185 vehicles exit NB I-270 via 2 successive ramps leaving 4625 vehicles in 2 GP lanes (2313 vehicles per lane)
- The On Ramp in the NE quadrant adds a 3rd lane and 670 vehicles, resulting in 5295 GP vehicles in 3 lanes (1765 vehicles per lane)

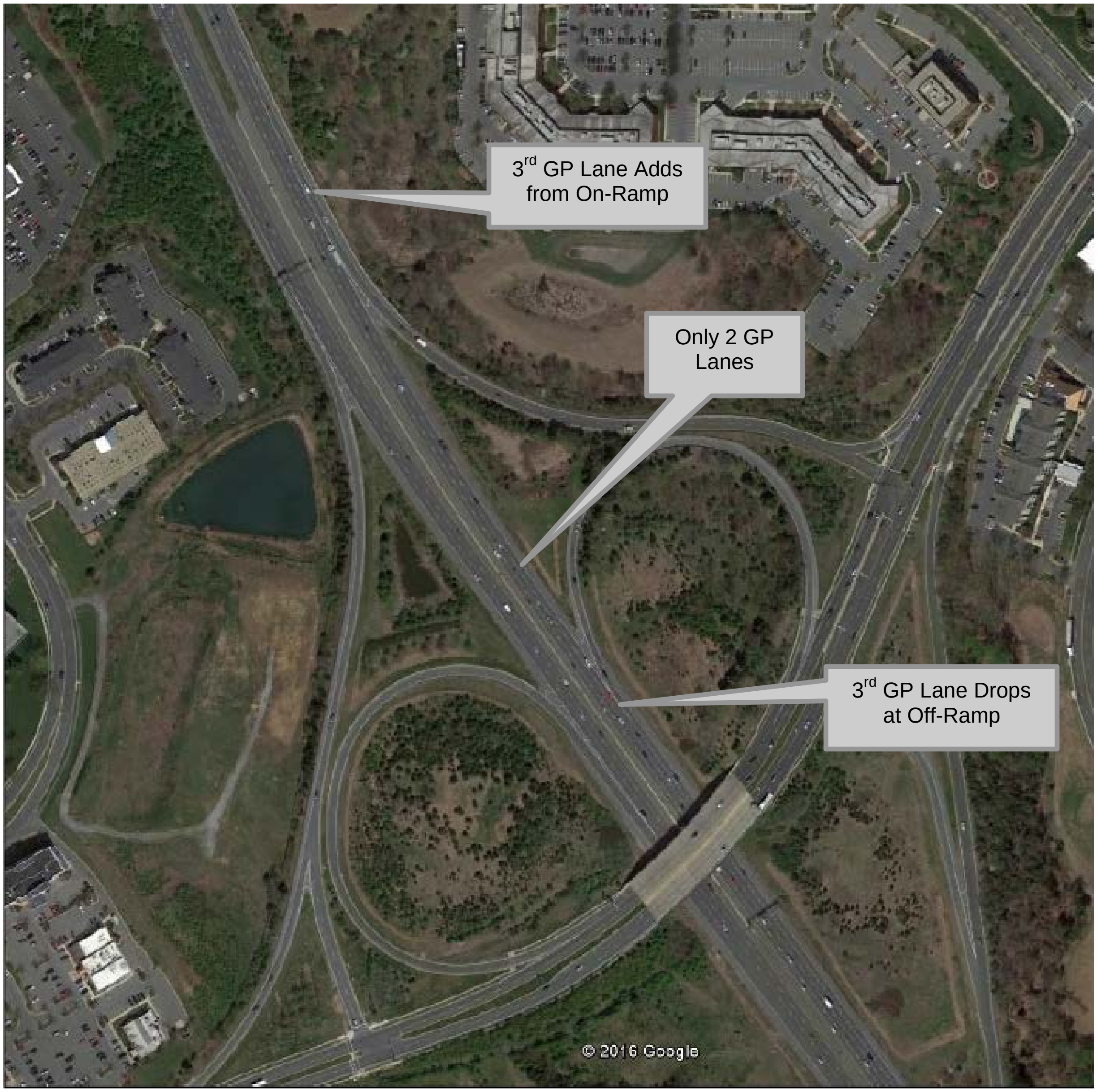


Figure 20: I-270 at MD 118 Interchange

4.3.2 Accident Analysis

Southbound I-270

Attached graphs show the number of crashes reported along SB I-270 and SB I-270Y, by location, for 2011 through 2013.

Review of these graphs shows that crash experiences tend to cluster around interchanges, and the crash rates are much higher between the I-270 Split and I-370 than areas farther north in the corridor. As expected, the locations where crash rates are the highest are also the locations with the highest number of vehicles, the highest number of lanes, and the highest interchange density along the corridor.

The crash types experienced most include:

- Rear End Crashes
- Sideswipe Crashes
- Fixed Object Crashes

The crash rates also show a distinct bias towards the AM peak period within roadway sections that experience high congestion during the AM peak period.

The highest number of crashes reported at any one mile point occurs at the Shady Grove Road overpass.

Northbound I-270

Attached graphs show the number of crashes reported along SB I-270 and SB I-270Y, by location, for 2011 through 2013.

Review of these graphs shows that crash experiences tend to cluster around interchanges, and the crash rates are much higher between the I-270 Split and I-370 than areas farther north in the corridor, although the crash rates for this section are lower than those experienced along SB I-270.

Compared to the SB I-270 crash experience, crash rates for the NB lanes are much higher north of MD 124, where the number of lanes first begins to drop. Both NB and SB I-270 experience similar crash rates within the Frederick County sections of the I-270 corridor.

As for the SB roadway, the crash types experienced most include:

- Rear End Crashes
- Sideswipe Crashes
- Fixed Object Crashes

The crash rates also show a distinct bias towards the PM peak period within roadway sections that experience high congestion during the PM peak period.

The highest number of crashes reported at any one mile point occurs at the MD 28 overpass

5. Proposed System Concept

This section describes the concept exploration. It starts with a list and description of the alternative concepts examined. The evaluation and assessment of each alternative follows, and leads into the justification for the selected approach. The operational concept for the selected approach is also described.

5.1 Active Traffic Management

This subsection provides a brief description of the individual ATM techniques considered for the I-270 ICM Project:

Variable Advisory Speed

- Allow for the change of advisory speeds based on road, traffic and weather conditions.
- Used in conjunction with vehicle detection and weather data to display optimal speed for current conditions.
- Speed harmonization studied along I-270 in St. Louis reduced total crash rate 4.5% to 8.0%.
- Highways England reported a 55.7% reduction in personal injury accidents on the M42 Managed Motorway in the 36 months that the variable speed system was installed

Queue Warning

- Allows for the detection of vehicles in a queue.
- Used to help manage the variability in vehicle flow and optimize system throughput.
- Warns motorists of downstream queues and directs traffic to alternate lanes, reducing the risk of speed differentials and collisions due to queuing.
- Can utilize existing detection technology for data collection.

Junction Control

- Dynamically change lane allocation at an interchange.
- Right lane may be closed for a free-flow of entering ramp traffic.
- Prioritizes the facility with higher volumes and decreases delays due to merging.
- Useful for high volume ramps associated with major freeway-to-freeway interchanges.

Dynamic Lane Assignment

- Allows easy communication of lane closures due to accidents or disabled vehicles to motorists.
- Aids in the maximization of throughput on existing infrastructure.
- Allows safer responses to unexpected delays or congestion.

Dynamic Shoulder Lanes

- Utilizes the shoulder as a travel lane during peak travel periods.
- Allows for additional lanes of traffic with relatively minor to no expansion of existing infrastructure required.

- Decreases amount of space emergency vehicles have to get through traffic and refuge for damaged vehicles.
- Dependent on existing roadway cross section.

Ramp Metering

- Effective way of controlling traffic entering freeway.
- Couples vehicle detection with pre-determined algorithms to control volume of traffic onto freeway.
- Reduces disruptions and accidents on high volume on ramps.

Connected Vehicle Applications

- Three major focus areas:
  - Vehicle-to-Vehicle
  - Vehicle-to-Infrastructure
  - Autonomous Vehicles.
- Evaluate existing ITS infrastructure for connected vehicle applications.
- Ensure enhancements will support future connected vehicle initiatives (i.e. dedicated short range communications).
- Identify potential partnership and grant opportunities.

5.1.1 Variable Advisory Speed (VAS)

VAS is a method to reduce congestion and improve traffic performance. The strategy involves gradually lowering speeds before a heavily congested area in order to reduce the stop-and-go traffic that contributes to frustration and crashes. A key component in this speed harmonizing strategy is the ability of the system to warn drivers of downstream queues (see queue warning). The system can be automated or controlled by a traffic management center operator. It is accomplished by installing lane control signals over each travel lane and posting (advisory) speed limits on the signs over lanes that are slower than the posted speed. As drivers progress along I-270, the speeds reduce. The signs are typically installed on gantries over the travel way and the system begins reducing speeds between three and four gantries before an incident. The Manual on Uniform Traffic Control Devices (MUTCD) states that these signs shall be located such that a driver can always see at least one set of signs and preferably, two. A recent implementation in Virginia on I-66 has gantries spaced ½-mile apart.

It is typically deployed on roadways with high traffic volumes. Speed harmonization is also referred to as variable speed limits, and it is used to manage congestion during incidents and maintenance/construction projects. Others applications include management of traffic during adverse weather conditions (e.g. fog), while others have been used to create more uniform travel speeds. The lane control displays are used for incidents, maintenance and construction.

VAS Components

A VAS system includes the following components:

- Vehicle Detection Device - VAS requires vehicle detection for volume, speeds and/or occupancy along the corridor to operate in an automated manner. I-270 is currently outfitted with a sampling of microwave vehicle detection devices. The density of devices and reporting frequency is not currently sufficient to meet the VAS needs. Third party probe-based data available through RIITIS does not provide the necessary temporal or spatial resolution. Additional infrastructure-based detection will be required.

- Video coverage – Video coverage is not required, but is helpful in verifying and monitoring conditions back at the SOC.
- VAS Display Device – Typically a two-character matrix dynamic message sign. Many times these signs are combined with static speed limit signs, and some agencies, such as the New Jersey Turnpike Commission utilize larger, full-matrix DMS that are configured to mimic a static sign.
- VAS Support Structure – Typically, VAS devices are mounted on vertical posts or overhead gantries or sign structures.
- Power and Communications Infrastructure – VAS devices are low-power, low-bandwidth devices (in general) so the power and communications requirements are relatively minor. VAS systems can be powered by either solar or utility sources and can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Typically an ATMS software application. CHART currently does not support this capability in its functional menu.

VAS Applications

Studies on the use of VAS technology have shown that accident reductions of 10% to 30% can be expected through the implementation of VAS. VAS is a technology that has been widely deployed throughout Europe and parts of the United States. The application areas for VAS deployment typically cover one (1) of two (2) scenarios:

- The deployment of variable speed limit signs (not VAS which is advisory) along an entire corridor to completely replace static speed limit signing. Nearby examples of similar deployments include I-495 in Delaware and the New Jersey Turnpike. In these examples, VAS devices are typically located at regular intervals along the roadway. Research from Europe and the United States shows that a typical VAS device spacing is approximately one device per quarter to half mile.
- The deployment of VAS approaching high-crash locations (especially high frequencies of rear-end crashes), locations with recurring queuing (especially those with limited sight distance), locations overly susceptible to changing weather conditions (such as bridges, steep hills, and low-lying areas), and work zones. In these instances VAS devices are located in advance of the area of concern in order to provide advanced warning to motorists and allow for a safe distance to decelerate prior to the queue or hazard.

VAS Standards

VAS deployments are governed by the Manual on Uniform Traffic Control Devices (MUTCD), as advisory signage.

VAS Implementation along I-270

Due to the persistent and widespread daily congestion along I-270, as well as the high occurrence of rear-end crashes; it is recommended that VAS be deployed as a corridor-wide implementation. This would not necessitate the complete replacement of all static speed limit signs along I-270 within the project limits. The signs (on gantries) should be co-located with the nearest existing/proposed ITS device location in order to economize power and communications services.

Where that is not feasible, a new VAS support structure will be placed adjacent to the roadway and new hard-wire power and fiber connection installed. Due to the requirement to keep VAS operational 24 hours per day / seven days per week, solar power is not a recommended alternative. It is anticipated that all VAS devices can be integrated into the existing fiber communications network along I-270.

Additional static signing will need to be installed along I-270, in advance of the VAS section to notify motorists that speeds will be variable ahead. In addition, it is recommended that notification signing be installed at all interchange on-ramps within the limits of VAS deployment.

Expectation

VAS has the potential to smooth traffic, increase the number of vehicles that a roadway can handle, and improve safety by making it easier for drivers to change lanes when necessary. It also has the potential to reduce the number of rear-end crashes caused by drivers who do not brake early enough when they encounter slow-moving or stopped vehicles.

5.1.2 Queue Warning (QW)

QW's purpose is to inform motorists of the presence of downstream stop and-go traffic (based on real-time traffic detection) using warning signs and in some cases, flashing lights. Drivers can anticipate an upcoming situation of emergency braking and slow down, avoid erratic behavior, and reduce queuing related collisions.

Similar to variable advisory speed, QW uses overhead lane control signals that provide indications of closed lanes ahead using symbols like arrows and "X"'s to indicate open and closed lanes, respectively. The system can be automated or controlled by a traffic management center operator. Work zones also benefit from queue warning with portable dynamic message signs units placed upstream of expected queue points.

QW Components

A typical QW system includes the following components:

- Vehicle Detection Device – These devices can utilize in-pavement sensors, radar sensors, video detection, probe data, or any other source to collect lane-based vehicle presence, speed, and occupancy. Vehicle detection devices are placed in strategic locations to locate the back of a queue of vehicles upstream of an incident or bottleneck in order to warn approaching motorist.
- Video coverage – Video coverage is not required, but is helpful in verifying and monitoring queue back at the SOC.
- Warning Display Device – These are the upstream devices that warn motorists to be aware that they are approaching slowed or stopped vehicles further down the roadway. These devices are typically dynamic but could include something as simple as a small blank-out sign to a full-size DMS. Many comprehensive ATM deployments utilize smaller

DMS in conjunction with variable advisory speed and lane use control in order to warn motorists of obstructions in the roadway.

- Power and Communications Infrastructure – QW detection devices are low-power, low bandwidth devices in general so the power and communications requirements are relatively minor. Depending on the messaging device, more robust power may be required, however many detection devices can be powered by either hard wiring or solar. QW systems can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Back-end software is required for the operation of a corridor-wide queue warning system. Of specific importance is the algorithm used to generate the warning. A high frequency of false alarms will lead to less trust in the detection and thus reduce the effectiveness during a real scenario. The existing CHART software does not have the ability to provide queue detection. Existing functionality will be referenced during system design and any required modifications or enhancements to meet design requirements will be included in the capital project.

QW Applications

QW systems are commonly used throughout the United States, most frequently in construction areas as part of Smart Work Zone Deployments. The primary goal of implementing a QW is to reduce the occurrence of rear-end crashes as a result of vehicles entering the back of a queue at a high rate of speed. When deployed in conjunction with variable speed limits, QW can also help to harmonize speed in areas of stop-and-go traffic.

Throughout 2012 and 2013 Caltrans utilized a QW system to alert motorist to backups resulting on heavy traffic attempting to enter a mall facility during peak holiday travel. Compared to the prior years, they documented a 66% reduction in the number of queuing related crashes after installing the system.

In 2010, Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable DMS) up to six miles in advance of the work zone. Over two (2) years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system.

QW Standards

There are no known standards regarding the design or implementation of permanent QW systems. However, in January, 2014, the FHWA published the Work Zone Intelligent Transportation Systems Implementation Guide which provides guidance for the usage of QW systems as part of Smart Work Zone installations.

QW Implementation along I-270

The intent of QW systems is to reduce the rate of rear-end crashes. Based on the crash data on I-270, it can be expected that QW will help to reduce these rear-end accident.

Detection for the QW system will include existing SFVD detection stations as well as the integration of the new detection proposed as part of the I-270 ICM Project.

In addition, all detection devices along the corridor should be re-calibrated to ensure that they are currently operating properly and collecting accurate and consistent data.

It is anticipated that probe vehicle data provided by RITIS (i.e. INRIX and HERE) will also be utilized to supplement point detector data in the data analysis algorithm for use when detectors malfunction as well as to collect and provide historical data for use by the algorithm.

QW signing is anticipated to be provided via a mix of existing full-size DMS as well as the installation of additional smaller-scale DMS to be utilized for queue warnings in advance of the areas of most need, as well as to provide any additional emergency notification or traveler information as required by the SOC.

Expectation

QW systems reduce primary and secondary crashes by alerting drivers to congested conditions; delay the onset of congestion, improving smooth and efficient traffic flow and trip reliability; provide environmental benefits through decreased emissions, noise, and fuel consumption.

5.1.3 Dynamic Junction Control (DJC)

DJC is a method to dynamically change lane allocation at an interchange. It can be used at freeway on-ramps or off-ramps. For example, when ramp volumes are relatively light or mainline volumes are very heavy, it might be most effective to have an entrance ramp merge into the right lane. However, there may be times that the volume on the ramp is extremely high while the mainline volumes are low. In this case, traffic merging from the onramp will have to find gaps in the mainline traffic. Even though the mainline traffic is relatively light, the hesitation needed at times to find a gap may be disruptive to ramp flows and may create a situation with higher rear-end collision potential on the ramp.

DJC could be used to “close” the right lane of the mainline roadway upstream of the ramp, through the use of lane control signs in order to give ramp traffic a freer-flowing merge transition onto the mainline. This use of junction control provides priority to the facility with the higher volume and reduces priority to the lesser volume roadway. DJC can also be used at off-ramps, especially when hard shoulder running is used, to dynamically create a two lane off-ramp with a freeway drop lane and an option lane.

DJC Components

A DJC installation consists of a series of overhead gantries or roadside signs (depending on the scope of the application) that dynamically change to indicate whether a given lane is open, closed, or about to end. A DJC system includes the following components:

- Vehicle Detection - DJC does not necessarily require a vehicle detection component, however a fully automated system would require that some feedback on traffic conditions be provided before opening or closing a certain lane.
- Video Coverage – For safety reasons, DJC installations will require full camera coverage of the area of implementation so that the absence of disabled vehicles or other debris can be verified prior to opening a lane to upstream traffic.
- Display Device – Typically a DMS. These display devices are often centered over individual lanes to clearly notify drivers. The use of dynamic pavement marking may also provide additional guidance regarding lane use for entering and existing movements.
- Support Structure – Support structures for the display devices will typically span all mainline and ramp lanes.
- Merge Area Lane Striping – Effectively striping the lanes in the merge area is critical to safely implementing a DJC strategy. Striping needs to be clear in both the condition of a ramp lane being allocated a through-lane and vice versa.

- Power and Communications Infrastructure – DJC devices are low-power, low-bandwidth devices in general so the power and communications requirements are relatively minor. DJC systems can be powered by either solar or hard-wired sources and can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Typically an ATMS software application.

The CHART software currently provides a DMS module that has the potential to be modified to operate DJC sign devices. Of particular importance, though, is the algorithm used to automatically control the system. The CHART software does not currently possess this needed functionality.

DJC Applications

DJC is a method used to regulate or close lanes at merge and diverge areas. In merge areas, this method is used where one (1) lane of at least a two (2) lane entrance ramp merges onto an existing highway lane. To avoid collisions and improve the flow of traffic on the highway the lane that is being merged onto must be closed. This keeps the flow of traffic continuous for the entrance ramp and decreases the probability of collision during the merge. Another option is for the lane on the entrance ramp to be closed. This allows the main highway to maintain a certain speed without the concern of a merge. DJC is best used on highways at high volume areas to improve congestion or to alleviate increased traffic during events. It can also be helpful on intersecting roadways with different peak hours.

DJC for merge control is the more difficult, and thus rare, of the two (2) types of DJC applications. An example of a successful case of DJC for merge control has been on the A1 freeway in the Netherlands. Using lane use control, DMS, and dynamic pavement markings, dynamic merge control has been used to effectively utilize roadway capacity to reduce congestion. In 2006 at the Diemen Interchange, the use of DJC was found to reduce average travel time of the main highway by seven (7) percent and reduced the vehicle delay by four (4) percent. The merging traffic's average travel time was reduced by eight (8) percent and delay by 13 percent.

The merge area utilizes a different striping pattern with more closely spaced lines start as the ramp ends and lane merges with the mainline. At the Diemen Interchange, the outside right lane of the main highway and the merging left lane slowly become one (1) lane over roughly 500 feet. The merging left lane will cross the closely spaced striping to merge onto the main highway, and the motorist on the main highway will stay in their respective lane, if it is open.

DJC installed at a diverge area would include overhead lane assignment signs to indicate which lanes are open/closed to existing vehicles. Allowing the dynamic opening and closing of exit lanes to traffic can help eliminate lane changes in advance of high-volume interchanges, thus reducing the incidence of sideswipe and rear end collisions as well as enhancing overall speed and throughput. At diverge areas, DJC is a much simpler design, as the safety concerns relating to vehicles attempting to utilize the same mainline lane are eliminated, however concerns with creating vehicle weaving still remain.

Expectation

Dynamic junction control balances the traffic demands at on- and off-ramps and reduces the turbulence at those locations.

DJC Standards

There are no known standards regarding the design or implementation of DJC systems. Signing and striping are critical components as it relates to standards compliance. Each application would have to be evaluated during the design phase in accordance with the MUTCD and SHA to identify conformance or any required variances from these standards.

Of note is that FHWA requires that all interstate facilities include a minimum of two (2) lanes in each direction.

According to the *Planning and Evaluating ATM Strategies* submitted by the Texas A&M Transportation Institute, the essential elements for use of dynamic merge control are as follows:

- There should be greater than 900 vph in a given area,
- The available capacity on upstream lanes that can be borrowed must not be worse than a LOS E after implementation, and
- Peak traffic upstream cannot be in both merging lane and the main highway.

There are preferable items as well:

- There is active incident management in the corridor,
- There is existing ITS with connections to the TMC, and
- It would be combined with shoulder use as well.

There are suggested ATM Strategies that are compatible with DJC such as dynamic speed limits, dynamic shoulder lanes, and dynamic lane use control. There are also a number of key factors to consider in order to facilitate successful ATM deployment:

- Lane use control signals should be used on the main lanes and merging lanes of a highway to dynamically adapt to varying demand and installed to ensure advance warning to motorists,
- The system should be based on prevailing roadway conditions without the use of an operator,
- In case of emergencies there should be a bypass lane for emergency vehicles, and
- DJC can be implemented in concurrence with temporary shoulder use as long as overhead lane use control signals are appropriately identified.

It should be noted that no examples of DJC (nationally or internationally) on a freeway-to-freeway interchanges with traffic merging at a high rate of speed could be found. DJC is, however, effectively used at many diverging interchanges. DJC is currently being considered along I-270 where the right shoulder will be used temporarily as an auxiliary lane.

5.1.4 Dynamic Lane Assignments (DLA)

DLA is used to indicate lane closures that may be due to downstream congestion, accidents, work zones, or debris. In accordance with the MUTCD the signs can display green arrows indicating the lane is open, a red “X” indicating the lane is closed, or a yellow “X” indicating pending lane closure notifying motorist the need to merge out of the lane.

5.1.5 Dynamic Shoulder Lanes (DSL)

DSL also known as hard shoulder running or temporary shoulder use, is a dynamic measure designed to adapt roadway capacity to high traffic volumes on a temporary basis. By allowing vehicles on the shoulder, it is possible to serve a higher number of vehicles and avoid congestion, either totally or partially, during peak periods. The decision to implement shoulder use on a segment is taken by the operator in the traffic management center based on operating policies and volume considerations after a check for obstacles.

DSL Components

A DSL installation consists of a series of overhead gantries or roadside signs (depending on the scope of the application) that dynamically change to indicate whether the shoulder lane is open, or closed to traffic. A DSL system includes the following components:

- Vehicle Detection – DSL does not necessarily require a vehicle detection component, however a fully automated system would require that some feedback on traffic conditions be provided before opening or closing a certain lane.

- Video Coverage – For safety reasons, DSL installations will require full camera coverage of the area of implementation so that the absence of disabled vehicles or other debris can be verified prior to opening the shoulder to upstream traffic. Video coverage will also assist operators to determine if the shoulders should be closed due to an incident to allow passage of emergency vehicles along the shoulder.
- DSL Display Device – Typically a character matrix dynamic message sign set below a static sign indicating that the dynamic sign is related to operations along the shoulder. These display devices are often centered over the shoulder to better notify drivers.
- DSL Support Structure – Support structures will typically span all mainline and ramp lanes if being utilized in conjunction with dynamic lane use control, variable speed limits, or other treatments. DSL only installations typically include a cantilever sign structure over the right shoulder.
- Emergency Refuge Areas – These are locations built outside the shoulder that provide disabled vehicles a place to pull over when the shoulder is in use.
- Power and Communications Infrastructure – DSL devices are low-power, low-bandwidth devices in general so the power and communications requirements are relatively minor. DJC systems can be powered by either solar or hard wired sources and can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Typically an ATMS software application. The CHART software currently does not provide the functionality necessary for this strategy.

DSL Applications

DSL has been applied in numerous applications throughout both the Untied Stated and Europe. In Massachusetts, shoulder lane use launched in 2002. A total of 45 miles were implemented with DSL, including I-93 and I-95. Traffic congestion was so bad that it was practically at a standstill during peak hours. The maximum speed limit on the shoulder is the same as the travel lanes. A 10-foot minimum shoulder width was required with 12-foot being desired. Emergency pull-off areas spaced every half a mile. This shoulder is only used for travel from 5:00 AM to 10:00 AM and 3:00 PM to 7:00 PM. Heavy trucks are not permitted to use the shoulder. Post-mounted signs show the availability of the shoulder. In addition, cameras and overhead DMS are used along with some sensors to monitor congestion and any issues that may arise. It was found that travel speeds improved in these facilities.

In Washington State, temporary shoulder usage on SR 0002 was launched in 2009. One (1) right shoulder is used for a 1.55 mile-long segment. This shoulder is opened Monday through Friday from 3:00 PM to 7:00 PM, and all vehicles are allowed to use it. The speed limit of the shoulder is 60 MPH. This segment was restriped for adequate shoulder use. Shoulder- or barrier-mounted manual flip signs are posted every 1,200 feet to alert motorists of the availability of the shoulder as a travel lane.

In Virginia, temporary shoulder use and HOV Lanes on I-66 launched in 1992. The right shoulder is opened for travel Monday through Friday from 5:30 AM to 11:00 AM in the eastbound direction and 2:00 PM to 8:00 PM in the westbound direction. There are 6.5 miles of dual HOV/Shoulder lane operations. I-66 is a major facility that connects Washington D.C. and North Virginia, and it has very heavy traffic with three (3) mainline lanes in each direction with a posted speed limit of 55 MPH. The three (3) mainline lanes are 12 feet, the left shoulder is eight (8) to 11 feet. The right shoulder is 12 feet wide. There are four (4) emergency areas in the eastbound direction and five (5) emergency areas in the westbound direction. An overhead lane control system is operational to indicate if the shoulder is open. Post-mounted signs provide notification as well as termination of restricted use and indicate where emergency areas are located. Virginia DOT hires a contractor to maintain the facility while VDOT handles ITS operations. Shoulder lanes are open to general-purpose traffic. The HOV lane is for vehicles with two (2) people or more.

Temporary shoulder use has been used in foreign applications and results appear to be positive. In the Netherlands, a capacity increase of 7% to 22% was reported during the implementation of a hard shoulder (depending on the usage levels) along 620 miles of highway throughout the country. In addition, traffic volumes increased up to 7% during congested periods along those highways in the Netherlands. Germany (who operates 125 miles of hard shoulder) reported a temporary increase of up to 25% in freeway capacity with the use of a shoulder as travel lane. On the M42 Motorway from J3A to J7, capacity increased by an average of 7% to 9%.

A study on A4-A86 in France shows that capacity increases by about 900 vehicles per hour with the use of dynamic shoulder lanes. Compared to the capacities of regular cross sections, dynamic shoulder lanes increased capacity of the two (2) lane highway by around 30%, and the three (3) lane highway from 22% to 27%.

DSL Standards

There are no known standards regarding the design or implementation of DSL, and Maryland does not currently have any DSL installations. However, it is anticipated that some form of waiver will be required to allow the use of the shoulder as a travel lane, on a temporary but recurring basis.

While not standardized, FHWA screening guidance does indicate the following criteria:

- Segment lengths should be a minimum of one (1) mile.
- Shoulder width should be 10 feet minimum, but 12 feet is desired.
- Mainline lane widths (e.g. restriping to accommodate DSL) should maintain 11 feet minimum.
- Emergency Refuge Areas should be placed every 0.5 to 1.5 mile.

Best practices originating in Europe have also noted the following as it relates to DSL design and installation:

- Safe havens should be provided for broken down vehicles. They should ensure a safe use, both length and width. The maximum distance between them should be 1000m.
- Road markings should be in line with general standards used for road sections without dynamic shoulder lanes.
- Quality surveillance and monitoring for traffic operators should be guaranteed
- Use dynamic message signs to indicate if the shoulder is opened/closed/clearing/ending for dynamic shoulder lanes.
- The applicable speed limit should be displayed.

DSL Implementation along I-270

I-270 cannot effectively handle current and future traffic demands. Recurring congestion occurs during both the AM and PM peak periods, and often during the off-peak periods. Multiple overlapping breakdowns in traffic or bottlenecks are difficult to analyze due to limitations in the

Highway Capacity Manual (HCM) methodologies. Other tools such as simulation modeling are more appropriate in this instance.

Traffic counts indicate that I-270 is at or over capacity along much of the corridor. I-270 seems to handle as much as 2,300 vehicles per hour per lane. However, the shoulder lane would likely have a lower capacity range between 1,200 and 1,500 vehicles per hour due to limited lateral clearance. Regardless, this would still provide as much as a 15% increase in capacity per direction.

Even though the increased capacity provided by the shoulder usage may alleviate local congestion, the discharge from previous unmet demand could result in shifting of bottlenecks downstream and may increase overall network congestion. Careful consideration of DSL locations and limits must be analyzed to minimize operational consequences outside the study area. Traffic modeling is necessary to evaluate the effects DSL has on the overall network.

Improved traffic flow provided by DSL could significantly decrease the number of incidents caused by congestion, particularly rear-end accidents. The decrease in non-recurring congestion caused by incidents would significantly improve the operations of the overall corridor. Some segments along the study limits may provide an opportunity to implement DSL in a relatively short-term period:

Expectation

Temporary shoulder use can help postpone the onset of congestion. By increasing capacity and encouraging more uniform speeds, traffic flows more smoothly and efficiently, which can improve trip travel time reliability. Increased vehicle volume can be another benefit of temporary shoulder use by temporarily increasing capacity.

5.1.6 Ramp Metering

Ramp Meters are traffic signals at freeway on-ramps that control the rate of vehicles entering the highway. The meters can be set for different flow rates to optimize traffic flow and minimize congestion. When in operation, ramp meters will alternate between red and green lights, restricting the number of vehicles entering I-270, thereby reducing congestion, bottlenecks and managing the traffic flow on the mainline.

Effective ramp metering programs using suitable strategies often realize significant, long-term benefits. While the magnitude of the benefits may vary depending on the level of congestion and configuration, common benefits persist. The widespread benefits of ramp metering, relative to its costs, make it one of the most cost-effective freeway management strategies.

Travel times, even when considering time in queue on the ramp, are generally reduced when ramp metering is implemented. Travel time reliability has become an important measure of ramp metering effectiveness. Many regions have experienced increased travel time reliability (reduced variations in day-to-day travel times) due to ramp metering.

Ramp meters help break up platoons of vehicles that are entering I-270 and competing for the same limited gaps in traffic. By allowing for smooth merging maneuvers, collisions on I-270 can be avoided. Many regions have reported significant reductions in crash rates after starting ramp metering.

RM Components

Each Ramp Meter Location consists of several field devices working together to provide input to the traffic controller and backend software to determine appropriate timings. The following items are included in a typical ramp signal deployment:

- Metering Traffic Signal - Indicates to driver when they can enter I-270 (green ball) or to wait (red ball).
- Ramp Meter Signage – A yellow "RAMP METERED WHEN FLASHING" light along with static signage, indicating that ramp metering is active.
- Demand Detectors - Notifies controller that a vehicle is waiting at the meter and that the signal should be turned to green.
- Passage Detectors - Notifies controller that a vehicle has passed through the meter and that the signal should be turned to red.
- Queue Detector - Notifies the controller that there is a significant queue so that the metering rate can be adjusted to prevent spillover onto the arterial street.
- Ramp Controller - Controls the ramp metering rate.
- Lane Detectors - Measures the mainline flow volume, occupancy and speed.
- SOC - Collects vehicle traffic flow and freeway condition information upstream, downstream, and at ramp entrance. The ramp metering system is monitored and controlled at the SOC.

Ramp metering detection is critical to the successful operations of the ramp metering system. Detection for both mainline and ramp vehicles is typically provided by one of the following three methods:

- Inductive Loop - Coiled wire forms an inductor that's embedded into the roadway. The loop's inductance changes and produces a readable signal when a vehicle passes over it. The inductive loop has been incorporated into the ramp metering system to provide information regarding vehicle presence on the ramps as well as speed, volume and occupancy of the mainline.
- SFVD – Side-Fire radar traffic sensor which detects presence and measures traffic parameters in multiple independent lanes. The SFVD is a true presence traffic detector providing presence, volume, occupancy, speed and classification information by lane. SFVD detectors are used at certain locations to provide volume, speed, and occupancy data for mainline lanes.
- Video Detection - This detector takes real-time traffic video and transforms it into digital data, from which critical information for analysis and traffic management can be easily gathered. Some of the capabilities include traffic counts, average traffic speed, traffic occupancy, vehicle classification, classifying traffic into categories based on vehicle length. Video detectors are utilized at certain ramp locations to detect vehicle presence.

RM Applications

Ramp meters are installed to address three (3) primary operational objectives:

1. Control the number of vehicles that are allowed to enter I-270.
2. Reduce freeway demand by introducing control delay at freeway entrance points.

3. Break up the platoons of vehicles released from an arterial traffic signal.

The purposes of the first and second objectives are to ensure that the total traffic entering a freeway system remains below its operational capacity. The purpose of the third objective is to provide a safe merge operation at I-270 entrance. Ramp metering has the potential to achieve the following benefits:

- Increase vehicle throughput during peak hours.
- Increase freeway speeds.
- Safer operation on a freeway and its entrances.
- Decrease fuel consumption and vehicular emissions.

No RM is implemented in Maryland. RM is currently not integrated into the CHART software.

RM Standards

Neither Maryland nor FHWA have standards for the design, installation or operations of ramp metering. Arizona, California, and Minnesota currently have standards for Ramp Metering and they were reviewed as part of the development of this ConOps. In determining whether or not a location is suitable for ramp metering, one of the primary concerns is ramp geometry and volume. It is not recommended to utilize ramp metering at locations where entering volumes exceed 900 vehicles per hour for single lane ramps and 1,600 vehicles per hour for dual lane ramps. An analysis of ramp metering along the I-476 corridor indicates that ramp operations begin to break down on dual lane ramps when entering volume exceeds 1,400 vehicles per hour. The Arizona DOT has developed a ramp metering warrant analysis procedure that looks at the following criteria when determining the suitability for ramp metering implementation:

- Recurring Congestion
- Collision History
- Freeway Level of Service
- Modal Shift
- Redistribution of Access
- Sporadic Congestion
- Total Volume
- Right Lane Plus Ramp Volume
- Interchange Geometry

RM Implementation along I-270

The exact locations and application of RM is still to be determined.

Expectations

RM reduces mainline congestion and overall delay, while increasing mobility through I-270 network and traffic throughput.

5.2 Other Intelligent Transportation System Strategies

5.2.1 Advanced Traveler Information

An Advanced Traveler Information System (ATIS) acquires, analyzes, and presents information to assist travelers in moving from a starting location (origin) to their desired destination. An ATIS operates by using data supplied by the traffic management centers. Relevant information may include locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions.

Traveler information can be categorized as either pre-trip which provides travelers with current roadway and/or transit information prior to deciding upon the time, mode, and route of travel, or en-route traveler information which provides the traveler with current roadway and transit information while traveling en-route.

Dynamic Message Signs

DMS's provide traveler advisory information such as incidents, events, construction and maintenance, road closures, and travel time to en-route motorists. The primary function of the DMS is to provide real-time congestion or incident information to travelers so that they can make informed choices of their travel mode or route.

5.2.2 Traffic Signal Synchronization

Traffic signal synchronization is a traffic engineering technique of matching the green phases for a series of intersections to enable the maximum number of vehicles to pass through, thereby reducing stops and delays experienced by motorists. Adaptive Signal Control Technology (ASCT) is the most current synchronization tool used in the country, and its results are impressive (where properly implemented), ASCT is currently being examined in Montgomery County, and a pilot is expected in the next year.

The main benefits of synchronization and adaptive signal control technology (ASCT) over conventional signal systems are that it can, automatically adapt to unexpected changes in traffic conditions, improve travel time reliability, reduce congestion and fuel consumption, prolong the effectiveness of traffic signal timing, reduce the complaints that agencies receive in response to outdated signal timing, make traffic signal operations proactive by monitoring and responding to gaps in performance. Along I-270 corridor, better synchronization of arterials will improve interchange operations and ensure a better flow of traffic within the region. ASCT may also automatically detect and respond to ramp congestion impacts on the local arterial roads, or increase volumes as a result of traffic being diverged from I-270 resulting from an incident.

5.2.3 Vehicle Detection

In a traffic management system, the detection and surveillance component supports the process in which data are collected to describe or characterize traffic flow conditions on the highway. The data are used to supply information about conditions on the roadway to other system components. Thus, detection and surveillance provide the information needed to perform the following traffic management functions including: Measuring traffic flow and environmental conditions, formulating control decisions, disseminating traveler information, monitoring and evaluating system performance, supporting other freeway management and operations functions such as incident detection and verification, planned special event and emergency management, ramp management, and transportation planning.

Vehicle detection, aside from improving incident detection, is used as a surveillance tool for the implementation of dynamic shoulder running. Typically, shoulders – where part-time shoulder usage is implemented, is outfitted with detection to immediately know when there is a blockage or other dangerous situation on the shoulder. Most commonly, video incident detection is used.

Vehicle detection on the mainline and (part-time) shoulder locations will provide faster detection of incidents while improving safety

5.2.4 CCTV Surveillance

Closed circuit television (CCTV) systems have been used for many years to provide visual surveillance of I-270 system. Control centers typically use CCTV systems for detecting and verifying incidents, monitoring traffic conditions, monitoring incident clearance, verifying message displays on changeable message signs, and monitoring environmental conditions (e.g., visibility distance, wet pavement). On critical freeways, like I-270, full video coverage is a necessity to allow control room personnel to visually monitor sections of roadway and to react directly to the actual conditions on the roadway.

5.2.5 Travel Time Signs

Signs along the highway display the amount of time it will take to get to specific destinations. Some of the signs provide times for alternate routes to the same destination, allowing the driver to choose which route to take. Travel Times can be displayed on DMS or on purpose-built signs

Travel times are calculated based on information collected from various sources either directly or indirectly measuring vehicle flow. Traditional infrastructure-based detection is able to detect and measure traffic parameters at a given point and derive speed and travel time information. Other more advanced probe-based technologies using Wi-Fi, Bluetooth, or GPS-based applications provide a direct measure of travel time between two points, but only for a sampling of the traffic. With Wi-Fi and Bluetooth readers installed along roadways are used to detect vehicles (actually vehicle inhabitants with mobile phones or other devices) using Bluetooth or Wi-Fi. As devices are detected by successive readers, the system compiles aggregate data on average speeds, travel times, and the number of non-arriving vehicles (vehicles expected but not yet detected by the next reader downstream). Commercial GPS probe-based solutions, such as INRIX and HERE, relay on smart phone applications to constantly and anonymously report back device position information which is then used as a surrogate to calculate travel time of the occupant in the vehicle. A large sample set will accurately represent the actual travel time conditions on the roadway. CHART currently uses an aggregation of all these data sets provided through RITIS to determine appropriate travel times to be displayed throughout the state. Travel time signs provide motorists knowledge of their future trip duration which aids in providing trip predictability.

5.3 System Operational Concept

This section describes the I-270 ICM Project operational concept.

5.3.1 Corridor Goals and Objectives

The operational goals of the I-270 ICM Project are:

- **Mobility** – Provide improvements that maximize vehicle throughput, minimize vehicle travel times, and create a more predictable commuter trip along IS 270.
- **Safety** – Provide for a safer IS 270 corridor.

The operational concept of the I-270 ICM Project is presented in the Table below.

Goal	Objective	ATM / ITS Strategy
Mobility	• Maximize vehicular throughput • Reduce overall trip and travel time through the corridor • Improve travel predictability • Maximize the efficient use of any spare corridor capacity, such that delays on other saturated networks may be reduced.	• Dynamic Shoulder Use (Hard Shoulder Running) • Travel Time Signing • Dynamic Junction • Adaptive Ramp • Dynamic Merge • Advanced Traveler Information • Traffic Signal Synchronization • Vehicle Detection • CCTV Surveillance
Safety	• Obtain accurate real-time information on the current operational status of the corridor • Detect incidents and locations • Expand coverage and availability of ATIS devices (e.g., to warn of accident or lane closures ahead) • Provide (lane use) traveler information in a consistent manner (e.g., display formats, terms and their meanings.	• Speed Harmonization • Queue Warning • Vehicle Detection • CCTV Surveillance

Table 2: Operation Concept of the I-270 ICM System

6. User-Oriented Operational Description

This section contains a description of each ATM/ITS technique from a user vantage point. Each individual technique is discussed separately, then a description of the proposed combined system is presented. This section also explains how organization/system-specific goals and objectives are accomplished. Emphasis is placed on who the users are and what the users do.

6.1 Stakeholders

Numerous stakeholders exist along the I-270 Corridor. The stakeholders that are discussed in this section can be broken into 3 categories:

- Owner / Operator / Maintainer
- Users
- Partners

6.1.1 Owner / Operator / Maintainer

The Owner / Operator / Maintainer category includes those transportation agencies that have responsibility for operating and/or maintain the I-270 corridor network.

Maryland State Highway Administration (SHA)

The Maryland Department of Transportation (MDOT) is an organization comprised of five business units and one Authority. They are: The Secretary's Office, State Highway Administration, Maryland Transit Administration, Motor Vehicle Administration, Maryland Port Administration, Maryland Aviation Administration and the Maryland Transportation Authority.

SHA is responsible for the development, operations and maintenance of the state roadway network. It is comprised of seven Engineering Districts (comprised of Counties) across the state. I-270 traverses both Montgomery County (District 3) and Frederick County (District 7). Along I-270, SHA will be responsible for management of I-270 network and Park-n-Ride facilities.

Other Offices within SHA that will have a role in operating and maintaining I-270 include:

Office of CHART and ITS Development (CHART) – CHART's responsibility, in cooperation with the Maryland State Police and the Maryland Transportation Authority, is to provide real-time operations along the SHA network. CHART will ultimately have responsibility for the ATM / ITS network to be installed as part of the I-270 ICM Project. Emergency Response Units (ERU) are on-road responders that survey the highway and respond to incidents or disabled vehicles. They operate 24 hours per day. Only two ERUs exist along the entire corridor.

Office of Traffic and Safety (OOTS) – OOTS develops and implements traffic systems management and operational strategies on the state highway network.

Office of Maintenance (OOM) – OOM maintains the communications network for SHA.

Districts 3 and 7 – the districts are responsible (ultimately) for the operation, construction and maintenance of all state highways in the Montgomery and Prince George's Counties (District 3) and Frederick, Howard and Carroll Counties (District 7). Emergency Service Patrols (ESP) from the District's maintenance shops augment the ERUs during peak periods. These patrols assist with disabled vehicles.

Montgomery County Department of Transportation (MCDOT)

MCDOT is responsible for the management of the county's arterial network, as well as the Ride On bus service. Under contract to SHA, they also operate and maintain signalized SHA intersections in the County.
The County manages all of its on-line signals from the Transportation Management Center (TMC) using a modern distributed Traffic Signal System (TSS) that operates as part of a larger Advanced Traffic Management System (ATMS). The TMC is located at the Public Safety Communications Center (PSCC) in Gaithersburg, Maryland. The County primarily relies on a network of closed-circuit television (CCTV) cameras, and other sources such as computer-aided dispatch systems and bus operators to relay real-time traffic surveillance information. The county is able to share CCTV video with SHA. Even though the TMC operates 7x19x365 (typically not staffed 00:30 - 05:30 daily) key operations staffing is centered on the peak weekday AM/PM peaks and special events. Off-peak monitoring coverage is limited leaving possible gaps in the ability to detect and respond to real-time traffic demand needs..

Maryland Transit Administration (MTA)

Along I-270, MTA operates the MARC train service from Frederick to the Shady Grove Metro Station. MTA also operates several local and express bus routes.

Washington Metropolitan Area Transit Authority (WMATA)

WMATA operates and maintains the transit networks Metrorail (subway) and Metrobus (bus) which run between the county and Washington, DC and Virginia. They also manage the parking facilities at their stations.

City of Rockville

The City of Rockville, MD is responsible for general roadway maintenance, pavement signing/marking, pedestrian safety efforts, and maintains direct operational management responsibility of its downtown signals using a separate field master type traffic control system (Econolite Aries). These signals are not tied into the County TMC. Operations need to be closely coordinated at signal boundary points to ensure common cycles and progression is maintained. The City does not currently monitor other County signal operations..

City of Gaithersburg

The City of Gaithersburg, MD is responsible for general roadway maintenance, pavement signing/marking, and pedestrian safety efforts. The City owns a few traffic signals within its jurisdiction; however, signal operations and maintenance is performed by the County.

6.1.2 Users

This group describes those stakeholders that benefit from the system but do not participate in the oversight, operation or maintenance of the system.

Media

Media, including local radio, ISPs and TV stations, collect traffic data from a central source and distribute and broadcast the information to the public.

TrafficLand

TrafficLand is a third-party provider that packages the real-time traffic conditions and transmits as part of SHA's 511 system.

6.1.3 Private Vehicle Operators

Private vehicle operators are the largest group of users of the corridor. Their use of the corridor is expected to grow in the future.

Private vehicle operator role and responsibility is limited to:

- Operating within the corridor; and
- Consuming information.

6.1.4 Commercial Vehicle Operators

Trucks and other heavy vehicles use I-270 to move goods between Washington, DC and other parts of Maryland and the country.

Commercial Vehicle Operation (CVO) role and responsibility is limited to:

- Operating within the corridor; and
- Consuming information.

Pedestrians

Pedestrians travel on the arterial corridors in the project area. This group needs to be included when introducing improvements on the arterials, in particular, traffic signal synchronization.

Pedestrian roles and responsibilities are limited to:

- Operating within the corridor; and
- Consuming information.

Bicyclists

Bicyclists travel on the arterial corridors in the project area. This groups needs to be included when introducing improvements on the arterials, in particular, traffic signal synchronization.

Bicyclist roles and responsibilities are limited to:

- Operating within the corridor; and
- Consuming information.

6.1.5 Partners

Maryland State Police (MSP)

MSP is responsible for enforcement, security, and accident investigations on freeways.

Montgomery County Police (MCP)

MCP is responsible for enforcement, security, and accident investigations on Montgomery County arterials. They also respond to accidents/incidents along I-270.

University of Maryland's Center for Advanced Transportation Technology (CATT)

CATT is responsible for the maintenance and operation of the Regional Integrated Transportation Information System (RITIS).

6.2 Current Capabilities

Current traffic and incident management practices along I-270 do not meet the I-270 ICM Project goals.

6.2.1 Freeway Management

SHA CHART, and to some extent, Districts 3 and 7 traffic groups, are responsible for coordinating much of the activity that occurs on I-270 as part of its role in managing all freeways located within the project area.

Events and incidents are detected through the SOC operator monitoring CCTV images or interfacing with MSP, MCP or District maintenance staff. This is currently a reactive approach to incident detection. In the event of an event or incident, the SOC will coordinate a response with an appropriate group, such as the MSP, ERUs, ESPs and emergency responders.

Demand onto I-270 is managed through traveler information and by controlling the traffic signals at the base of freeway on-ramps. Fixed and moveable Dynamic Message Signs (DMS) and Traveler Advisory Radios (TAR) provide information on upcoming events and freeway incidents.

Lane control is managed through static signage, striping, and police or maintenance personnel. HOV lane restrictions are communicated to drivers by static signs on I-270 shoulder and via diamond markings on the roadway. HOV lanes operate in both directions during specified times. Changes to lane use as dictated by incidents or maintenance activities are managed by some or all of the following activities:

- MSP/MCP vehicles slowing down traffic;
- MSP/MCP or maintenance personnel placing flares on I-270 to indicate the closing of a lane;
- MSP/MCP or maintenance personnel placing cones on I-270 to indicate the closing of a lane; and
- A temporary DMS is set-up on I-270 shoulder.

Vehicle speed is managed through static signs located on the right shoulder of I-270. In the event that an advisory speed needs to be temporarily modified, a temporary sign is erected and the permanent sign is covered.

6.3 Arterial Management

In Montgomery County, time of day signal coordination is accomplished by the County on all arterials. In Frederick County, the coordination is accomplished by SHA forces (District 7) on state highways and County of Frederick staff on county roads.

In the event of an incident along the corridor, each jurisdiction modifies its own signal timing. There is little interaction between agencies to assist with traffic signal coordination. Improving this coordination between agencies requires upgrades in many cities signal systems.

When incidents do happen on I-270 that increase the vehicle load on the arterial, there is little each jurisdiction can do to quickly direct vehicles that have diverted onto the arterial back onto I-270 downstream of an incident. There is no arterial signage to identify to the drivers where an incident is and how to get back onto I-270 beyond the incident. As a result vehicles may have a tendency to stay on the arterial longer than required, thus unnecessarily increasing the load on the arterials downstream of the incident.

Montgomery County has significant CCTV coverage along their arterials (and the state roadways they manage), however, Frederick County has little in the way of arterial coverage, so they are not able to verify the conditions quickly.

6.4 Incident Management

Freeway incident management is coordinated through the CHART SOC. Incidents are reported to the SOC operator by MSP/MCP, ERUs, ETP's or maintenance teams. The SOC operator will then coordinate a response with the appropriate CHART team and/or the MSP. In addition, the SOC operator can post information to DMS and TAR if necessary. The SOC operator will also use CCTV camera feed, when available, to assist with assessing and managing the incident.

Lane control around an incident is controlled by jurisdiction on-site. MSP will use flares, hand signals and cones to indicate which lanes are open and closed. CHART ETPs and ERUs support the police on scene with their arrow board-mounted trucks.

6.5 Traffic Surveillance and Monitoring

Closed circuit television (CCTV) cameras are installed on I-270 for surveillance. In Montgomery County, most of the cameras are owned and operated by the County. The images are streamed to the SOC, but CHART has no control. The CCTV cameras provide some coverage, but they do not provide a very detailed view of the corridor. There are many gaps in the coverage. However, the images that are available are streamed back to the SOC and used by the operators to view the traffic conditions. In addition, these images are made available to other agencies through the Maryland State Network and to the public via the web to allow them to view the images when the cameras are not being used by CHART for an incident. In the event that CHART deems the images seen on the video unsuitable for public consumption, access to the images can be interrupted.

SFVD microwave detectors are installed on I-270 for traffic monitoring. These detectors provide some coverage, and with a density and data polling frequency suitable for basic traffic flow information reporting, but not sufficient for active traffic management purposes. The CHART system to which they connect also does not provide any support for automated incident detection. As a result the detector station data is not used for much real-time traffic responsive operational decisions.

6.6 Traveler Information

Traveler information is provided via DMS, TAR, telephone (511) and the Internet. DMS and TAR systems are used to provide real time information and directions to the driver, plus they are used to advise about upcoming events. These systems are controlled from the CHART SOC. The Internet is used to provide more detailed information to the public.

The primary method of sharing information on the Internet and the telephone is via the MDOT 511 system (md511.org). The 511 system receives real time information from RITIS, CCTV cameras and from some management applications. This information is then analyzed and used to display meaningful, up to the minute information.

6.7 Commercial Vehicle Operation

Many commercial vehicle trips are completed into and through the corridor. Many of the commercial vehicle trips focus on trips to/from the Washington, DC metropolitan area and the southern end of the I-270 corridor. There is a scales/inspection station along the southbound portion of I-270 in Frederick County. There is little real -time information provided to the commercial vehicles and there are no restrictions to the commercial vehicle operation.

6.8 Summary

The applications being considered for implementation along the I-270 corridor through the IS 270 ICM Project have the potential to significantly impact mobility and safety along the corridor. The table below provides a summary of how each application would help achieve the Project Goals identified in Section 2.2.

Application / Project Goal	Variable Advisory Speed	Queue Warning	Dynamic Junction Control	Dynamic Lane Assignment	Dynamic Shoulder Use	Ramp Metering	Connected Vehicles
Mobility – Maximize Vehicle Throughput	X		X	X	X	X	X
Mobility – Minimize Vehicle Travel Time	X	X	X	X	X	X	
Mobility – Create a more Predictable Commuter Trip	X		X	X	X	X	X
Safety – Provide a Safer IS 270 corridor	X	X		X	X		X

Table 3: ATM Application Summary Impacts

7. Operational Needs

This section describes what is required by the I-270 corridor freeway managers that the current system does not provide.

7.1 I-270 Vision

The health of the area's economy and community life is heavily dependent on the state's infrastructure networks. The quality of these networks is vital to the viability of business, as well as effective community services.

The vision for the I-270 ICM Project is to deliver a safe, efficient, maintainable roadway using innovative traffic management techniques.

The I-270 ICM Project will provide:

- a mechanism to manage mainline speeds to reduce turbulence,
- sufficient density of traveler information,
- easy lane control and incident warning,
- ability to accommodate peak period capacity increases,
- consistent real-time travel times at major decision points, and
- flexible lane use and control that would be appropriate for the varying conditions of the corridor

7.2 Staffing

The ATM can operate in fully-automated mode – requiring no operator confirmation before implementing a response plan; semi-automatic – requiring operator confirmation before implementing a plan; or fully manual – allowing the operator to control individual devices or select and implement a particular plan. Regardless of the mode of operation, the move to incorporate ATM into the operational structure will require additional operations staffing or at least a dedicated operator to monitor the corridor. Twenty-four hour staffed operation currently exists at the SOC in order to activate the techniques whenever they are needed.

Additional equipment will require an increase in maintenance efforts. The additional maintenance would pertain to structural inspections of the gantries and regular maintenance for the data stations, detectors, VAS and DMS displays, and associated utilities.

7.3 Data Support and Communications Structure

ATM techniques such as variable speed limits require a higher density of detectors than presently available. In addition, the ATM control algorithms may need detector data by lane. Current control algorithms (e.g., for ramp control) require detectors across all lanes at a single location be grouped as a station of detectors. Furthermore, because the operational responses will likely include freeway and arterial coordination, there is a strong need for center-to-center communications. This requires data sharing between the SOC and the counties TMCs. There will be tremendous amounts of data coming into the SOC which will need to be archived. The current archive will continue to maintain and store the data, as well as post the data on the internet for public use.

7.4 Business Requirements

There are requirements within the system engineering framework that must be used for the development of the I-270 ICM system. The following subsections identify the requirements that, when satisfied, will allow SHA to achieve its objectives. These requirements, referred to as Business Requirements, permit the development of this concept of operation. The requirement hierarchy is:

- Business Requirements – identify the stakeholder's goals and objectives of the system.
- User Requirements – identify the characteristics of the system that need to be in place for the operators to perform their assigned responsibilities.
- Functional Requirements – at a high level, identify many of the elements, subsystems and data inputs and outputs of the system.

All requirements must satisfy a higher level requirement and must be satisfied by a lower level requirement. All Business requirements must be satisfied by a User requirement. All User requirements must satisfy a business requirement.

7.4.1 Vehicle Impact

1. Shall allow safe movement of vehicles in the corridor.
2. Shall allow efficient movement in the corridor.
3. Shall permit reliable movement of vehicles in the corridor.
4. Shall reduce incident rate.
5. Shall decrease impact of incidents.
6. Shall reduce driver frustration.
7. Shall balance the needs of long distance commuters with the needs of people making short trips.
8. Shall reduce the number of bottlenecks.
9. Shall decrease number of vehicle delay hours along the corridor.
10. Shall reduce the instance of traffic queue waiting on the on ramps to back up onto the local arterial networks.
11. Shall provide a reliable trip on I-270

7.4.2 Vehicle Occupancy

1. Shall increase passenger per vehicle volume on corridor.
2. Shall balance traffic flow between single occupancy vehicles and HOV.
3. Shall maximize passenger volume through the corridor.
4. Shall improve the utilization of transportation resources.

7.4.3 Incident Response and Management

1. Shall minimize diversion of freeway traffic to county roads.
2. Shall improve incident response times.
3. Shall improve Incident Management and clearance times.

7.4.4 User Satisfaction

1. Shall improve the level of information available to travelers.

7.4.5 System Management

1. Shall improve information distribution between agencies.
2. Shall improve the operations and maintenance of the I-270 corridor.
3. Shall institute agreements to help with project implementation.
4. Shall coordinate solutions and operations between all agencies operating along corridor.
5. Shall allow each agency to continue to plan, develop implement and operate its own Traffic Management System.
6. Operational procedures shall be developed to ensure continued uniform operation of the environment. This will be done outside this project, but is necessary for the I-270 ICM Project's success.
7. Agencies shall maintain ownership and operation of all components located within their jurisdiction.
8. Project shall be a coordinated approach by all corridor agencies.

7.4.6 Other

1. Shall use ITS standards

8. System Overview

This section describes the concepts of the proposed ATM system. The subsections that follow contain high-level descriptions and discussions of the operational features with explanations of how the proposed system will operate. Items discussed in this subsection include:

- Integration with Current ITS Infrastructure and Programs
- Major System Components
- Interfaces to External Systems
- Proposed Capabilities or Functions

8.1 Project Scope

The I-270 ICM Project will involve applying ATM and ITS techniques along the length of I-270 and on a segment of I-495 (Capital Beltway). The strategies or subsystems include:

- Freeway management system
- Traveler information system
- Traffic surveillance and monitoring system

The components of these systems and their anticipated benefits are illustrated in the table below.

System	Components
Freeway Management System	• Advanced traffic management system o Variable advisory speed o Lane use signals o Vehicle detectors • Queue warning • Adaptive ramp metering • Travel time information • Surveillance (closed-circuit television) • Dynamic message signs • Traffic signal synchronization
Traveler Information System	• Dynamic message signs • In-vehicle information from Connected Vehicle system • Travel times
Traffic Surveillance and Monitoring System	• Traffic detection on mainline • Presence detection on temporary use shoulder

Table 4: I-270 System Components

The ATM implementation addresses a number of issues, focusing on congestion mitigation and incident management. Strategies that will be employed include:

Southbound (SB)

- Operating the SB HOV lane on the shoulder from its origin north of I-370 all the way to the Split and repurposing the current HOV lane as a general purpose lane to add capacity. This will only operate during AM HOV hours.
- Operating the SB HOV lane on the shoulder along the Spur, from just south of the Westlake Terrace overpass to the approach to I-495. This extra lane will only be used during the AM peak period.
- Maintain 3 lanes from I-270 Spur at the merge with I-495. Drop 1 lane along the right side of I-495, south of the merge with I-270 Spur. This will be a full-time improvement.
- Along the SB CD (both full-time improvements):
  - South of Shady Grove Road the CD experiences a Slip onto the CD, then a Slip off of the CD. Create an auxiliary lane between the 2 slips, creating a brief 3-lane segment.
  - South of MD 189 the CD experiences a merge on the right from the interchange followed by a diverge on the left via a Slip to the mainline. Modify the lane balance so the ramp from the interchange becomes a lane add and the Slip to the mainline becomes a lane drop, again creating a short 3-lane section between two ramp junctions.
- Modify the merge from MD 124 to be a lane add, continue that lane beyond MD 117, and drop it at I-370 (eliminating the creation of a new lane along the right approaching I-370). This will be a full-time improvement.
- Provide a 3rd SB lane in the shoulder from just south of MD 85 to where the 3rd lane begins just north of MD 121. This improvement will only be in effect during the AM peak period.

SB Alternative

- Push the SB HOV lane into the shoulder along the Spur, from just south of the Westlake Terrace overpass to the approach to I-495. This extra lane will only be used during the AM peak period.
- Maintain 3 lanes from I-270 Spur at the merge with I-495. Drop 1 lane along the right side of I-495, south of the merge with I-270 Spur (may be done at River Road, if feasible). This will be a full-time improvement.
- Along the SB CD (all full-time improvements):
  - South of Shady Grove Road the CD experiences a Slip onto the CD, then a Slip off of the CD. Create an auxiliary lane between the 2 slips, creating a brief 3-lane segment.
  - Lengthen the acceleration lane from MD 28.
  - South of MD 28 the CD experiences a Slip from the mainline followed by a diverge to MD 189. Modify the lane balance so the ramp from the Slip becomes a lane add and the diverge to MD 189 becomes a lane drop, creating a short 3-lane section.
  - South of MD 189 the CD experiences a merge on the right from the interchange followed by a diverge on the left via a Slip to the mainline. Modify the lane balance so the ramp from the interchange becomes a lane add and the Slip to the mainline becomes a lane drop, again creating a short 3-lane section between two ramp junctions.
- Lengthen the acceleration lane from Montrose Road. Lengthen the acceleration lane from MD 124. (taper in before the Muddy Branch overpass.) This will be a full-time improvement.

- The existing merge from the Slip to the mainline, just north of Montrose Road, becomes a lane add via right-side hard shoulder running. Shoulder use will end at the Split, where lane use controls will direct 3 lanes (including the shoulder lane) south to the Spur, and 3 lanes to the east (no choice lane). This will require shifting the lanes along the Spur towards the left, out of the shoulder. This improvement will operate during the AM peak hour only.
- Provide additional acceleration and deceleration lane length at the MD 80 and MD 109 interchanges. These improvements will be full-time.

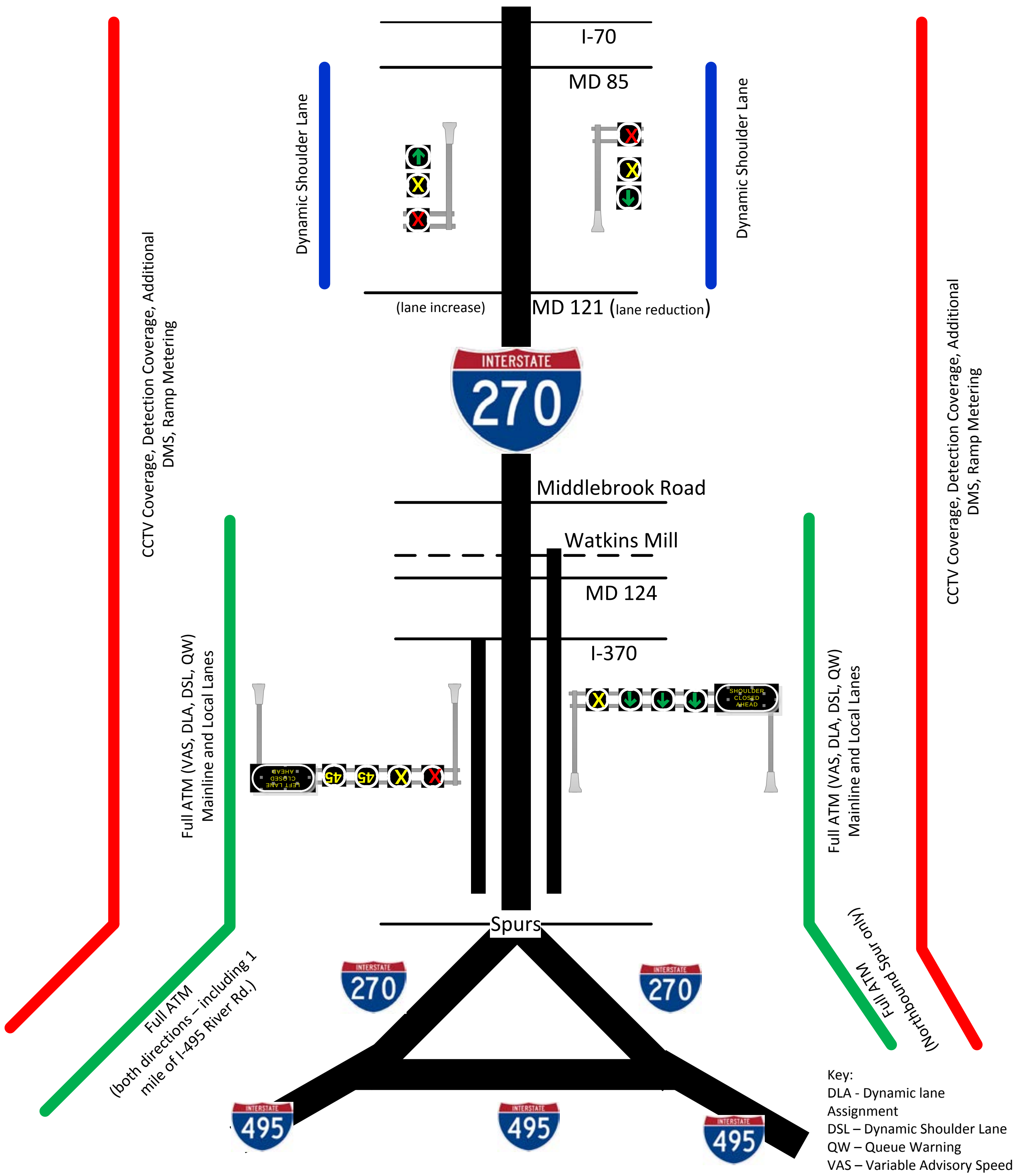
Northbound (NB)

- Widen the exit ramp at MD 124 to provide 3 lanes for a couple hundred feet (widened to the left, to avoid ROW issues). This will be a full-time improvement.
- Put the signal for the intersection of MD 124 and MD 117 on maximum recall for the WB MD 117 approach (a simple signal controller modification) and modify the offset of the signal at the intersection of MD 117 and Bureau Drive to allow WB MD 117 queues to flush during the PM peak period.
    - Install a queue detector on the MD 117 off ramp, so if vehicles queue back too far the timings at the MD 124 / MD 117 intersection get temporarily modified to flush WB MD 117.
- Approach to the Split, from the east (full-time improvement):
    - Maintain 3 GP lanes along the approach from the east (1 extra lane).
    - To avoid outright widening, north of Split, merge the HOV lane from the east into the HOV lane from the Spur. There will still be 1 extra lane from the Split, north, until the HOV lane from the east merges in (we should give them a few hundred feet to do so), but the overall cross section just south of the beginning of the CD lanes should not be affected.
        - During the AM peak, the HOV lane from the east approach will lead straight into the Shoulder HOV lane, and the HOV traffic from the Spur will move left to access the HOV lane (as they do today).
- Along the Spur (improvements can be applied during the PM peak period):
    - North of the diverge from I-495, where the shoulder widens out, begin the decel for the off ramp to Democracy.
    - Extend the accel for the directional on ramp from Democracy farther north, to about where the HOV lane from Westlake Terrace merges. This will result in a merge along both the left and right sides of the Spur, but it's different vehicles that will be affected by each - HOV on the left, GP on the right, so it shouldn't cause trouble.
- Shift the HOV lane into the shoulder from the Split to its end at MD 121. (PM peak period only)
- Shady Grove Road (full-time improvement):
    - Shift the Slip to the CD, located at Shady Grove Road, a few hundred feet south of its current location. This will be a 2-lane Slip, with one Choice Lane and 1 lane drop. The CD will widen to 4 lanes. The mainline will drop to 4 GPs plus 1 Shoulder HOV.
    - Drop 2 CD lanes at the Shady Grove off ramp. Continue 2 CD lanes through (widened from 1 lane).

- Add 1 lane at the loop ramp. (here the CD will be narrower by 1 lane, due to the lack of the Slip coming on at this spot.) At this point, the mainline will match existing lane configurations.
- Allow the directional ramp from Shady Grove to be an Add Lane. Now we've got 4 lanes along the CD.
- Drop 1 CD lane as a Slip to the mainline (left side) and drop 1 CD lane to I-370 (right side). Now we're back to 2 lanes along the CD.

- Along the NB CD (both full-time improvements):
  - North of MD 189, make the on ramp from MD 189 an Add Lane. Drop this lane at MD 28.
  - North of Montrose Road, extend the accel along the CD about 300 feet.
- Provide a 3rd NB lane in the shoulder from north of MD 121 (where NB drops from 3 lanes to 2) to MD 85. (PM peak period only)

ATM Deployment Schematic



8.2 Integration with Current ITS Infrastructure and Programs

The ATM techniques discussed in this document are consistent with the SHA traffic management philosophy. They provide SHA with another set of tools to help them actively manage traffic conditions.

A new third party COTS Surface Transport Management (STM) platform will be used to support the ATM and ITS techniques described in this document. The system workstation operator interface will be located at the SOC with the supporting server functionality located in a cloud-hosted facility and/or at the SHA primary and backup data centers. The system has the ability to exchange and share information with other third party centrals and will integrate with CHART and RITIS consistent with the ITS regional architecture. However, its operation of ATM and ITS field elements is not dependent upon these external interfaces. The figure below shows the initial conceptual architecture with final architectural decision on the external interface to be developed during design. It is envisioned that a new STM / CHART ATMS Interface Web Services component will be developed as an adaptation layer between STM and CHART. The new Web Services component will allow STM integration with CHART existing capabilities in event/incident management, DMS and CCTV control, without needing to change the way CHART operates and while keeping CHART as the primary "top level" tool for statewide freeway operations.

The I-270 STM application will control each system, based on the current corridor conditions. Primarily the system will be operating automatically, without the requirement for user intervention (however it is likely that upon initial turn-on the system will operate with operator confirmation). In this way the system will be able to quickly react to the prevailing conditions. The system will not need to wait for an Operator (or other user) to evaluate the existing conditions and determine the best course of action. This places the onus for managing the corridor on those users responsible for planning coordinated responses, and away from the Operator who may also have multiple tasks to manage. The system will respond to condition changes as simple as changing congestion levels to as complex as a major incident that requires emergency response and that causes vehicles to seek alternate routes.

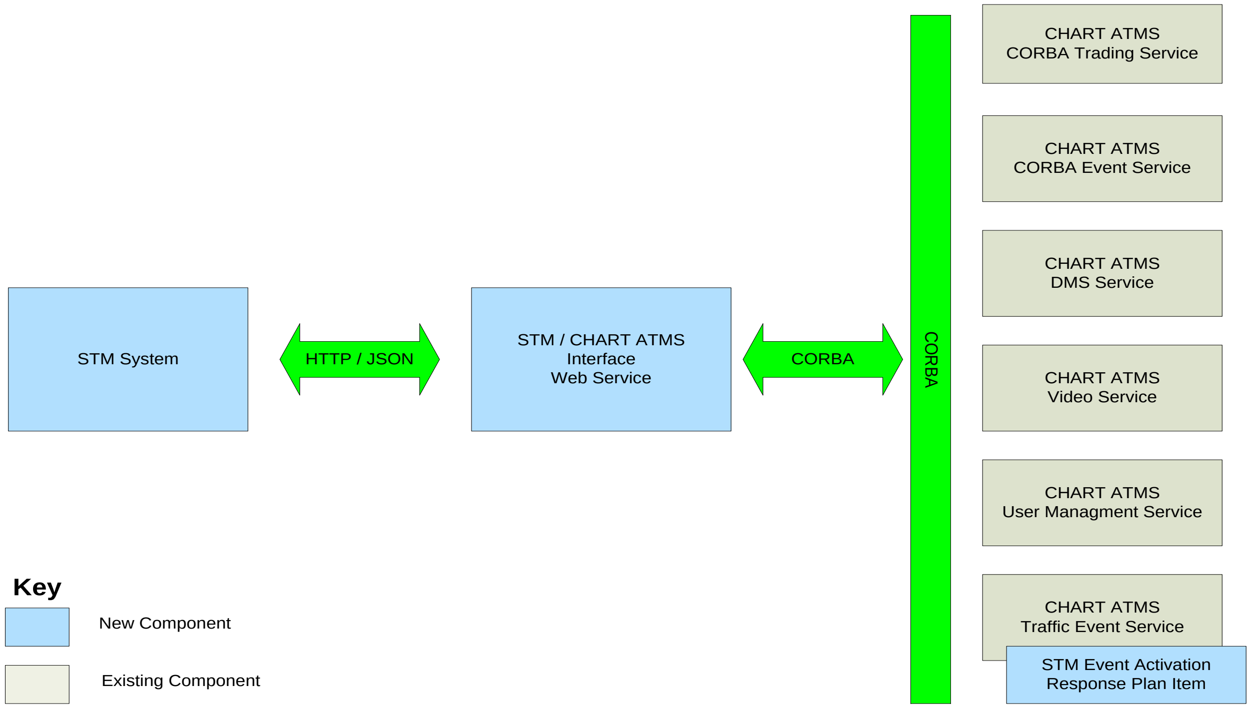


Figure 222: STM / CHART Interface Architecture

8.3 Surface Transport Management (STM)

The I-270 STM consists of a number of subsystems that are supported by field devices. These devices play a vital role in improving freeway operation.

The STM will implement the following strategies to support ATM operations:

- Lane control and variable advisory speeds (VAS) will be focused on the southern section of the corridor along the HOV segments
- Lane control (part-time shoulder use) will be installed NB where the I-270 lanes drop from 3 lanes to 2
- DMS will be installed at strategic locations along the corridor
- Full CCTV coverage will be installed along the corridor for typical surveillance requirements, but also to view and verify lane control signal displays
- Vehicle detection will be expanded to provide significantly more coverage along I-270
- Video incident detection will be installed at all locations where temporary shoulder use will be implemented.

8.3.1 Major STM Components

The STM will be composed of several different ITS components. Each component provides specific capabilities required to meet the operational needs of the system.

- Dynamic message signs (DMS) capable of displaying advisory and lane status notifications to supplement lane control signal status. These are traffic management specific messages displayed on smaller signs co-located with lane use signals
- Lane control signals displaying lane status and advisory speed
- Traffic detectors gathering speed, volume and occupancy at ½ - mile spacing. Non-intrusive side fire radar ("by-lane") configuration is proposed.
- CCTV cameras able to respond to preposition control commands and camera video selection and display in response to an incident.
- Communication systems to monitor and control these devices

8.3.2 Interfaces to External Systems

The STM external systems interface will support the following data exchanges. These are two-way exchanges so that information derived from field devices connected directly to the STM can be shared with the CHART/RITIS environment, and information derived outside of the STM may be used by the STM in making control decisions.

- Vehicle Detection: Vehicle volume, occupancy, speed and classification by lane and by time interval. Reporting intervals can vary but are typically 15 seconds from the field for congestion/incident detection and may be aggregated to longer intervals such as 5-15 minutes for status reporting. Aggregated records may be shared with RITIS for general condition reporting.
- Events: these may include incident detection events automatically detected by the STM; response plan activations; lane control, variable advisory speed, and ramp meter activations. External data exchange logic and message content can be configured to adapt to the capabilities and needs of the external systems. STM originated events and response plans may be linked to CHART events for overall management and situational awareness.
- DMS messages: Traveler information messages initiated by STM as part of response plan may be shared with CHART for display on full size CHART DMS.

Center-to-center data exchanges with other jurisdictions, such as Montgomery County, may be supported through RITIS consistent with the ITS regional architecture. Although Montgomery County does not currently support a center-to-center interface it may in the future. The ability of the county to coordinate arterial operations with the I-270 operation would be dependent upon the county completing this capability.

8.4 Proposed ATM Elements

The following sections describe the various elements and illustrate their proposed locations.

8.4.1 Active Traffic Management - Lane Use Signals

The LUS will be used to advise the travelers which lanes are open for use, under what conditions they are open for use and to display the Variable Advisory Speed. These signs will be placed on full span sign structures directly above each lane, as shown in the figure below. The LUS on the structure will be a full matrix DMS.

LUS will be installed on I-270. They will be located at locations on I-270 as per the design alternative selected. The preliminary proposed locations of the sign structures are provided in the Appendix. In addition, the LUS can display the advisory speed as illustrated in the figure below.

The information provided by the LUS will reduce the likelihood that travelers will be surprised by events ahead, thereby decreasing the chance of a sudden change in speed or lane change.

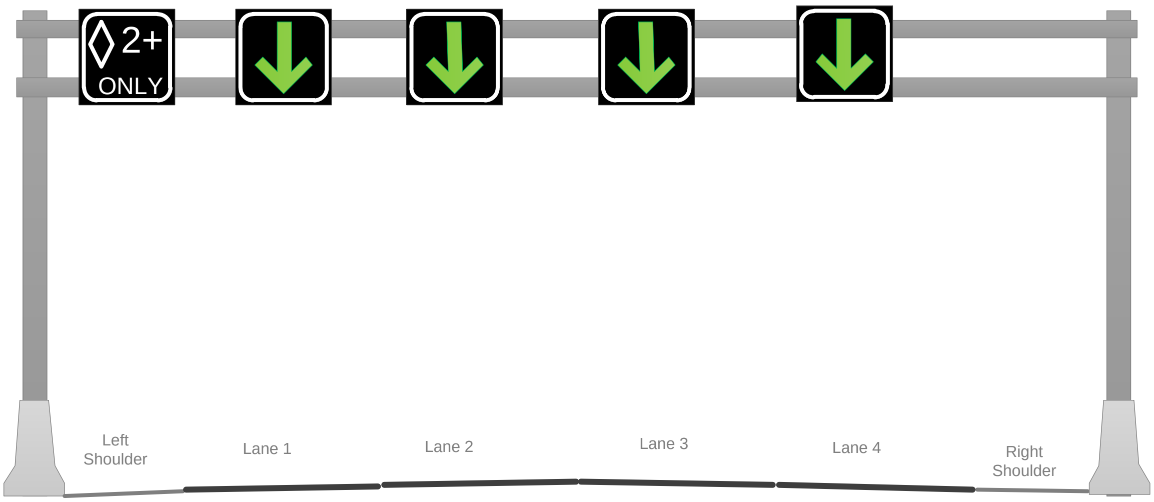


Figure 233: Typical Full-Span with Lane Use Control Signals (during temporary shoulder use)

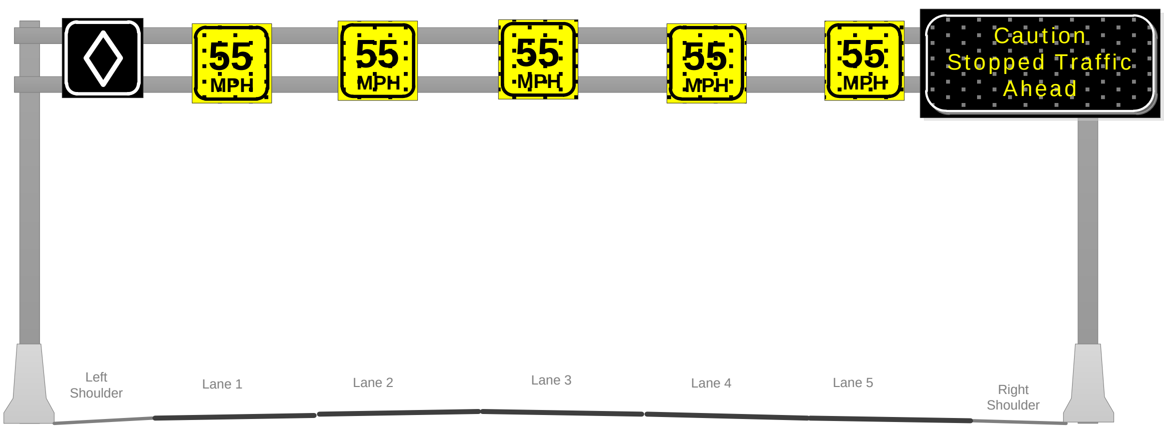


Figure 244: Typical Full Span ATM Sign Structure with VAS Displays

These signs will be:

- Full matrix DMS
- Full Color

8.4.2 Active Traffic Management - Ramp Metering

RM will be implemented at 23 I-270 on-ramps. The objective is to implement ramp metering to streamline traffic flow onto I-270 and minimize the impact of merging traffic. This is achieved by regulating the total traffic flow entering I-270, preventing congestion and breaking up platoons of vehicles.

8.4.3 Traveler Information System

Information will be provided in real time to motorists on I-270 via DMS, TAR, Internet, and telephone. This section describes elements of the project which is designed to provide information to motorists using I-270. This information may decrease congestion since it encourages travelers to use transit options and/or travel when congestion is lower.

Presenting traveler information during an incident could assist SHA with controlling the flow of vehicles. The information provided could inform drivers about the severity of any congestion or incident, and encourage these motorists to stay on I-270.

8.4.4 Dynamic Message Signs

Full size DMS will be implemented along I-270 corridor for supporting the Active Traffic Management (ATM) and Ramp Metering (RM) strategies. The DMS messages will be updated as part of the procedure for responding to any event affecting the ATM and RM devices. In addition, DMS may be used to provide general information in accordance with SHA standard procedures. The DMS will continue to be controlled through CHART.

Any new signs are proposed to l be full color full graphic matrix signs. The alphanumeric messages on these signs will meet all current standards, including those for visibility and legibility distances.

These signs will be used to display a variety of information, including:

- Warnings and alerts;
- Vehicle Travel Times;
- Available parking spaces at park and ride facilities;

8.4.5 CCTV Cameras

CCTV cameras will be used to fill in the gaps along all of I-270 to monitor traffic conditions. A total of 50 additional CCTV locations will be added along the corridor. See Appendix for existing and proposed camera location information. Cameras may also be placed on incident management routes to observe trailblazer detours and signal flush plans.

8.4.6 Detection

- Detection will be situated along I-270 in the densest portions to run incident detection algorithms and to supply data to the I-270 STM software.
- Freeway ramp detection is included in I-270 concept.
- Video incident detection will be installed to monitor the temporary shoulders.

8.4.7 Traffic Surveillance and Monitoring System

Traffic surveillance and monitoring system will be used to provide information to all the other systems. This system will allow the operators of the I-270 corridor to make informed decisions about how to best operate the I-270 corridor to achieve their objectives; it will also allow users to make informed decisions about traveling within the corridor.

8.4.8 Traffic Surveillance System

Color CCTV cameras, both fixed and Pan/Tilt/Zoom (PTZ) will be located along I-270. These cameras will be placed at strategic locations to assist SHA and local agencies with monitoring and managing traffic, incidents and events. The cameras will be mounted either on sign structures or on standalone poles.

The corridor has existing CCTV cameras. The specifications of the existing CCTV cameras are sufficient for the surveillance needs of this project; hence, they will not require any replacement. The addition of new CCTV cameras, supplementing the existing CCTV cameras, will provide a wider coverage area, thereby increasing the speed of incident detection.

The surveillance system will be managed and operated via the CHART SOC. The video stream from the cameras will be available to operators in the I-270 TMC, the public via websites and other stakeholders, as required.

9. Operational Environment

This section contains information about the system, operations, and maintenance costs.

9.1 System Costs

Conceptual cost estimates were completed for each ATM element. The following factors were considered:

- Analysis – if required
- Design
- Utilities
- Right-of-Way
- Maintenance and Protection of Traffic
- ITS Devices
- ITS Integration and Software
- Roadway Enhancements
- Structures
- Drainage
- Storm Water
- Erosion and Sedimentation Control
- Landscaping
- Construction Management and Construction Inspection

The following tables provide a high-level summary cost estimate for each strategy. THESE TABLES HAVE BEEN INTENTIONALLY LEFT BLANK.

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost
Northbound I-270				
Southbound I-270				

Table 5: ATM Cost Estimate (including LUS, detection, DMS and structure)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 6: Traffic Surveillance Cost Estimate Along Entire Corridor (full pan, tilt, zoom)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 7: Detection Cost Estimate (outside ATM-deployed area)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 8: Ramp Metering Cost Estimate

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 9: Traveler Information Cost Estimate

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 10: Connected Vehicle Cost Estimate

9.2 Maintenance Costs

CHART will be the primary operator and maintainer of the ATM enhancements. All ITS devices and systems will have to be included in the existing CHART maintenance program. That includes an operational test period as part of device installation as well as an ongoing support period following construction. The durations for these periods range from 60- days to 6-months, and 6-months to 2-years, respectively. Following the completion of the project's support period, the devices will most likely be integrated into the CHART's existing ITS maintenance contract. Below is a high level analysis of the devices associated with each of the ATM deployment concepts, their lifecycle and anticipated maintenance costs. Annual maintenance costs were derived the FHWA's 2010 Cost Elements Database. THIS TABLE HAS BEEN INTENTIAONALLY LEFT BLANK

Concept / Component	Lifecycle (years)	Number of Devices	Annual Maintenance Cost of Device	Total Annual Maintenance Cost
VAS				
Queue Warning				
Detection				
Signs				
Dynamic Lane Assignment				
Signs				
Structures				
Dynamic Speed				
Signs				
Structures				
Dynamic Junction Control				
Signs				
Structures				
Ramp Metering				

Concept / Component	Lifecycle (years)	Number of Devices	Annual Maintenance Cost of Device	Total Annual Maintenance Cost

Table 111: Life Cycle Cost Estimate

10. Support Environment

This information is provided to allow all affected organizations to prepare for the changes that will be brought about by the ATM system and to allow for planning of the impacts on SHA, user groups, and the support maintenance organizations during the development of, and transition to the new system.

The support environment for the ATM System will be one that compliments the existing support environment processes and capabilities of the client. Hardware and central software components will be replaced as determined by the support staff. Development and deployment of new components for the ATM System will be coordinated with the assigned support staff. Support of the system is anticipated to require additional SOC maintenance support and must be considered for the full life of the ATM Project.

10.1 Impacts during Development

This subsection describes the anticipated impacts on the operations and maintenance staff during the retrofit process for the proposed system. Other impacts during development may be discovered during the remaining phases of the system lifecycle. The currently identified impacts during the retrofit process include the following:

- Involvement in studies, meetings, and discussions – In order to ensure the success of the project, there will be a need for client involvement in all aspects of the system lifecycle. This will necessarily require involvement in studies, meetings, and discussions that will occur throughout the development of the system.
- User and support involvement – There will also be a need for increased involvement by the user and support groups. This involvement will include participation in reviews and demonstrations, evaluation of initial operating capabilities and evolving versions of the system, development or modification of databases, and required training.

10.2 ATM Strategies

10.2.1 VAS

Variable Advisory Speed should address traffic congestion before or during a breakdown in operations. Breakdowns in traffic can be caused by several factors including high demand, weather, work zones and incidents. Dynamic speed limits reduce rear-end collisions due to speed differentials due to these breakdowns. In order to be deployed successfully, the operational needs for the VAS subsystem are at a minimum:

- Coordination with regulators and MSP to confirm VAS operational usage and enforcement.
- Static speed limit signs need to be removed from the project area
- VAS signs need to be placed in a location such that speed limits are visible to all motorists.
- VAS signs need to be placed in a location viewable from a local CCTV camera in order to manually verify operation.
- VAS devices need to have a redundant power supply in order to assure continuous display of speed limits.
- Ensure a consistent supply of accurate and reliable traffic data to feed VAS algorithms.

- Archiving of vehicle speed data to identify areas where VAS enforcement is needed.
- Integration into existing SHA communications network to ensure connectivity to field devices.
- Implementation of a VAS software system at the SOC.
- Archiving of VAS data and generation of performance measures to evaluate the system.
- MSP Workstation at SOC – archiving speed limit information for use in court cases and for use by on-site MSP personnel.

10.2.2 QW

Queue Warning installations should support the reduction in rear-end collisions throughout the corridor by providing advanced warning of downstream queues. In order to be deployed successfully, the operational needs for the QW subsystem are at a minimum:

- Ensure that proper detection coverage is in place to ensure the collection of data at locations with persistent queueing.
- Ensure that all detection devices are properly working and calibrated.
- Ensure that the queue detection algorithm is sufficiently calibrated to minimize the amount of false alarms.
- Ensure that dynamic signage is located sufficiently in advance of the queueing area to provide advanced warning and that signs are oriented and sized sufficiently to provide to provide clear and consistent messages
- QW installation needs to be coordinated with variable speed limits in order to better harmonize speeds approaching queuing traffic.
- QW detection and signage will require a redundant power supply in order to assure continuous display of available lane usage.
- Implementation of a Queue Warning software module at the SOC. This software module should automatically generate and post queue detection warnings and provide an alarm to SOC operators.

10.2.3 DJC

Dynamic junction control installations should address congestion and safety in areas where there is an imbalance in the available roadway usage by entering and exiting vehicles. The implementation of DJC shall provide the ability to allocate additional lane assignments without detrimentally impacting the operations or safety of the mainline corridor. In order to be deployed successfully, the operational needs for the DJC subsystem are at a minimum:

- Coordination with regulators and MSP to confirm lane striping, signing, DJC operational usage and enforcement.
- DJC signs need to be placed in a location such that lane use signals are visible to all motorists and provide coverage of all available lanes.
- DJC signs need to be placed in a location such that motorists have the time necessary to safely make all lane changes.
- DJC signage must be clear to ensure that motorists are using the proper lane.

- DJC installation needs to be coordinated with lane assignment, VAS and other ATM deployments in order to ensure an efficient operation of the corridor.
- DJC signs need to be placed in a location viewable from a local CCTV camera in order to manually verify operation.
- DJC devices need to have a redundant power supply in order to assure continuous display of available lane usage.
- Integration into existing SHA communications network to ensure connectivity to field devices.
- Implementation of a DJC software system of modification of the existing DMS module at the SHA SOC.
- Archiving of DJC usage data and generation of performance measures to evaluate the system.

10.2.4 DSL

Dynamic shoulder lane installations should address areas of persistent congestion due to demand exceeding roadway capacity by opening up use of the shoulder to through moving vehicles. In order to be deployed successfully, the operational needs for the DSL subsystem are at a minimum:

- Coordination with regulators and MSP to confirm shoulder usage, lane striping, signing, DJC operational usage and enforcement.
- Geometrical and structural improvements need to be made to provide the cross section and vertical clearances needed to safely operate DSL.
- Emergency pull-off areas need to be provided to allow refuge for disabled vehicles.
- DSL signage must be clear to ensure that motorists have the time necessary to safely make all lane changes.
- Full video coverage of the DSL operation area must be provided to ensure that the shoulder is clear of debris and stopped vehicles prior to opening the shoulder.
- DSL installation needs to be coordinated with lane assignment, junction control, variable speed limit and other ATM deployments in order to ensure an efficient operation of the corridor.
- DSL devices will require a redundant power supply in order to assure continuous display of available lane usage.
- Implementation of a DSL software system of modification of the existing DMS module at the SHA SOC.
- DSL implementation will require addition resources from SHA ETPs or Maintenance to clear debris from the shoulders.

10.2.5 RM

Ramp metering installations should address unsafe and over-capacity merge locations by regulating and smoothing out the number of vehicles entering I-270 from an on-ramp location. In order to be deployed successfully, the operational needs for the RM subsystem are at a minimum:

- Ensure a consistent supply of accurate and reliable traffic data to feed ramp metering algorithms.
- Support automated and remote operation.
- Operate as an integrated system with multiple locations communicating and coordinating ramp release rates.
- Coordination with regulators and MSP to confirm RM operational usage and enforcement.
- Locations recommended at interstate locations will require approval for installation on freeway to freeway interchanges.

10.2.6 CV

Connected vehicle applications should support SHA and USDOT goals to continue research and development of connected vehicle research and deployment programs. In order to be implemented successfully, the needs for the connected vehicle subsystem are at a minimum:

- Ensure that all CV research and initiatives support developing national and industry standards for CV deployment.
- Ensure that all CV research and initiatives further SHA TIMS program, goals for traffic operations, and are supported by ITS architecture.
- Ensure CV research and initiatives are supported by SHA IT and data/network security requirements.
- Coordinate with private industry, universities, other state/local agencies and USDOT in order to develop partnerships and identify opportunities for CV research and deployments.

10.3 MDOT Communications System

The communications network should serve both the current needs of the devices and future expansion of the system.

More specifically, the operational needs for the communications subsystem are at a minimum:

- Provide highly reliable high-speed data and video links between field devices / communications hubs and the SOC to support data and high-resolution full motion video.
- Provide the ability for high-speed connections to control centers of stakeholders.
- Provide compatibility with existing SHA communications infrastructure and protocols.
- Provide communications network redundancy where feasible.
- Provide capability of transmitting multiple networks.
- Provide capability to integrate and connect with adjacent ITS deployments.
- Provide necessary bandwidth to support future ATM and connected vehicle initiatives.

10.4 SOC

10.4.1 Staffing

Even though many of the functions of ATM are intended to be automated, there will be a significant verification and asset management component to their operations which will place additional responsibilities on SOC operators. For example, SOC operators will need to visually verify that there are no roadway obstructions prior to manually implementing, or allowing the automated implementation of lane use control, junction control, or dynamic shoulder lanes.

Additionally, due to the safety issues that could arise as a result of long-term outages of warning and channelizing devices associated with some ATM enhancements, the asset management and maintenance of these devices is more critical. Therefore, device operational status will need to be verified on an ongoing basis and maintenance will require more attention on behalf of operators and/or SHA SOC staff.

It is envisioned that the ultimate deployment of ATM enhancements recommended in this report will require at a minimum one (1) additional SOC Operator per daytime shift and potentially an additional SHA SOC engineer to facilitate maintenance and operator supervision. In addition, all SOC Operators and SHA staff will require additional training in all ATM components, their operations, and maintenance.

Due to the response time that is required to address field issues on lane use control, dynamic shoulder lane, junction control, and variable speed limit equipment, it is recommended that an additional ITS field maintenance personnel position be created within the SOC.

It is also anticipated that additional responsibilities for clearing the shoulders of debris will be the responsibility of the SOC staff (ESPs) and/or Maintenance.

10.4.2 Hardware

No additional hardware is anticipated at the SOC to support the ATM enhancements. The STM workstation operator user interface functions as a thin client that can operate on any existing workstation platform. It is envisioned that the STM user interface will operate alongside the CHART interface on the same platform. The STM server environment can be supported on premise with dedicated server hardware or in a virtualized environment, or off premise in the cloud. It is envisioned that the system would be deployed in a virtualized environment with front end processing hosted within the SHA primary and backup data centers, and backend application services hosted in the cloud. A standard Internet Protocol (IP) network is used to communicate between server hardware, field devices and operator workstations. It is envisioned that the MDOT/SHA network would be utilized for this purpose.

10.4.3 Software

Client server software architecture is utilized by the STM to support the necessary ATM enhancements. Server components are supported in a standard Microsoft Windows environment with all system data maintained in a standard SQL-based database platform. The operator workstation environment utilizes a standard browser-based thin client interface and is therefore available from any authorized workstation without the need for additional local software.

10.5 Enforcement

If ATM strategies are not actively enforced and adhered to by motorists, it can create significant safety concerns. At this time, it is not anticipated that any ATM enhancements will include an automated enforcement component (i.e. automatically generating speeding violations for motorists not adhering to variable speed limits). As a result, there will be a need to closely coordinate with MSP for the manual enforcement of speed limits, lane use, and ramp metering aspects. In order to effectively enforce ATM operations, the following two (2) requirements must be met:

1. Officers in the field will need to have a real-time awareness of what ATM operations are in place and how they are being used. Examples include what the current posted speed limit is, what lanes are open to what traffic, and whether ramp metering is operational or not. The optimal deployment of this information would be directly through a data feed to the patrol vehicle in real time. A more low-tech approach could include posting information on the back of signage as well, so an officer can see the information regardless of where they are posted in relation to the device. This is typically how ramp metering red light running is enforced.
2. In order for traffic citations to be defended in court, accurate records must be kept for a period of time and available to the state police for use in court. Records must indicate what ATM operations were in place, what the speed limits were along the roadway, and when they changed. Records must be stored for a sufficient time in order to ensure they are available for court. This could be achieved through a direct data feed to MSP or by having SHA store and provide the data to the police upon request.

In regards to both requirements, close coordination with the MSP will be required at a regional or statewide level to put policies and procedures in place for the provision of ATM data to law enforcement officers, the enforcement of ATM operations, and the storage of ATM data for further law enforcement use.

10.6 Public Outreach and Education

It is widely accepted throughout the industry that ATM applications have the potential to provide significant benefits to the traveling public. Certain benefits, like the reduction in rear end collisions as a result of queue detection and variable speed limits may not be as perceptible to the driver day-to-day, while the capacity enhancements provided by opening the shoulder during peak periods will provide noticeable benefits. Certain enhancements such as lane use/junction control and ramp metering may be seen as prohibitive by some motorists, as some public comments have already been documented related to passage of emergency vehicles in conjunction with DSL, underlying the need to properly inform and educate the public prior to implementation.

Engaging in public outreach can also have operational benefits. One of the lessons-learned during the re-activation of ramp metering devices along I-476 in 2010 was that it took motorists a few weeks to learn how the meters operated and the most effective way to queue and proceed through the signal. Once motorists were sufficiently educated, the operation of the ramps became much more efficient.

This ConOps, as well as schedule and funding constraints, will require that the recommended ATM enhancements be implemented incrementally over a period of two (2) to 10 years. SHA is also pursuing ATM deployments along other interstates within the region, which may be deployed in advance of those on I-270. This staged approach will allow motorists to become familiar with ATM operations over a period of time beginning with queue detection/warning and variable speed limits in the first phase. In any event, it is recommended that prior to any new ATM deployment becoming operational, that the Department engage directly with media outlets, develop press releases and educational materials, and provide notification on regional DMS noting the upcoming changes in traffic operations. Engagement with the media and through press releases and educational materials should stress education and highlight the overall benefits of the ATM strategies being deployed.

11. Operational Scenarios

Operational Scenarios describe how ATM strategies will operate under different circumstances. The scenarios presented do not represent every possible condition of the roadway but reflect typical events the ATM system will encounter. This should provide a better understanding of how the various ATM strategies, traffic operators and patrol units work together to resolve issues and improve traffic conditions.

Traffic operators will play a key role in determining the appropriate utilization of certain ATM strategies such as DSL. Operators will rely on communication with patrol units or CCTV to make sure the shoulders are clear for DSL activation. Furthermore, operators will be able to submit changes to the proposed ATM plan, input additional data, and approve the ATM plan before implementation. The extent of operator involvement will vary based on how much information is necessary for the given scenario.

The six (6) scenarios used in this section represent typical conditions the ATM system will encounter:

1. Free flow – No congestion or adverse conditions. Represents how ATM strategies will operate/display during normal conditions
2. Recurrent congestion (AM/PM) - occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. Represents how ATM strategies will operate during AM/PM rush hour.
3. Lane Restriction – Lane closure due to work zone, accident, debris, etc.
4. Weather conditions – Represents how ATM strategies will operate in reaction to weather conditions impacting the roadway (i.e. ice, snow, heavy rain, flooding, or fog).
5. Complete closure – Full closure of all traffic lanes.
6. Non-recurrent congestion – Represents how ATM strategies will operate when the roadway is congested during hours that typically have free flow traffic.

The following sections will describe each phase of the system, and how it is intended to respond individually to each of the six (6) representative scenarios:

- Variable Speed Limit & Queue Warning
- Junction Control & Dynamic Lane Assignment
- Dynamic shoulder lanes
- Ramp Metering
- Full Implementation

At the end of each section, a graphic is presented showing the progression of ATM operations beginning in advance of the situational areas, progressing through the area, and then returning to normal operations. It should be noted that a dynamic message sign (12 characters by 3 lines) is proposed for each gantry. The figures that follow illustrate just a single DMS introducing the issue. When no issue exists, the signs would be blank or project travel times.

11.1 Variable Advisory Speed & Queue Warning

VAS signs and the QW system work to reduce speed differentials that cause unanticipated speed reductions. This system steadily reduces the speed of traffic as it approaches a congestion area and warns drivers of congestion ahead. With this system, drivers anticipate reduced speeds, rather than unexpectedly coming upon congested, slow moving traffic. Differential speeds can cause rear-end collisions or sideswipes that cause further traffic congestion. The QW system utilizes the DMS to display warning messages to drivers.

11.1.1 Free Flow

During free flow conditions, VAS signs may either be left blank or display the normal posted speed limit (55 mph).

The DMS will be left blank or display travel time information.

11.1.2 Recurrent Congestion

During recurrent congestion, VAS signs will display speeds that ease upstream traffic speeds to that of speed in the congestion area, by reducing speeds in a step-pattern. Upstream from the congestion, the VAS signs will display the normal speed limit. Closer to the congestion area, signs will start to display lower speeds (e.g. 55, 45, 40, etc.). After the congestion, VAS signs will display increased speed limits to bring the traffic flow up to the normal speed limit. If the congestion occurs again downstream, VAS signs will display a speed limit between the congestion area reduced speed and the normal speed limit (between 40 and 50 for example). As traffic approaches the new congestion area, the VAS signs will again display a reduced speed.

DMS will display a queue advisory upstream from the congestion area. Near the congestion area, DMS will display an imminent warning message.

11.1.3 Lane Restriction

When a lane restriction is in place, VAS signs will react similar to a congestion scenario by gradually reducing traffic speeds upstream of any queues that form due to reduced road capacity.

In general, the DMS will display a lane closure warning and queue warning upstream of the lane closure. The DMS may display a more specific message depending on the type of lane restriction (i.e. work zone, accident, debris, etc.).

11.1.4 Weather Conditions

Adverse weather conditions may necessitate reduction of speeds, even if expressway flow is less than capacity for safety. If the system detects reduced speeds downstream, VAS signs will gradually slow down traffic similar to the recurrent congestion scenario.

DMS signs will display weather advisory messages throughout the corridor or in areas where adverse conditions are known to occur.

11.1.5 Complete Closure

In the event of a complete road closure, VAS and DMS can be left blank or display a speed limit and “Road Closed” message respectively.

DMS located outside of the project limits, but approaching I-270 will need to notify motorists of the closure and provide detour information.

11.1.6 Non-recurrent Congestion

During non-peak hour congestion, the system will detect the reduced speed of traffic and react to the situation similar to how it would approach the recurrent congestion scenario by reducing speeds gradually in a step-pattern and warning drivers of imminent queues.

11.2 Junction Control & Dynamic Lane Assignment

Junction control and dynamic lane assignment use overhead dynamic signing to close and open lanes on the highway. The DJC system detects on-ramp and mainline traffic volumes. Similar to ramp metering, DJC regulates the flow of traffic onto the mainline. DJC accomplishes this by closing/opening a lane and allowing smoother entrance/exit to/from the mainline.

DLA is used to indicate lane closures that may be due to downstream congestion, accidents, work zones, or debris. The signs can display green arrows indicating the lane is open, a red “X” indicating the lane is closed or a yellow X indicating pending lane closure and that motorist need to merge out of the lane.

11.2.1 Free Flow

DJC activation depends on the relation between mainline traffic flow and on-ramp traffic flow. Free flow conditions on the mainline and congestion on the on-ramp is an appropriate scenario to activate DJC.

The DLA sign closest to the ramp will display a red “X” indicating that lane is now closed. Upstream from the lane closure, the DLA sign will display a yellow “X” above the lane, indicating to drivers to merge out of that lane. If on-ramp traffic flow is at or near free flow, then DJC activation is not appropriate. In that case, both DLA signs will display green arrows to indicate that both lanes are open.

11.2.2 Recurrent Congestion

During congestion, DJC will stay inactive to allow mainline traffic to flow uninterrupted. Both travel lanes will remain open and DLA signs will display green arrows to maintain maximum road capacity. With regards to on-ramp junction control, the DLA may restrict through traffic to the left lane and allow traffic entering from the ramp the ability to use both the right mainline lane as well as the ramp acceleration lane.

11.2.3 Lane Restriction

Depending on the nature of the lane restriction, the right lane or left lane of the mainline may be closed. If the lane farthest from the ramp is closed, DJC cannot be activated. If the lane closest to the ramp is closed, DJC will remain inactive to maintain maximum capacity. Upstream from the lane closure, a yellow “X” will be displayed on the DLA sign indicating a merge out of the closed lane.

Before the lane closure, a red “X” will indicate that the lane is closed. After the lane closure, the DLA sign will display a green arrow indicating that the lane is again accessible.

11.2.4 Weather Conditions

If poor road conditions have created congestion on the on-ramp and traffic flow on the mainline is near free flow, DJC may be activated to allow quicker entrance onto the mainline.

11.2.5 Complete Closure

In the event of complete closure of the highway, all traffic lane signs will be left blank.

11.2.6 Non-recurrent Congestion

DJC will remain inactive if there is congestion on the mainline. Closing a lane on the congested mainline will cause further delays from merging and reduced capacity.

11.3 Dynamic Shoulder Lanes

DSL will be activated to increase roadway capacity during recurrent congestion periods and appropriate non-recurrent congestion scenarios. Traffic flow will increase by increasing the roadway capacity, reducing travel times for drivers.

11.3.1 Free Flow

Under normal conditions, the DSL sign will display a red "X" indicating that the shoulder will be used for emergency stopping only.

11.3.2 Recurrent Congestion

DSL will be activated to increase capacity and reduce traffic congestion in the normal traffic lanes.

The DSL sign will display a green arrow notifying drivers that the shoulder lane is open to traffic. DSL should activate at set times during the week that would classify as peak hour.

11.3.3 Lane Restriction

During a lane restriction, DSL will be inactive to allow emergency vehicle access or refuge for disabled vehicles. In the event that the lane blockage is contained to the left lane, and cannot be moved to the shoulder for some time, DSL may be useful in clearing queues from the right or pushing all traffic onto the shoulder to allow the staging of response vehicles in the right travel lane.

11.3.4 Weather Conditions

DSL will be inactive in adverse weather conditions to allow emergency vehicle access or refuge for disabled vehicles. Any snow accumulation is likely to be pushed into the shoulder by snowplows. This snow will likely reduce the shoulder width and make DSL unsafe.

11.3.5 Complete Closure

In the event of a complete road closure, DSL signs will display the normal red “X”.

11.3.6 Non-recurrent Congestion

Activation of DSL during non-recurrent congestion would require the authorization of an SOC operator. The SOC operator would utilize CCTV cameras and service patrols to make sure the shoulders are clear. A disabled vehicle may be stopped in the shoulder, or an emergency vehicle may need to utilize the shoulder. If the SOC operator can verify that the shoulders are clear, then they can activate DSL to alleviate traffic congestion.

11.4 Ramp Metering

Ramp Metering is used to dynamically control the flow of traffic entering a mainline highway. This reduces differential speeds caused by the disparity between mainline traffic flow and influent traffic flow, while also minimizing the impact of merging traffic. Metering allows vehicles to enter the mainline at a rate near the capacity of I-270, preventing further traffic flow breakdown.

Ramp meters "rest on red". Each car must stop at the line, and only one may proceed when the signal turns green. This ensures that the flow of traffic onto I-270 can be balanced and controlled corridor wide.

11.4.1 Free Flow

During free flow conditions on the mainline, ramp meters will be inactive. Cars will enter and merge onto the mainline normally as they would without the ramp meters. Drivers will not need to stop at the stop line. The yellow “RAMP METERED WHEN FLASHING” light, indicating that ramp metering is active, will remain off.

11.4.2 Recurrent Congestion

During congestion, the yellow light will flash indicating that ramp metering is active. The driver will see the red light and stop at the stop line. When the light turns green, the driver will enter the mainline.

Only one (1) vehicle per lane is allowed to enter when the light turns green, and each vehicle must stop at the stop line. It is likely that ramp metering for recurring congestion will occur through a time of day operation.

11.4.3 Lane Restriction

When the capacity of the road is reduced due to a lane restriction, ramp metering can be initiated by the SOC operator to decrease the rate of ingress traffic flow to the mainline.

11.4.4 Weather Conditions

In adverse weather conditions, ramp meters will treat reduced traffic flow the same as recurrent congestion, unless the conditions make it unsafe to stop on the ramp. For conditions where stopping on the ramp would be unsafe and the ramp meter is operating under its normal time of day schedule, the SOC operator will have the ability to manually disable the signal.

11.4.5 Complete Closure

In the event of a complete road closure, ramp meters will be inactive.

11.4.6 Non-recurrent Congestion

Ramp metering for non-recurrent congestion will have to be implemented by the SOC operator through either visual verification of the congestion or by accepting a recommended response as part of queue warning/vehicle detection system alerts. The operation of the ramp metering system will be similar to the recurrent congestion scenario.

11.5 Full Implementation

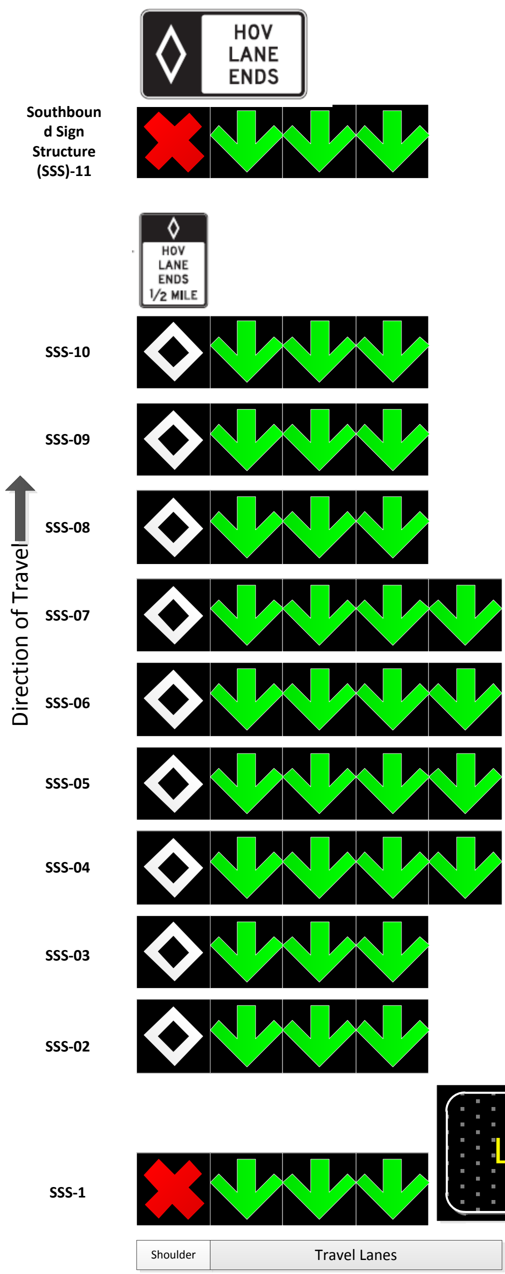
The following figures show representative operational diagrams for each of the six (6) scenarios.

These diagrams show how a full implementation of the system could work to respond to each scenario. The graphics show a conceptual configuration for the ATM devices.

11.6 Free Flow Scenario

The objective of this scenario is to manage traffic on the project corridor under Normal Operation conditions.

- No freeway congestion exists;
- No crashes have occurred on the freeway;
- No construction or maintenance activities are being carried out on the freeway;
- No debris is present on the freeway; and
- No other event has occurred that reduces the freeway level of service.



Sequence of Events

- Vehicle detectors send data to the I--270 ICM system;
- I-270 ICM system determines that there is no need to implement any freeway or arterial management strategies;
- If an operation scenario was active then the I-270 ICM system will recommend removing the active strategy;
- (Optional) The I-270 ICM system presents the recommended options to the C Operator and requests approval for the Action Plan;
- Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan; and
- I-270 system transmits instructions to each sub system, as per the Action Plan.

End Result

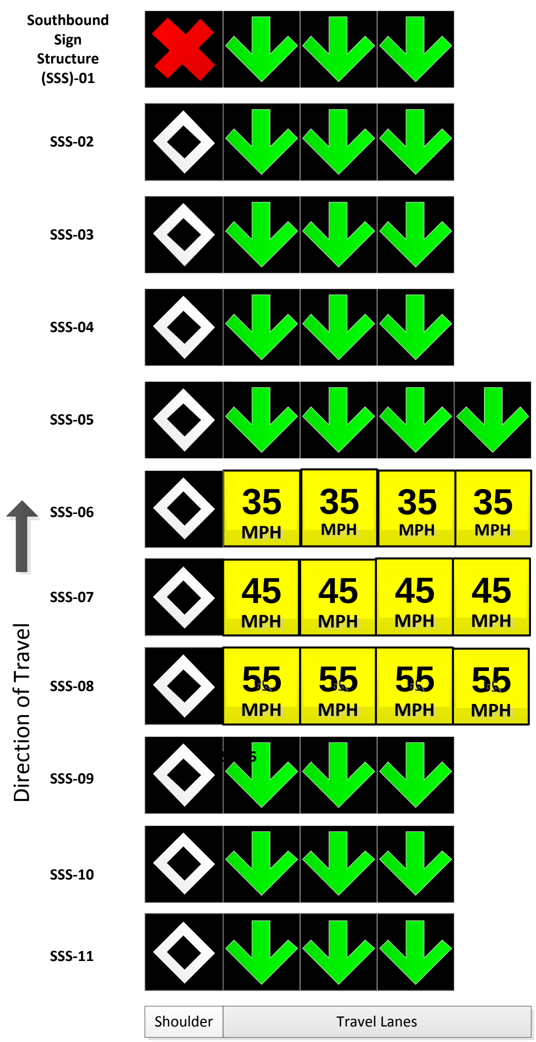
Under normal traffic operations the freeway active traffic management systems (ATM) elements will operate as follows:

- All VASS, both in the northbound and southbound directions, will be blank;
- The Lane Use Signs (LUS) will show either all lanes with downward pointing green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a High Occupancy Vehicle (HOV) lane and the rest of the lanes are open to all vehicles);
- Adaptive ramp metering (ARM) may or may not be operating during periods of no congestion.;
- All Dynamic Message Signs (DMS) on I-270 will be blank or displaying a standard message;
- Closed circuit television (CCTV) cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then focused as directed by the authorized user.
- Under normal operations the Arterial system will operate as follows:
- Traffic Signals will be operating using normal timing plans, as per each SHA or Montgomery County normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then focused as directed by the authorized user;

11.7 Recurrent Congestion

The objective of this scenario is to manage traffic on I-270 under Recurrent Congestion conditions. Recurrent Congestion is defined as congestion that occurs routinely and is not caused by crashes, events, weather or construction.

Under recurrent congestion, the volume of traffic entering the freeway will gradually increase until speeds are affected and the volume approaches the level that produces unstable flow at bottleneck locations. This congestion usually occurs during the AM and PM peaks on weekdays and at other times of the day on weekends.



Sequence of Events

During Recurrent Congestion, the I-270 ICM system will respon follows:

- ARM will be operational during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM Management Application;
- I-270 ICM System determines that a queue has formed on t freeway;
- (Optional) SOC Operator views the CCTV camera feed fror vicinity of the detected queue to determine the cause of the queue;
- The I-270 ICM system selects an Action Plan. The Action P may:
  - Reduce the advisory speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations;
  - Display the VAS speed on certain LUS; and
  - Display an end of queue warning message on specific D
- (Optional) The I-270 ICM system presents the recommende options to the SOC
- SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modi the Action Plan; and
- I-270 System transmits instructions to each sub system, as the Action Plan.

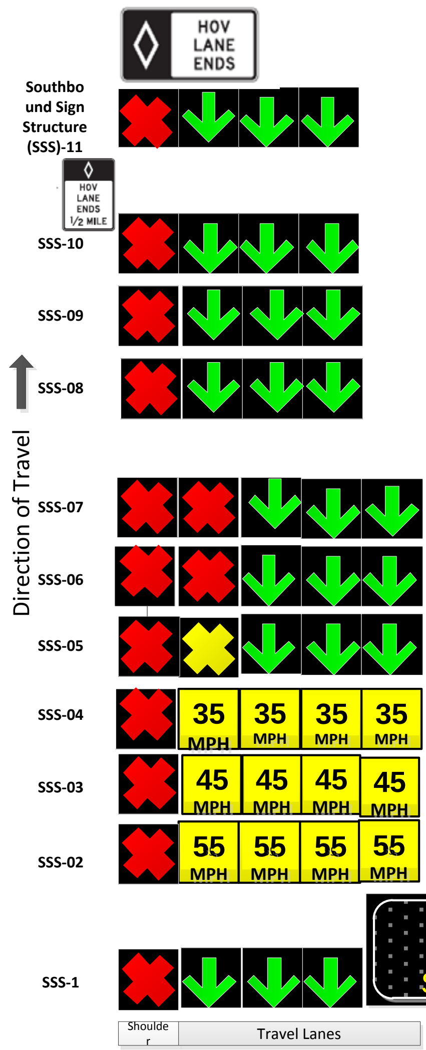
End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively re the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will blank;
- LUS will show either all lanes with downward pointing greer arrows (indicating all lanes open to all vehicles) or a diamor above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a HOV lane the rest of the lanes are open to all vehicles);
- ARM will be turned on. When appropriate, metering rates m be adjusted to prevent queue backups onto the arterials;
- All DMS on I-270 will show standard advisory messages or predefined messages for recurrent congestion,
- CCTV cameras will be turned on with each camera directec towards its default preset position, or if an authorized user i accessing the CCTV camera then it will be focused..

11.8 Lane Restriction on I-270

The objective of this scenario is to manage traffic on the project corridor when there is a minor incident. This is a non-recurring, non-planned event.



Sequence of Events

During a minor crash on I-270, the I-270 ICM system will respond as follows:

- ARM will be operational if event occurs during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM system;
- I-270 ICM system determines that a queue has formed on the freeway;
- (Optional) SOC Operator receives information from an external source that debris is present on the freeway;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- (Optional)SOC Operator inputs details of crash into the I-270 ICM system;
- The I-270 ICM system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations or turn on the ARM;
  - Display the VASS posted speed at certain LUS locations;
  - Use the LUS to close the affected lane(s) via displaying a yellow arrow, yellow x or red x;
  - Display an end of queue warning message on appropriate DMS;
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan;
- I-270 System transmits instructions to each sub system, as per the Action Plan; and
- SOC Operator will liaise with emergency services personnel as required.

End Result

In reaction to the minor accident:

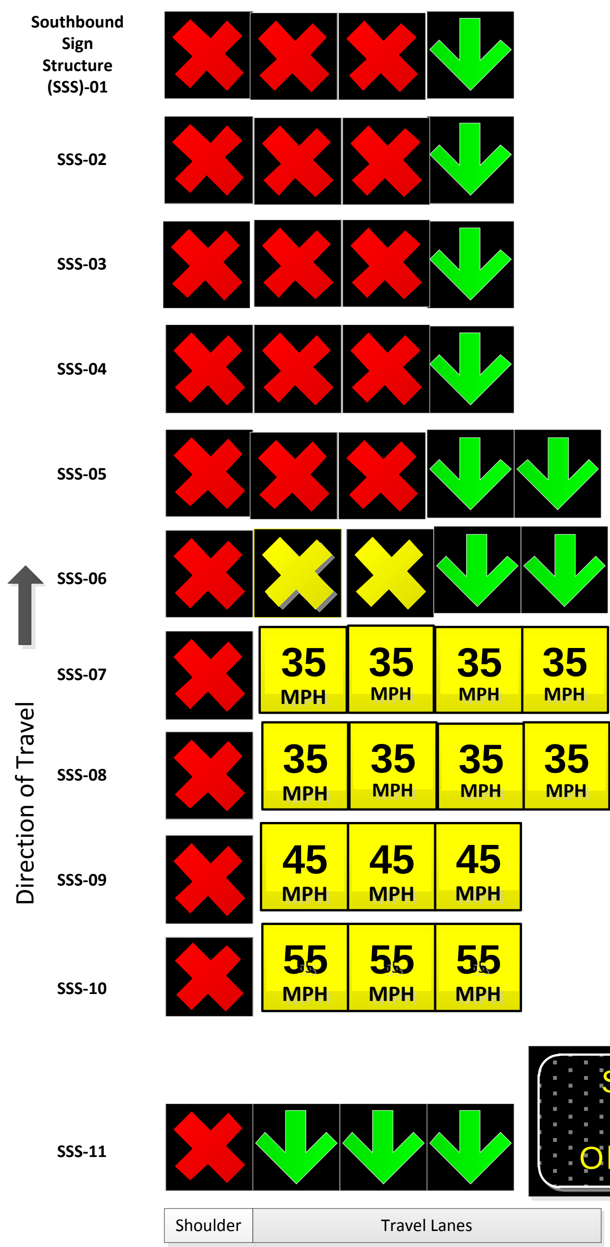
- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- ARM may be turned on if the crash results in a level of congestion that meets CHART congestion criteria for turning on the ARM;
- LUS will show green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- The DMS's upstream of the accident on the freeway may display a message identifying the location of the
- crash and/or advising the motorists to expect delays. If they do not display a specific message they will display a standard advisory message, as per current SHA practice.
- HAR may broadcast a message identifying the location of the crash and/or advising the motorists to expect delays. If it is not broadcasting a specific message it will be either turned on with a general statement or turned off; and
- The system may automatically detect that a crash has occurred and automatically focus the CCTV cameras in the vicinity onto the crash. The CCTV monitors will automatically display the video stream from these CCTV cameras. All other CCTV cameras will either be directed to their default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

Under minor crash congestion operations the arterial and transit systems will operate as follows:

- Traffic signals will be operating using normal timing plans, as per each agency's normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.9 Weather Condition

The objective of this scenario is to manage traffic on I-270 during snow operations.



Sequence of Events

During Snow Removal Operation, the I-270 ICM system will respond as follows:

- ARM will be non-operational during period of scheduled ARM operation;
- OOM and Contract snow plows will report their location and removal plan to EOC and SOC;
- (Optional) SOC Operator views the CCTV camera feed in the vicinity of the vicinity of the operation to confirm location of snow plow;
- The SOC Operator selects an manual Action Plan from I-270 ICM system. The Action Plan may:
  - Reduce the advisory speed on the VASS in the mile upstream of the operation;
  - Display the VAS speed on certain LUS; and
  - Clsoe appropriate lanes where plowing is underway
  - Display a lane closure warning message on specific DMS;
- I-270 System transmits instructions to each sub system, as per the Action Plan.

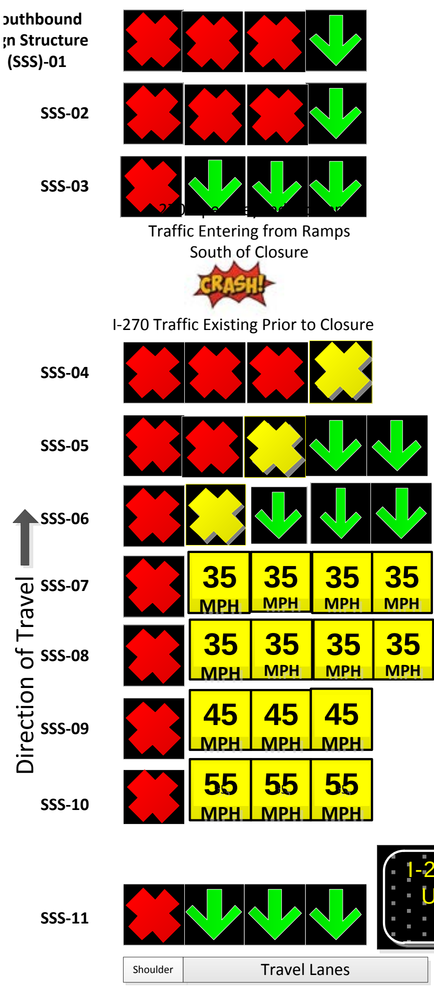
End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- LUS will show successive yellow “x” and red “x”to indicate lanes closing and closed, respectively.
- ARM will be turned on. When appropriate, metering rates may be adjusted to prevent queue backups onto the arterials;
- All DMS on I-270 will show standard advisory messages or predefined messages for snow operation,
- CCTV cameras will be turned on with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.10 Complete Closure

The objective of this scenario is to manage traffic on the project corridor when there is a major incident on I-270 requiring a complete closure. This is a non-recurring, non-planned event.



Sequence of Events

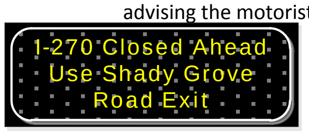
During a major incident requiring full closure of I-270, the I-270 ICM system will respond as follows:

- ARM will be operational if event occurs during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM system;
- I-270 ICM system determines that a queue has formed on the freeway;
- SOC Operator receives information from an external source that incident is present;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- SOC Operator inputs details of incident into the I-270 ICM system;
- The I-270 system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations or turn on the ARM if it is not already active;
  - Display the VASS peed at certain LUS locations;
  - Use the LUS to close the affected lane(s) via a yellow or red;
  - Display an end of queue warning message on appropriate DMS;
  - Broadcast a message on the HAR;
  - Activate a flush plan on the arterials long the incident route.
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves or modifies the Action Plan;
- I-270 system transmits instructions to each sub system; and
- SOC Operator will liaise with emergency services personnel as required.

End Result

In reaction to the closure:

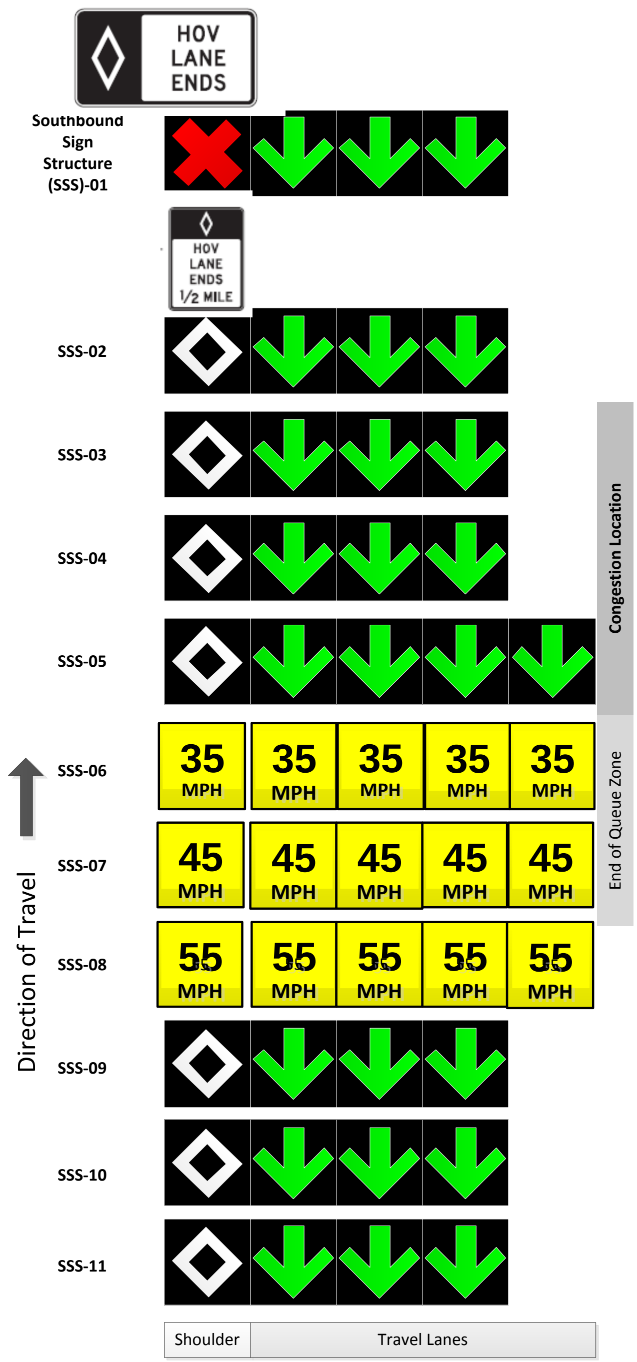
- The VASS upstream of the congestion will progressively reduce the Advisory speed to 35 mph as vehicles approach the congestion;
- ARM may be turned on if the crash results in a level of congestion that meets CHART congestion criteria for turning on the ARM;
- LUS will show green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- The DMS's upstream of the incident on the freeway may display a message identifying the location of the crash and/or advising the motorists to expect delays. If they do not display a specific message they will display a standard advisory message;
- TAR may broadcast a message identifying the location of the crash and/or advising the motorists to expect delays; and



- The system may automatically detect that an incident has occurred and focus the CCTV cameras in the vicinity of the crash onto the crash. All other CCTV cameras will either be directed to their default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.11 Recurring Congestion

The objective of this scenario is to manage traffic on the project corridor under Recurrent Congestion conditions. Recurrent Congestion is defined as congestion that occurs routinely and is not caused by incidents, events, weather or construction. Under recurrent congestion, the volume of traffic entering the freeway will gradually increase until speeds are affected and the volume approaches the level that produces unstable flow at bottleneck locations. This congestion usually occurs during the AM and PM peaks on weekdays and at other times of the day on weekends.



Sequence of Events

During Recurrent Congestion, the I-270 ICM system will respond as follows:

- ARM will be operational during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 system;
- I-270 system determines that a queue has formed on the freeway;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- The I-270 system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations;
  - Display the VASS advisory speed on certain LUS; and
  - Display an end of queue warning message on specific DMS;
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan; and
- I-270 ICM transmits instructions to each sub system, as per the Action Plan.

End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- LUS will show either all lanes with downward pointing green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- ARM will be turned on. When appropriate, metering rates may be adjusted to prevent queue backups onto the arterials;
- All DMS on the freeway will show standard advisory messages or predefined messages for recurrent congestion, as per current CHART practice;
- TAR will be either turned on with a general statement, as per CHART practice, or turned off;
- CCTV cameras will be turned on with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

Under recurrent congestion operations the Arterial and Transit system will operate as follows:

- Traffic Signals will be operating using normal timing plans, as per each agencies normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

12. SUMMARY OF IMPACTS

This chapter provides an analysis of the proposed system and the impacts on each of the stakeholders. It is presented from the viewpoint of each, so that they can readily understand and validate how the proposed system will impact their operations. Any major constraints on system development are documented.

Metrics for assessing system performance are also included.

12.1 Stakeholders

The stakeholders of the I-270 ICM Project must fully commit to active operation of the project concept elements. The technologies that will be deployed will not achieve the goals of the project unless they are actively used by all agencies to manage traffic. In order to have the system operate efficiently, stakeholders must collectively commit staff and budget to operate the system.

12.1.1 Maryland State Highway Administration

This project will provide SHA with new equipment to operate and maintain. Equipment included on this project that will be under SHA's control includes:

- additional closed circuit television (CCTV) cameras;
- ramp metering;
- additional vehicle detection;
- additional dynamic message signs (DMS);
- overhead sign structures;
- lane use signals (LUS);
- variable advisory speed (VAS) signs; and
- I-270 Active Traffic Management STM Application.

During the construction phase SHA will need to approve and permit the construction activities to occur at a rate that will meet the project timetable. The construction activities will require lane closures at various times to permit the installation of some of the equipment. SHA will need to assist in the coordination of the lane closures.

SHA must contribute to the I-270 ICM Operation and Maintenance (O&M) cost. Without the appropriate O&M funding the I-270 ICM system will not be able to operate efficiently.

12.1.2 Montgomery County Department of Transportation (MCDOT)

MCDOT will be involved in developing the operation plans, incident management plans and defining any other criteria required for the operation of the I-270 ICM system as it pertains to county-maintained roads.

These plans include the strategies and configuration of:

- Ramp metering
- Incident management plans
- Flush plan implementation on the arterial

12.1.3 Maryland State Police / Montgomery County Police

The MSP/MCP are responsible for the enforcement of the Maryland Vehicle Code and has the legal authority and responsibility for incident management on I-270.

With the assistance of the I-270 ICM SOC operator, the MSP/MCP could close lanes without the need for squad cars to travel out to the beginning of the lane closure. This would allow quicker response for the MSP/MCP and help to reduce the chance of secondary crashes after an incident on I-270. These lane closures could also assist the MSP/MCP in clearing a path for emergency vehicles responding to a crash.

MSP/MCP will have the ability to view the status of the corridor through the traffic surveillance and monitoring systems. Through this system the dispatch center will be able to view the CCTV cameras along the length of the corridor. This will allow the MSP/MCP to confirm the presence of a crash; hence, they will be able to quickly coordinate an appropriate response. In addition, crashes will be identified quicker via the incident detection system alerting the operator to a potential crash location.

MSP/MCP will be partners in the development of the corridor incident management strategies.

12.1.4 City of Rockville/City of Gaithersburg

The cities will be involved in developing the operation plans, incident management plans and defining any other criteria required for the operation of the I-270 ICM system as it pertains to city-maintained roads.

These plans include the strategies and configuration of:

- Ramp metering
- Incident management plans
- Flush plan implementation on the arterial

12.1.5 University of Maryland Center for Applied Transportation Technology

The University of Maryland CATT lab is responsible for operating and maintaining the regional ITS architecture computing infrastructure (RITIS) necessary to exchange information between various regional transportation management systems. The RITIS system enables key data exchange between CHART, Montgomery County, the I-270 ATM STM, and other regional systems. The CATT lab also maintains various tools that may be suitable for reporting and analyzing key performance metrics related to the I-270 corridor operation.

12.1.6 Private Vehicle Operators

Private vehicle operators will experience an improved level of service for their travels through the I-270 ICM corridor.

In the event of a crash, the people involved in the crash will receive assistance faster and those who are not involved in the crash will experience a reduced impact on their travel time through the corridor. If the crash occurs on I-270, lanes may be closed and the advisory speed may be lowered.

If a vehicle exits I-270 in order to avoid the crash, the vehicle will be directed along the arterial road and back to I-270 at the earliest convenient site downstream of the crash.

Travel information will be improved for traveling in the corridor. The traveler will be able to access this information as they currently do through the 511MD website and phone services.

Additional information will be provided on the many new DMSs and overhead sign structures that will be installed in the corridor.

A variety of new equipment will be installed in the corridor. Some of the devices installed will be new to the area, such as the LUS and VAS. Private vehicle operators will have to adapt to these new devices.

Signals are already coordinated, but local drivers may be more impacted when there is a flush plan in operation.

Improvements made in the corridor will make transit travel more accessible. Additional signs providing information about parking and transit will provide private vehicle operators the opportunity to switch to transit travel for their journey into or through the corridor. These signs, coupled with DMS displayed corridor travel times, will allow private vehicle operators to make an informed decision about the travel advantage of using transit options for completing their journey.

With the implementation of VAS, RM and LUS, travel along I-270 will be safer with more consistent travel times. With the implementation of the Traveler Information System, the travel times and conditions will be more easily determined by the private vehicle operator. All of this combined will lead to more satisfied private vehicle operators.

12.1.7 Bicycles and Pedestrians

Pedestrians and bicycles will continue to operate in the corridor unaffected by the changes.

12.1.8 Commercial and Transit Vehicle Operators

Commercial and transit vehicles will continue to operate in the traffic stream along with private vehicles. The conditions and benefits described above for private vehicles operators will also apply to commercial vehicle operators.

12.2 System Constraints

System must be developed within the time and budget dictated by the terms and conditions of the project funds. System should use existing infrastructure as much as feasible.

12.3 Required Agreements

The I-270 ICM system crosses multiple jurisdictional boundaries and will require inter-agency coordination to effectively manage the system and to coordinate response to incidents or traffic congestion. The foundation of this cooperation will be a Memorandum of Understanding for the I-270 ICM Project that addressed the transportation management of the I-270 Corridor. The following agreements should be developed or modified:

- Video Access and Control;
- Interagency Agreement and Standard Operating and Maintenance Procedures;
- Incident Management Agreements; and
- Ramp Metering Agreement.

12.4 Video Access and Control

The purpose of this agreement is to define the terms of sharing video images and controlling camera operation. This agreement will be between SHA and Montgomery and Frederick Counties with the intent to provide video image access to all agencies. This functionality will include individual agency-definable security on a per camera, per agency and per person basis to allow an agency to define which cameras are available to which users, pre-set views (if any) and to allow for an agency to maintain priority control of the cameras in their ownership. An interagency operating agreement would include the parameters of allowable use by each agency that owns CCTV cameras, including SHA.

12.4.1 Interagency Agreement and Standard Operating and Maintenance Procedures

This agreement will outline procedures for normal operations of the project. This will include operation of CCTV cameras, maintenance of equipment, and signal coordination.

12.4.2 Incident Management Agreements

This agreement will outline incident management procedures including operations of trailblazers and incident response routes and initiation and termination of signal flush plans. The agreement will stipulate that the local agencies delegate operation of the trailblazers to provide a unified response to an incident.

These agreements will also specify the implementation and operations of the signal flush plans.

12.4.3 Ramp Metering Agreements

This agreement is a memorandum of understanding between local agencies and SHA to determine the operations of ramp meters including when the ramp metering rates should be adjusted, thresholds for congestion, and operations of field equipment.

12.5 Performance Measures

Performance measures are important for determining the extent to which the system achieves the project's goals and objectives. The performance measures can be either quantitative or qualitative. Each business requirement should be associated with a measurable metric that allows the stakeholders to assess whether or not the requirement has been met, or continues to be met, by the system.

In addition to system performance measures, it will be appropriate to measure the efficiency and effectiveness of the stakeholders through measures of agency performance. These metrics will quantify the extent to which each organization performs the tasks for which it is responsible.

As the system is developed, metrics will be defined that quantify the performance of the transportation system. As far as possible, these metrics should rely on data that will be automatically collected by the system. However, if they need to be supplemented by separate surveys, these will be identified and explicit test or evaluation plans developed.

As operation and maintenance plans are developed, each stakeholder will agree on their roles and responsibilities for both day to day operation and routine and preventative maintenance. Specific metrics will be prepared and incorporated into agreements, as appropriate.

12.5.1 Performance Metrics

The exact metrics that will be used as performance measures will be dependent upon the availability of data. The metrics that may be used include:

- Incidents
- Time to respond to incident after detection;
- Time to clear incident;

- Extent of congestion on freeway as a result of incident;
- Extent of diversion of traffic from freeway as a result of incident;
- Changes in traffic conditions on arterials as a result of incident;
- Crash patterns and causes;

Frequency, type, and severity of primary and secondary incidents;

Changes in transit patronage during incidents; and

Changes in emergency vehicle travel times while responding to incident.

12.5.2 Recurrent Congestion

- Throughput at bottlenecks;
- Average travel time or speed;
- Variability in travel time or speed;
- Time of onset of flow breakdown at bottlenecks;
- Extent and duration of queuing at bottlenecks;
- Traffic volumes on arterial roads; and
- Delays at on-ramps.

12.5.3 Traveler information

Reliability of traveler information; and

Effect of traveler information on travel choices (mode, route and time of travel).

Agency performance measures will be prepared to measure the extent to which each stakeholder achieves the efficiency and effectiveness agreed to for their respective responsibilities. These will include such items as:

<u>Operation</u>

- Time to take requested action when requested by another agency or by the incident management software;
- Time to respond to requests for changes to operational plans (such as incident management plans; traffic signal flush plans); and
- Tracking operators’ response to detection or notification of incidents.

<u>Maintenance</u>

- Time to respond to equipment faults of various types;
- Time to repair equipment faults; and
- Time to respond to requests for changes to system configuration.

Appendix A.

INTENTIONALLY LEFT BLANK

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 29, 2016

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 1 (Revised) for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on December 15, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract. There are no additional comments for this revised PTC.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

SHA State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 1, 2016

PTC-01: ACTIVE TRAFFIC MANAGEMENT

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 1 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract.
2. Page 2, Section A, Description: We agree with the potential benefits of Lane Use signals to provide advanced warning, and a measure of lane-specific traffic management. To assure the feasibility of this strategy, we would recommend that the existing sign inventory on I-270 be considered. I-270 already experiences "sign congestion," and the successful implementation of additional Dynamic Lane Use Control and Dynamic Speed Advisory gantries would depend on meeting, or successfully requesting waivers for MUTCD design standards. Also, these strategies will need to be reviewed to determine if Maryland would make the lane control and speed limits regulatory or advisory (noted that this PTC recommends advisory, but this would be a Maryland policy decision).
3. Page 5, Section A, Description, Dynamic Shoulder Lanes (DSL): It would be helpful to clarify the planned architecture for the Video Incident Detection System (VIDS). Would the processing be done in the field, with camera based software, or would the images be processed at a back-end server location where the video streams can be captured? Are the cameras fixed, purpose built for VIDS, or would they be capable of Pan-Tilt-Zoom for incident management, with the ability to automatically recalibrate to support an automated monitoring mode? How would identified obstructions be flagged and how would operational staff be notified of safety concerns?

My telephone number/toll-free number is 410-545-8800 or 1-888-228-6971
Maryland Relay Service for Impaired Hearing or Speech 1.800.735.2258 Statewide Toll Free

Street Address: 707 North Calvert Street • Baltimore, Maryland 21202 • *Phone* 410.545.0300 • www.roads.maryland.gov

4. Page 6. Section A, Description, Dynamic Shoulder Lanes (DSL): The PTC indicates that in areas with reduced shoulders, Emergency Refuge pull-off areas will be constructed. It would be helpful to have more information on the intended design of these refuge areas, length, taper, width, number, location, etc. to determine the applicability for emergency and incident management.
5. Page 7, Section A, Description: The PTC states that the Variable Speed Limit signing could use solar power and cellular communications. Since lane control signals and variable speed limit signing provide real-time dynamic guidance to vehicles, and due to safety considerations, they must be highly reliable, available and maintainable. It would be helpful to have some description and additional information on the premise that solar power and cellular communications could be suitably reliable for operating these devices.
6. Page 13, Section C, Analysis: We noted that the proposed active traffic management (ATM) Decision Support System (DSS) would include algorithms to predict traffic issues in advance. It would be helpful to have additional details regarding the data processing and algorithms to support this functionality, and how predictive information would be used operationally in managing the roadway.
7. Page 13, Section D, Potential Impacts: An I-270 ATM will introduce entirely new traffic control patterns and devices for many local travelers in Maryland. The impacts on driver expectation, outreach and education should be addressed.
8. Page 15, Section F, Administration Risk: There will be Operations and Maintenance expenses associated with any ATM. It is understood that this project will not include funding for ongoing Operations and Maintenance. However, per the goal of providing a sustainable solution, we would anticipate the final technical solution would include a plan and estimate of the operations and maintenance requirements and costs, in order to program ongoing support and provide documentation and justification for the required Operational Budget enhancements.
9. Concept of Operations, Section 10.3 & 10.4: (Note, although there is a Table of Contents with page numbers for the Concept of Operation Appendix, there are no page numbers on the pages in this section.) Regarding the roadway management system, we understand there are various hosting models. We would recommend that the discussion of the command and control of the traffic management elements address:

    Configuration management: From the PTC, it appears that at some point, the CHART system, roadway weather information systems and possibly other systems (e.g. the Montgomery County Signal System) will need to share key data as triggers (e.g. when and where an incident occurs, specific lanes blocked, etc.) The PTC needs to address how changes to one system, impacting the format of how data is output and/or input, will be coordinated in order to prevent "breakage" of the integrated connection of systems.

Security: As mentioned in previous comments, the CHART system resides inside the secured firewalls of the MDOT Enterprise Network. As such, data passed into the CHART system needs to meet the security requirements of the Maryland Department of Information Technology. This does not apply to data passing out of the CHART system. CHART provides a Representation State Transfer (REST) feed for real-time incident information.

Hosting: If a stand-alone traffic management command and control system for the I-270 will be hosted, we would like to have additional information on the perpetual operations and maintenance, as well as potential licensing, requirements to assess the sustainability of the solution.

Business Process: The CHART Program has specific responsibilities in coordinating the response of various agencies at highway incident scenes and providing traveler information. ATM systems represent another tool, but also additional responsibilities in the incident management process. We would like the proposer to describe how the existing Traffic Incident Management (TIM) process will be coordinated in the Operations Center, and in the software, with managing ATM tools as well.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

PTC 2. Part time shoulder running civil solution

A) Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.

The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to implement Part-Time-Shoulder (PTS) use along I-270 to address congestion during the peak hours, improve mobility and predictability for the users of the I-270 Corridor and provide opportunity for a dynamically managed lane to assist with dispersion of traffic in the event of abnormal traffic event or incident.

PTS is a proven means of adding capacity to a congested facility while requiring relatively low construction costs and reducing impacts to right-of-way, environmental features, utilities, and stormwater management facilities, as compared to widening the facility which would require adding a lane to the roadway network. For PTS, during off peak hours, when the shoulder is used as a shoulder, traffic along the freeway is able to benefit from the safety and mobility that a shoulder allows. During peak hours, when congestion levels are high, opening a shoulder to traffic helps to improve traffic flow, thereby reducing network delays and reducing the occurrence of rear end crashes, and other congestion related incidents.

Application of the PTS use must be done in a way that correlates to driver expectation. The portion of roadway in which the shoulder is used as a travel lane must have a logical beginning point and a logical end point to reduce driver confusion. The Part Time Shoulder Lanes proposed in this PTC has been developed in accordance with recommendations and suggestions put forth in the FHWA guide Use of Freeway Shoulders for Travel: a Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy (February 2016). Two exceptions to this guide are specifically identified in this PTC. For the I-270 Corridor, the following factors were considered when selecting the locations for application of this concept:

The existing inside shoulder, along the I-270 mainline, is generally 10-foot wide and GP lanes are striped as 12-foot lanes. Shoulders in excess of 14 feet are realized along the I-270Y spur, in the area of proposed PTS. The outside shoulder is generally 10 feet wide.

Along southbound I-270Y:

- The most congested period is the AM peak period from 6:00 to 9:00.
- The left-most lane along southbound I-270Y, beginning just north of the Westlake Terrace Overpass and continuing to the merge with WB I-495, is designated as a High Occupancy Vehicle (HOV) lane during the AM peak period, from 6:00 AM to 9:00 AM.

Because the time when PTS use would be desired overlaps with the time when HOV use is implemented, and because use of the left shoulder for PTS use will eliminate conflicts with ramp junctions, it is proposed that the SB I-270Y HOV lane be shifted into the SB I-270Y PTS lane during the AM peak period.
To implement the PTS lane, Wellington/Jacobs is proposing to utilize an 11-foot PTS lane with a 1.5-foot minimum lateral offset to obstructions (concrete median barrier, bridge piers, overhead sign foundations). In development of the layout for the proposed PTS lane Wellington/Jacobs aimed at minimizing the locations with the 1.5-foot minimum lateral offset, minimizing the need for additional widening to achieve throughput benefits, maintaining consistent lane alignment without unnecessary lane shifts and lane width changes, maintaining adequate spacing between the existing concrete median barrier and the PTS lane to keep the existing drainage inlets outside of the PTS lane and at maximizing the use of available pavement in order to increase capacity of the Corridor.

Much of the length of the PTS implementation currently has a shoulder in excess of 10 feet allowing the PTS to be incorporated by restriping the shoulder and the PTS only (Station 1+50 to 53+50). Microsurfacing as defined in A.vi. below will be performed over the shoulder and stripe removal locations to mitigate ghost stripes associated with stripe removal. Between stations 53+50 and 71+00, placement of the PTS on the inside shoulder will require restriping and narrowing of all I-270Y lanes to 11 feet to develop adequate space for the PTS. The need to restripe all I-270Y lanes is dependent on the existing geometry with north of station 53+50 requiring only restriping of the shoulder due to its existing width as indicated above.

Wellington/Jacobs anticipates utilizing the following design measures in order to implements PTS:

i. The width of the shoulder will be reduced from 10 feet to a minimum of 1.5 feet in order to develop adequate space for the PTS.
   For the PTS , this reduction will only be in place during HOV operating hours and during use as a managed lane in accordance with PTC 1. Outside of the HOV operating hours the width of the inside shoulder will be greater than in existing conditions. The reduction in the width of the shoulder during the operation of the PTS lane will require a design exception, which will be developed and submitted to SHA for review and approval prior to establishing a Construction Agreed Price (CAP). The primary reason for not providing AASHTO compliant shoulder width was the lack of available space to provide the PTS lane without significant widening. Although the shoulder will be reduced during the HOV operating hours, the improvements proposed under PTC 1 will provide SHA with the ability for continuous coverage and management of the PTS lane, which could be closed and reopened as needed to address broken-down vehicles, traffic incidents, unexpected congestion or snow removal operation.
ii. This PTC proposes to change the location of the existing HOV lane, by shifting it into the median, and proposes to reduce the width of the HOV lane from 12 feet to 11 feet over an approximate 6,950 foot distance. Due to the changes in the location and the width of the HOV lane, Wellington/Jacobs will prepare an equivalency study to prove that the proposed changes to the location and the width of the HOV lane will not have a negative impact on the current or design year operation of the HOV lane. Reasoning is as follows:
   - Current use of the SB HOV lane is approximately 1800 vehicles per hour in the busiest stretch near Montrose Road.
   - The projected 2040 use of the SB HOV lane is approximately 1900 vehicles per hour in the busiest stretch near Montrose Road.
   - Reducing the lane width from 12 foot to 11 foot has a minor effect on free flow speeds (approximately 1.9 miles per hour). When determining capacity of a lane the free flow speed is rounded to the nearest 5 miles per hour which would result in no reduced capacity for an 11-foot lane. Reducing the shoulder width from 10 foot to a 1.5-foot minimum does not have an effect on free flow speeds for left shoulders. Currently the free flow speed of 75 miles per hour the I-270 corridor has a lane capacity of 2400 vehicles per hour. Based on the current year and design year projected uses and the above impacts for 11 foot lanes and reduced left shoulders an equivalency status should be granted.
iii. South of station 53+00, the width of the three (all) lanes adjacent to the PTS will be reduced from 12 feet to 11 feet minimum to develop adequate space for the PTS depending on current geometry and striping of existing lanes.

iv. The implementation of the proposed PTS lane will not require modifications to the existing I-270 structures located within the limits of this PTC. The development of the PTS lane took into consideration existing clearances, locations of piers and abutments and the lateral offsets between the structure elements and the proposed lane configuration. The piers and/or abutments were used as the controlling points and the minimum 1.5-foot offset was used to develop the lane configuration that would deliver the required number of lanes under or over the existing structures. Wellington/Jacobs evaluated construction, schedule and financial implications associated with modification of the structures and decided to forgo modification to existing structures in order to maximize the amount of improvements under this project.

v. The FHWA guide Use of Freeway Shoulders for Travel: a Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy recommends placement of refuge spaces (turnouts) for disabled vehicles approximately every half-mile along a facility with static or dynamic shoulder use. It is recommended that the turnouts be a minimum of 16 feet wide, to provide separation between a broken down vehicle and moving traffic in the shoulder. The tapers, leading in and out of the turnouts, are recommended to be approximately 300 feet with and the length of the turnout itself of approximately 110 feet or more. In this PTC turnout areas are physically impossible without extensive widening and/or reconstruction required to achieve the recommended separation. Refuge areas for the roadway would be the opposite shoulder which as shown below in the typical sections for Section 1 is generally 8 to 10 feet, a deviation from the manual mentioned above.

vi. In order to eliminate conflicts with the pavement markings (ghost stripes) Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings will be installed in accordance with the SHA’s Pavement Marking Material Selection Policy.

The areas where Wellington/Jacobs proposes revisions to the pavement markings impacted sections will be treated with microsurfacing application prior to the placement of final pavement marking material.

For microsurfacing applications, this PTC proposes to use:

- Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
- VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways.

vii. For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers removal process.

viii. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO. In the areas where the PTS is adjacent to a superelevated GP lane, the variation between the cross slope of the GP lane and the PTS lane will be maximum of 3.0% which is an exception to and slightly more than the FHWA guidelines listed in the “Use of Freeway Shoulders for Travel: A Guide for Planning, Evaluating, and Designing Part-Time Shoulders Use as a Traffic Management Strategy” publication. With a 3% maximum break on superelevated areas the cross-slope would be similar to adjacent lanes. The wedge and leveling identified in this PTC would remedy areas in excess of this.

ix. The concrete median barrier is the primary method of separation between the northbound and southbound lanes of I-270. In the areas where the PTS lane is proposed to be shifted onto the existing inside shoulder, and where the cross slope adjustments between the adjacent GP lane and the PTS lane are required, the existing concrete median barrier will be adjusted. Wellington/Jacobs has assumed that in the areas where the cross slope adjustment is required, the barrier will be replaced with a 42-inch F-shaped or constant slope slip formed barrier, and in the areas where the existing barrier is a part of a retaining wall separating northbound and southbound lanes, the barrier will be retrofitted to provide a F-shape barrier. While the existing concrete barrier has some flexibility to add overlays (e.g. available barrier lip for overlay), to minimize risk associated with not having final survey and final knowledge of where additional overlay can be implemented using the available lip, Wellington/Jacobs has assumed to replace the concrete median barrier along areas receiving a wedge and level application (Stations 6+50 to 71+00) or a retrofit with added width and height. After award and during the scope validation period, final survey will allow the Wellington/Jacobs team to identify lengths of barrier that have the flexibility to allow the needed wedge and leveling, mainly areas where the reveal of the barrier lip would allow for placement of the proposed wedge and leveling without replacement of the barrier or retrofitting. We will work with SHA at that time to provide project cost savings as applicable.

x. The existing drainage inlets, currently located adjacent to the concrete median barrier will remain in place and will be adjusted to accommodate any proposed wedge and leveling adjacent to the concrete median barrier. The development of the PTS layout took into consideration location of the inlets and operational, safety and maintenance concerns associated with the inlets in the footprint of the PTS lane. Under the proposed configuration 15 inlets will be located in the shoulder between the PTS lane and the concrete median barrier and one inlet that falls within the footprint of the PTS. This inlet will be adjusted and/or replaced with narrow grate inlet to keep the inlet outside of the PTS lane.

xi. Based on the As-built plans and Ground Penetrating Radar Pavement Shoulder Structure Evaluation on the I-270 Corridor, provided by SHA, there are locations where the pavement section of the existing inside shoulder varies from the pavement section of the through lanes. The Wellington/Jacobs Team expects three primary options of addressing the existing pavement conditions within the shoulders. Those include keeping the existing pavement in place, resurfacing and/or wedge (1 ½" minimum) and leveling existing pavement (resurface, wedge/leveling, cross slope adjustment) or reconstruction of the existing pavement.

- Southbound I-270Y (the western Spur) from south of the Westlake Terrace Overpass to of the I-495/I-270Y merge (Stations 1+50 to 71+00). Based on the review of the available pavement data, Wellington/Jacobs places this area in a low risk category for pavement thickness variations and required reconstruction of the exiting shoulders.
  - As-built plans and design drawings provided by SHA covering this section of I-270Y show the following pavement sections for the inside shoulders along I-270Y, which are adequate to convert to a part time running shoulder:
    - M-401-513-372 (I-270 West Spur – South of Democracy Boulevard to Tuckerman Lane) - 12 inches of hot mix asphalt (HMA) on top of 15 inches of graded aggregate base (GAB). Plans dated 1994.
    - M-401-507-372 (I-270 West Spur I-495 from North of MD 190 to South of Democracy Boulevard) show proposed pavement section for the

inside shoulder as 12 inches of HMA on top of 15 inches of GAB. Plans Dated 1994.

- GPR information for the I-270Y between Tuckerman Lane and Democracy Boulevard show the thickness of hot mix asphalt ranging from 7.7 inches (isolated to near the Democracy Boulevard Overpass centerline) to 13.0 inches with the average thickness of all readings at 11.0 inches.
- GPR information for the I-270Y between Democracy Boulevard and I-494 Merge show the thickness of hot mix asphalt ranging from 7.8 inches to 14.7 inches with the average thickness of all readings at 12.2 inches.
- Preliminary pavement design data using assumptions outlined in Section D of this PTC revealed a required pavement section of 8.7 inches of HMA over 12 inches of GAB.
- Based on the As-built plans, design drawings and GPR information provided by SHA, it is expected to have more than 10 inches of asphalt over graded base along the entire section. Therefore, the existing pavement will be left in place, wedge and leveling will be performed to address existing cross slope variations and the PTS will be run on the existing shoulder. Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are significant stretches (two consecutive borings) of asphalt less than 8.7 inches in thickness, these areas will be reconstructed by one of the following two methods:
  - Reconstructed full depth
  - Reconstructed using a hybrid pavement section that would:
    - Remove the existing asphalt
    - Remove a portion of the existing GAB (leaving at least 12 inches in place)
    - Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 9 inches of asphalt pavement, (slightly more than the as-built/design plan pavement section).

- We have assumed any locations where wedge and leveling is performed adjacent to barrier that the lip of the barrier will be insufficient to accommodate the wedge and leveling and therefore the barrier will be reconstructed. After survey if there are sections where the wedge and level can be accomplished within the available lip of the barrier we will work with SHA to determine if those sections of barrier reconstruction can be omitted to allow SHA to benefit from the cost savings.

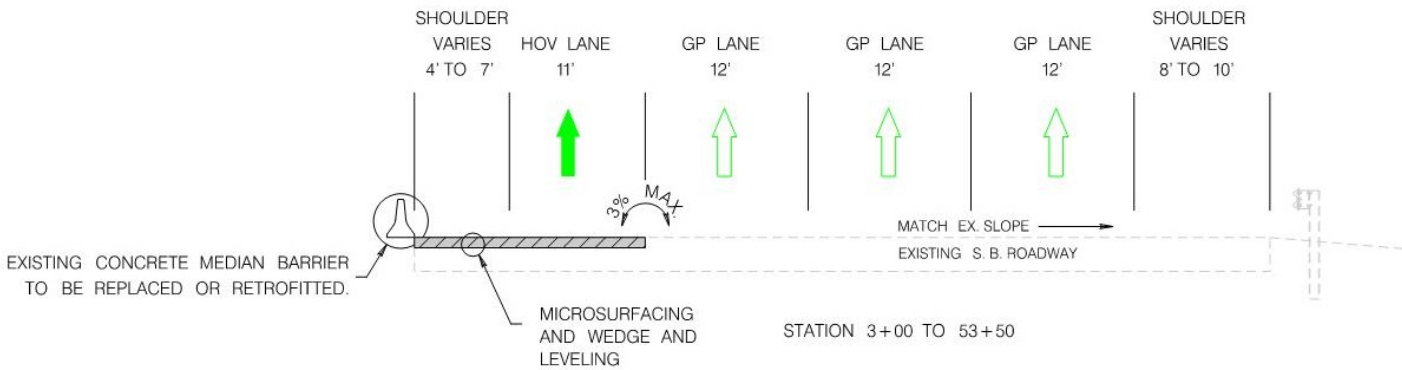
B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.

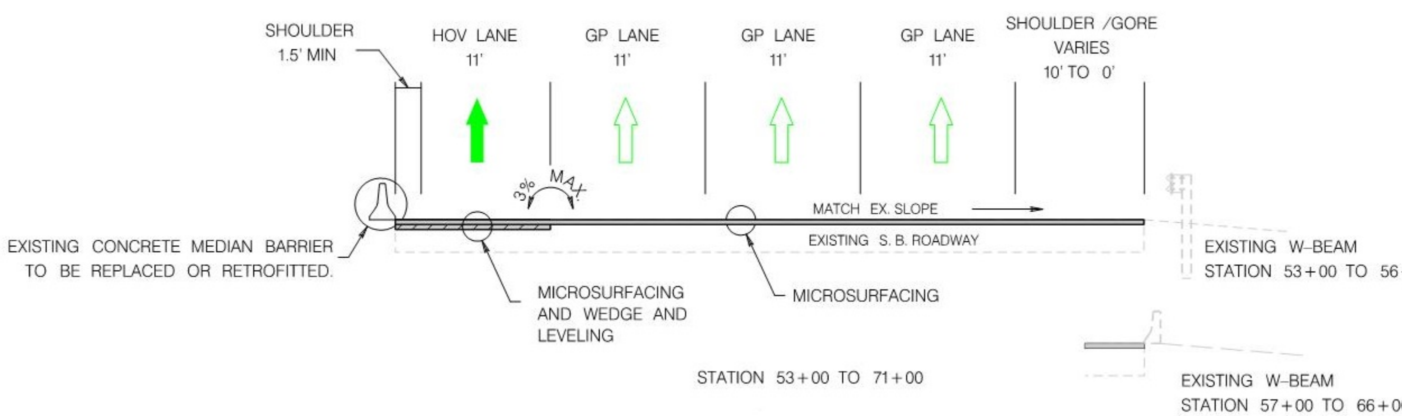
The HOV lane, in each direction along the corridor, is in place only during the most congested periods, and in the most congested sections of the Corridor. Those times and areas are when and where shifting traffic onto a shoulder lane would be most desired. Additionally, the left shoulder along the majority of the Corridor in which an HOV lane is present, is wide enough to support conversion to a PTS lane. We have identified one location to implement a PTS for HOV use; along SB I-270Y (the western Spur) from just south of the Westlake Terrace overpass to the merge with WB I-495. The PTS would be used as an

HOV lane during the currently designated HOV lane operation hours. The shift of the HOV traffic onto the shoulder would result in an additional GP lane during the AM peak hours. Outside of the HOV operation hours, the PTS will be a dynamically managed lane, and used as needed to address incidents along SB I-270Y

The section along the southbound I-270Y between Westlake Terrace and the merge with westbound I-495 was determined to deliver more throughput benefit to the Corridor and therefore is the focus of our proposed improvements. This section of the PTS includes:

Part time Shoulder use and HOV lane use, Southbound I-270Y from south of Westlake Terrace Overpass to the WB I-495 / SB I-270Y Merge (Stations 1+50 to 71+00) . A total length of approximately 6,950 feet (1.3 miles). Typical sections are provided below for Section 1.





C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 Corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270.

Implementation of this improvement will result in a local increase in throughput of 17 percent under base conditions and 23 percent in 2040. Additionally, travel times in the vicinity of this improvement will reduce by 1.3 minutes in the base year and by 0.7 minutes in 2040. This improvement will also serve to alleviate a critical bottleneck along the corridor, allowing significant benefits to be gained by additional improvements implemented at other points along the corridor.

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – Utilization of the PTS lanes will decrease travel times and increase throughput along SB I-270Y as identified above, which will relieve a significant bottleneck at a critical location thereby resulting in better operations along SB I-270 approaching the I-270 Split. Additionally, it improves predictability of travel along the Corridor by reducing the number of crashes and improving travel speeds. The PTS lane will provide additional capacity when and where the Corridor needs it the most, in the AM peak hours at the primary bottleneck locations SB I-270Y.

ii. **Safety** – Experience in the U.S. to date has not identified major safety issues with static or dynamic part-time shoulder use that led implementing agencies to discontinue their use. Based on the available safety information on locations utilizing narrowed lanes and shoulders there appears to be a general tendency for the frequency (or number) of crashes to increase with a narrowing of lanes and shoulders while the crash rate (e.g., number of crashes per million vehicle-miles) often decreases. It may be that even with an increase in the number of crashes, the additional throughput provided by the extra lane results in an even greater increase in the denominator of vehicle-miles of travel, resulting in a decreased crash rate. By adding capacity to the Corridor, the through lanes will operate at more consistent speeds, decreasing stop-and-go conditions conducive to traffic incidents. An added benefit from the PTS is that during non-peak hours the shoulder width will be increased, improving the refuge area for incidents.

iii. **Operability / adaptive/ maintainable** - Combined with construction of ATM devices along the I-270 Corridor, the PTS lane provides an opportunity for an additional dynamically managed lane to assist with dispersion of traffic in the event of abnormal traffic event or incident. Refer to PTC 1)

iv. **Well managed project** – The development, implementation and dynamic management of the PTS lane will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order the develop a facility that addresses project goals and fulfills SHA's expectations.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with these options. The proposed improvements will be performed within the existing footprint of pavement.

ii. **Geotechnical** –We have reviewed available construction plans for past improvements along the I-270 Corridor and the GPR investigation performed along the shoulders of I-270 in 2015 to determine the available pavement thickness for the PTS. As indicated in Section A above, the data revealed:

- As-built plans and design drawings provided by SHA show the proposed pavement section for the reconstruction of inside medians of at least 12 inches of HMA on top of at least 15 inches of graded aggregate base.
- Ground penetrating radar – GPR runs show similar results with asphalt thicknesses averaging between 11.0 and 12.2 inches between Tuckerman Lane and I-495.
- The Preliminary pavement design calculations revealed following required pavement section for the PTS lane:
  - Total # vehicles (20 years): 56,575,000 (based on 100% of HOV lane occupancy provided)
  - Design 18-kip ESAL's: 3.6 million
  - AASHTO Structural No. (SN) = 4.9
  - Minimum HMA thickness: 8.7" on 12" GAB
  - Conservative 5% truck distribution for the HOV lane

Based on this data, we are proposing to convert the shoulder to a PTS HOV lane utilizing wedge and leveling to address cross slope requirements.

In areas where the geotechnical investigation reveals inadequate asphalt (less than 8.7 inches) for PTS use, we propose to reconstruct the section. If there is a thick layer of graded aggregate base (GAB)(e.g. more than 12 inches), we propose to use a hybrid pavement section when feasible. The hybrid section will allow for the existing asphalt and a portion of the GAB to be removed and replaced with asphalt. The resulting asphalt/GAB section would be at least 9 inches of asphalt and 12 inches of base after reconstruction. The approach to a hybrid section will be as follows:

i. Remove the existing asphalt
ii. Remove a portion of the existing GAB (leaving at least 12 inches in place)
iii. Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 9 inches of asphalt pavement

iii. **Utilities** – There are limited utility impacts associated with these the PTS options. According to the utility designation file provided to Wellington/Jacobs, there are no utility lines detected in the footprint of the inside shoulders along the southbound ~~and northbound~~ lanes. There is an SHA electrical line located in in the existing concrete median barrier. That electrical line extends from south of Montrose Road Interchange to the I-270/I-270Y split. Test pits will be performed for the utility lines crossing under I-270, if those are located in the areas where the concrete median barrier might be reconstructed.

iv. **Environmental Permitting** - There are no anticipated impacts to environmental resources which would require environmental permits. Since the improvements call for striping existing outside shoulders as additional lanes, a noise analysis will be performed to determine if the proposed improvements require noise mitigation measures. Based on evaluation of existing noise reports no noise wall updates are anticipated. Based on proposed improvements, it is not anticipated that an IAPA will be required for this PTC, but Wellington/Jacobs will coordinate with SHA/FHWA to confirm this assumption.

v. **Local Community** – Utilization of the PTS will introduce an extra lane to be used by vehicles during the peak traffic hours. Because the extra lane will be located within the existing inside shoulder for I-270, informational meeting(s) and educational campaign for use of PTS lanes and how the PTS will be operated by the ATM will be beneficial to the users prior to opening the PTC. Communities impacted by the proposed improvements to the noise walls will be involved throughout the design/ pre-construction and construction phases of the project.

vi. **Safety** – The implementation of the PTS lane will result in increased capacity along the SB I-270 Corridor during the AM peak hours, will allow for the SB I-270 Corridor to operate at more consistent speeds, will decrease stop-and-go conditions, and reduce potential of rear-end crashes. During construction, the traffic will be impacted by the resurfacing/restriping operations and in the areas where the concrete median barrier will be reconstructed, the traffic will be impacted by a construction zone located in the existing median and inside shoulder and along portions of the outside shoulder. Impacts from a reduced shoulder and reduced lane widths have also been reviewed. The Wellington/Jacobs team is proposing a minimum lane width of 11 feet for general purpose and 11 feet for the PTS HOV lane. AASHTO anecdotal data indicates that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet. Studies in California have revealed that reduced shoulders of 2 to 3 feet when converting to shoulder use for a lane have not detrimentally impacted safety. In general, the greater the average daily traffic, and presumably the greater level of congestion during the "before" conditions, the more likely that the safety benefits from reduced congestion (resulting from an additional lane) will outweigh the potential safety issues associated with narrower lanes and shoulders.

vii. **Maintenance and Operation**- This proposed PTC centers on utilizing existing shoulder during the peak operating hours. During those hours the shoulder will be reduced to a minimum of 1.5 feet. While the reduction in the width of the shoulder seems to remove all of the safety, operational and maintenance benefits of the shoulders, the improvements proposed under this PTC combined with the ATM improvements proposed under PTC 1 will alleviate issues associated with reduction of the shoulder width. Because of the adaptability and dynamic management capabilities of the ATM solutions, the PTS lanes should not be looked as a reduction of shoulder but as an extra lane that can be managed to most efficiently, safely, and effectively move the traffic through the Corridor.

   a. The part time shoulder use will have a separate system for opening and closing the shoulder. If a vehicle becomes disabled in the part time shoulder use lane the detection system will identify the stopped vehicle and send an alert to the personnel assigned to the I 270 systems. This SHA Highway Operations Technician (HOT) can then verify the issue, close the shoulder lane in advance of the shoulder lane blockage utilizing the shoulder use overhead signs, alert the CHART and MSP patrols to initiate a response, and since the event has now been verified start a private tow service to the location, depending on final procedures agreed to with SHA. This process starts to add a layer of protection to the vehicle stopped in the part time shoulder lane prior to responders arriving on the scene and greatly expedites the detection, verification, response and clearance timelines thereby lessening the exposure time and associated danger to the disabled or incapacitated vehicle in the lane as well as approaching motorists and responding agencies. At this stage it is a virtual closure and there are no physical barriers or traffic control in place but by decreasing the detection and verification times the response times are also decreased allowing the CHART vehicles to get to the scene sooner to set up the proper traffic control and creating a safe temporary traffic control zone utilizing the roof mounted arrow boards as well as establishing a proper cone taper to protect the motorists and responders on the scene as well as warning approaching motorists of what is expected of them.

b. CHART personnel will be able to continue CHART Standard Operating Procedures (2014 version) section 2 article 7 which allows for "Disabled vehicles located in hazardous areas (travel lanes, gore areas, etc.) to be pushed, pulled, or towed to the nearest safe location before performing any type of troubleshooting on the vehicle" and "If the disabled vehicle cannot be relocated unassisted, the CHART field personnel on the scene can contact the SOC/TOC and request assistance from another CHART unit, law enforcement and/or a towing & recovery service, in order to safely remove the vehicle to a safe location. A safe location can be considered as off the freeway or to the opposite shoulder area, or the part time shoulder operation could be discontinued temporarily allowing for the part time shoulder to be a normal shoulder again. The goal is to get the travel lanes back open as soon as possible by relocating the vehicle to the nearest available safe location. This practice also creates another level of safety for the private towing companies as they are retrieving the vehicle from a safer location lessening the risk of them being struck.

c. The CHART patrols are registered "Emergency Vehicles" and are equipped with red lights both front and rear facing with sirens. The CHART Standard Operating Procedures (2014 version) section 2 article 9 states "Due to the nature of emergency response required by SHA personnel, a group of vehicles have been designated Emergency Response Vehicles. This ability along with our ATM managed lane should provide better access to incident locations.

d. Maryland is one of the top performing states when it comes to dealing with major incidents as they have response plans and procedures in place to deal with these types of events. The backbone behind Maryland's success is the MSP/SHA open roads agreement which originated in 1989 and has been recently updated (August 2015) states:

> "Whenever the travel lanes of a roadway are closed or partially blocked by a crash, disabled or unattended vehicle and traffic delays or safety problems may occur as a result, the SHA representative in cooperation with the trooper in charge should attempt to reopen the roadway as soon as possible **<u>ON AN URGENT BASIS"</u>**

Although not part of this PTC other initiatives such as towing incentive programs or policy changes or procedures could be modified to make Maryland's responses to some of these incidents even better. The quick clearance of complex incidents is not really impacted by the part time shoulder use as the shoulders can be closed to traffic at any time and utilized as a shoulder at the request of any of the response agencies. This would allow for the movement of specialty or heavy equipment to stage properly for recovery efforts as the same amount of roadway is available. Our proposed managed lane solution will enhance the ability for response to major incidents by allowing control of lanes for access of incident vehicles.

viii. **Life Cycle Project Infrastructure Cost –** This proposed PTC does not affect life cycle costs of the corridor outside increased wear of the shoulder used as a PTS. However, SHA typically schedules the entire width of the corridor to be resurfaced during pavement preservation projects, which would include the PTS under regularly scheduled maintenance regardless of its use as a PTS or not.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

The PTS concept has been used in a number of states in the United States and is a popular method of developing additional capacity in Europe. The use of the existing inside or outside shoulder as a part time running shoulder has been implemented in Virginia, along I-66, I-495 northbound and I-264, in Minnesota along westbound I-35 and in Massachusetts along I-93, I-95 and SR-3, In New Jersey along NJ-29 and I-78 eastbound Washington along US 2 near Seattle and several areas in California including I-5 both southbound and northbound, I-405, CA 22, US 101 and others. The concept has also been implemented in number of locations in United Kingdom and Netherlands.

In the locations in California shoulders were reduced to 2 to 3 feet in width for inside shoulder use.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. This Wellington/Jacobs proposed PTC would allow conversion to the Part-Time-Shoulder with few traffic restrictions during construction because we are using the shoulder section in-place with wedge and leveling required for cross slope modifications and microsurfacing. If reconstruction is required, MOT would be more significant and in-place longer than initially anticipated. Wellington/Jacobs would work with SHA to provide adequate public information to ensure the public is well informed of anticipated construction sequencing.

ii. A condition study of existing drainage assets was not provided with the RFP materials for the Wellington/Jacobs team to assess the risk of deteriorating drainage assets. After award the Wellington/Jacobs team will perform an inventory and study of cross drainages to determine if there are any assets recommended to replace or otherwise mitigate, prior to preceding with final construction.

- The Wellington/Jacobs team proposes to base our Scope of the Part-Time-Shoulder use on the existing drainage assets being adequate for continued use aside from vertical adjustments for wedge and level asphalt placement and width adjustments to several inlets to maintain inlets outside of the PTS. Our proposed PTC is also to extend drainage facilities in kind with extended drainage facilities end sections meeting current SHA requirements).

iii. This PTC proposes to allow the Design Storm Water Spread to encroach upon the Part-Time-Shoulder use lane to accommodate a total spread of 8 feet. This spread will equate to slightly more than ½ the PTS during the storm event. The Wellington/Jacobs team proposes that the Dynamic Variable Speed Control and Dynamic Lane Control would be integrated to allow Variable Speed control of the lane or dynamic closure of the lane during a storm event that would result in water encroaching upon the PTS during its use. Currently a 2-year storm in general requires approximately 7 feet of spread with shoulders at 2 to 4 percent cross slopes. We anticipate a storm event to exceed the available shoulder of 1.5 to 2 feet would be less than a 1 year storm, thus requiring control to be established a few times each year at most depending on how final design accounts for drainage patterns near the pinch points. During this control period the corridor would revert to the cross section of available general purpose lanes and HOV lane that is functioning today.

iv. Risks associated with snow removal or reduced shoulder width as refuge for disabled vehicles will be mitigated by the implementation of PTC 1 and existing full width shoulder along the outside southbound lanes. Through ATM deployment the shoulder use for refuge, snow storage, water spread from storm events will be managed through active lane management. The HOV lane can actively be controlled and closed if unsafe conditions arise for the above reasons or other reasons such as maintenance operations. When implemented the road network would revert to the currently available lane configuration.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

.

i. Based on the available as-built and design plans referenced in section A, the Wellington/Jacobs team is assuming the inside shoulder which will be used for the Part–Time-Shoulder use has sufficient sectional thickness to perform satisfactorily for an inside part time shoulder lane use for Section 1. The available GPR data along this section is somewhat variable, however the trends seem to indicate a sufficient section of asphalt, more than 10 inches for a part-time-shoulder use.
    - The Wellington/Jacobs team proposes to base our Scope of the Part-Time-Shoulder use on the existing shoulder being sufficient for use in this area. Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 8.7 inches in thickness, these areas will be reconstructed.

ii. If during grinding for removal of the pavement markings or grade control of the cross slope, the underlying pavement is found to be not stable, additional depths of grinding may be required.

iii. The Wellington/Jacobs team is not proposing to install storm water management facilities under this PTC as no new pavement or full depth construction is proposed. If additional reconstruction is required based on final pavement investigations, Storm Water Management facilities and approvals would be required for additional reconstructed areas.

iv. Wellington/Jacobs will be required to obtain a design exception for a significant length of reduced shoulder during the Part-Time-Shoulder lane use. We propose to team with SHA to have the design exceptions prepared soon after award to reduce potential impacts to the project schedule. If the design exception is rejected by SHA/FHWA in part or in full, Wellington/Jacobs will work with SHA to identify alternative approaches to achieve an acceptable shoulder. Design exceptions identified for this PTC are as follows:
   - Shoulder width – a significant section of the HOV PTS will have a reduced shoulder. The nominal shoulder is 2.5 feet with several areas at pinch points being 1.5 feet. The risk associated with obtaining SHA/FHWA approval of the design exception prior to CAP agreement are minimal. The reasoning to be provided for the exception include:
     - Outside of the designated hours of use the shoulder will be wider than currently available
     - The implementation of ATM on the project will provide a means to control speeds during highly congested times.
     - Widening the interstate to accommodate a full width shoulder would be cost prohibitive.
   - Lane widths – the entire area where the PTS is proposed will require revisions of lane lanes from existing 12 foot lanes to 11-foot lane. The risk associated with obtaining FHWA approval of the design exception prior to CAP agreement are low. The reasoning to be provided for the exception include:
     - Implementation of 11 foot lanes along interstates throughout the country.
     - Widening the interstate to accommodate a full width shoulder would be cost prohibitive.
   - Shoulder Cross Slope Variation – The cross slope of the existing shoulder, proposed to be used as a PTC lanes, will be required to be adjusted in order to run the traffic on it. The cross slope of the PTS lane will be designed to be with-in 3% of the existing cross slope of the adjacent lane
     - The PTC lane will be primarily used only during HOV operating hours.
     - FHWA allows for cross slope variations between PTS lanes and the adjacent running lanes.

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

Part Time Shoulders (PTS) along I-270 during peak hours will improve mobility and predictability and provide a dynamically managed lane. During peak hours opening the inside shoulder to traffic will improve traffic flow and reduce delays. The PTS will be performed within the existing footprint of the pavement. Significant cost and schedule benefits are realized from:

a. No additional right-of-way required,
b. No widening of I-270 for an additional lane required,
c. No retaining structures or bridge modifications required,
d. Reduced MOT- short term lane closures versus long term traffic movements,
e. Minimal to no environmental impacts outside of additional noise walls,
f. A significant reduction SHA administrative and engineering costs and

g. No additional costs to Utilities or Third parties.

The proposed method of PTS use may entail a mill and overlay of the existing inside shoulder and portions of the adjacent general purpose lane, median barrier replacement along with re-striping as described in the PTC. This work can be completed in one year and significantly less that the cost for a reconstruction approach as detailed below.

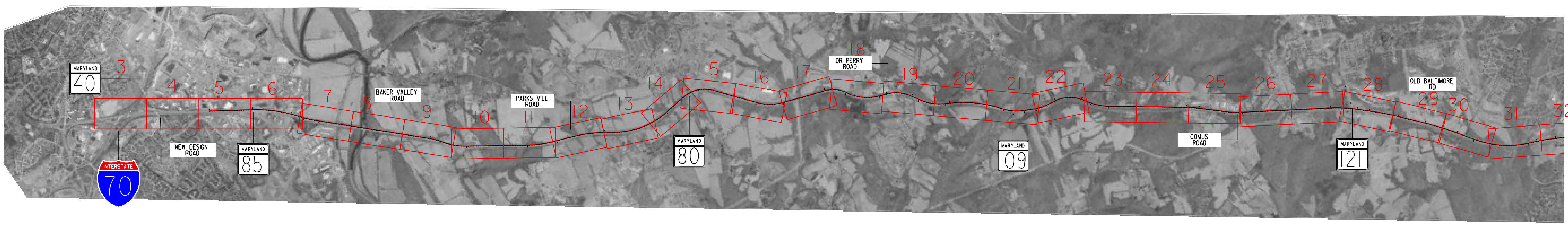
Alternatively, the estimated cost associated with the widening and reconstruction of the same length of I-270 to achieve similar congestion relief would be much more. This estimate is for SHA categories 1, 2, 3, 5, 6 and 7. This work would take up to a year to complete, not including ROW and permitting. PTC 2 presents a significant cost savings to conventional widening.

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

a. See attached VDOT memorandum for pavement markings on Microsurfacing.

Appendix 1

PTC Schematic Drawings



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

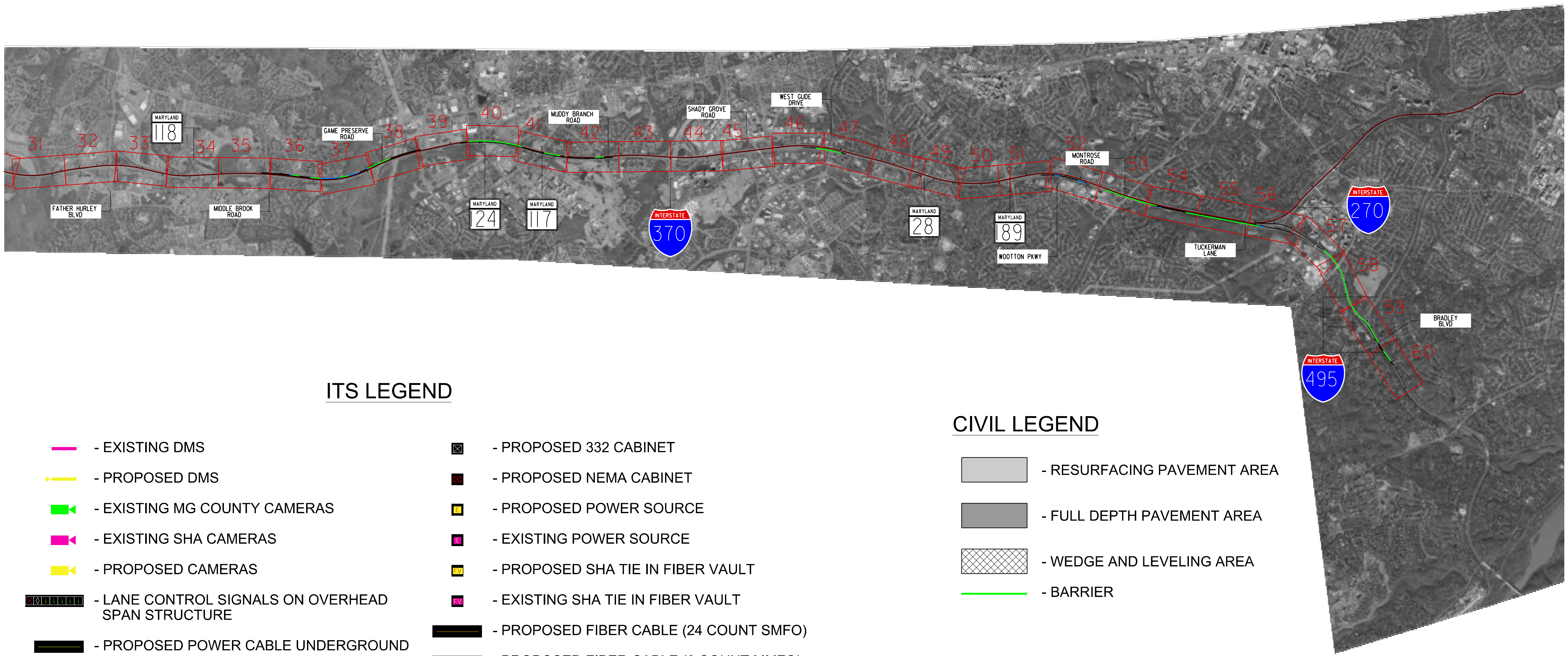
NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO.

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

SEE SHEET 56

SEE SHEET 58

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:41 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO.
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	Page 328 OF 60

SEE SHEET 57

SEE SHEET 59

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 58 OF 60

SEE SHEET 58

SEE SHEET 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:51 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV

CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 59 OF 60

Appendix 2

VDOT memorandum for

pavement markings on Microsurfacing

VIRGINIA DEPARTMENT OF TRANSPORTATION

TRAFFIC ENGINEERING DIVISION

MEMORANDUM

<table>
<tr><td colspan="2" rowspan="2">GENERAL SUBJECT:

PAVEMENT MARKINGS</td><td>NUMBER:
TE-261.1</td></tr>
<tr><td>TO SUPERSEDE:
TE-261</td></tr>
<tr><td colspan="2" rowspan="2">SPECIFIC SUBJECT:

TYPE B, CLASS VI PAVEMENT MARKINGS</td><td>PROJECTED DATE:
September 19, 2011
Clarification Issued June 25, 2014</td></tr>
<tr><td>SUNSET DATE:
None</td></tr>
<tr><td><u>DIRECTED TO:</u>
<u>District Administrators</u>
<u>State L&D Engineer</u>
<u>State Maintenance Engineer</u>
<u>State Materials Engineer</u>
<u>State Construction Engineer</u>
<u>Regional Operations Directors</u>
<u>Regional Traffic Engineers</u>
<u>Regional Operations Maintenance Managers</u>
<u>District Maintenance Engineers</u></td><td colspan="2"><u>SIGNATURE:</u></td></tr>
</table>

Changes are shaded

The Department is revising its policy on the use of Type B, Class VI pavement markings to increase flexibility and reduce constructability concerns. This memorandum outlines areas where Type B, Class VI markings shall be used and areas where they may be used subject to engineering judgment. This clarification is effective for projects to be issued for advertisement on or after December 1, 2014. Projects being assembled for bid should utilize the revised Policy effective immediately. Exception is permitted if quantities and estimates are already completed and bid advertised is scheduled prior to December 2014.

<u>Limited Access Highways</u>

The figure at the end of this memorandum provides guidance for when to use Type B, Class VI markings on limited access roadways. The guidance in that diagram is summarized as follows:

- If the remaining pavement surface service life is 6 years or more:
  - Type B, Class VI markings shall be used for all lane division line, edge line, and gore line markings, including:
    - Skip lines between through lanes
    - Dotted lines to separate through lanes from deceleration lanes

        - Solid lines separating through lanes from deceleration/acceleration lanes
        - Solid and skip lines used to separate multiple exit lanes
        - Left and right edge lines
        - Outside gore lines (excluding gore hatchings)
    - Durable markings specified as being Type B in the *VDOT Road and Bridge Specifications* shall be used for all other markings (~~edge lines,~~ gore ~~areas~~ hatchings and all ramp markings). Selection of the marking material will be based on engineering judgment. Examples of appropriate materials may include B-VI tape, thermoplastic, epoxy, or any other approved Type B material.
- If the remaining pavement surface service life is between 3 years and 5 years:
    - Durable markings specified as being Type B in the *VDOT Road and Bridge Specifications* shall be used for all markings. Selection of the marking material will be based on engineering judgment. Examples of appropriate materials may include tape, thermoplastic, epoxy, polyurea or any other approved Type B material. However, Type B, Class VI markings may not be a cost-effective choice when the pavement surface life is in this category.
- If the remaining pavement surface service life is less than 3 years:
    - Any marking material specified as Type A or Type B in the *VDOT Road and Bridge Specifications*, may be used for all markings. Selection of the marking material is based on engineering judgment.

<u>Other High Volume Highways</u>

The installation of Type B, Class VI pavement markings on high volume roadways other than limited access highways may be appropriate and is allowed at the discretion of the Regional Traffic Engineer, but shall be accomplished in accordance with the limitations outlined for Limited Access Highways.

<u>Installation of Type B, Class VI markings</u>

Regardless of the pavement type (asphalt concrete or hydraulic cement concrete), installation shall be as provided by the latest *VDOT Road and Bridge Specifications* and any relevant revisions.

Proper records (Form C-85) needed for replacement of Type B, Class VI markings shall be maintained by the Regional Operations Maintenance Manager's office. This requirement is based on life cycle cost analysis and the current warranty period.

If there is insufficient contrast between hydraulic cement concrete pavements and white pavement markings, the use of Type B, Class VI contrast pavement markings consisting of white pavement markings with black non-reflective borders should be considered for lane lines edge lines, and gore lines.

When choosing among different marking material alternatives, the life cycle cost and compatibility between different marking materials for restriping should be considered. Table 1 summarizes typical service life values for different marking materials. Table 2 summarizes the compatibility between different marking materials when restriping.

Table 1. Typical Service Life of Different Marking Materials.

Marking Material	Typical Service Life[1]
Latex Paint	1 Year
Epoxy	3 Years
Thermoplastic	3 Years
Patterned Preformed Tape	6 Years

1: From 2001 Virginia Transportation Research Council Report, "Determining the Effectiveness of Pavement Marking Materials" by Cottrell and Hanson.

Table 2. Pavement Marking Material Compatibility Matrix.

If Existing Material is:	**If Desired New Material is:**			
	Latex Paint	**Thermoplastic**	**Epoxy**	**B-6 Tape**
Latex Paint	Compatible	If existing is 90% removed	If existing is 90% removed	Not Compatible
Thermoplastic	Compatible	Compatible	If existing is 90% removed	Not Compatible
Epoxy	Compatible	Not Compatible	If existing is 90% removed	Not Compatible
B-6 Tape	Compatible	Not Compatible	Not Compatible	Not Compatible

Note: "Not Compatible" means that the desired new pavement marking material cannot be applied unless the existing material is eradicated in accordance with sections 512 and 704 of the VDOT *Road and Bridge Specifications*. "Compatible" implies that the existing pavement marking is still well-adhered to the pavement.

CC: Mr. Quintin Elliot, Chief Deputy Commissioner
Mr. Garrett Moore, P.E., Chief Engineer
Mr. Mohammad Mirshahi, P.E., Deputy Chief Engineer
Jose Gomez, Director of Research, VCTIR
Division Administrators
Ms. Irene Rico

Pavement Marking Decision Tree:
Limited Access Roads (Freeways and Expressways)

(START)
Estimated remaining pavement surface service life

≥ 6 years

All lane division, edge, and gore lines: B-VI tape shall be used.

~~**Edge lines**~~**, Gore** ~~**areas**~~ **hatchings and all ramp markings:**
Durable markings (Type B markings) shall be used. Use Engineering Judgment to choose between:

- B-VI tape
- Thermoplastic
- Epoxy

3 to 5 years

All Markings: Durable markings (Type B markings) shall be used for all markings. Use Engineering Judgment to choose between:

- B-VI tape
- Thermoplastic
- Epoxy
- Other approved Type B marking material

< 3 years

All Markings: Durable markings not required. B-VI tape shall not be used. Use Engineering Judgment to choose between:

- Thermoplastic
- Epoxy
- Paint
- Other approved Type A or B materials

Notes:

- Note that thermoplastic should not be used on hydraulic cement concrete, unless properly primed.
- When selecting a marking material, consider the anticipated service life of the material shown in Table 1.
- When re-striping, ensure that markings can be placed on top of existing marking material or eradicate existing material completely. Consult Table 2 for guidance on compatibility between marking materials.

January 4, 2017

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 2 (Revised) for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on December 21, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the technical concept appears to be a reasonable solution to address the goals of this contract; however, the language related to the scope of improvements the Design-Builder will construct is noncommittal.
    a. Much of the language is in reference to the adequacy of the existing shoulder pavement section to support traffic loads. For example, at the bottom of page 9 the PTC states, "If during the scope validation period of final design additional investigation indicates … inadequate pavement section in areas we have assumed to be adequate … Wellington/Jacobs and SHA would negotiate monetary or scope adjustments." Sentences like this prompt some questions and comments:
        i. As stated in the RFP at the bottom of page 42, "The verbiage used in each Proposal will be interpreted and evaluated by the Administration based on the level of commitment provided by the Proposer. **No consideration will be given to tentative or ambiguous commitments.**" For this PTC, the Design-Builder should commit to delivering those improvements it will deliver that directly advance the contract goals (e.g. Part Time Shoulder from X to Y). It does not need to commit to a certain length or area of full depth shoulder pavement reconstruction because the extent of full depth shoulder will be hashed out during the preconstruction phase and will be controlled by (1) the applicable design manual(s) and (2) the length of Part Time Shoulder (PTS) committed to by the Design-Builder. In other words, the PTS commitment will control how much full depth reconstruction is necessary, not the other way around. The Design-Builder should balance the limits of PTS with the amount of risk it is willing to accept.

If the Design-Builder is extremely risk averse, it may choose to assume all shoulders will need full depth reconstruction.

ii. Does the Design-Builder understand that it is entering into a contract with the Administration for Design and Preconstruction Services, and that the Scope Validation Period is only for the Design and Preconstruction Services? If so, what is there to negotiate since the Design and Preconstruction Services Fee submitted with the Design-Builder's proposal is an upset limit and should encompass all required design to deliver the project? If the Design-Builder proposes X miles of PTS and subsurface investigations during the preconstruction phase reveal the entire length requires full depth shoulder pavement reconstruction, the Design-Builder will be required to complete all the associated design (e.g. pavement design, stormwater management design, etc.). See responses 17 and 56 in the Questions and Responses document.

b. The PTC continues to propose risk sharing with the Administration (e.g. last paragraph of Geotechnical Potential Impacts on page 15).
   i. The Design-Builder should make a commitment for the PTS, which will control the extent of the design elements needed to implement the PTS.
   ii. The last bullet on page 10 is confusing. If the Design-Build Team is assuming that there is no lip available for wedge/level, the replacement of the barrier should be reflected in its proposal. The proposal provided by the Design-Builder must provide the improvements it will provide within the project budget. Any risk sharing pool will not be considered until after award during the Design and Preconstruction phase.

c. Sections G, Risk: The Design-Builder has not considered many risks, some of which have been assigned to the Administration in Section F. In doing so, it reduces confidence that the proposal could be delivered within the fixed budget. Per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed budget.

2. Page 3, 2nd bullet from the bottom: How does the Design-Builder intend to push a part time shoulder lane across the Middlebrook Road bridge, which has a 7' to 8' inside shoulder and no outside shoulder?
3. Page 4, second paragraph: How does "continuous surveillance" alleviate the need for turnouts?

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 1, 2016

PTC-02: PART-TIME SHOULDER

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 2 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract.
2. Please confirm if the design will conform to the recommendations and suggestions put forth in the FHWA guide *Use of Freeway Shoulders for Travel: A Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy (February 2016)*.
3. This PTC will require design exceptions. More detailed information related to impacts and costs of fully meeting AASHTO requirements, potential impacts to safety and operations for implementing the design exception, and mitigation, if any, which would be implemented as a result of the design exception(s) will be required for formal approval. The design exception(s) and a safety analysis must be approved prior to establishing a Construction Agreed Price (CAP).
4. Narrowing and/or shifting the HOV lane(s) will require an equivalency study, to be approved by FHWA, prior to establishing a CAP.
5. This PTC states that adjustments to shoulder cross slopes may be necessary on the part-time shoulder (PTS). Concrete traffic barriers have some flexibility to add overlays, but if previous overlays have used that flexibility, flattening the cross slopes for PTS may reduce the barriers heights to less than acceptable. Please elaborate on this topic. Should concrete traffic barrier heights be insufficient, what does the Design-Builder propose? Does the Design-Builder know if the flatter cross slopes will create an issue? If not, will this be a Design-Builder risk and how will the Design-Builder mitigate that risk?
6. Please discuss how the Design-Builder intends to implement PTS at mainline bridges over a roadway or stream valley below.

7. Page 2, Section A, Description: The 3rd paragraph states the PTS will have a 2-foot shoulder and a 1.5-foot minimum lateral offset. Does that mean there will be 3.5 feet from the edge of the PTS to an obstruction?
8. Page 2, iii: The placement of pavement markings on an interstate typically adhere to the attached Pavement Marking Material Selection Policy. Any deviation must be approved as noted in the policy.
9. Page 2, iv: Please clarify where the microsurfacing will be applied. Over the entire width of the PTS and mainline lanes that are being narrowed? Please note the use of microsurfacing will be subject to the condition of the existing surface course as specified in the MDSHA Pavement and Geotechnical Design Guide.
10. Page 2, v: This paragraph states the 3.0% difference in cross slope is slightly more than the FHWA guidelines. Please refer to comment 2 above.
11. Page 2, vi: Does the Design-Builder consider having the inlets in the travel way an acceptable design? If so, please discuss with respect to the Safety and Operability/Maintainability/Adaptability goals.
12. Page 2, Section A, Description: The proposal should address alterations to operational procedures that might be necessary. Changes to shoulder areas will influence traffic incident management in the following ways:
    - Providing a safe buffer zone for emergency responders. Managed lanes can facilitate lane use and advanced warning, but full shoulders provide a work area for emergency responders which, by vehicular regulation and driver behavior, motorist don't use. Managed lanes can help, but positive guidance and physical barriers (e.g. cones) will be the only protection in a normally traveled lane (i.e. hard shoulder).
    - Use as a staging area for vehicle recovery. In Maryland, by policy and regulation in support of the towing and recovery industry, public agencies only relocate damaged and disabled vehicles to the shoulder, to stage them for final removal by industry towers. Limited shoulder availability would likely require new policies and procedures to minimize the blockage time impact while preparing for private towers to arrive.
    - The CHART patrols, in Maryland, function as an extension of staff for the Maryland State Police, in the area of Traffic Incident Management. However, CHART patrols are not enforcement vehicles and do not have the authority of a "blue light" (police) or a "red light" (fire and rescue) emergency responders in traveling through traffic (even though they are equipped with lights and sirens). Consequently motorists may, or may not, yield right of way to CHART vehicles.

- Impacts of more complex incidents. Procedures and impacts need to be analyzed and addressed for more complex incidents that require more complex recovery procedures and other public safety impacts. Some of these complicating factors include: heavy/large vehicles, injuries, hazardous materials, fires, criminal activities, significant debris (e.g. a load of mulch) etc. Each of these scenarios requires different personnel and equipment on scene: fire trucks, ambulances, police vehicles, heavy equipment, etc. Shoulders provide the additional geometry to stage and maneuver these resources.

13. Page 2, Section A, Description: As mentioned in PTC 1, areas with reduced shoulders will incorporate Emergency Refuge pull-off areas to facilitate maintaining clear lanes. It is suggested to present more information on the intended design of these refuge areas, length, taper, width, number, location, etc. to determine the applicability for emergency and incident management.
14. Page 2, Section A, Description: Since this PTC directly involves re-assigning the lane assignment/utilization in the existing right-of-way, illustrations of the typical cross-sections at various stations along the centerline would be helpful in conveying the proposed geometric configuration and greatly improve communication of the Design-Builder's intent.
15. Page 5, Section A, Description: What risk the Design-Builder wishes to share with the Administration in the last bullet is unclear. Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. Please refer to response 17 in the Questions & Responses document.
16. Section F, Administration Risks: The sections with significantly reduced shoulder geometry will lose a location to stockpile snow during winter storm operations. The PTC should address mitigation strategies for this impact.
17. General comment related to risks. In the PTC, the Design-Builder in proposing to not consider many risks in its proposal which may come to fruition. In doing so, it reduces confidence that the proposal could be delivered within the fixed price. Please note that, per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed price.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION POLICY

PAVEMENT MARKINGS - NEW PAVEMENT

PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS AND BRIDGE DECKS

Roadway Designation	Line Striping Material
Interstates (R and U) Principal Arterial-Other (R and U) Freeway & Expressway-Other (U)	Lane Lines: Contrast Patterned Tape with SRPMs Center Lines: Patterned Tape w/ SRPMs Edge Lines: Patterned Tape
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R&U)	Lane Lines: Contrast Patterned Tape Center Lines: Patterned Tape Edge Line: Patterned Tape

ASPHALT PAVEMENTS

Roadway Designation	Line Striping Material
Interstates (R and U) Freeways and Expressways-Other (U)	Lane Lines: Inlaid Patterned Tape with SRPMs Center Lines: Inlaid Patterned Tape with SRPMs Edge Lines: Inlaid Patterned Tape
Principal Arterial-Other (R and U)	Lane Lines: Durable Pavement Markings with SRPMs Center Lines: Durable Pavement Markings with SRPMs Edge Lines: Durable Pavement Markings
Minor Arterial (R and U) Collectors-Major and Minor (R and U) Local (R and U)	Lane Lines: Durable Pavement Markings Center Lines: Durable Pavement Markings Edge Lines: Durable Pavement Markings

(R) = Rural and (U) = Urban

Notes:

1. **Durable Markings:** Currently defined as all pavement marking materials other than waterborne paint. Patterned tape, thermoplastic, and epoxy are three options currently available to provide material selection options to the Engineer.
2. Other new durable marking materials (i.e. polyurea, methylmethacrylate) and approaches/processes (i.e. grooving) options are available and can be used by coordinating with the Office of Materials Technology.
3. All material replacement should follow Maryland specifications for pavement marking and the manufacturer's product recommendations.
4. Eradication procedures should be followed in accordance to the Maryland Specification 565 and manufacturer recommendations.
5. **SRPM**: Currently defined as a Snowplowable raised pavement marking (SRPM) includes:
   a. Housing and lens recessed in groove
   b. Housing and lens in metal holders
   c. Housing and lens in plastic holders

Any deviations from this policy shall require documented justification and must be approved by the MDSHA Statewide Pavement Marking Committee prior to application of marking material.

EXISTING PAVEMENT MARKINGS - RE-STRIPING

PORTLAND CEMENT CONCRETE- (PCC) PAVEMENTS AND BRIDGE DECKS	
Existing Roadway Designation	**Line Striping Material**
All Roadway Types	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A - Contrast pattern tape for lane lines (patterned tape for edge lines) Option 1B - Epoxy **Option 2**: Restriping over existing line, use waterborne paint
ASPHALT PAVEMENTS	
Existing Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeway & Expressway-Other (U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1- 90-mil thermoplastic **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Principal Arterial-Other (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line, Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint

(R) = Rural and (U) = Urban

Note: (The notes on page one of this policy & guideline pertain to both existing & new pavements).

TEMPORARY PAVEMENT MARKINGS

ALL PAVEMENT TYPES	
Roadway Designation	**Line Striping Material**
All Roadway Types	**(Options are in prioritized sequence)** **Option 1** – Removable Preformed Wet Reflective Tape **Option 2** – Removable Preformed Tape **Option 3A** – Paint **Option 3B** – 40 Mil Thermoplastic **Option 3C** – Epoxy

Notes:

1. Paint may be used for up to 60 day's duration. If a longer duration is needed, use durable markings such as 40 Mil Thermoplastic or Epoxy or replace paint after 60 days.
2. If Option 1 is not used, temporary RPMs should be used to provide better wet night visibility. Temporary RPM's should be used to provide better delineation at critical work zone locations such as lateral shifts, curved alignments and ramp gore areas.
3. For letters, symbols, numbers, use Removable Preformed Tape.

PTC 3. Lane Reassignment

A) Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.

The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to implement Lane Reassignment along southbound I-495/I-270 Spur (I-270Y) merge to improve lane distribution for the traffic using this stretch of the Corridor from approximate Station 71+50 to 87+00.

Under existing conditions, both southbound I-270Y and westbound I-495 provide three travel lanes approaching the merge. South of the merge point southbound I-495 provides five travel lanes. While the existing condition requires that the lane drop at the merge occur along the left, from the southbound I-270Y lanes, recent traffic counts show that southbound I-270Y carries higher traffic volumes (5435 AM/4315 PM) than westbound I-495 (4480 AM/3635 PM) during both the AM and PM peak hours.

As I-270Y approaches the merge with I-495, signs and pavement markings advise that the High Occupancy Vehicles (HOV) lane traffic must merge into the adjacent two General Purpose (GP) lanes. The lane drop officially occurs at the point where the I-270Y lanes meet the lanes from westbound I-495, resulting in 5,435 vehicles in two GP lanes along southbound I-270Y (2,718 per lane) and 4,480 vehicles in three lanes along westbound I-495 (1,494 per lane) during the AM peak hour. The southbound I-270Y approach is capable of handling the AM peak hour traffic volume in three travel lanes, but is severely over capacity when the cross section is reduced to two travel lanes.

Reassigning a receiving lane at the merge between the SB I-270 Spur (I-270Y) and WB I-495 from the WB I-495 approach to the SB I-270 Spur (I-270Y) approach will result in increased capacity for SB I-270Y traffic and decreased capacity for WB I-495 traffic. At the merge point, during the AM peak hour of the base year, SB I-270Y contributes 5435 vehicles, for a distribution of 2718 vehicles per lane, and WB I-495 contributes 4480 vehicles, for a distribution of 1493 vehicles per lane. The lane reassignment at the merge will change the per-lane distributions to 1811 and 2240 vehicles per lane from SB I-270Y and WB I-495, respectively. Per-lane volumes along the approach from SB I-270 will decrease by 33 percent while per lane volumes along the approach from WB I-495 will increase by 50 percent. The per-lane volume along the WB I-495 approach with the merge lane reassignment in place will still be 18 percent less than along the SB I-270Y approach before the merge lane reassignment (2240 vehicles for I-270 versus 2717 vehicles for I-495 (after lane reassignment). Collectively, the lane reassignment at the merge point will reduce congestion the most for the most people. The traffic operations analyses show that during the AM peak hour in 2040, under the No Build condition, a total of 4610 vehicles (general purpose and HOV) are able to enter SB I-495 from the SB I-270Y approach. Alternatively, under the Build condition, 5678 vehicles can enter SB I-495 from the SB I-270Y approach, which is in increase in throughput of 1068 vehicles, or 23 percent.

In the existing conditions the I-495 approach consists of three – 12 foot lanes and 10-foot outside shoulder. The I-270Y approach consists of two – 12 foot lanes and a 10 foot inside shoulder. In order to implement the lane reassignment, Wellington/Jacobs is proposing a lane drop along the outside lane of I-495, and a lane shift to tie-in with the existing lane configuration approximately 1,600 feet south of MD 191 Overpass. Wellington/Jacobs anticipates utilizing following design measures in order to implements the lane reassignment:

i. The width of the inside shoulder along I-270Y will be reduced from 10 feet to 4 feet (minimum) in order to maintain three full lanes along I-270Y;

ii. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO.;

iii. In order to eliminate conflicts with the pavement markings (ghost stripes) Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings will be installed in accordance with the SHA's Pavement Marking Material Selection Policy.

   The areas where Wellington/Jacobs proposes revisions to the pavement markings, to accommodate the lane re-assignment, impacts will be treated with Micro Surfacing application prior to the placement of final pavement marking material.

   - For Micro Surfacing applications, this PTC proposes to use:
     - Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
     - VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways

iv. For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers removal process.

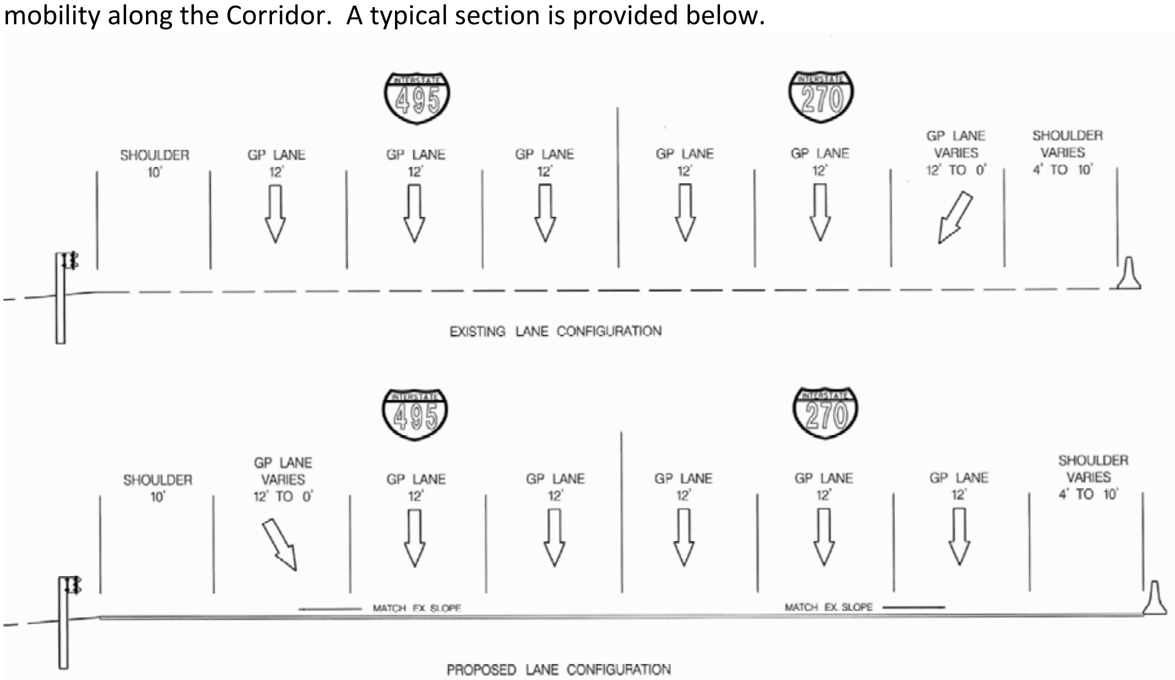
v. The Wellington/Jacobs Team expects one primary option of addressing the existing pavement conditions within the shoulders. It includes wedge and leveling (1 1/2" minimum) of the existing pavement.

   - As-built plans and design drawings provided by SHA covering this section of I-270 show the following pavement sections for the inside shoulders along I-270 which are adequate to convert to a full time running lane (12 inches of asphalt):
     - M-401-507-372 (I-270 West Spur I-495 from North of MD 190 to South of Democracy Boulevard) – 12.5 inches of hot mix asphalt (HMA) on top of 18 inches of graded aggregate base (GAB). Plans Dated 1994. Specifically, the plans show the shoulders and mainline were constructed to include 2 inches of surface course over 3 layers of 3 ½ inches HMA over 3 lifts of 6 inches of GAB.
   - There was no GPR data provided for this area.
   - There were no pavement borings available in this area.
   - Preliminary pavement section design calculations determined that a pavement section required to convert the outside shoulder to a full time travel lane should include at least 9.4" of HMA over 12" of GAB based on assumptions presented in Section D of this PTC..
   - Based on the As-built plans and design drawings provided by SHA it is expected to have approximately 12.5 inches of asphalt over thick graded aggregate base. Therefore, the existing pavement will be left in place, wedge and leveling will be performed to address existing cross slope variations and the new lane configuration will be run on the existing shoulder as needed through the transition. Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are significant stretches of shoulder (two consecutive borings) of asphalt less than 9.4

inches in thickness, these areas will be either reconstructed by one of the following two methods or lanes restriped to 11 foot in width to avoid using a portion of the existing shoulder as a travel lane:

- Reconstructed full depth
- Reconstructed using a hybrid pavement section that would:
    - Remove the existing asphalt
    - Remove a portion of existing GAB (leaving at least 12 inches in place)
    - Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 9.5 inches of asphalt pavement-built/design plan pavement section).

B) **Location: The locations where, and an explanation of how, the PTC will be used on the Project.**
The lane reassignment will be implemented along I-495/I-270Y merge and the lane transition will be completed within approximately 1,600 feet south of the MD 191 Overpass (stations 71+50 to 87+00). This is the only place along the Corridor where this solution will be used to address congestion and mobility along the Corridor. A typical section is provided below.



C) **Analysis justifying the use of the PTC including how it advances the project goals.**
Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270.

The traffic operations analysis models show that throughput in the vicinity of PTC 3 will increase by 18 percent during the AM peak hour under base year conditions, and by 25 percent in 2040. Additionally travel times during the AM peak hour, in the vicinity of PTC 3, will improve by 3.9 minutes in the base year and 2.6 minutes in 2040.

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – Utilization of the lane reassignment will decrease the travel time and increase the throughput as detailed above. Lane reassignment is intended to allocate higher number of lanes to the approach with the heavier traffic, unlike the existing configuration. Better lane allocation will improve traffic flow through the merge and decrease the backup from forming along the I-270 lanes as it does in existing configuration.
ii. **Safety** – Utilization of the lane reassignment will improve the flow of traffic along the I-270, reduce the back-up of cars along I-270, allow the traffic to flow at a more consistent speed all of which will result in reduction of congestion-related crashes.
iii. **Operability / adaptive/ maintainable** – The lane reassignment will increase the ease of operation by better allocating available travel lanes, while maintaining the same maintenance requirements.
iv. **Well managed project** – The development, implementation and implementation of these proposed improvements will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order the develop a facility that addresses project goals and fulfills SHA's expectations.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with this option. The proposed improvements will be performed within the existing footprint of pavement.
ii. **Geotechnical** - Based on the As-built plans provided by SHA, the pavement section of the existing inside shoulder is approximately 12.5 inches of hot mix asphalt on top of 18 inches of graded aggregate base.
    a. The preliminary pavement design calculations revealed the following required pavement sections for conversion of the outside shoulder to a travel lane:
        a. Total # vehicles (20 years): 478,788,750
        b. Percent of vehicles in left lane: 20%
        c. Design 18-kip ESAL's: 6.2 million
        d. AASHTO Structural No. (SN): 5.2
        e. Minimum HMA thickness: 9.4" on 12" of GAB
    b. The existing pavement will be left in place and the lane reassignment will be performed on the existing pavement. The improvements proposed for this location will include wedge and leveling and application of microsurfacing which will extend the life cycle of the existing pavement by approximately 4 to 10 years.
iii. **Utilities** – There are no anticipated utility impacts associated with this option. The improvements consist of the restriping existing lanes.
iv. **Environmental Permitting** - There are no anticipated environmental permitting impacts associated with this option. The improvements consist of the restriping existing lanes. There is no added capacity along this section which would result in noise evaluation and potential noise mitigation. It is anticipated that an IAPA will not be needed for this improvement, but Wellington/Jacobs will coordinate with SHA/FHWA to confirm this assumption.
v. **Local Community** – Due to a revised traffic pattern along the merge, the local communities will be notified of the change in the traffic pattern prior to the new traffic patterns being implemented.

vi. **Safety** – The lane reassignment will improve mobility and congestion along the I-495/I-270Y merge resulting in decreasing congestion-related crashes.

vii. **Life Cycle Project Infrastructure Cost –** The cost to repair, maintain and operate the facility after the lane reassignment is not anticipated to be different than maintenance and operating costs in the existing conditions.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

The improvements proposed as a part of this PTC include common approaches to making lane transition changes and no specific project is referenced.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. This PTC results in the inside shoulder being less than 8 feet in width over a 880 foot section of the approximate 1600 foot length of the PTC. This will result in the Design Storm Water Spread to encroach upon a general purpose lane to accommodate a total spread of 8 feet. This spread will equate to a variable amount of the lane (1 to 3 feet) during the storm event into the travel lane. Currently a 2-year storm in general requires approximately 7 feet of spread with shoulders at 2 to 4 percent cross slopes. We anticipate this happening infrequently potentially less than once each year. During this period the corridor would result in the same capacity for I-270 as currently exists but less capacity than is currently available for I-495 and less capacity than the improvements proposed for the short period of time of the storm event.

ii. Risks associated with snow removal or reduced shoulder width as refuge for disabled vehicles will be mitigated by the implementation of PTC 1 and existence of a full width shoulder on the outside of travel lanes. Through ATM deployment the shoulder use for refuge snow storage, water spread from storm events will be managed through active lane management. The HOV lane can actively be controlled and closed if unsafe conditions arise for the above reasons or other reasons such as maintenance operations. When implemented the road network would revert to the currently available lane configuration.

iii. Reassigning a lane from I-495 to I-270 may adversely impact I-495. Review of the Vissim models shows that, during the AM peak hour of both the base year and 2040, reassignment of the lane drop from the SB I-270Y approach to the WB I-495 approach does not have an adverse effect on operations along either approach to the merge as long as capacity is available downstream. However, because this improvement increases the number of vehicles that are able to reach SB I-495 south of the merge, a capacity constraint along SB I-495 at the I-495 / River Road interchange becomes congested due to the additional vehicles in the network, resulting in queues extending north along SB I-495 towards the I-495 / I-270Y merge point. Because the source of congestion is a ramp junction along the right side of SB I-495, and the WB I-495 approach is aligned along the right side of the roadway at the merge point, the WB I-495 lanes are more significantly affected by the downstream capacity constraint. This issue is not a result of the reassigned lanes at the I-495 / I-270Y merge; it is a result of a capacity constraint at a downstream interchange being exacerbated by the additional vehicles that this improvement allows into the system.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

i. Based on the available as-built and design plans referenced in section A, the Wellington/Jacobs team is assuming the outside shoulder which will be partially used for a full time general purpose lane has sufficient sectional thickness to perform satisfactorily a general-purpose lane. The as-built/design plans provided indicate the shoulders were constructed with the same pavement section as the mainline. There is no GPR data available for this area along the shoulder. The Wellington/Jacobs team will perform a roadway geotechnical exploration after award in compliance with the SHA Pavement and Geotechnical Design Guide.
   - The Wellington/Jacobs team has based our Scope of the converting the existing inside shoulder in the lane reassignment to a general-purpose lane being sufficient for use. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 9.4 inches in thickness, these areas will be reconstructed as indicated in Section A above or the area will be restriped using 11 foot lanes thus not requiring use of the shoulder for the general-purpose lane.

ii. If during grinding for removal of the pavement markings or grade control of the cross slope, the underlying pavement is found to be not stable, additional depths of grinding may be required.

iii. Wellington/Jacobs will be required to obtain a design exception for a significant length of reduced shoulder to accommodate the new permanent configuration. We propose to team with SHA to have the design exceptions prepared soon after award to reduce potential impacts to the project schedule. If the design exception is rejected by FHWA in part or in full, Wellington/Jacobs will work with SHA to identify alternative approaches to achieve an acceptable shoulder. Design exceptions identified for this PTC are as follows:
   - Shoulder width over approximately 800 feet of this 1,600 foot transition the ~~Shoulders~~ will vary between 4 and 10 feet the reasoning to be provided include:
     - Widening the interstate to accommodate a full width shoulder would be cost prohibitive.
   - Lane widths – the entire area where the transition is could revise of lane lanes from existing 12 foot lanes to 11-foot lane if the existing shoulder is found not to be sufficient in thickness. The risk associated with obtaining SHA/FHWA approval of the design exception prior to CAP agreement are low. The reasoning to be provided for the exception include
     - Implementation of 11 foot lanes along interstates throughout the country.
     - Widening the interstate to accommodate a full width shoulder would be cost prohibitive

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

The implementation of lane reassignments along southbound I-495/I-270 (I-270 Y) merge will improve lane distribution for traffic. This PTC will increase the throughput and reduce congestion related crashes. All construction will be done over the existing pavement footprint, maximizing space for the benefit of I-270 traffic flow.

The work for this 1,550’ section includes a microsurfacing along with pavement re-striping. This work can be completed in less than 2 months and significantly less than the alternative identified below.

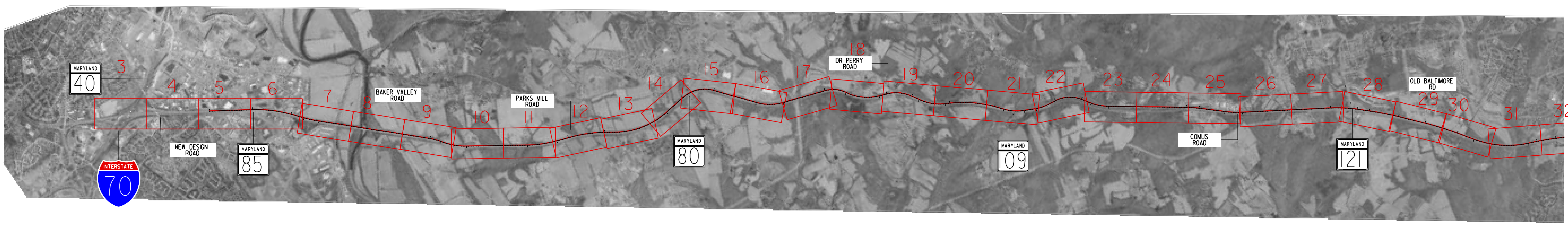
Alternatively, the estimated cost associated with the widening or reconstruction of the same roadway section to achieve similar congestion relief would approach $4 million. This estimate is for SHA categories 1, 2, 3, 5, 6 and 7. This work would take 1 year to complete, not including ROW and permitting.

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

None

Appendix 1

PTC Schematic Drawings



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

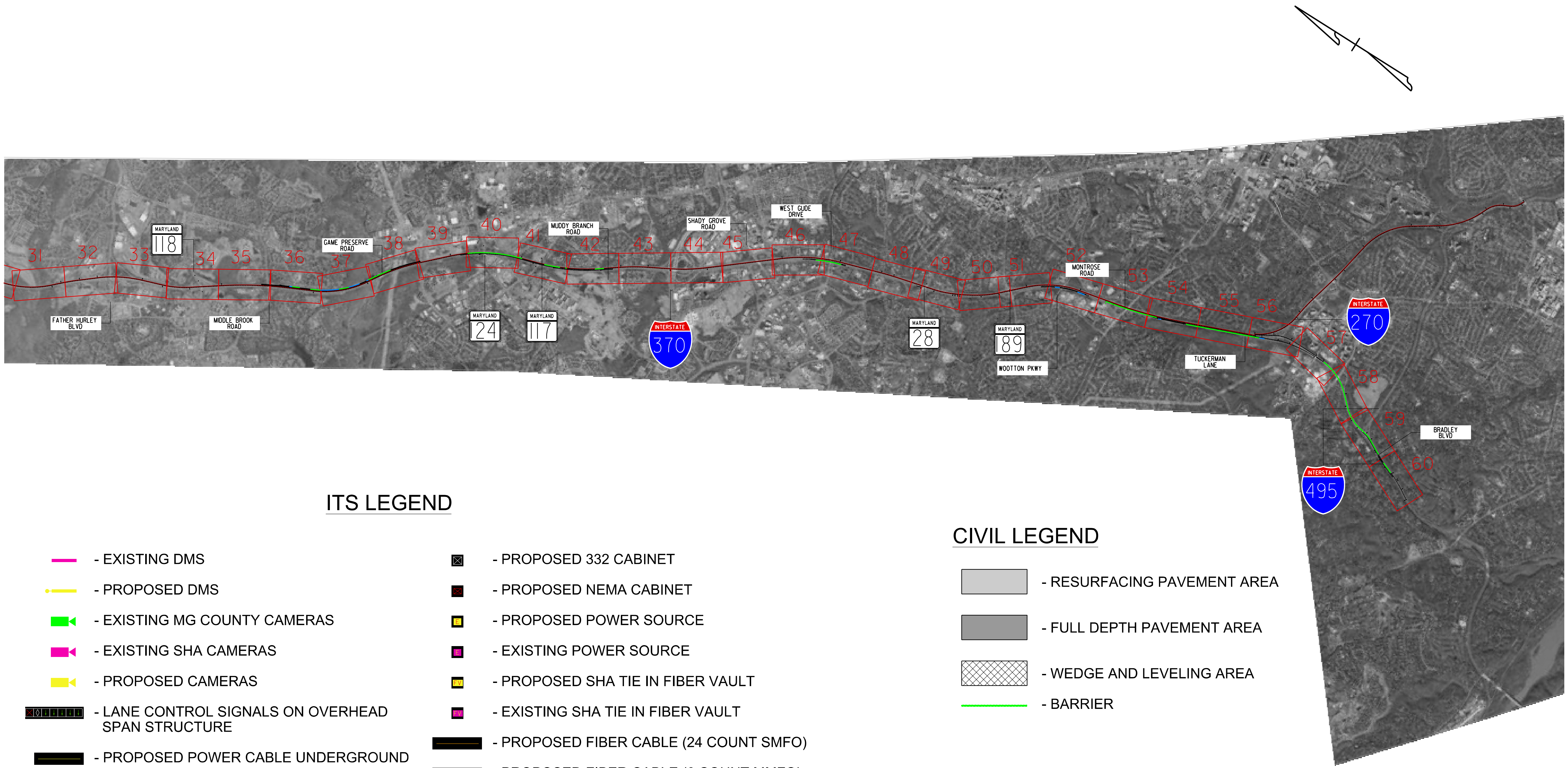
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO. OF 60

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SEE SHEET 58

SEE SHEET 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:57 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV | SHEET NO.
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200' | Page 362 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:01 AM

SEE SHEET 59

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO.
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	Page 364 OF 60

December 1, 2016

PTC-03: LANE REASSIGNMENT

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 3 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract.
2. Page 1, iii: The placement of pavement markings on an interstate typically adhere to the attached Pavement Marking Material Selection Policy. Any deviation must be approved as noted in the policy.
3. Page 2, iv:.Please clarify where the microsurfacing will be applied. Please note the use of microsurfacing will be subject to the condition of the existing surface course as specified in the MDSHA Pavement and Geotechnical Design Guide.
4. Page 2, v: What risk the Design-Builder wishes to share with the Administration in the last bullet is unclear. Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. Please refer to response 17 in the Questions & Responses document.
5. Pages 1 and 2, i thru v: The design shall conform to AASHTO (unless a design exception is approved), the MUTCD, the MDSHA Pavement and Geotechnical Design Guide, and all other applicable design standards and publications listed in the RFP.
6. Section F, Administration's Risk: Roman numerals i, iii, iv, and vi are risks to the Design-Builder and belong in Section G, Design-Builder Risk.
7. This PTC will require a design exception(s). More detailed information related to impacts and costs of fully meeting AASHTO requirements, potential impacts to safety and operations for implementing the design exception, and mitigation, if any, which would be implemented as a result of the design exception(s) will be required for formal approval. The design exception(s) and a safety analysis must be approved prior to establishing a Construction Agreed Price (CAP).

8. Please document any degradation of traffic operations on I-495.
9. In general, a typical section(s) and pavement marking plan with dimensions would improve communication of the Design-Builder's intent.
10. A National Environmental Policy (NEPA) document and an Interstate Access Point Approval (IAPA) approved by the Federal Highway Administration (FHWA) will be required prior to establishing a CAP. In preparation of the IAPA, the Design-Builder must meet the requirements of the FHWA Interstate System Access Informational Guide including demonstrating there are no safety or operational impacts to the interstate.
11. General comment related to risks. In the PTC, the Design-Builder in proposing to not consider many risks in its proposal which may come to fruition. In doing so, it reduces confidence that the proposal could be delivered within the fixed price. Please note that, per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed price.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION POLICY

PAVEMENT MARKINGS - NEW PAVEMENT

PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS AND BRIDGE DECKS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Principal Arterial-Other (R and U) Freeway & Expressway-Other (U)	Lane Lines: Contrast Patterned Tape with SRPMs Center Lines: Patterned Tape w/ SRPMs Edge Lines: Patterned Tape
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R&U)	Lane Lines: Contrast Patterned Tape Center Lines: Patterned Tape Edge Line: Patterned Tape
ASPHALT PAVEMENTS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeways and Expressways-Other (U)	Lane Lines: Inlaid Patterned Tape with SRPMs Center Lines: Inlaid Patterned Tape with SRPMs Edge Lines: Inlaid Patterned Tape
Principal Arterial-Other (R and U)	Lane Lines: Durable Pavement Markings with SRPMs Center Lines: Durable Pavement Markings with SRPMs Edge Lines: Durable Pavement Markings
Minor Arterial (R and U) Collectors-Major and Minor (R and U) Local (R and U)	Lane Lines: Durable Pavement Markings Center Lines: Durable Pavement Markings Edge Lines: Durable Pavement Markings

(R) = Rural and (U) = Urban

Notes:

1. **Durable Markings:** Currently defined as all pavement marking materials other than waterborne paint. Patterned tape, thermoplastic, and epoxy are three options currently available to provide material selection options to the Engineer.
2. Other new durable marking materials (i.e. polyurea, methylmethacrylate) and approaches/processes (i.e. grooving) options are available and can be used by coordinating with the Office of Materials Technology.
3. All material replacement should follow Maryland specifications for pavement marking and the manufacturer's product recommendations.
4. Eradication procedures should be followed in accordance to the Maryland Specification 565 and manufacturer recommendations.
5. **SRPM**: Currently defined as a Snowplowable raised pavement marking (SRPM) includes:
   a. Housing and lens recessed in groove
   b. Housing and lens in metal holders
   c. Housing and lens in plastic holders

Any deviations from this policy shall require documented justification and must be approved by the MDSHA Statewide Pavement Marking Committee prior to application of marking material.

EXISTING PAVEMENT MARKINGS - RE-STRIPING

PORTLAND CEMENT CONCRETE- (PCC) PAVEMENTS AND BRIDGE DECKS	
Existing Roadway Designation	**Line Striping Material**
All Roadway Types	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A - Contrast pattern tape for lane lines (patterned tape for edge lines) Option 1B - Epoxy **Option 2**: Restriping over existing line, use waterborne paint
ASPHALT PAVEMENTS	
Existing Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeway & Expressway-Other (U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1- 90-mil thermoplastic **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Principal Arterial-Other (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line, Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint

(R) = Rural and (U) = Urban

Note: (The notes on page one of this policy & guideline pertain to both existing & new pavements).

TEMPORARY PAVEMENT MARKINGS

ALL PAVEMENT TYPES	
Roadway Designation	**Line Striping Material**
All Roadway Types	**(Options are in prioritized sequence)** **Option 1** – Removable Preformed Wet Reflective Tape **Option 2** – Removable Preformed Tape **Option 3A** – Paint **Option 3B** – 40 Mil Thermoplastic **Option 3C** – Epoxy

Notes:

1. Paint may be used for up to 60 day's duration. If a longer duration is needed, use durable markings such as 40 Mil Thermoplastic or Epoxy or replace paint after 60 days.
2. If Option 1 is not used, temporary RPMs should be used to provide better wet night visibility. Temporary RPM's should be used to provide better delineation at critical work zone locations such as lateral shifts, curved alignments and ramp gore areas.
3. For letters, symbols, numbers, use Removable Preformed Tape.

PTC 4. CD and Auxiliary Lane Modifications

A) Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.

The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to improve traffic operations along the southbound I-270 CD lanes by adjusting lane balances and connectivity. The improvements are intended to address localized congestion along the CD lanes resulting from numerous merges and diverges by converting a 2-lane segment with a merge / acceleration lane at one end and a diverge / deceleration lane at the other end into a 3-lane segment with a lane add at one end and a lane drop at the other end, effectively increasing the capacity between the two junction points, and improving maneuverability for vehicles along these sections of the CD lanes. Two locations have been identified where traffic operation along the CD lanes would benefit from implementation of a continuous 3-lane sections between ramp junctions. Those locations include southbound CD lanes between Shady Grove Road and MD 28 – from the slip from I-270 mainline lanes located approximately 1,400 feet north of Gude Drive Overpass to the slip to I-270 mainline lanes, located approximately 800 feet south of Gude Drive Overpass (Stations 348+00 to 374+00), and southbound CD lanes, from the MD 189 on-ramp located approximately 1,200 feet north of Wootton Parkway Overpass to the slip to the I-270 mainline lanes, located approximately 1,600 feet south of Wootton Parkway Overpass, (approximate Stations 201+00 to 230+00). The two locations are described in Section B, below.

In the existing condition the CD lanes are separated from the I-270 mainline lanes by a concrete median barrier. The lateral separation between the concrete median barrier and the inside CD lane is approximately 4 feet or less. The CD lanes are 12 feet wide, and the outside shoulder along the CD lanes is approximately 12 to 14 feet wide. One of the two locations where this solution is proposed, there is concrete barrier located at the edge of the outside shoulder. To avoid extensive widening and/or construction of retaining walls, Wellington/Jacobs proposes to utilize available pavement width, restripe the lanes at 11 feet, and narrow the width of the existing outside shoulders in order to provide a continuous 3 lane section along the CD lanes. The outside shoulder will be reduced to 1.5 foot in the narrowest point.

Wellington/Jacobs anticipates utilizing following design measures in order to implements this PTC:

i. The width of the shoulder will be reduced from 12 to 14 feet to 1.5 feet minimum in order to develop adequate space for a continuous 3 lane section along the CD lanes. The reduction in the width of the shoulder during for the extra lane will require a design exception which will be developed and submitted to SHA for their review and approval prior to establishing a Construction Agreed Price (CAP). The primary reason for not providing AASHTO compliant shoulder width is the lack of available space to provide the extra lane without significant widening on the outside of the CD lanes. Although the shoulder will be reduced, the improvements proposed under PTC 1 will provide SHA with the ability for continuous coverage and management of all lanes, which would allow the new lane to be closed and reopened as needed to address broken-down vehicles, traffic incidents, unexpected congestion or snow removal operations.

ii. The width of the CD lanes will be reduced from 12 feet to 11 minimum feet to develop adequate space for continuous 3 lane section along the CD lanes. Reducing the lane width from 12 foot to 11 foot has a minor effect on free flow speeds (approximately 1.9 miles per hour). When determining capacity of a lane the free flow speed is rounded to the nearest 5 miles per hour which would result in no reduced capacity for an 11foot lane. Reducing the shoulder width from

10 foot to a 1.5-foot minimum does not have an effect on free flow speeds for left shoulders. For right shoulders, widths greater than 6 feet have no effect on free flow speeds, however a 1.5-foot shoulder would have an effect of 1.8 mph on the free flow speed, which is offset by the extra lane and the fact that the 1.5-foot width is sporadic at pinchpoints only. Currently the free flow speed of 65 miles per hour the I-270 corridor has a lane capacity of 2350 vehicles per hour. With the reduction in lane width and right shoulder width the free flow speed will decrease to 60 mph and the lane capacity will decrease to 2300 vehicles per hour. The additional capacity provided by the continuous auxiliary lane will more than make up for the minor decrease in per-lane capacity.

iii. In order to eliminate conflicts with the pavement markings Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations.–The final surface pavement markings will be installed in accordance with the SHA's Pavement Marking Material Selection Policy. below.

    The areas where Wellington/Jacobs proposes revisions to the pavement markings, to accommodate the added lanes, impacts will be treated with Micro Surfacing application prior to the placement of final pavement marking material.

    - For Micro Surfacing applications, this PTC proposes to use:
        - Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
        - VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways

iv. For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers removal process.

v. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO.

vi. The existing drainage inlets, currently located adjacent to the concrete barrier will remain in place and will be adjusted to accommodate any proposed pavement or barrier reconstruction. The development of the added lane configurations took into consideration location of the inlets and operational, safety and maintenance concerns associated with the inlets in the footprint of the added lane. Under the proposed configuration all of the inlets will be located in the shoulder between the added lane and the concrete barrier.

    - **Section 1** – Southbound CD lanes between Shady Grove Road and MD 28 – from the slip from I-270 mainline lanes located approximately 1,400 feet north of Gude Drive Overpass to the slip to I-270 mainline lanes, located approximately 800 feet south of Gude Drive Overpass (Stations 348+00 to 374+00)
        - As-built plans and design drawings provided by SHA covering this section of I-270 show the following pavement sections for the outside shoulders along southbound I-270 CD lanes, which appear to be not adequate to convert to a full time running lane
            - M 404-503-372 (I-270 South of Shady Grove Road to South of MD 28) – 5 ¾ inches of HMA on top of 15 inches of GAB. Plans dated 1987.

- GPR information for the outside shoulder of I-270 southbound CD lanes within Section 1 show the thickness of hot mix asphalt ranging from 3.1 inches to 10.6 inches with the average thickness of all readings of 4.9 inches.

- Preliminary pavement design data using assumptions outlined in Section D of this PTC, revealed a required pavement section of 11.1 inches in this area based on traffic data provided.

  Review of available GPR data reveals the entire length of the existing shoulder within Section 1 has less than 11 inches of asphalt. The following lengths correspond to GPR data that reveals a thickness of less than 11 inches.

Location by Stationing	Length	GPR Comment
348+00 to 374+00	2,600	GPR shows consistent less than 11 inches,

  The areas where the footprint of the proposed 3rd lane enters the footprint of the existing shoulder between stations 349+00 to 369+00 will be reconstructed as defined below.

- Based on the As-built plans, design drawings and GPR information provided by SHA, it is expected to have on the order of 5 to more than 10 ~~6~~ inches of asphalt over graded base. Based on this data and preliminary pavement design we propose to reconstruct the existing outside shoulder to provide a 3rd lane along the CD lanes. If there are areas of sufficient graded aggregate base (GAB) of more than 12 inches we propose to reconstruct full depth as shown on the typical sections below.

  If after award the geotechnical investigations reveal satisfactory conditions, GAB sections exceeding 12 inches, a hybrid pavement section could be used and cost savings shared with SHA and used to fund a Risk Share Pool. A hybrid section is defined below:
  - Reconstructed using a hybrid pavement section that would:
    - Remove the existing asphalt
    - Remove portion of the existing GAB (leaving at least 12 inches in place)
    - Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 11.5 inches of asphalt pavement, slightly higher than the preliminary design pavement thickness.

  Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. If pavement borings reveal adequate pavement thickness of greater than 11 inches we will be able to share that price savings with SHA through the OPCC and CAP process.

- In Section 1 it is proposed to reconstruct/retrofit 1,500 linear feet of the barrier along the outside median.

- **Section 2** – Southbound CD lanes, from the MD 189 on-ramp located approximately 1,200 feet north of Wootton Parkway Overpass to the slip to the I-270 mainline lanes, located approximately 1,600 feet south of Wootton Parkway Overpass, (approximate Stations 200+75 to 230+00).
  - As-built plans and design drawings provided by SHA covering this section of I-270 show the following pavement sections for the outside shoulders along southbound I-270 CD lanes, which appear to be not adequate to convert to a full time running lane:
    - M 278-501-372 (I-270 from South of MD 28 to North of Montrose Road and MD 189 Interchange and Reconstruction of MD 189 from West of Ritchie Parkway to East of Maryland Avenue) – 5 ¾ inches of HMA on top of 15 inches of GAB. Plans dated 1986.
  - GPR information for the outside shoulder of I-270 southbound CD lanes within Section 2 show the thickness of hot mix asphalt ranging from 4.7 inches to 7.7 inches with the average thickness of all readings of 5.7 inches on the outside shoulder.

  - Preliminary pavement design data using assumptions outlined in Section D of this PTC, revealed a required pavement section of 11.7 inches in this area based on traffic data provided.

    Review of available GPR data reveals that 2,625 linear feet of the existing shoulder out of 2925 linear feet for the entire section appears to have less than 12 inches of HMA.

Location by Stationing	Length	GPR Comment
201+00 to 227+00	2,600	GPR shows consistent less than 12 inches,

  - Based on the As-built plans, design drawings and GPR information provided by SHA, it is expected to have on the order of less than 5 to 8 inches of asphalt over graded base on the outside shoulder where we are converting a portion of the shoulder to permanent CD lane. Based on this data and our preliminary pavement design we propose to reconstruct the existing outside shoulder where the footprint of the proposed 3rd lane enters the footprint of the existing shoulder between stations 202+00 to 225+25 using full depth paving section.

  - Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. If there are areas of sufficient graded aggregate base (GAB) of more than 12 inches we propose to either reconstruct full depth as shown on the typical sections below.

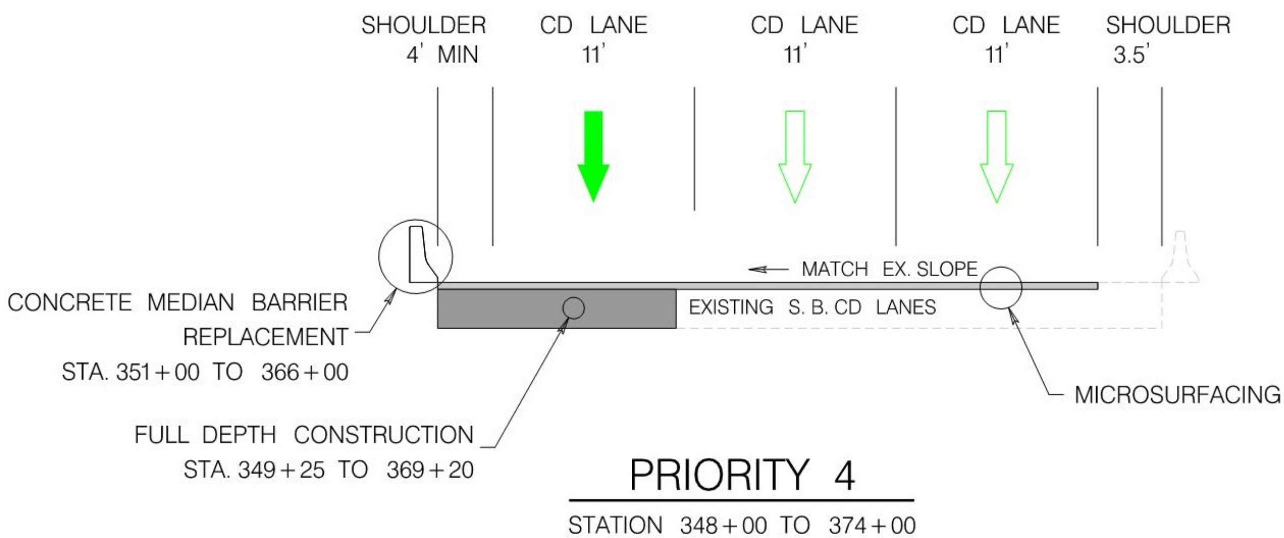
    If after award the geotechnical investigations reveal satisfactory conditions, GAB sections exceeding 12 inches, a hybrid pavement section could be used and cost savings shared with SHA and used to fund a Risk Share Pool. A hybrid section is defined below: : .

- Reconstructed using a hybrid pavement section that would:
  - Remove the existing asphalt
  - Remove portion of the existing GAB (leaving at least 12 inches in place)
  - Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 12 inches of asphalt pavement, slightly higher than the preliminary design pavement thickness.

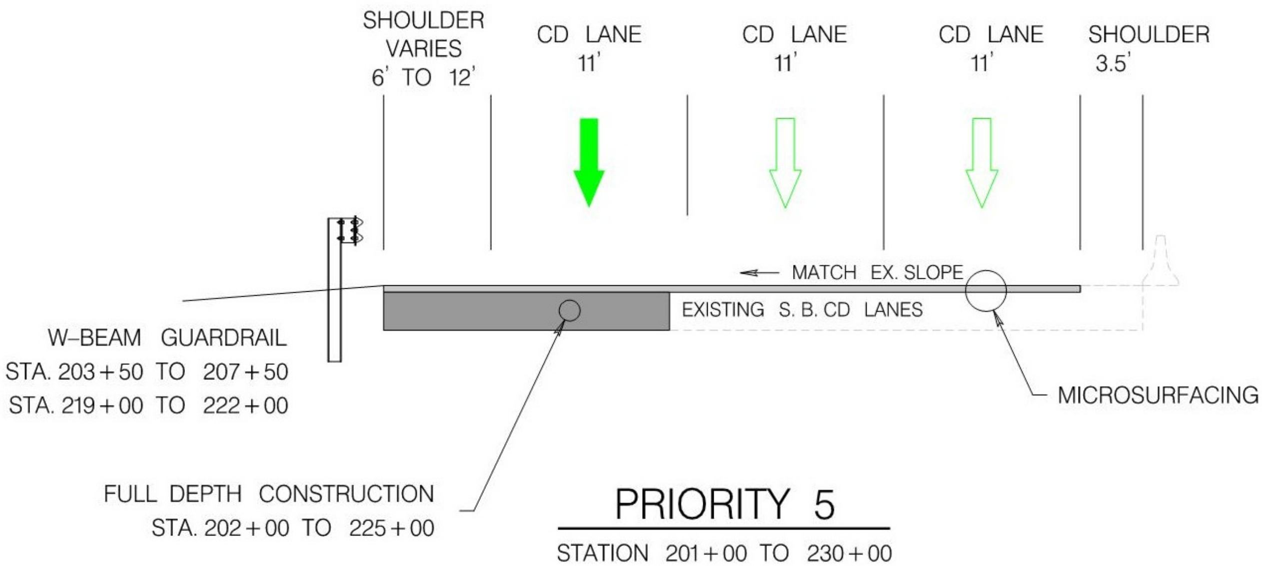
Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. If pavement borings reveal adequate pavement thickness of greater than 11 inches we would work with SHA in the price savings through the OPCCC and CAP process/..

B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.
There are two locations where the modifications to the CD/Auxiliary lanes are proposed to improve the mobility and predictability of the Corridor and to address local congestion and weaving concerns. The proposed improvements at those two locations were prioritized by the overall traffic and throughput benefit they bring to the Corridor. The proposed locations include:

Section 1 – Southbound CD lanes between Shady Grove Road and MD 28 – from the slip from I-270 mainline lanes located approximately 1,400 feet north of Gude Drive Overpass to the slip to I-270 mainline lanes, located approximately 800 feet south of Gude Drive Overpass. This section has a total length of approximately 2,600 feet, (Stations 348+00 to 374+00). A typical section is depicted below.



Section 2 – Southbound CD lanes, from the MD 189 on-ramp located approximately 1,200 feet north of Wootton Parkway Overpass to the slip to the I-270 mainline lanes, located approximately 1,600 feet south of Wootton Parkway Overpass. This section has a total length of approximately 2,900 feet, (approximate Stations 201+00 to 230+00). A typical section is depicted below.



C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270.

Review of existing traffic patterns during the AM peak hour reveals that traffic volumes increase as the corridor moves south, and that, although the corridor widens approaching the southern limits, the traffic volumes flowing into the corridor are higher than the roadway is able to handle. The Wellington/Jacobs team is presenting PTCs individually for review based on like conditions. Although all PTCs provide benefit the largest benefit to SHA will come from implementing all proposed PTCs. Alleviation of over-capacity condition is best mitigated through implementation of both PTC 2 and PTC 3. Once the primary congestion along the Corridor is relieved, other, more local bottlenecks appear, which are addressed in other PTCs.

The traffic operations analyses show that implementation of the improvements listed in PTC 4 are expected to have a significant effect on throughput along the corridor, along with travel time improvements. With these improvements in place, in 2040, during the AM peak hour, throughput along the SB I-270 CD is expected to improve by 33 percent, and travel time along the SB I-270 CD is expected to improve from 33.4 minutes to 8.6 minutes (a 74 percent improvement).

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – Implementation of proposed improvements along the CD lanes will improve localized congestion, improve traffic flow along the CD lanes and I-270 mainline lanes and improve the throughput along the Corridor as detailed above.

ii. **Safety** – Removal of localized congestion and improved weaving along the CD lane will reduce congestion related incidents along the CD lanes and I-270 mainline lanes.

iii. **Operability / adaptive/ maintainable** – The continuous three lane sections along the CD lane will improve traffic operations and enable efficient flow of traffic along I-270. Since the proposed improvements will utilize portions of existing shoulder as a travel lane, the maintenance requirements may increase, however based on the fact that we are proposing to reconstruct the length of the shoulder to be used and that SHA typically provides maintenance of shoulders during maintenance of general purpose lanes additional requirements should be minimal If this approach to maintenance continues little affect to maintenance will be realized.

iv. **Well managed project** – The development and implementation of these proposed improvements will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order the develop a facility that addresses project goals and fulfills SHA's expectations.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with these options. The proposed improvements will be performed within the existing footprint of pavement or with minor widening along southbound CD lanes near Wootton Parkway (Section 2).

ii. **Geotechnical** - We have reviewed available construction plans for past improvements along the I-270 Corridor and on the GPR investigation performed along the shoulders of I-270 in 2015 to determine the existing pavement sections of the outside shoulders along the CD lanes. As indicated in section A above, the data revealed:

- As-built plans and design drawings provided by SHA show the proposed pavement section for the outside shoulders along the CD lanes as 5 ¾ inches of HMA on top of 15 inches of GAB. The existing outside lanes adjacent to the shoulders have 11 ¾ inch HMA on 9 inches of GAB. While the overall depth of the section is the same between outside lane and the outside shoulder, the outside shoulders have thinner HMA section and a thicker GAB section.
- Ground penetrating radar – GPR runs show the asphalt thicknesses ranging between 2.9 inches and 13.4 inches with averages of all readings above 3.6 inches.

Based on the as-built and GPR data and the preliminary pavement design Wellington/Jacobs is proposing reconstruct the areas where GPR data reveled sections of less than 11.1 inches of HMA for Section 1 and less than 11.7 inches of HMA for Section 2.

In areas where the geotechnical investigation reveals inadequate asphalt as listed above for shoulder use, but there is a thick layer of graded aggregate base (GAB), (e.g. more than 12 inches), we could use a hybrid pavement section in lieu of full depth reconstruction, as a cost savings through the OPCC and CAP process. The hybrid section will allow for the existing asphalt and a portion of the GAB to be removed and replaced with asphalt. The resulting asphalt/GAB section would be at least the HMA thickness listed above and 12 inches of base after reconstruction. The approach to a hybrid section will be as follows:

- Remove the existing asphalt
- Remove a portion of the existing GAB (leaving at least 12 inches in place)
- Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum depth of asphalt pavement as listed above.

The preliminary pavement design calculations reveled following required pavement sections for 3rd running lane within Section 1 and section 2:

i. Section 1:
   1. Total # vehicles (20 years): 307,000,000
   2. Percent of vehicles in design lane: 60%
   3. Design 18-kip ESAL's: 11.8 million
   4. AASHTO Structural No. (SN): 5.9
   5. Minimum HMA thickness: 11.1" on 12" of GAB

ii. Section 1
   1. Total # vehicles (20 years): 385,000,000
   2. Percent of vehicles in design lane: 60%
   3. Design 18-kip ESAL's: 14.8 million
   4. AASHTO Structural No. (SN): 6.1
   5. Minimum HMA thickness: 11.7" on 12" of GAB

iii. **Utilities** – There are no anticipated utility impacts associated with these options. The improvements consist of the restriping existing lanes and shoulders. If the shoulders are to be reconstructed, there are SHA electric lines and telephone/fiber optic lines located in the footprint of the existing shoulder that will be test pitted to determine if relocation is required.

Environmental Permitting - There are no anticipated impacts to environmental resources which would require environmental permits. It is anticipated that an IAPA will not be needed for these improvements, but Wellington/Jacobs will coordinate with SHA/FHWA to confirm these assumptions. Since the improvements call for striping existing outside shoulders as additional lanes. Proposed improvements are within the limits of the PTC 5 Mainline Modifications, and would not require any additional noise walls that have not been identified as a part of that PTC.

iv. **Local Community** – Due to a revised lane configuration along the CD lanes, the local communities will be notified of the change in the traffic pattern prior to the implementation of the improvements.

v. **Safety** – The implementation of 3-lane continuous section along the CD lanes, will improve mobility and congestion along the CD lanes and the I-270 mainline lanes resulting in potential decrease of congestion-related crashes. AASHTO anecdotal data indicates that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet. In general, the greater the average daily traffic, and presumably the greater level of congestion during the "before" conditions, the more likely that the safety benefits from reduced congestion (resulting from an additional lane) will outweigh the potential safety issues associated with narrower lanes and shoulders.

vi. **Life Cycle Project Infrastructure Cost –** Resurfacing and/or reconstruction of the outside shoulders in order to provide the 3rd CD lane will result in an up-front investment, but it will prolong the life of the pavement and will postpone SHA's required resurfacing/reconstruction activities. For areas where the new CD lane will be placed directly on the existing shoulder with no upgrade there is no change in life cycle costs, because shoulders are maintained at the same frequency as general purpose lanes under SHA preservation projects.

vii. **Maintenance and Operation**- This proposed PTC centers on reducing the existing shoulder permanently to provide a means for extra lanes. The shoulder will have minimum widths as shown in the typical sections shown in Section B above. While the reduction in the width of the shoulders seem to remove some of the safety, operational and maintenance benefits of the wider shoulders in use today, the improvements proposed under this PTC combined with the ATM improvements proposed under PTC 1 will alleviate issues associated with reduction of the shoulder width. Because of the adaptability and dynamic management capabilities of the ATM solutions, the added lanes should not be looked at as a reduction of shoulder but also as an extra lane that can be managed to most efficiently, safely, and effectively move the traffic through the Corridor.

a. There are approximately 5500 feet of corridor for which this PTC is applicable to (Sections 1 and 2 identified in Section B above). In each of these areas shoulders will be reduced in width as shown on the typical section presented in section B above. Although these shoulder widths generally do not provide a safe refuge area for disabled vehicles, if a vehicle becomes disabled in adjacent lanes the detection system will identify the stopped vehicle and send an alert to the personnel assigned to the I 270 systems. This SHA Highway Operations Technician (HOT) can then verify the issue, close the lane in advance of the lane blockage utilizing the overhead signs, alert the CHART and MSP patrols to initiate a response, and since the event has now been verified start a private tow service to the location, depending on final procedures agreed to with SHA. At this time the incident has both the existing lane and shoulder as incident response area. This process starts to add a layer of protection to the vehicle stopped in the lane prior to responders arriving on the scene and greatly expedites the detection, verification, response and clearance timelines thereby lessening the exposure time and associated danger to the disabled or incapacitated vehicle in the lane as well as approaching motorists and responding agencies. At this stage it is a virtual closure and there are no physical barriers or traffic control in place but by decreasing the detection and verification times the response times are also decreased allowing the CHART vehicles to get to the scene sooner to set up the proper traffic control and creating a safe temporary traffic control zone utilizing the roof mounted arrow boards as well as establishing a proper cone taper to protect the motorists and responders on the scene as well as warning approaching motorists of what is expected of them.
b. CHART personnel will be able to continue CHART Standard Operating Procedures (2014 version) section 2 article 7 which allows for "Disabled vehicles located in hazardous areas (travel lanes, gore areas, etc.) to be pushed, pulled, or towed to the nearest safe location before performing any type of troubleshooting on the vehicle" and "If the disabled vehicle cannot be relocated unassisted, the CHART field personnel on the scene can contact the SOC/TOC and request assistance from another CHART unit, law enforcement and/or a towing & recovery service, in order to safely remove the vehicle to a safe location. A safe location can be considered as off the freeway. The goal is to get the travel lanes back open as soon as possible by relocating the vehicle to the nearest available safe location. This practice also

creates another level of safety for the private towing companies as they are retrieving the vehicle from a safer location lessening the risk of them being struck.

c. The CHART patrols are registered “Emergency Vehicles” and are equipped with red lights both front and rear facing with sirens. The CHART Standard Operating Procedures (2014 version) section 2 article 9 states “Due to the nature of emergency response required by SHA personnel, a group of vehicles have been designated Emergency Response Vehicles. This ability along with our ATM managed lane should provide better access to incident locations.

d. Maryland is one of the top performing states when it comes to dealing with major incidents as they have response plans and procedures in place to deal with these types of events. The backbone behind Maryland’s success is the MSP/SHA open roads agreement which originated in 1989 and has been recently updated (August 2015) states:

   > “Whenever the travel lanes of a roadway are closed or partially blocked by a crash, disabled or unattended vehicle and traffic delays or safety problems may occur as a result, the SHA representative in cooperation with the trooper in charge should attempt to reopen the roadway as soon as possible **<u>ON AN URGENT BASIS”</u>**

   Although not part of this PTC other initiatives such as towing incentive programs or policy changes or procedures could be modified to make Maryland’s responses to some of these incidents even better. The quick clearance of complex incidents is not really impacted by the reduced shoulder use as individual lanes can be closed to traffic at any time and utilized at the request of any of the response agencies. This would allow for the movement of specialty or heavy equipment to stage properly for recovery efforts as the same amount of roadway is available. Our proposed managed lane solution will enhance the ability for response to major incidents by allowing control of lanes for access of incident vehicles.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

Providing an additional CD lane, or auxiliary lane between two access points, is a common practice and no specific project is referenced.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. The Wellington/Jacobs team is proposing to install storm water management facilities where reconstruction is proposed as indicated in this PTC. If additional reconstruction is required based on final pavement investigations, Storm Water Management approval would be required for these additional areas reconstructed.

ii. A condition study of existing drainage assets was not provided with the RFP materials for the Wellington/Jacobs team to assess the risk of deteriorating drainage assets. After award the Wellington/Jacobs team will perform an inventory and study of cross drainages to determine if there are any assets recommended to replace or otherwise mitigate, prior to preceding with final construction.

- The Wellington/Jacobs team proposes to base our Scope for the conversion of the shoulder to general purpose /Auxiliary lane use on the existing drainage assets being adequate for continued use aside from vertical adjustments for wedge and level asphalt placement and width adjustments to several inlets to maintain inlets outside of the shoulder use area. Our proposed PTC is also to extend drainage facilities in kind with extended drainage facilities end sections meeting current SHA requirements.

iii. This PTC proposes to allow the Design Storm Water Spread to encroach upon the new general purpose/auxiliary CD use lane to accommodate a total spread of 8 feet. This spread will equate to slightly more than ½ the adjacent general purpose / auxiliary CD lane during the storm event. The Dynamic Variable Speed Control and Dynamic Lane Control would be integrated in this area to allow Variable Speed control of the lane or dynamic closure of the lane during an excessive storm event or other events as deemed appropriate by final operating procedures. Currently a 2-year storm in general requires approximately 7 feet of spread with shoulders at 2 to 4 percent cross slopes. We anticipate a storm event to exceed the available shoulder of 1.5 to 2 feet would be less than a 1 year storm, thus requiring control, if used, to be established a few times each year at most depending on how final design accounts for drainage patterns near the pinchpoints. During this control period, if used, the corridor would revert to the cross section of available general purpose lanes and auxiliary CD lane that is functioning today.

iv. Risks associated with snow removal or reduced shoulder width as refuge for disabled vehicles will be mitigated by the implementation of PTC 1. Through ATM deployment the shoulder use for refuge snow storage, water spread from storm events will be managed through active lane management. The added lane can actively be controlled and closed if unsafe conditions arise for the above reasons or other reasons such as maintenance operations. When implemented the road network would revert to the currently available lane configuration.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

i. Based on the available as-built and design drawings provided by SHA referenced in section A of this PTC, the Wellington/Jacobs team is assuming the shoulder which will be used for new general purpose/auxiliary CD lane generally does not have sectional thickness to perform satisfactorily. The available GPR data along this section is variable but generally shows a deficient section.

  - The Wellington/Jacobs team proposes to base our Scope of the general purpose/auxiliary CD lane use on the existing shoulder being sufficient for use in areas not indicated in the tables above, Section 1 and 2 are proposed to be reconstructed their full length. Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 11 inches of HMA for Section 1 and less than 12 inches of HMA for Section 2, these areas will be reconstructed or if it shows significant areas not requiring reconstruction , we will share the savings with SHA through the OPCC and CAP process.

ii. If during grinding for removal of the pavement markings or grade control of the cross slope, the underlying pavement is found to be not stable, additional depths of grinding may be required.
iii. During construction multiple lanes will be shifted to the inside lane to allow reconstruction/improvements on the outside of the roadway. As work progresses, additional time for MOT may be required for unexpected conditions.
iv. Wellington/Jacobs will be required to obtain a design exception for a significant length of reduced shoulder for the new general purpose/auxiliary CD lane use. We propose to team with SHA to have the design exceptions prepared soon after award to reduce potential impacts to the project schedule. If the design exception is rejected by FHWA in part or in full, Wellington/Jacobs will work with SHA to identify alternative approaches to achieve an acceptable shoulder. Design exceptions identified for this PTC are as follows:

   a. Shoulder width – a significant section of the CD will have a reduced shoulder. The risk associated with obtaining FHWA approval of the design exception prior to CAP agreement are minimal. The reasoning to be provided for the exception include:

      i. Widening the interstate to accommodate a full width shoulder would be cost prohibitive

   b. Lane widths – the entire length of Section 1 and Section 2 will require revisions of lane lines from existing 12 foot lanes to 11-foot lanes. The risk associated with obtaining SHA/FHWA approval of the design exception prior to CAP agreement are low. The reasoning to be provided for the exception include:

      i. Implementation of 11 foot lanes along interstates throughout the country.

      ii. Widening the interstate to accommodate a full width shoulder would be cost prohibitive

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

Traffic operations will improve along the southbound I-270 CD lanes by adjusting lane balances and connectivity. The improvement will be made by converting 2-lane CD segments into 3-lane CD segments. There are three locations where the modifications will be constructed. To avoid extensive widening and construction of retaining walls, all work will be done within the boundary of the existing pavement footprint. Minor widening is anticipated at Section 2. The work for this PTC includes mill and overlay along with pavement re-striping at all Sections. A noise analysis will be performed, based on existing noise reports noise wall upgrades are also anticipated.

Each one of the Sections can be completed in 4 to 8 months or less. As with the previous PTC's, work will be performed within the existing pavement footprint. Significant cost and schedule benefits are realized from PTC 4 including; no additional right-of-way required, no widening, minimal to no environmental impacts and no additional costs to Utilities or Third parties.

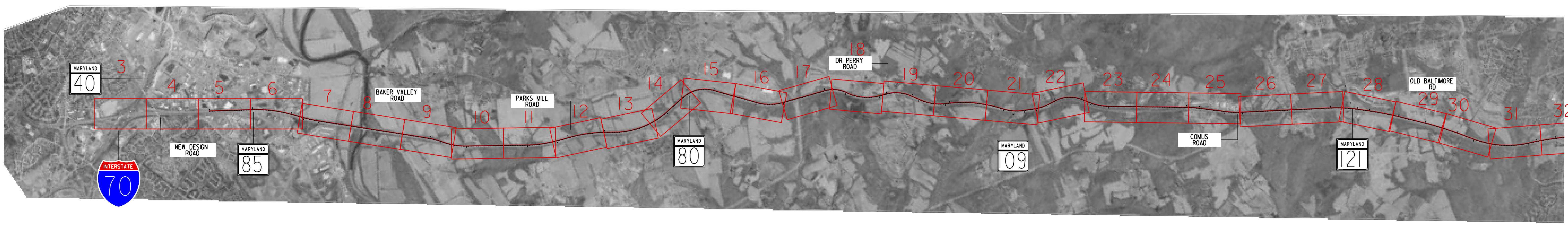
Alternatively, the estimated cost associated with the widening or reconstruction of the same roadway section to achieve similar congestion relief would considerably more expensive. This estimate is for SHA categories 1, 2, 3, 5, 6 and 7. This work would take 1 year to complete, not including ROW and permitting.

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

None

Appendix 1

PTC Schematic Drawings



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

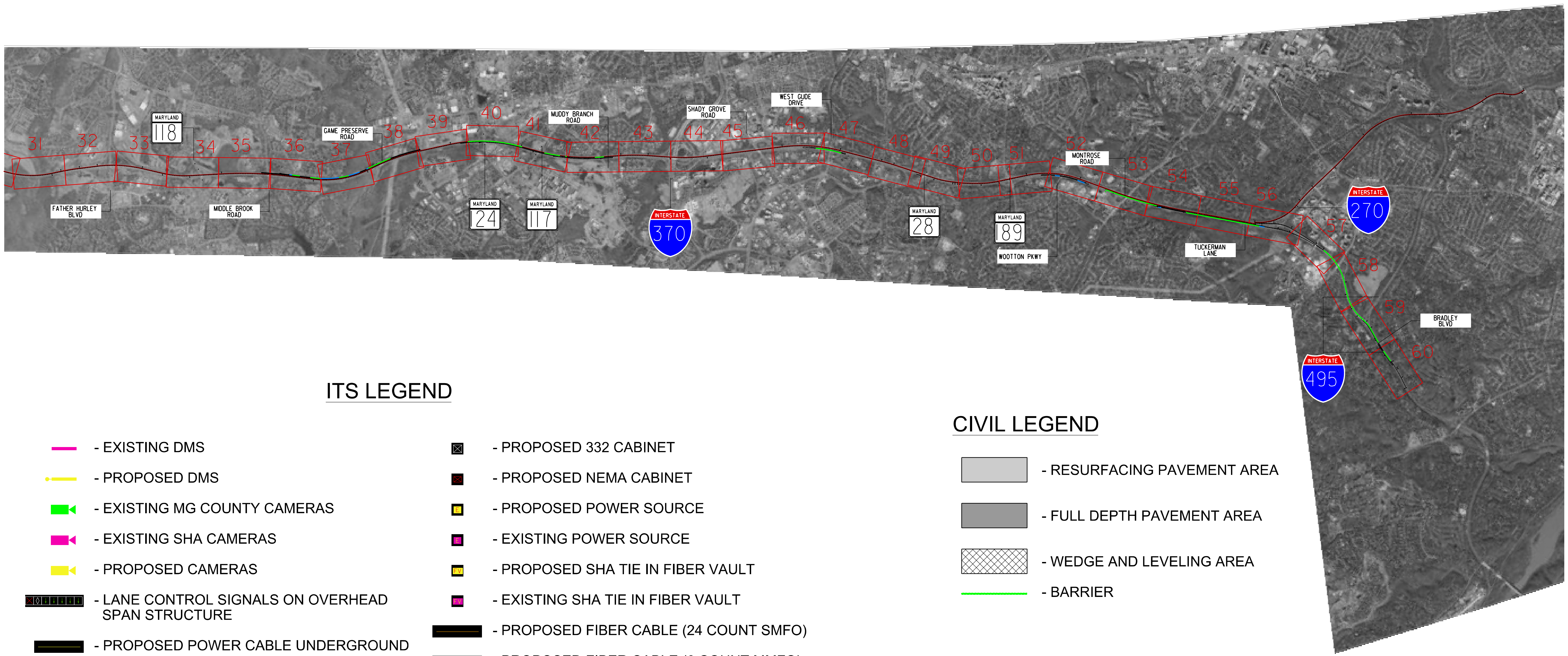
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO. OF 60

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO.

SEE SHEET 45

SEE SHEET 47

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'
SHEET NO. OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:19 AM

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:21 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

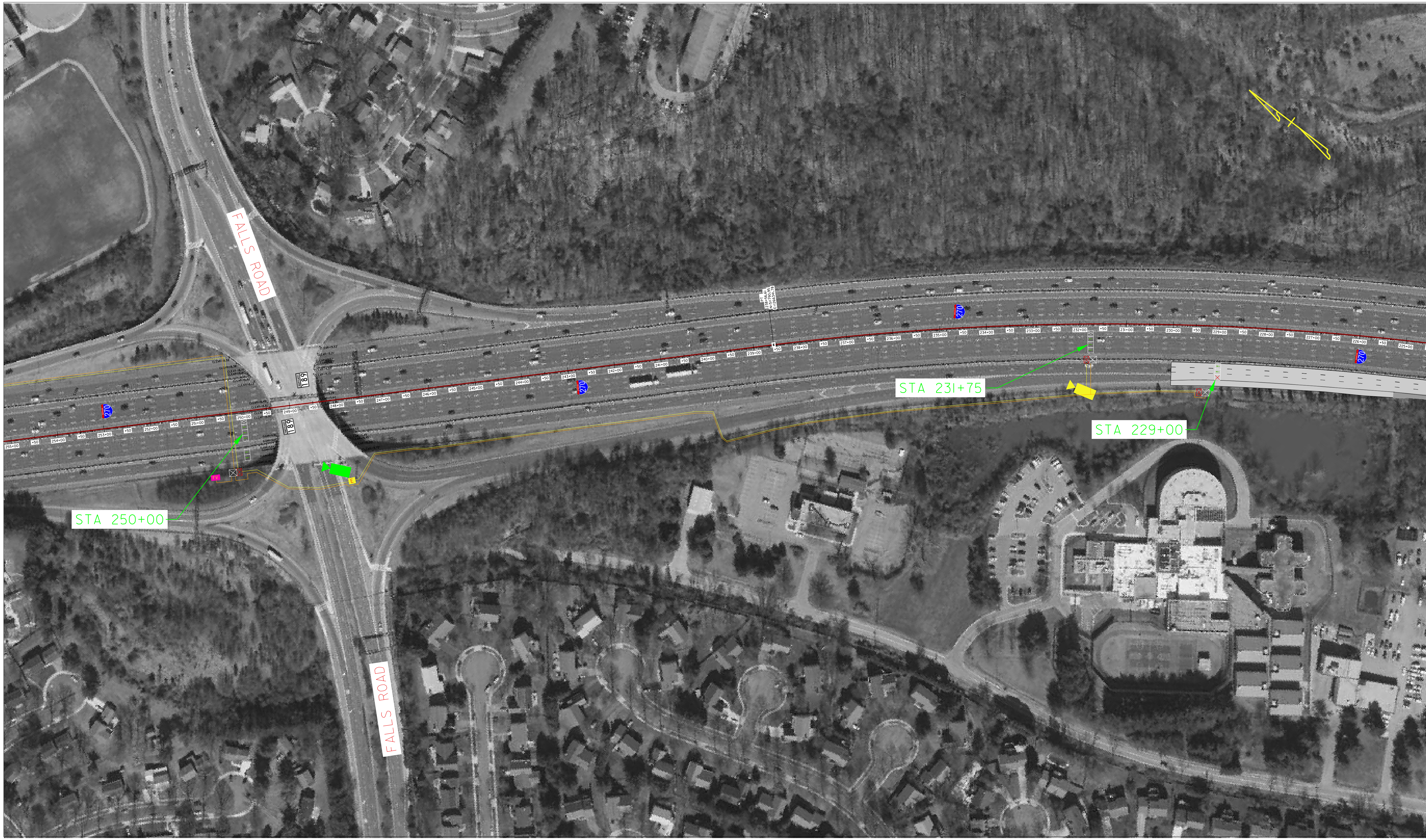
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 47 OF 60

SEE SHEET 50



SEE SHEET 52

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:37 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 51 OF 60

SEE SHEET 51

SEE SHEET 53

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:21 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO.

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

SHA State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 1, 2016

PTC-04: CD and AUXILIARY LANE MODIFICATIONS

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 4 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract.
2. Section A, Description: The proposal should address alterations to operational procedures that might be necessary. Changes to shoulder areas will influence traffic incident management in the following ways:
   - Providing a safe buffer zone for emergency responders. Managed lanes can facilitate lane use and advanced warning, but full shoulders provide a work area for emergency responders which, by vehicular regulation and driver behavior, motorist don't use. Managed lanes can help, but positive guidance and physical barriers (e.g. cones) will be the only protection in a normally traveled lane (i.e. hard shoulder).
   - Use as a staging area for vehicle recovery. In Maryland, by policy and regulation in support of the towing and recovery industry, public agencies only relocate damaged and disabled vehicles to the shoulder, to stage them for final removal by industry towers. Limited shoulder availability would likely require new policies and procedures to minimize the blockage time impact while preparing for private towers to arrive.
   - The CHART patrols, in Maryland, function as an extension of staff for the Maryland State Police, in the area of Traffic Incident Management. However, CHART patrols are not enforcement vehicles and do not have the authority of a "blue light" (police) or a "red light" (fire and rescue) emergency responders in traveling through traffic (even though they are equipped with lights and sirens). Consequently motorists may, or may not, yield right of way to CHART vehicles.

- Impacts of more complex incidents. Procedures and impacts need to be analyzed and addressed for more complex incidents that require more complex recovery procedures and other public safety impacts. Some of these complicating factors include: heavy/large vehicles, injuries, hazardous materials, fires, criminal activities, significant debris (e.g. a load of mulch) etc. Each of these scenarios requires different personnel and equipment on scene: fire trucks, ambulances, police vehicles, heavy equipment, etc. Shoulders provide the additional geometry to stage and maneuver these resources.

3. This PTC will require design exceptions. More detailed information related to impacts and costs of fully meeting AASHTO requirements, potential impacts to safety and operations for implementing the design exception, and mitigation, if any, which would be implemented as a result of the design exception(s) will be required for formal approval. The design exception(s) and a safety analysis must be approved prior to establishing a CAP.
4. Page 1, i: Does the Design-Builder consider having the inlets in the travel way an acceptable design? If so, please discuss with respect to the Safety and Operability/Maintainability/Adaptability goals.
5. Page 1, iii: The placement of pavement markings on an interstate typically adhere to the attached Pavement Marking Material Selection Policy. Any deviation must be approved as noted in the policy.
6. Page 1, iv: Please clarify where the microsurfacing will be applied. Please note the use of microsurfacing will be subject to the condition of the existing surface course as specified in the MDSHA Pavement and Geotechnical Design Guide.
7. Page 1, vi: Does the Design-Builder consider having the inlets in the travel way an acceptable design? If so, please discuss with respect to the Safety and Operability/Maintainability/Adaptability goals.
8. Page 4, Section A, Description: What risk the Design-Builder wishes to share with the Administration in the last bullet is unclear. Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. Please refer to response 17 in the Questions & Responses document.
9. A National Environmental Policy (NEPA) document and an Interstate Access Point Approval (IAPA) approved by the Federal Highway Administration (FHWA) will be required prior to establishing a CAP. In preparation of the IAPA, the Design-Builder must meet the requirements of the FHWA Interstate System Access Informational Guide including demonstrating there are no safety or operational impacts to the interstate.
10. General comment related to risks. In the PTC, the Design-Builder in proposing to not consider many risks in its proposal which may come to fruition. In doing so, it reduces confidence that the proposal could be delivered within the fixed price. Please note that, per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed price.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION POLICY

PAVEMENT MARKINGS - NEW PAVEMENT

PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS AND BRIDGE DECKS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Principal Arterial-Other (R and U) Freeway & Expressway-Other (U)	Lane Lines: Contrast Patterned Tape with SRPMs Center Lines: Patterned Tape w/ SRPMs Edge Lines: Patterned Tape
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R&U)	Lane Lines: Contrast Patterned Tape Center Lines: Patterned Tape Edge Line: Patterned Tape
ASPHALT PAVEMENTS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeways and Expressways-Other (U)	Lane Lines: Inlaid Patterned Tape with SRPMs Center Lines: Inlaid Patterned Tape with SRPMs Edge Lines: Inlaid Patterned Tape
Principal Arterial-Other (R and U)	Lane Lines: Durable Pavement Markings with SRPMs Center Lines: Durable Pavement Markings with SRPMs Edge Lines: Durable Pavement Markings
Minor Arterial (R and U) Collectors-Major and Minor (R and U) Local (R and U)	Lane Lines: Durable Pavement Markings Center Lines: Durable Pavement Markings Edge Lines: Durable Pavement Markings

(R) = Rural and (U) = Urban

Notes:

1. **Durable Markings:** Currently defined as all pavement marking materials other than waterborne paint. Patterned tape, thermoplastic, and epoxy are three options currently available to provide material selection options to the Engineer.
2. Other new durable marking materials (i.e. polyurea, methylmethacrylate) and approaches/processes (i.e. grooving) options are available and can be used by coordinating with the Office of Materials Technology.
3. All material replacement should follow Maryland specifications for pavement marking and the manufacturer's product recommendations.
4. Eradication procedures should be followed in accordance to the Maryland Specification 565 and manufacturer recommendations.
5. **SRPM**: Currently defined as a Snowplowable raised pavement marking (SRPM) includes:
   a. Housing and lens recessed in groove
   b. Housing and lens in metal holders
   c. Housing and lens in plastic holders

Any deviations from this policy shall require documented justification and must be approved by the MDSHA Statewide Pavement Marking Committee prior to application of marking material.

EXISTING PAVEMENT MARKINGS - RE-STRIPING

PORTLAND CEMENT CONCRETE- (PCC) PAVEMENTS AND BRIDGE DECKS	
Existing Roadway Designation	**Line Striping Material**
All Roadway Types	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A - Contrast pattern tape for lane lines (patterned tape for edge lines) Option 1B - Epoxy **Option 2**: Restriping over existing line, use waterborne paint
ASPHALT PAVEMENTS	
Existing Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeway & Expressway-Other (U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1- 90-mil thermoplastic **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Principal Arterial-Other (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line, Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint

(R) = Rural and (U) = Urban

Note: (The notes on page one of this policy & guideline pertain to both existing & new pavements).

TEMPORARY PAVEMENT MARKINGS

ALL PAVEMENT TYPES	
Roadway Designation	**Line Striping Material**
All Roadway Types	**(Options are in prioritized sequence)** **Option 1** – Removable Preformed Wet Reflective Tape **Option 2** – Removable Preformed Tape **Option 3A** – Paint **Option 3B** – 40 Mil Thermoplastic **Option 3C** – Epoxy

Notes:

1. Paint may be used for up to 60 day's duration. If a longer duration is needed, use durable markings such as 40 Mil Thermoplastic or Epoxy or replace paint after 60 days.
2. If Option 1 is not used, temporary RPMs should be used to provide better wet night visibility. Temporary RPM's should be used to provide better delineation at critical work zone locations such as lateral shifts, curved alignments and ramp gore areas.
3. For letters, symbols, numbers, use Removable Preformed Tape.

PTC 5. Mainline modifications

A) **Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.**

The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to modify lane configurations along I-270 at three locations:

i. Southbound I-270 from just north of Montrose Road to the I-270 Split;
ii. Southbound I-270 between MD 124 and I-370;
iii. Northbound I-270 between proposed Watkins Mill Road Interchange and Middlebrook Road.

i. **Southbound I-270 from Montrose Road to the I-270 Split** – Wellington/Jacobs proposes to convert the existing outside shoulder along southbound I-270 from the slip lane from the SB I-270 CD just north of Montrose Road (Station 190+00) into an additional general purpose lane that would extend to the I-270 Split. Since the southbound CD lanes from eastbound Montrose Road merge with the I-270 lanes south of Station 150+00, to continue the added general purpose lane, the CD lanes will be shifted onto the existing shoulder starting south of station 159+00. To implement addition of the general purpose lane will require restriping of the existing lanes from 12 to 11 feet. We propose to restripe 3 lanes along the I-270 lanes between stations 190+00 and 150+00 and 4 lanes between station 159+00 to the split. Microsurfacing is proposed for all of the areas where pavement markings and lane widths are modified.

a) The width of the shoulder will be reduced from 10 feet to a minimum of 1.5 feet in order to develop adequate space for shoulder conversion. This shoulder conversion to a travel lane is proposed to be on a full-time, fully managed, basis to provide much needed additional capacity through this section of SB I-270. A shoulder reduction design exception will be prepared. The improvements from PTC 1 will allow management of this lane to address broken-down vehicles, traffic incidents, unexpected congestion, or snow removal operation.

b) The width of the lanes impacted by this improvement will be reduced from 12 feet to 11 feet minimum to develop adequate space for the new depending on current geometry and striping of existing lanes, as discussed above.

c) The implementation of the proposed PTS lane will not require modifications to the existing I-270 structures located within the limits of this PTC. The development of the new lane took into consideration existing clearances, locations of piers and abutments and the lateral offsets between the structure elements and the proposed lane configuration. The piers and/or abutments were used as the controlling points and the minimum 1.5-foot offset was used to develop the lane configuration that would deliver the required number of lanes under or over the existing structures. Wellington/Jacobs evaluated construction, schedule and financial implications associated with modification of the structures and decided to forgo modification to existing structures in order to maximize the amount of improvements under this project.

d) In order to eliminate conflicts with the pavement markings (ghost stripes) Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings will be installed in accordance with the SHA's Pavement Marking Material Selection Policy.

The areas where Wellington/Jacobs proposes revisions to the pavement markings impacted sections will be treated with Microsurfacing applications prior to the placement of final pavement marking material.

For Microsurfacing applications, this PTC proposes to use:

- Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
- VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways.

e) For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers removal process.

f) The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO. Under the proposed improvements, the outside shoulder along I-270 lanes and the existing gore area between I-270 lanes and I-270 CD lanes (Station 190+00 to 150+00) will be modified by wedge and leveling and reconstruction. The outside shoulder along CD lanes from station 160+00 to Tuckerman Lane overpass will be reconstructed and the remaining shoulder south of Tuckerman overpass will be modified with wedge and leveling.

g) In the proposed configurations there are 20 inlets that fall within the areas of proposed wedge and leveling of full depth reconstruction. 17 of those inlets will fall within the edge of the travel lane and the edge of the barrier, while 3 of those inlets currently fall within the footprint to the lane and will be replaced with narrow grate inlets or will be relocated to be outside of the footprint of the travel lane.

h) In this section, the inside shoulder is protected by a median barrier and the outside shoulder is protected by a single face concrete barrier. the proposed configuration proposes reconstruction of 3,100 linear feet of median barrier with a 42-inch F-shaped or constant slope slip formed barrier, and replace/retrofit 4,400 linear feet of the outside concrete barrier. While the existing concrete barrier has some flexibility to add overlays (e.g. available barrier lip for overlay), to minimize risk associated with not having final survey and final knowledge of where additional overlay can be implemented using the available lip, Wellington/Jacobs has assumed to replace the concrete where the cross slope of reduced shoulder would have to exceed 6.0% percent cross slope.

i) The Wellington/Jacobs Team expects two primary options of addressing the existing pavement conditions within the shoulders. Those include wedge and leveling and reconstruction. However, if final survey or geotechnical investigations are favorable the pavement could remain in-place as a cost savings to SHA.

j) The as-built/design plan data indicates pavement should be approximately 9 inches over 16 graded aggregate base.

  - M 278-501-372 (I-270 from South of MD 28 to North of Montrose Road and MD 189 Interchange and Reconstruction of MD 189 from West of Ritchie Parkway to East of Maryland Avenue) – 8.75 inches of HMA on top of 16 inches of GAB for new construction and 4 inch overlay of existing shoulders. Plans dated 1986.
  - M 401-505-372 (I-270 from I-270 Spur to North of Montrose Road) - 9 ¾ inches of HMA on top of 16 inches of GAB for new construction and 5 ¼ inch overlay of existing shoulders. Plans dated 1987.
  - GPR Information for the outside shoulder of I-270 southbound between Montrose Road and I-270 Split show the thickness of HMA ranging from 3.7 inches to 14.9 inches with the average thickness of all readings of 9.7 inches. This may be in contrast to the design plans reviewed which, as indicated above indicate an overlay of 4 to 5 1/4 inches on the shoulders in this area.

- Preliminary pavement section design calculations determined that a pavement section required to convert the outside shoulder to a full time travel lane should include at least 9.9” of HMA over 12” of GAB.
- Based on the As-built plans, design drawings and GPR information provided by SHA, and our preliminary pavement design, Wellington/Jacobs is proposing to reconstruct areas with the depth of existing pavement of less than 9.9” of HMA and wedge and level areas with existing depth of HMA of more than 9.9” of HMA. This will result in 3,425 linear feet of wedge and leveling and 6,350 linear feet of reconstruction, over the 9,775 feet of this area as shown on the Typical Sections below.
- A microsurface application will be applied to areas that have striping changes that are either wedge and leveled or reconstructed.
- The GPR data generally indicates pavement thicknesses in excess of 10 inches. However, in several areas as defined in the below table there is GPR data that reveals pavement thicknesses less than 10 inches, which is deemed the minimum section for converting the shoulder to general purpose traffic based on our preliminary pavement design, which was based on the assumptions presented in Section D of this PTC.
- In the area where the Montrose Road ramp acceleration lane is lengthened the new lane is moved to the outside lane, transitioning from approximately station 158+00 to 148+00. Throughout this area from the southern end Station 4006 to the northern end Station 161+00, based on GPR readings in the shoulder, the portion of the shoulder to receive new lane will be reconstructed.

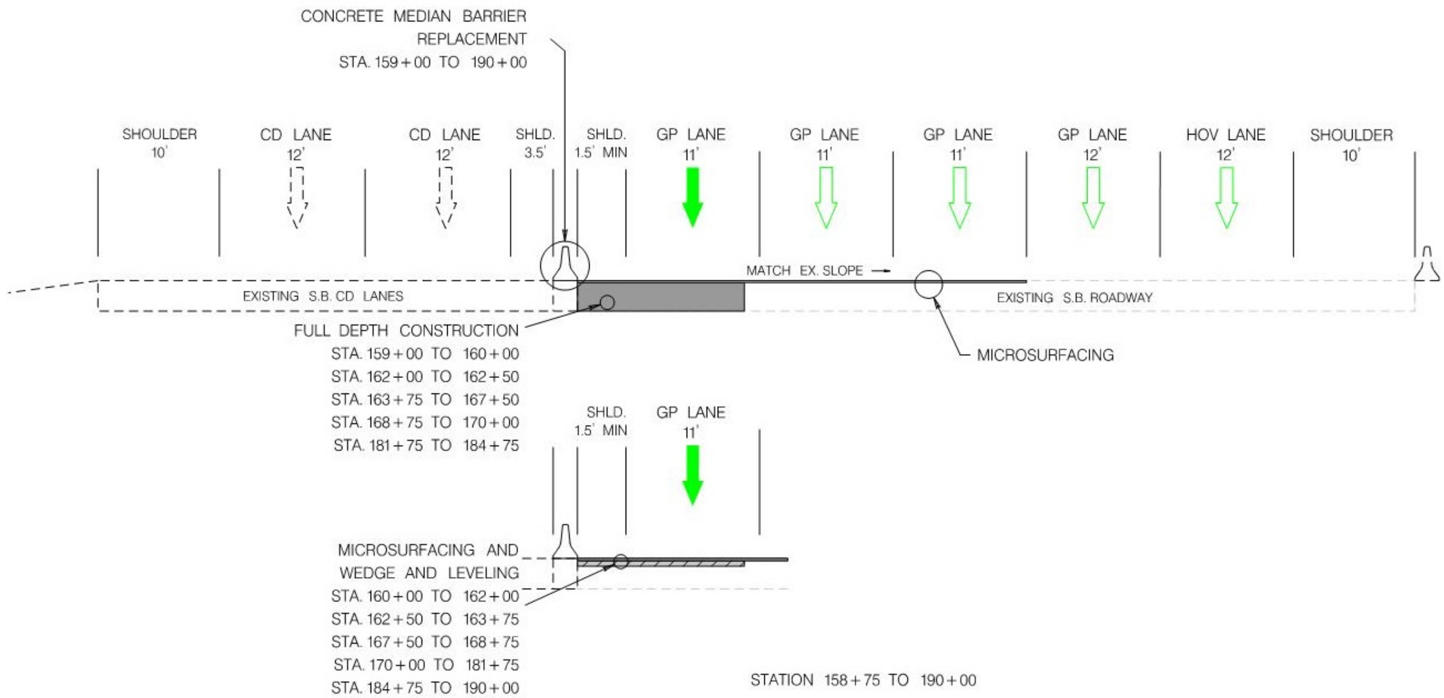
  The areas defined in the typical section below are therefore proposed to be reconstructed based on the GPR data revealing a potential for asphalt of less than 10 inches in thickness through full depth reconstruction.

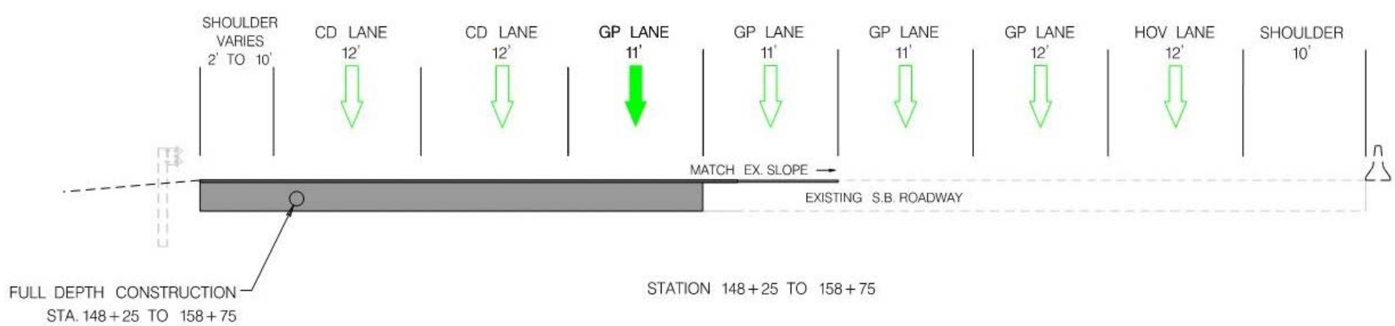
  If after award the geotechnical investigations reveal satisfactory conditions, GAB sections exceeding 12 inches, a hybrid pavement section could be used and cost savings shared with SHA and used to fund a Risk Share Pool. A hybrid section is defined below:

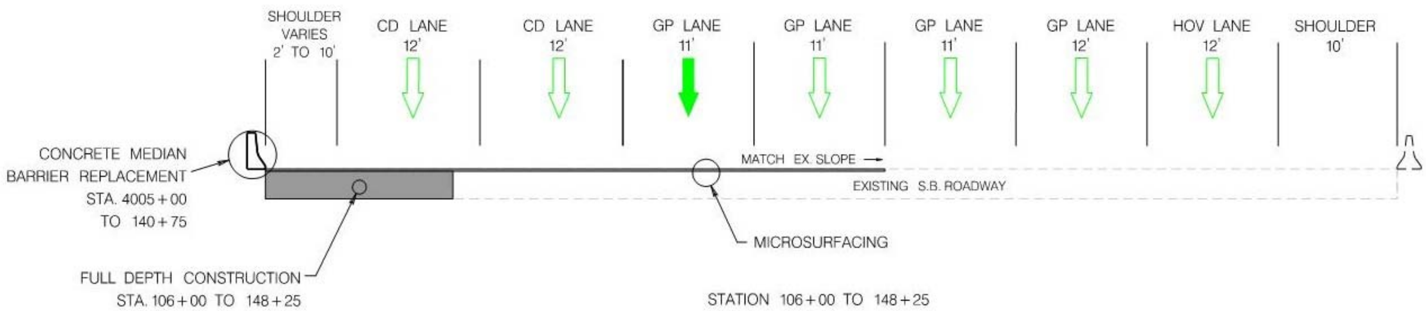
  1. Reconstructed using a hybrid pavement section that would:
     a. Remove the existing asphalt
     b. Remove a portion of the existing GAB (leaving at least 12 inches in place)
     c. Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 10 inches of asphalt pavement

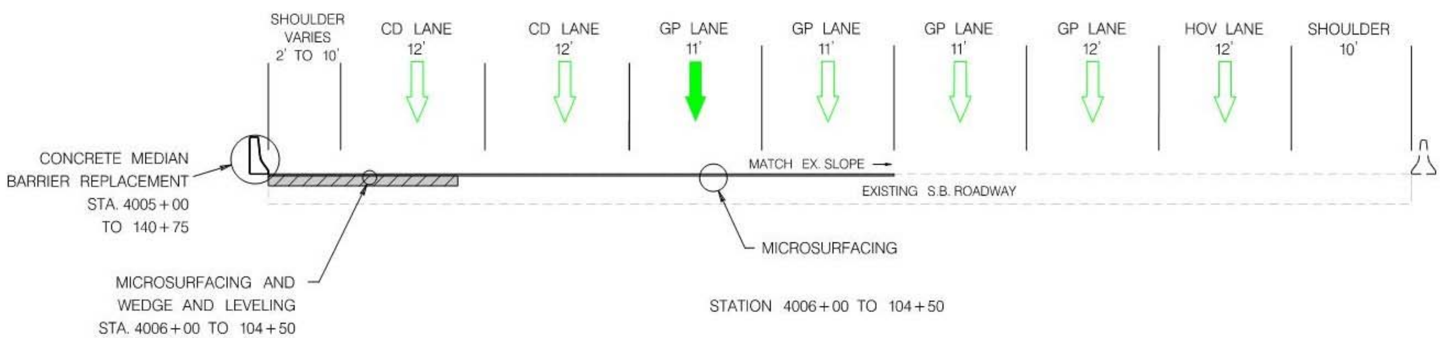
- As detailed above, the Wellington/Jacobs team has assumed in areas where GPR data shows less than 9.9” inches of pavement the portion of the new lane on the shoulder where GPR data was gathered will be reconstructed. Sections of the new lane in existing travel lanes are assumed to have sufficient pavement based on as-builts and design plans provided. If during the scope validation period of final design additional investigation indicates sections of the shoulder with adequate pavement section that is proposed to be reconstructed, we will be able to share that price savings with SHA through the OPCC and CAP process.

- Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 9.9 inches in thickness, these areas will be reconstructed also.
- We have assumed any locations where wedge and leveling is performed adjacent to barrier that the lip of the barrier will be insufficient to accommodate the wedge and leveling and therefore the barrier will be reconstructed. After survey if there are sections where the wedge and level can be accomplished within the available lip of the barrier we will work with SHA to determine if those sections of barrier reconstruction can be omitted to allow SHA to benefit from the cost savings.









ii. **Southbound I-270 between MD 124 and I-370** – To improve the flow of traffic along southbound I-270 between MD 124 and I-370, Wellington/Jacobs is proposing to convert the acceleration lane for the loop ramp from MD 124 into a lane add, continue that lane through the MD 117 interchange, then drop the added lane at the diverge to I-370. The existing auxiliary lane between MD 117 and I-370 will be maintained.

- Under existing conditions, the loop-ramp from MD 124 leads into an acceleration lane that merges in with the southbound I-270 General Purpose lanes prior to the railroad overpass located approximately 1,200 feet south of MD 124 Overpass. Of the two lanes that drop at I-370, one originates from the MD 117 on-ramp, and the second develops along the right side of southbound I-270 approaching the diverge to I-370.

This lane configuration modification would add capacity to a portion of southbound I-270 that experiences significant congestion due to high volume merges from both MD 124 and MD 117 and a very high volume diverge at I-370. Additionally, the added lane, with origins north of MD 117, will drop at I-370, allowing southbound traffic intending to depart I-270 at I-370 to do so with fewer lane changes, resulting in a less congested weaving segment between MD 117 and I-370. Wellington/Jacobs is proposing to increase the total number of through lanes along southbound I-270, south of MD 124, from four to five lanes, and increase the total number of lanes along southbound I-270, south of MD 117, from five to six lanes.

The existing lanes along southbound I-270 are 12-foot wide with 10-foot inside and outside shoulders. A concrete median barrier separates the southbound and northbound lanes, and the roadside treatment for the southbound lanes includes open section, W-beam and concrete barrier.

The proposed lane additions can be accomplished by utilizing the footprint of existing shoulders, and restriping the southbound I-270 lanes at 11 feet.

Wellington/Jacobs anticipates utilizing following design measures to implement the lane modifications along southbound I-270 between MD 124 and I-370, (Stations 577+50 to 486+75):

a. The width of the existing inside shoulder will be reduced from 10 feet to 4 feet, with 1.5 feet wide
b. The width of the lanes be narrowed to 11 feet, by restriping according to this PTC.
c. In order to eliminate conflicts with the pavement markings (ghost stripes) Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings will be installed in accordance with the SHA's Pavement Marking Material Selection Policy.
   The areas where Wellington/Jacobs proposes revisions to the pavement markings, to accommodate the added lanes, impacts will be treated with microsurfacing application prior to the placement of final pavement marking material.
   - For microsurfacing applications, this PTC proposes to use:
     - Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
     - VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways.
d. For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers during the removal process.
e. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO.
f. There are 24 inlets that are within the improvements proposed under this section. . The existing drainage inlets, currently located adjacent to the concrete barrier will remain in place and will be adjusted to accommodate any proposed wedge and leveling and full depth reconstruction adjacent to the concrete median barrier. The development of the added lane configurations took into consideration location of the inlets and operational, safety and maintenance concerns associated with the inlets in the footprint of the added lane. Under the proposed configuration there are no inlets that fall within the footprint of the travel lane.
g. In this section, the inside shoulder is protected by a median barrier and the proposed configuration proposed reconstruction of 4,700 linear feet of median barrier with a 42-inch F-shaped or constant slope slip formed barrier. While the existing concrete barrier has some flexibility to add overlays (e.g. available barrier lip for overlay), to minimize risk associated with not having final survey and final knowledge of where additional overlay can be implemented using the available lip, Wellington/Jacobs has assumed to replace the concrete where the cross slope of reduced shoulder would have to exceed 6.0% percent cross slope. Refer to Section D.ii, bullet 2, sub bullet 3. for more detail regarding use of the available barrier lip for overlay construction
h. The Wellington/Jacobs Team expects two primary options of addressing the existing pavement conditions within the shoulders. Those include wedge and leveling or full depth

reconstruction. However, if final survey or geotechnical investigations are favorable the pavement could remain in-place as a cost savings to SHA.

- o As-built plans covering this section of I-270 show the following pavement sections for the inside and outside shoulders along southbound lanes of I-270:
  - ▪ M 401-502-372 (I-270 from South of the B&O Railroad Bridge to North of the I-370 Interchange) 9 ¾ inches of HMA on top of 16 inches of GAB for new construction of inside and outside shoulders and 5 ¼ inch overlay of existing shoulder. Plans dated 1987.
- o GPR information for the inside shoulder of I-270 southbound between MD 124 and I-370 show the thickness of HMA ranging from 3.4 inches to 14.8 inches with the average thickness of all readings of 8.5 inches. This may be in contrast to the design plans reviewed which, as indicated above indicate an overlay of 5 1/4 inches on the shoulders in this area.
- o GPR Information for the outside shoulder of I-270 northbound between MD 124 and I-370 show the thickness of HMA ranging from 3.4 inches to 20.9 inches with the average thickness of all readings of 10.6 inches. This may be in contrast to the design plans reviewed which, as indicated above indicate an overlay of 5 1/4 inches on the shoulders in this area.
- o The preliminary pavement calculations determined that a pavement section required to convert the inside shoulder to a full time travel lane should include at least 9.4" of HMA over 12" of GAB.
- o Based on the As-built plans, design drawings and GPR information provided by SHA and our preliminary pavement design Wellington/Jacobs is proposing to reconstruct areas with the depth of existing pavement of less than 9.4" of HMA and wedge and level areas with existing depth of HMA of more than 9.4" of HMA. This will result in 2,980 linear feet of wedge and leveling and 6,105 linear feet of reconstruction as shown on the typical section below.

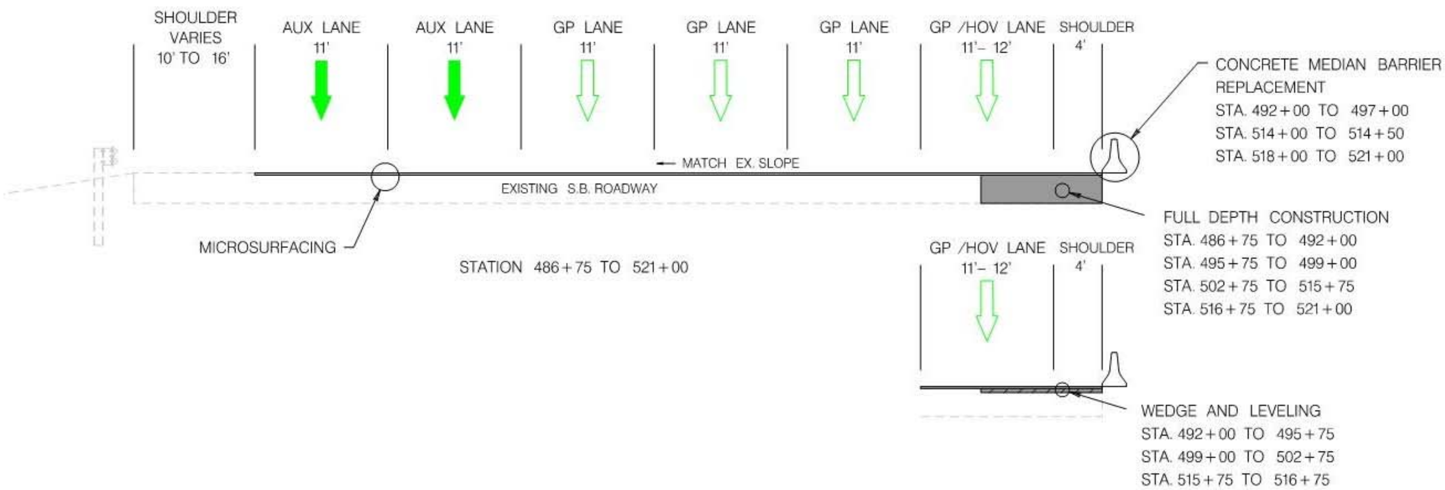
  The areas defined in the typical sections below are therefore proposed to be reconstructed full depth based on the GPR data revealing a potential for asphalt of less than 9.4 inches in thickness.

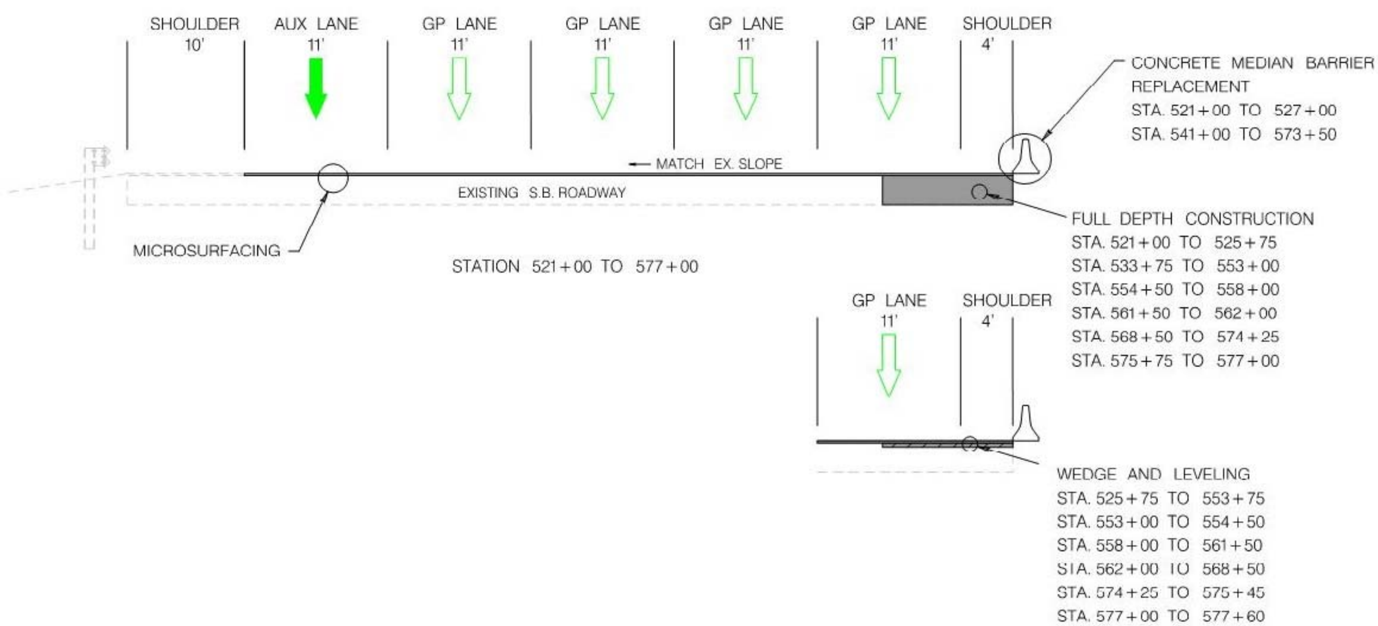
  If after award the geotechnical investigations reveal satisfactory conditions, GAB sections exceeding 12 inches, a hybrid pavement section could be used and cost savings shared with SHA and used to fund a Risk Share Pool. A hybrid section is defined below::

  1. Reconstructed using a hybrid pavement section that would:
     a. Remove the existing asphalt
     b. Remove a portion of the existing GAB (leaving at least 12 inches in place)
     c. Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 9.5 inches of asphalt pavement

  We propose to reconstruct to full depth as indicated on the below typical sections, however if the hybrid section can be incorporated based on field conditions it will be a point of potential savings to SHA through the OPCC and CAP process.
- o A microsurface application will be applied to areas that have striping changes that are either wedge and leveled or reconstructed.

- Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 9.4 inches in thickness, these areas will be reconstructed also. Likewise if sections are revealed that a sufficient section that currently are assumed, based on GPR data to be insufficient, we will be able to provide project savings through the OPCC and CAP process





PTC 5. Mainline modifications

iii. **Northbound I-270 between the proposed Watkins Mill Road (WMR) Interchange and Middlebrook Road,** (Stations 601+75 to 698+75). The modifications for the section of NB I-270 between the proposed WMR Interchange and Middlebrook Road Interchange include maintaining a 5 lane section (1 HOV lane and 4 GP lanes) between the proposed interchange and the loop ramp to westbound Middlebrook Road. In the configuration proposed under the I-270 at WMR Interchange project (MO3515172), there are five lanes in the northbound direction crossing under the proposed WMR overpass. North of the proposed overpass, the outside lane (CD lane) is dropped, and a four lane section is proposed for the remainder of the WMR project. The acceleration lane for the on-ramp from WMR to northbound I-270 merges in with the four lane section just south of the existing structure over Game Preserve Road. When the CD road ends, and the lane from the CD road merges in with the mainline lanes, capacity of the corridor is significantly reduced. To alleviate this issue, Wellington/Jacobs proposes to continue the lane from the CD road, converting the acceleration lane to an auxiliary lane that will drop at the loop ramp to westbound Middlebrook Road.

In our proposed configuration, the continuation of the CD lane would begin where the CD is proposed to end under the WMR project, or approximately 400 feet north of the proposed WMR overpass, and would continue to the existing loop ramp to westbound Middlebrook Road, a distance of approximately 8,700 linear feet. The proposed extension of the 5-lane section would be primarily accomplished by utilizing the footprint of existing shoulders, and restriping I-270 general purpose lanes at 11 feet. The width of the inside shoulder along I-270 and the width of the existing HOV lane will remain unchanged.

Wellington/Jacobs anticipates utilizing following design measures in order to implement the lane modifications along I-270 near Watkins Mill Road and Middlebrook Road are:

a. The width of the existing outside shoulder will be reduced from 10 to 12 feet to 1.5 feet (minimum).
b. The width of the lanes will be narrowed to 11 feet by restriping according to this PTC. It is anticipated that the GP lanes as shown on the typical section below, will be restriped and the HOV lane and the existing inside shoulder will remain unchanged.
c. In order to eliminate conflicts with the pavement markings Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings shall be installed in accordance with the SHA's Pavement Marking Material Selection Policy.

   The areas where Wellington/Jacobs proposes revisions to the pavement markings, to accommodate the added lanes, impacts will be treated with microsurfacing application prior to the placement of final pavement marking material.

   - For Micro Surfacing applications, this PTC proposes to use:
     - Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
     - VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways

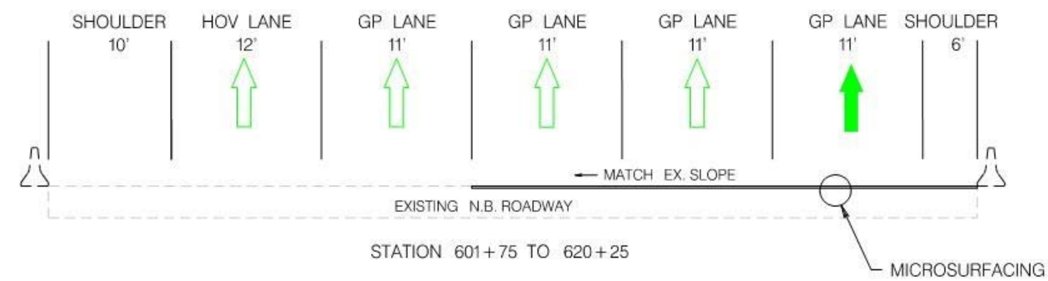
d. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO.
e. There are 7 inlets that are within the improvements proposed under this section. The existing drainage inlets, currently located adjacent to the concrete barrier will remain in place and will be adjusted to accommodate any proposed wedge and leveling and full depth reconstruction adjacent to the concrete median barrier. The development of the added lane configurations took into consideration location of the inlets and operational, safety and maintenance concerns associated with the inlets in the footprint of the added lane. Under the proposed configuration there are no inlets that fall within the footprint of the travel lane.
f. In this section, the outside roadside treatments include open sections, W-beam guardrail and concrete barrier. In areas where reconstruction of the shoulder is proposed adjacent to the barrier, the barrier will remain in place. In areas where a wedge and level or reconstruction is proposed to achieve final grades adjacent to the barrier, the barrier is assumed to be replaced or retrofitted to provide a F-shaped or single slope barrier. While the existing concrete barrier has some flexibility to add overlays (e.g. available barrier lip for overlay), to minimize risk associated with not having final survey and final knowledge of where additional overlay can be implemented using the available lip, Wellington/Jacobs has assumed to replace or retrofit 3,075 feet of outside concrete barrier.
g. Preliminary pavement section design calculations determined that a pavement section required to convert the outside shoulder to a full time travel lane should include at least 11.9" of HMA over 12" of GAB. Refer to Section D of this PTC for assumptions made.
h. Based on the As-built plans, design drawings and GPR information provided by SHA and the preliminary pavement section design, Wellington/Jacobs is proposing to reconstruct areas with the depth of existing pavement of less than 11.9" of HMA and wedge and level areas with existing depth of HMA of more than 11.9" of HMA. This will result in 2,550 linear feet of wedge and leveling and 4,875 linear feet of reconstruction.

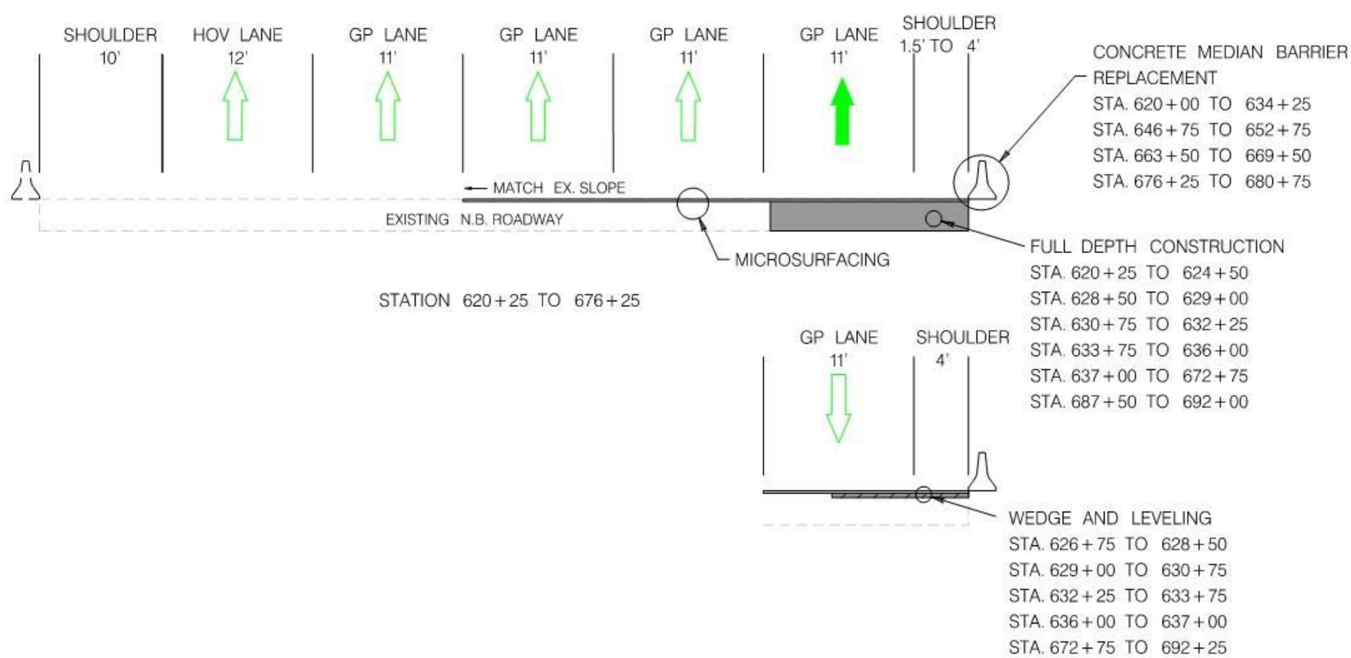
   The areas defined in the typical sections below are therefore proposed to be full depth reconstructed based on the GPR data revealing a potential for asphalt of less than 11.9 inches in thickness.

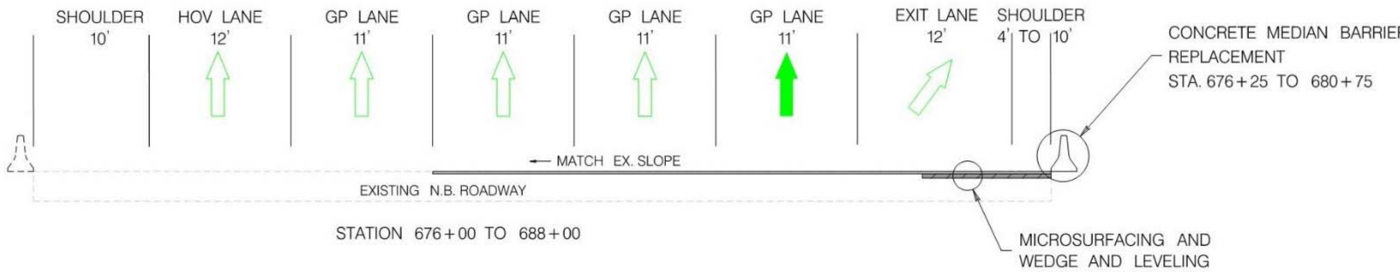
   If after award the geotechnical investigations reveal satisfactory conditions, GAB sections exceeding 12 inches, a hybrid pavement section could be used and cost savings shared with SHA and used to fund a Risk Share Pool. A hybrid section is defined below:
   1. Reconstructed using a hybrid pavement section that would:
      a. Remove the existing asphalt
      b. Remove a portion of the existing GAB (leaving at least 12 inches in place)
      c. Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 11.9 inches of asphalt pavement

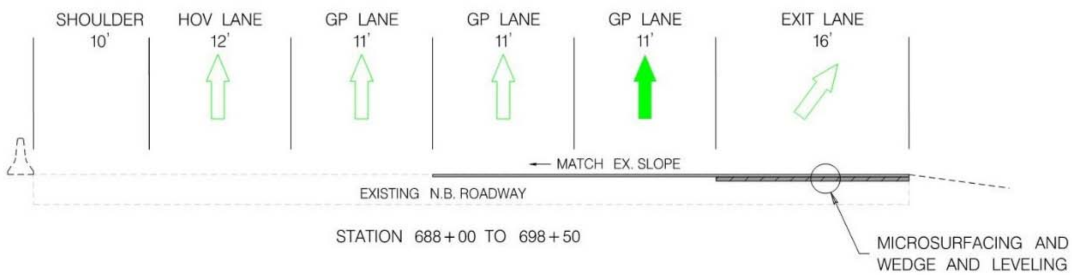
   We propose to reconstruct to full depth as indicated on the below typical sections, however if the hybrid section can be incorporated based on field conditions it will be a point of potential savings to SHA.
i. A microsurface application will be applied to areas that have striping changes that are either wedge and leveled or reconstructed.

Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than 11.9 inches in thickness, these areas will be reconstructed also. Likewise if sections are revealed that a sufficient section that currently are assumed, based on GPR data to be insufficient, we will be able to provide project savings through the OPCC and CAP process. Refer to Sections D and F of this PTC for more detail.









B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.

There are two locations where Wellington/Jacobs proposes to perform lane modifications along I-270. Those locations include:

i. Southbound I-270 from just north of Montrose to near the north end of the physical gore of the I-270 Split (Approximate stations 190+00 to 100+00 (4000+00) and 4000+00 to 4006+00). Total length of improvements along this section is approximately 9,600 linear feet.

ii. **SB I-270, from MD 124 to I-370** – The improvements along southbound I-270 consist of development of a continuous lane between the on-ramp from MD 124 and the off-ramp to I-370; maintaining the continuous lane between MD 117 on-ramp and the ramps for I-370, Stations 577+50 to 486+75. Total length of improvements along this section is approximately 9,075 linear feet.

iii. **NB I-270, from Watkins Mill Road to Middlebrook Road** – The improvements along northbound I-270 include extension of a 5 lane section between proposed WMR interchange and Middlebrook Road (Stations 601+70 to 698+75). Total length of improvements along this section is approximately 9700 linear feet.

C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270 and the PM peak hour models were used to develop improvement concepts for NB I-270.

The traffic operations analyses show that this improvement, in conjunction with the improvements listed in PTCs 2, 3, and 4, will allow travel time along mainline SB I-270 to reduce from 73.2 minutes to 43.6 minutes during the AM peak hour of the base year and from 89.5 minutes to 68.1 minutes during

11 percent during the base year, with local improvements of 11 percent in the vicinity of MD 124 and 17 percent in the vicinity of the I-270 Split during the base year, and by 19 percent, with local improvements of 17 percent in the vicinity of MD 124 and 23 percent in the vicinity of the I-270 Split in 2040.

The traffic operations analyses show that this improvement, in conjunction with an improvement that will alleviate the bottleneck at the NB exit ramp to MD 117 (PTC 7), will allow travel time along the NB I-270 CD to reduce from 59.2 minutes to 21.7 minutes with an overall improvement in throughput of 23 percent during the PM peak hour in 2040.

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – The provision of continuous lanes along SB I-270 from both MD 124 and MD 117 to I-370, and provision of an additional lane along SB I-270 between Montrose Road and the I-270 Split, will improve mobility by removing local congestion and addressing reduced speed areas approaching those interchanges and the diverges to I-370 and the I-270 Spurs. Additionally, the added capacity along NB I-270 between the proposed end of the CD road at Watkins Mill Road and Middlebrook Road will alleviate a significant bottleneck in the NB system, allowing travel time and throughput along the NB I-270 CD to improve dramatically. The continuous lanes will alleviate the speed differential between the vehicles on the ramps and vehicles in the general purpose lanes.

ii. **Safety** – The added continuous lane along SB I-270 between MD 124 and I-370, along SB I-270 between Montrose Road and the I-270 Split, and along NB I-270 between Watkins Mill Road and Middlebrook Road will increase safety by significantly reducing queues and delays during the peak hours and improving lane balances between high volume merges and diverges. The removal of backups approaching and within these sections has potential to decrease rear end and sideswipe crashes.

iii. **Operability / adaptive/ maintainable** – The mainline I-270 lane modifications will improve traffic operations and allow efficient flow of traffic along I-270. Since the proposed improvements will utilize existing shoulders as a travel lane, the maintenance requirements will increase as the travel lane requires more maintenance than the shoulder.

iv. **Well managed project** – The development, implementation and implementation of these proposed improvements will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order the develop a facility that addresses project goals and fulfills SHA's expectations.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with the options proposed for I-270 southbound from just north of Montrose Road to I-270 Split, I-270 southbound between MD 124 and I-370, and for the Watkins Mill Road option. The improvements proposed for both of those locations utilize existing footprint of the pavement.

ii. **Geotechnical** - We have reviewed available construction plans for past improvements along the I-270 Corridor and on the GPR investigation performed along the shoulders of I-270 in 2015 to determine the existing pavement thickness for inside and outside shoulders along the I-270 within this PTC. As indicated in section A above, the data revealed:

a. As-built plans show the proposed pavement section for the reconstruction of inside and outside shoulder between MD 124 and I-370 at 9 ¾ inches of HMA on top of 16 inches of GAB. For the I-270/I-270Y Merge, the as-built plans show the outside shoulders as 12 inches of HMA on top of 12 inches of GAB.
b. GPR information for the inside shoulder of I-270 southbound between MD 124 and I-370 show the thickness of HMA ranging from 3.4 inches to 14.8 inches with the average thickness of all readings of 8.5 inches.
c. GPR Information for the outside shoulder of I-270 northbound between MD 124 and I-370 show the thickness of HMA ranging from 3.4 inches to 20.9 inches with the average thickness of all readings of 10.6 inches.
d. The preliminary pavement design calculations revealed the following required pavement sections for mainline modification in the three evaluated locations:
    i. I-270 southbound from just north of Montrose Road to the I-270 Split:
        1. I-270 Mainline
            a. Total # vehicles (20 years): 220,700,000
            b. Percent of vehicles in design lane: 50%
            c. Design 18-kip ESAL's: 7.1 million
            d. AASHTO Structural No. (SN): 5.4
            e. Minimum HMA thickness: 9.9" on 12" of GAB
        2. I-270 CD lanes
            a. Total # vehicles (20 years): 126,000,000
            b. Percent of vehicles in design lane: 80%
            c. Design 18-kip ESAL's: 6.5 million
            d. AASHTO Structural No. (SN): 5.3
            e. Minimum HMA thickness: 9.7" on 12" of GAB
    ii. I-270 southbound from MD 124 to I-370:
        1. MD 124 to MD 117
            a. Total # vehicles (20 years): 642,000,000
            b. Percent of vehicles in design lane: 15%
            c. Design 18-kip ESAL's: 6.2 million
            d. AASHTO Structural No. (SN): 5.2
            e. Minimum HMA thickness: 9.4" on 12" of GAB
        2. MD 117 to I-370
            a. Total # vehicles (20 years): 776,000,000
            b. Percent of vehicles in design lane: 12%
            c. Design 18-kip ESAL's: 6.0 million
            d. AASHTO Structural No. (SN): 5.2
            e. Minimum HMA thickness: 9.4" on 12" of GAB
    iii. I-270 northbound from Watkins Mill Road to Middlebrook Road:
            a. Total # vehicles (20 years): 540,000,000
            b. Percent of vehicles in design lane: 50%
            c. Design 18-kip ESAL's: 17.3 million
            d. AASHTO Structural No. (SN): 6.2
            e. Minimum HMA thickness: 11.9" on 12" of GAB

Based on this available data we are proposing to implement improvements under this PTC for the three locations as follows:

I-270 southbound from just north of Montrose Road to the I-270 Split - reconstruct the areas where GPR data reveled sections of less than 9.9 inches of asphalt and wedge and level areas with existing depth of more than 9.9 inches.

I-270 southbound from MD 124 to I-370 - reconstruct the areas where GPR data reveled sections of less than 9.4 inches of asphalt and wedge and level areas with existing depth of more than 9.4 inches.

I-270 northbound from Watkins Mill Road to Middlebrook Road - reconstruct the areas where GPR data reveled sections of less than 11.9 inches of asphalt and wedge and level areas with existing depth of more than 11.9 inches.

In areas where the geotechnical investigation reveals inadequate asphalt as listed above for shoulder use, but there is a thick layer of graded aggregate base (GAB), (e.g. more than 12 inches), we could use a hybrid pavement section in lieu of full depth reconstruction, as a cost savings through the OPCC and CAP process. The hybrid section will allow for the existing asphalt and a portion of the GAB to be removed and replaced with asphalt. The resulting asphalt/GAB section would be at least the HMA thickness listed above and 12 inches of base after reconstruction. The approach to a hybrid section will be as follows:

- Remove the existing asphalt
- Remove a portion of the existing GAB (leaving at least 12 inches in place)
- Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum depth of asphalt pavement as listed above.

iii. **Utilities** – There are no anticipated utility impacts associated with this option. The improvements consist of the restriping existing lanes. If the shoulders are to be reconstructed, there are SHA electrical lines and telephone/fiber optic lines located in the footprint of the existing shoulder that will be test pitted to determine if relocation is required.

iv. **Environmental Permitting –** There are no anticipated impacts to natural resources associated the improvements proposed for either one of the locations in this PTC. It is anticipated that IAPA will not be required for improvements along southbound I-270 from just north of Montrose Road to the I-270 Split and for improvements along northbound I-270 between proposed Watkins Mill Road Interchange and Middlebrook Road. Based on the type of improvements proposed along southbound I-270 between MD 124 and I-370 it is anticipated that IAPA will be required this this location. Wellington/Jacobs will coordinate with SHA/FHWA to confirm those assumptions. A noise analysis will be performed to determine if the proposed improvements required noise mitigation measures. Based on evaluation of existing noise reports the following noise wall updates are anticipated:

a. Extension of existing noise wall 15125NO along southbound I-270, south of Muddy Branch Road by approximately 200 feet.
b. Construction of new noise wall along northbound I-270 from Muddy Branch Road to south of Diamond Avenue, approximately 3,000 feet long.
c. Extension of existing noise wall 15121NO along northbound I-270, south of Montrose Road Interchange by approximately 300 feet.

d. Extension of existing noise wall 15123NO along southbound I-270, just north of MD189, by approximately ~~1,000~~ 600 feet.
e. Construction of a new noise wall near Tuckerman Lane, along northbound lanes. The length of new noise wall would be about 1,400 feet.

v. **Local Community** – Due to a revised traffic pattern along the ramps and near the merge, the local communities will be notified of the change in the traffic pattern prior to the implementation of the improvements. The communities in the areas requiring noise mitigation measures will be notified during the noise evaluation and construction of noise walls, if those are required.

vi. **Safety** – The lane modification along southbound I-270 between Montrose Road and the I-270 Split and between MD 124 and I-370, and along northbound I-270 between Watkins Mill Road and Middlebrook Road, will increase the safety along the corridor by increasing weaving distances between interchanges and provide additional capacity to alleviate significant bottlenecks. Replacement of acceleration lanes with continuous auxiliary lanes will alleviate the speed differential between the vehicles on the ramps and vehicles in the general purpose lanes. AASHTO anecdotal data indicates that safety is not significantly impacted by reducing lanes widths from 12 to 11 feet. In general, the greater the average daily traffic, and presumably the greater level of congestion during the "before" conditions, the more likely that the safety benefits from reduced congestion (resulting from an additional lane) will outweigh the potential safety issues associated with narrower lanes and shoulders.

vii. **Life Cycle Project Infrastructure Cost –** Resurfacing of the mainline of I-270, including the inside and outside shoulders, to implement improvements under this PTC will result in an up-front investment, but will prolong the life of the pavement and will postpone SHA's required resurfacing/reconstruction activities. For areas where the new traffic will be placed directly on the existing shoulder with no upgrade there is no change in life cycle costs, because shoulders are maintained at the same frequency as general purpose lanes under SHA preservation projects.

viii. **Maintenance and Operation**- This proposed PTC centers on reducing the existing shoulder permanently to provide a means for extra lanes. The shoulder will have minimum widths as shown in the typical sections shown in Section B above. While the reduction in the width of the shoulders seem to remove some of the safety, operational and maintenance benefits of the wider shoulders in use today, the improvements proposed under this PTC combined with the ATM improvements proposed under PTC 1 will alleviate issues associated with reduction of the shoulder width. Because of the adaptability and dynamic management capabilities of the ATM solutions, the added lanes should not be looked at as a reduction of shoulder but also as an extra lane that can be managed to most efficiently, safely, and effectively move the traffic through the Corridor.
   a. In the three locations identified in Section B above, there are approximately 28,400 feet of corridor for which this PTC is applicable to. In each of these areas shoulders will be reduced in width as shown on the typical section presented in section B above. Although these shoulder widths generally do not provide a safe refuge area for disabled vehicles, if a vehicle becomes disabled in adjacent lanes the detection system will identify the stopped vehicle and send an alert to the personnel assigned to the I 270 systems. This SHA Highway Operations Technician (HOT) can then verify the issue, close the lane in advance of the lane blockage utilizing the overhead signs, alert the CHART and MSP patrols to initiate a response, and since the event has now

been verified start a private tow service to the location, depending on final procedures agreed to with SHA. At this time the incident has both the existing lane and shoulder as incident response area. This process starts to add a layer of protection to the vehicle stopped in the lane prior to responders arriving on the scene and greatly expedites the detection, verification, response and clearance timelines thereby lessening the exposure time and associated danger to the disabled or incapacitated vehicle in the lane as well as approaching motorists and responding agencies. At this stage it is a virtual closure and there are no physical barriers or traffic control in place but by decreasing the detection and verification times the response times are also decreased allowing the CHART vehicles to get to the scene sooner to set up the proper traffic control and creating a safe temporary traffic control zone utilizing the roof mounted arrow boards as well as establishing a proper cone taper to protect the motorists and responders on the scene as well as warning approaching motorists of what is expected of them.

b. CHART personnel will be able to continue CHART Standard Operating Procedures (2014 version) section 2 article 7 which allows for "Disabled vehicles located in hazardous areas (travel lanes, gore areas, etc.) to be pushed, pulled, or towed to the nearest safe location before performing any type of troubleshooting on the vehicle" and "If the disabled vehicle cannot be relocated unassisted, the CHART field personnel on the scene can contact the SOC/TOC and request assistance from another CHART unit, law enforcement and/or a towing & recovery service, in order to safely remove the vehicle to a safe location. A safe location can be considered as off the freeway or to one of the proposed Emergency Refuge pull-off areas, the opposite shoulder area. The goal is to get the travel lanes back open as soon as possible by relocating the vehicle to the nearest available safe location. This practice also creates another level of safety for the private towing companies as they are retrieving the vehicle from a safer location lessening the risk of them being struck.

c. The CHART patrols are registered "Emergency Vehicles" and are equipped with red lights both front and rear facing with sirens. The CHART Standard Operating Procedures (2014 version) section 2 article 9 states "Due to the nature of emergency response required by SHA personnel, a group of vehicles have been designated Emergency Response Vehicles. This ability along with our ATM managed lane should provide better access to incident locations.

d. Maryland is one of the top performing states when it comes to dealing with major incidents as they have response plans and procedures in place to deal with these types of events. The backbone behind Maryland's success is the MSP/SHA open roads agreement which originated in 1989 and has been recently updated (August 2015) states:

   "Whenever the travel lanes of a roadway are closed or partially blocked by a crash, disabled or unattended vehicle and traffic delays or safety problems may occur as a result, the SHA representative in cooperation with the trooper in charge should attempt to reopen the roadway as soon as possible **ON AN URGENT BASIS"**

Although not part of this PTC other initiatives, such as towing incentive programs or policy changes or procedures, could be modified to make Maryland's responses to some of these incidents even better. The quick clearance of complex incidents is not really impacted by the reduced shoulder use as individual lanes can be closed to traffic at any time and utilized at the request of any of the response agencies. This would allow for the movement of specialty or heavy equipment to stage properly for recovery efforts as the same amount of roadway is available. Our proposed managed lane solution will enhance the ability for response to major incidents by allowing control of lanes for access of incident vehicles.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

The improvements proposed as a part of this PTC include common approaches to mainline modifications.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. This Wellington/Jacobs proposed PTC would allow shift of through lanes closer to the concrete median barrier, by approximately 6 feet. The shift would still maintain 4 foot inside shoulder, with the minimum offset of approximately 1.5 feet located adjacent to the pier of the railroad rail overpass. The shift, combined with narrowing of the lanes along I-270 from 12 feet to 11 feet will allow for the conversion of the outside shoulder into to a new auxiliary lane between MD 124 and I-370. Wedge and leveling of the inside shoulder will require shoulder and lane closures, but it will be completed faster and with less traffic impacts when compared to reconstruction of the shoulder. If more reconstruction is required, MOT would be more significant and in-place longer than initially anticipated. Wellington/Jacobs would work with SHA to provide adequate public information to ensure the public is well informed of anticipated construction sequencing.

ii. The Wellington/Jacobs team is proposing to install storm water management facilities where reconstruction is proposed as indicated in this PTC. If additional reconstruction is required based on final pavement investigations, Storm Water Management approvals would be required for these additional areas reconstructed.

iii. A condition study of existing drainage assets was not provided with the RFP materials for the Wellington/Jacobs team to assess the risk of deteriorating drainage assets. After award the Wellington/Jacobs team will perform an inventory and study of cross drainages to determine if there are any assets recommended to replace or otherwise mitigate, prior to preceding with final construction

- The Wellington/Jacobs team proposes to base our Scope for the conversion of the shoulder to general purpose /auxiliary lane use on the existing drainage assets being adequate for continued use. Our proposed PTC is to extend drainage facilities in kind with extended drainage facilities end sections meeting current SHA requirements.

iv. This PTC proposes to allow the Design Storm Water Spread to encroach upon the new auxiliary use lane to accommodate a total spread of 8 feet. This spread will equate to approximately 2 feet into the adjacent CD/auxiliary lane during the storm event. The Dynamic Variable Speed Control and Dynamic Lane Control would be integrated in Section 1 and 2 mentioned above to allow Variable Speed control of the lane or dynamic closure of the lane during an excessive storm event or other events as deemed appropriate by final operating procedures. . Currently a 2-year storm in general requires approximately 7 feet of spread with shoulders at 2 to 4 percent cross slopes. We anticipate requiring control, if used, to be established infrequently potentially less than once each year. During this control period, if used, the corridor would revert back to its current capacity.

v. Risks associated with snow removal or reduced shoulder width as refuge for disabled vehicles will be mitigated by the implementation of PTC 1. Through ATM deployment the shoulder use for refuge snow storage, water spread from storm events will be managed through active lane management. The lane configuration modifications (new auxiliary lane) can actively be controlled and closed if unsafe conditions arise for the above reasons or other reasons such as maintenance operations. When implemented the road network would revert to the currently available lane configuration.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

i. Based on the available as-built and design drawings provided by SHA referenced in Section A of this PTC, the Wellington/Jacobs team is assuming the shoulders along southbound I-270 lanes and NB I-270 lanes at Watkins Mill Road have a mix of shoulders with sufficient depth and not sufficient depth for converting to a travel lane.
   - The Wellington/Jacobs team proposes to base our Scope of the modified lane use on the existing shoulder being reconstructed in areas where GPR data revealed an asphalt thickness as listed in section D. d. of this PTC (e.g. less than our preliminary pavement section design). Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. It is proposed that if the investigation reveals there are additional significant stretches (two consecutive borings) of asphalt less than those values, these areas will be reconstructed. If borings reveal adequate pavements sections savings will be realized through the OPCC and CAP process.

ii. If during grinding for removal of the pavement markings or grade control of the cross slope, the underlying pavement is found to be not stable, additional depths of grinding may be required.

iii. During construction multiple lanes will be shifted to the inside lane to allow reconstruction/improvements on the outside of the roadway. As work progresses, additional time for MOT may be required for unexpected conditions.

iv. Wellington/Jacobs will be required to obtain a design exception for a significant length of reduced shoulder for the new auxiliary lane use. We propose to team with SHA to have the design exceptions prepared soon after award to reduce potential impacts to the project schedule. If the design exception is rejected by FHWA in part or in full, Wellington/Jacobs will work with SHA to identify alternative approaches to achieve an acceptable shoulder. Design exceptions identified for this PTC are as follows:

a. Shoulder width – a significant section of the section between MD 124 and I-370 will have a reduced inside shoulder. The nominal shoulder is 4.0 feet with one pinch points being 1.5 feet. The outside shoulders for the improvements between WMR and Middlebrook Road will have reduced width ranging from 1.5 feet to 6 feet wide. The outside shoulders between north of Montrose Road to the I-270 split will also have reduced shoulders. The risk associated with obtaining FHWA approval of the design exception prior to CAP agreement are minimal. The reasoning to be provided for the exception include:

    i. The implementation of ATM on the project will provide a means to control speeds during highly congested times.

    ii. Widening the interstate to accommodate a full width shoulder would be cost prohibitive

b. Lane widths – the entire area between MD 124 and I-370, I-270 southbound from north of Montrose Road to the I-270 split and part of improvements between WMR and Middlebrook Road will require revisions of lane lanes from existing 12 foot lanes to 11-foot lane. The risk associated with obtaining FHWA approval of the design exception prior to CAP agreement are low. The reasoning to be provided for the exception include:

    i. Implementation of 11 foot lanes along interstates throughout the country.

    ii. Widening the interstate to accommodate a full width shoulder would be cost prohibitive

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

Mobility and operation will improve along the Corridor by modifying lane configurations at two locations on I-270: southbound I-270 between MD 124 and I-370; and northbound I-270 between Watkins Mill Road and Middlebrook Road. The improvements along southbound I-270 consist of adding a continuous auxiliary lane between MD 124 and I-370. The improvements along the northbound I-270 include adding a continuous auxiliary lane between the end of the CD road at Watkins Mill Road and Middlebrook Road.

Again, the improvements for both these locations utilize the existing pavement footprint. The work for this PTC includes mill and overlay along with pavement re-striping at both Sections. A noise analysis will be performed, based on existing noise reports noise wall upgrades are also anticipated.

Work will be performed within the existing pavement footprint. Significant cost and schedule benefits are realized from PTC 5 including; no additional right-of-way required, no widening, minimal to no environmental impacts and no additional costs to Utilities or Third parties.

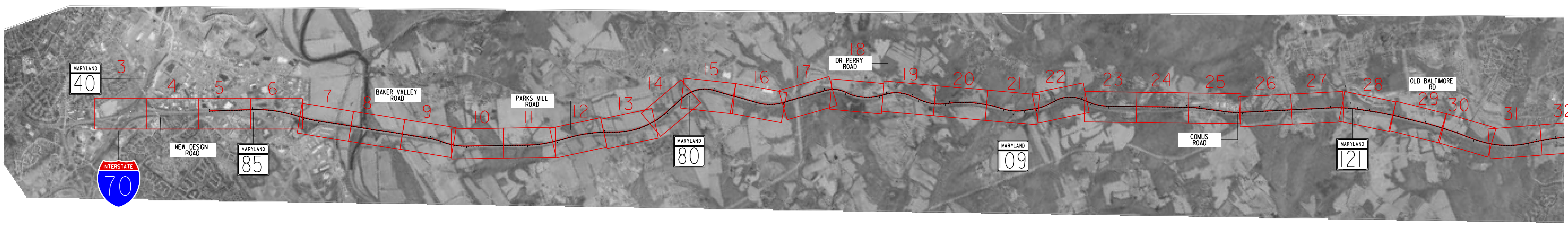
Alternatively, the estimated cost associated with the widening or reconstruction of the same roadway section to achieve similar congestion relief would be considerably more expensive. This estimate is for SHA categories 1, 2, 3, 4, 5, 6 and 7. This work would take 18 to 22 months to complete, not including ROW and permitting.

l) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

None

Appendix 1

PTC Schematic Drawings



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

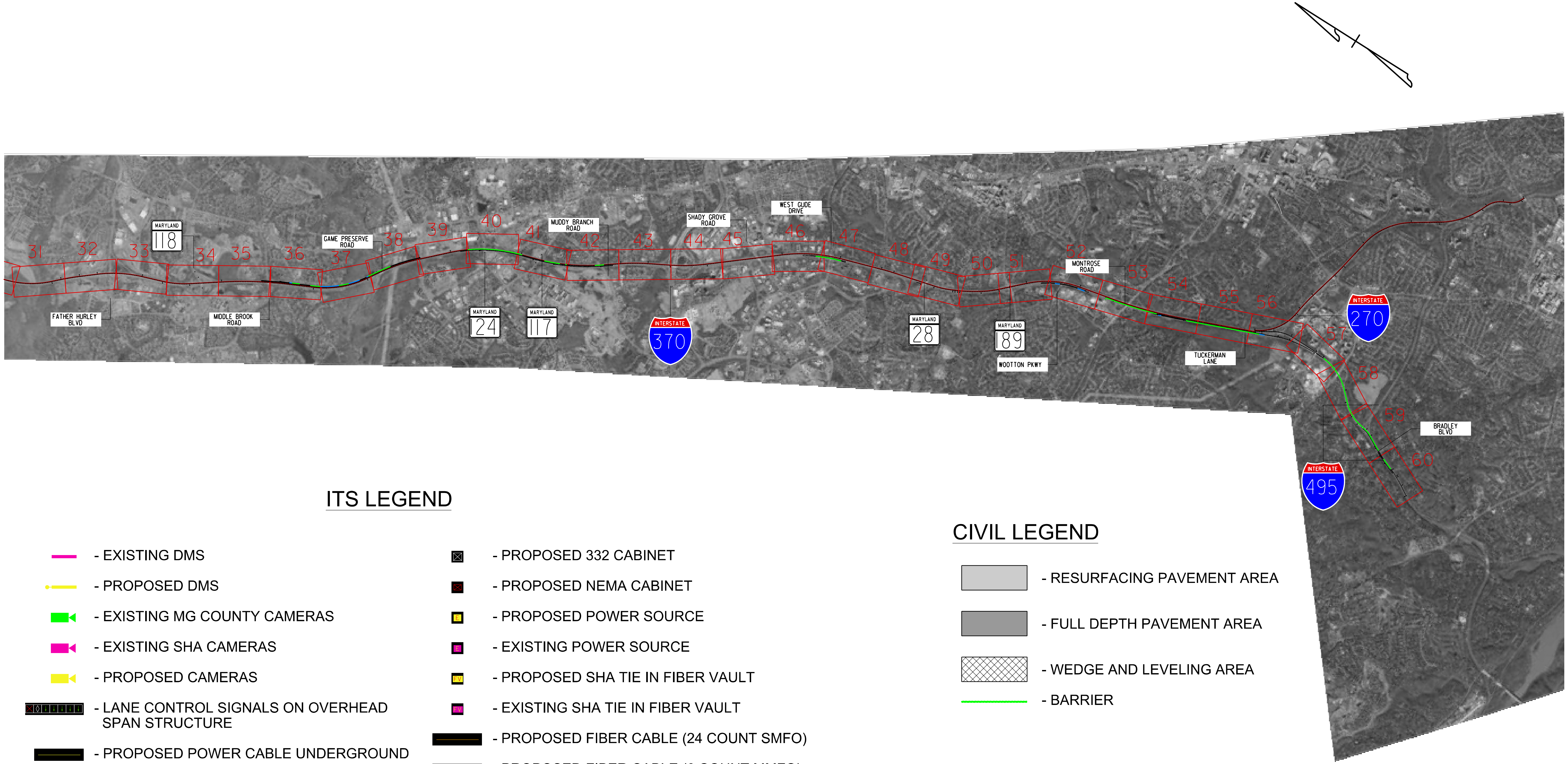
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO.

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO.

SEE SHEET 34

SEE SHEET 36

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:29 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:33 AM

SEE SHEET 35

SEE SHEET 37

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV | SHEET NO.
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200' | OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:37 AM

SEE SHEET 36

SEE SHEET 38

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

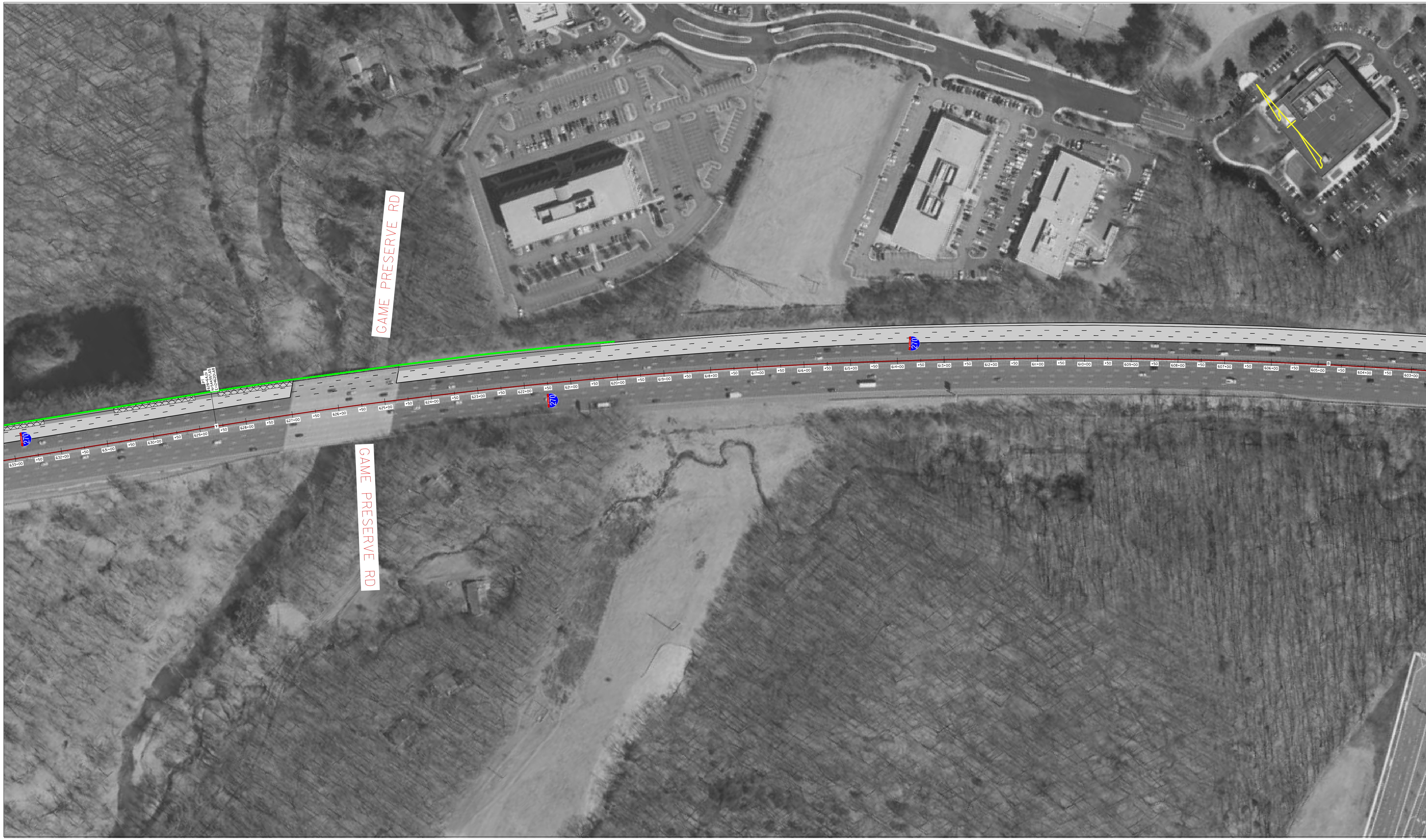
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

SHEET NO.

SEE SHEET 37



SEE SHEET 39

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:39 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

SHEET NO.

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

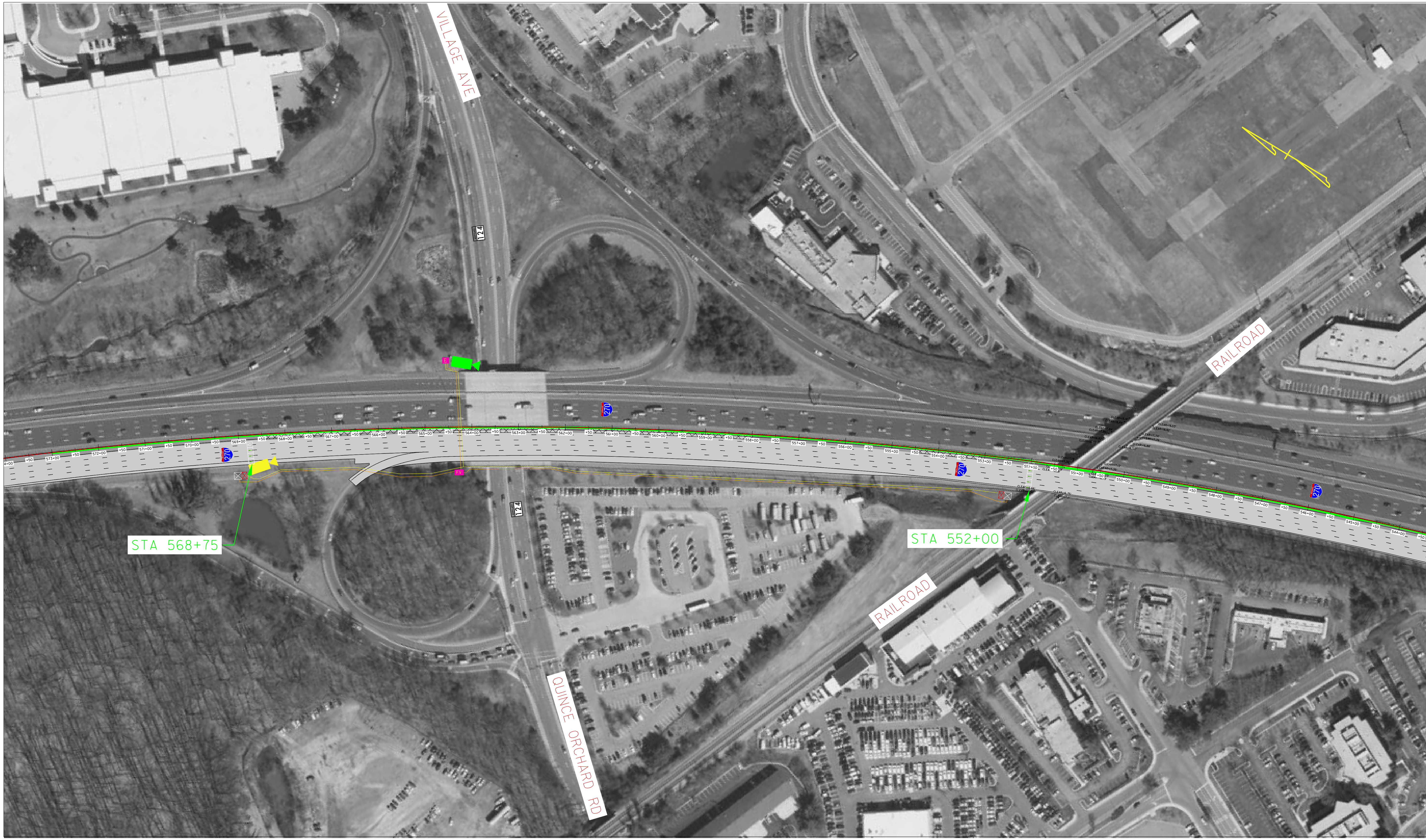
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

SHEET NO.

SEE SHEET 39



SEE SHEET 41

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:43 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 40 OF 60

SEE SHEET 40

SEE SHEET 42

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:46 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
CONST. REVIEW BY
DRAWN BY DNP
DATE 01/19/17
CHECKED BY DV
SCALE 1" = 200'

SHEET NO. 41 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:50 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 42 OF 60

SEE SHEET 52

SEE SHEET 54

DATE: TUESDAY, JANUARY 17, 2017 AT 11:10 AM

BY: PATELDH -

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP
CONST. REVIEW BY
DRAWN BY DNP
DATE 01/19/17
CHECKED BY DV
SCALE 1" = 200'

SHEET NO. 53 OF 60

SEE SHEET 53

SEE SHEET 55

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:27 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. OF 60

SEE SHEET 54

SEE SHEET 56

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:12 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. OF 60

SEE SHEET 55

SEE SHEET 57

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:14 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV | SHEET NO.

CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200' | OF 60

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

January 10, 2017

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 5 (Revised) for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on December 29, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the technical concept appears to be a reasonable solution to address the goals of this contract; however, some language in this PTC hinders the level of commitment or confidence that the Design-Builder will deliver the proposed improvements within the fixed budget.
    a. Much of the language is in reference to the adequacy of the existing shoulder pavement section to support traffic loads. For example, at the bottom of page 4 the PTC states, "If during the scope validation period of final design additional investigation indicates portions of this PTC have inadequate pavement sections … Wellington/Jacobs and SHA would negotiate monetary or scope adjustments." Sentences like this prompt some questions and comments:
        i. As stated in the RFP at the bottom of page 42, "The verbiage used in each Proposal will be interpreted and evaluated by the Administration based on the level of commitment provided by the Proposer. **No consideration will be given to tentative or ambiguous commitments.**" For this PTC, the Design-Builder should commit to delivering those improvements it will deliver that directly advance the contract goals (e.g. adding a lane of capacity by converting the acceleration lane for the loop ramp from MD 124 into a lane add to I-370). It does not need to commit to a certain length or area of full depth shoulder pavement reconstruction because the extent of full depth shoulder will be hashed out during the preconstruction phase and will be controlled by (1) the applicable design manual(s) and (2) the commitment mentioned above.

My telephone number/toll-free number is 410-545-8800 or 1-888-228-6971
Maryland Relay Service for Impaired Hearing or Speech 1.800.735.2258 Statewide Toll Free

Street Address: 707 North Calvert Street • Baltimore, Maryland 21202 • *Phone* 410.545.0300 • www.roads.maryland.gov

In other words, the above commitment will control how much full depth reconstruction is necessary, not the other way around. The Design-Builder should balance the extent of those improvements it will deliver that directly advance the contract goals with the amount of risk it is willing to accept. If the Design-Builder is extremely risk averse, it may elect to assume all shoulders will need full depth reconstruction.

ii. Does the Design-Builder understand that it is entering into a contract with the Administration for Design and Preconstruction Services, and that the Scope Validation Period is only for the Design and Preconstruction Services? If so, what is there to negotiate since the Design and Preconstruction Services Fee submitted with the Design-Builder's proposal is an upset limit and should encompass all required design to deliver the project? If the Design-Builder proposes converting a shoulder to an add lane and subsurface investigations during the preconstruction phase reveal full depth shoulder pavement reconstruction is required, the Design-Builder will be required to complete all the associated design (e.g. pavement design, stormwater management design, etc.). See responses 17 and 56 in the Questions and Responses document.

b. The PTC continues to propose risk sharing and negotiation of scope with the Administration.

   i. To propose risk sharing at this stage is premature. Any risk sharing pool will not be considered until after award during the Design and Preconstruction phase.

   ii. As noted above, the Design-Builder should make a commitment for the main improvements that directly advance the contract goals. This commitment will control the extent of the design elements (e.g. full depth pavement reconstruction, concrete barrier reconstruction, stormwater management, etc.) needed to implement it.

c. Section G, Risk: The Design-Builder has not considered many risks, some of which have been assigned to the Administration in Section F. In doing so, it reduces confidence that the proposal could be delivered within the fixed budget. Per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed budget.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 1, 2016

PTC-05: MAINLINES MODIFICATIONS

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 5 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the Mobility goal of this contract; however, having 6-foot shoulders on the median side and outside of the mainline is potentially concerning. The proposal should address alterations to operational procedures that might be necessary. Changes to shoulder areas will influence traffic incident management in the following ways:
   - Providing a safe buffer zone for emergency responders. Managed lanes can facilitate lane use and advanced warning, but full shoulders provide a work area for emergency responders which, by vehicular regulation and driver behavior, motorist don't use. Managed lanes can help, but positive guidance and physical barriers (e.g. cones) will be the only protection in a normally traveled lane (i.e. hard shoulder).
   - Use as a staging area for vehicle recovery. In Maryland, by policy and regulation in support of the towing and recovery industry, public agencies only relocate damaged and disabled vehicles to the shoulder, to stage them for final removal by industry towers. Limited shoulder availability would likely require new policies and procedures to minimize the blockage time impact while preparing for private towers to arrive.
   - The CHART patrols, in Maryland, function as an extension of staff for the Maryland State Police, in the area of Traffic Incident Management. However, CHART patrols are not enforcement vehicles and do not have the authority of a "blue light" (police) or a "red light" (fire and rescue) emergency responders in traveling through traffic (even though they are equipped with lights and sirens). Consequently motorists may, or may not, yield right of way to CHART vehicles.

- Impacts of more complex incidents. Procedures and impacts need to be analyzed and addressed for more complex incidents that require more complex recovery procedures and other public safety impacts. Some of these complicating factors include: heavy/large vehicles, injuries, hazardous materials, fires, criminal activities, significant debris (e.g. a load of mulch) etc. Each of these scenarios requires different personnel and equipment on scene: fire trucks, ambulances, police vehicles, heavy equipment, etc. Shoulders provide the additional geometry to stage and maneuver these resources.

2. This PTC will require design exceptions. More detailed information related to impacts and costs of fully meeting AASHTO requirements, potential impacts to safety and operations for implementing the design exception, and mitigation, if any, which would be implemented as a result of the design exception(s) will be required for formal approval. The design exception(s) and a safety analysis must be approved prior to establishing a CAP.
3. Adjustments to shoulder cross slopes may be necessary. Concrete traffic barriers have some flexibility to add overlays, but if previous overlays have used that flexibility, flattening the cross slopes may reduce the barriers heights to less than acceptable. Please elaborate on this topic. Should concrete traffic barrier heights be insufficient, what does the Design-Builder propose? Does the Design-Builder know if the flatter cross slopes will create an issue? If not, will this be a Design-builder risk and how will the Design-Builder mitigate that risk?
4. Page 1, d: The placement of pavement markings on an interstate typically adhere to the attached Pavement Marking Material Selection Policy. Any deviation must be approved as noted in the policy.
5. Page 2, e: Please clarify where the microsurfacing will be applied. Over the entire width of the PTS and mainline lanes that are being narrowed? Please note the use of microsurfacing will be subject to the condition of the existing surface course as specified in the MDSHA Pavement and Geotechnical Design Guide.
6. Page 2, g: What risk the Design-Builder wishes to share with the Administration in the last bullet is unclear. Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. Please refer to response 17 in the Questions & Responses document.
7. Page 3, b: Please clarify how the Design-Builder intends to narrow the lanes to 11 feet. Will ghost pavement markings be visible?
8. In general, typical sections would greatly improve communication of the Design-Builder's intent.
9. A National Environmental Policy (NEPA) document and an Interstate Access Point Approval (IAPA) approved by the Federal Highway Administration (FHWA) will be required prior to establishing a CAP. In preparation of the IAPA, the Design-Builder must meet the requirements of the FHWA Interstate System Access Informational Guide including demonstrating there are no safety or operational impacts to the interstate.

10. General comment related to risks. In the PTC, the Design-Builder in proposing to not consider many risks in its proposal which may come to fruition. In doing so, it reduces confidence that the proposal could be delivered within the fixed price. Please note that, per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed price.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

MARYLAND STATE HIGHWAY ADMINISTRATION

PTC-05: MAINLINES MODIFICATIONS

PAVEMENT MARKING MATERIAL SELECTION POLICY

PAVEMENT MARKINGS - NEW PAVEMENT

PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS AND BRIDGE DECKS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Principal Arterial-Other (R and U) Freeway & Expressway-Other (U)	Lane Lines: Contrast Patterned Tape with SRPMs Center Lines: Patterned Tape w/ SRPMs Edge Lines: Patterned Tape
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R&U)	Lane Lines: Contrast Patterned Tape Center Lines: Patterned Tape Edge Line: Patterned Tape
ASPHALT PAVEMENTS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeways and Expressways-Other (U)	Lane Lines: Inlaid Patterned Tape with SRPMs Center Lines: Inlaid Patterned Tape with SRPMs Edge Lines: Inlaid Patterned Tape
Principal Arterial-Other (R and U)	Lane Lines: Durable Pavement Markings with SRPMs Center Lines: Durable Pavement Markings with SRPMs Edge Lines: Durable Pavement Markings
Minor Arterial (R and U) Collectors-Major and Minor (R and U) Local (R and U)	Lane Lines: Durable Pavement Markings Center Lines: Durable Pavement Markings Edge Lines: Durable Pavement Markings

(R) = Rural and (U) = Urban

Notes:

1. **Durable Markings:** Currently defined as all pavement marking materials other than waterborne paint. Patterned tape, thermoplastic, and epoxy are three options currently available to provide material selection options to the Engineer.
2. Other new durable marking materials (i.e. polyurea, methylmethacrylate) and approaches/processes (i.e. grooving) options are available and can be used by coordinating with the Office of Materials Technology.
3. All material replacement should follow Maryland specifications for pavement marking and the manufacturer's product recommendations.
4. Eradication procedures should be followed in accordance to the Maryland Specification 565 and manufacturer recommendations.
5. **SRPM**: Currently defined as a Snowplowable raised pavement marking (SRPM) includes:
   a. Housing and lens recessed in groove
   b. Housing and lens in metal holders
   c. Housing and lens in plastic holders

Any deviations from this policy shall require documented justification and must be approved by the MDSHA Statewide Pavement Marking Committee prior to application of marking material.

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION GUIDELINES

EXISTING PAVEMENT MARKINGS - RE-STRIPING

PORTLAND CEMENT CONCRETE- (PCC) PAVEMENTS AND BRIDGE DECKS	
Existing Roadway Designation	**Line Striping Material**
All Roadway Types	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A - Contrast pattern tape for lane lines (patterned tape for edge lines) Option 1B - Epoxy **Option 2**: Restriping over existing line, use waterborne paint
ASPHALT PAVEMENTS	
Existing Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeway & Expressway-Other (U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1- 90-mil thermoplastic **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Principal Arterial-Other (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line, Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint

(R) = Rural and (U) = Urban

Note: (The notes on page one of this policy & guideline pertain to both existing & new pavements).

TEMPORARY PAVEMENT MARKINGS

ALL PAVEMENT TYPES	
Roadway Designation	**Line Striping Material**
All Roadway Types	**(Options are in prioritized sequence)** **Option 1** – Removable Preformed Wet Reflective Tape **Option 2** – Removable Preformed Tape **Option 3A** – Paint **Option 3B** – 40 Mil Thermoplastic **Option 3C** – Epoxy

Notes:

1. Paint may be used for up to 60 day's duration. If a longer duration is needed, use durable markings such as 40 Mil Thermoplastic or Epoxy or replace paint after 60 days.
2. If Option 1 is not used, temporary RPMs should be used to provide better wet night visibility. Temporary RPM's should be used to provide better delineation at critical work zone locations such as lateral shifts, curved alignments and ramp gore areas.
3. For letters, symbols, numbers, use Removable Preformed Tape.

PTC 6. Interchange Modifications

A) **Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.**

The Wellington/Jacobs Design-Build Team (Wellington/Jacobs) is proposing to improve acceleration lanes at two of the interchanges along the Corridor. Review of existing travel time data and review of the traffic operations analysis model provided by SHA reveals multiple locations where congestion occurs in the immediate vicinity of an interchange entrance ramp. Alleviating this congestion will improve overall mobility of the corridor.

These locations, which both involve high volume merges, the acceleration lanes are not long enough to allow high volumes of entering vehicles to position themselves to merge into high volume through lanes. In each instance, traffic operations within the vicinity of these ramp junctions would benefit from lengthening existing acceleration lanes.

The purpose of this PTC is not to bring all the interchanges along the Corridor into compliance with AASHTO guidelines, but to improve the ramps that cause the biggest delays in operation along the I-270 Corridor. In the locations where full AASTHO compliant acceleration lengths cannot be achieved (both sections of this PTC) due to existing obstacles (bridge abutments/piers) the length of the acceleration lanes will be extended as much as feasible without impacting the obstacles. The proposed interchange modifications include:

Montrose Road – Lengthen the acceleration lane along the southbound I-270 CD for the on-ramp from eastbound Montrose Road by 400 feet. The extension would require full depth widening to accommodate the 11-foot acceleration lane and an outside shoulder. The extension does not provide AASHTO compliant acceleration lane.

MD 28 – Lengthen the acceleration lane along the southbound I-270 CD for the loop ramp from westbound MD 28 by approximately 100 feet. The extension of the acceleration length will be performed within the footprint of the existing shoulder. Further extension of the acceleration lane would require modification to the MD 28 Overpass. The extension does not provide AASHTO compliant acceleration lane.

The existing acceleration lanes at MD 28 and Montrose Road are not AASHTO compliant, however, the proposed extensions will improve traffic operations for each of these ramps, even though they will not be fully AASHTO compliant.

Wellington/Jacobs anticipates utilizing following design measures in order to implement PTC:

i. The width of the existing shoulder will be reduced from 10-12 feet to 6.0 feet for Montrose location. MD 28 location does not have an existing shoulder in the existing condition and this configuration will not change once the extension is implemented.
ii. The width of the acceleration lanes will be narrowed to 11 feet, by restriping according to this PTC.
iii. In order to eliminate conflicts with the pavement markings (ghost stripes) Wellington/Jacobs will remove existing pavement markings by grinding existing stripes and install temporary pavement markings (paint or tape) as needed prior to final striping configurations. The final surface pavement markings shall be installed in accordance with the SHA's Pavement Marking Material Selection Policy.

- For Micro Surfacing applications, this PTC proposes to use:
  - Thin line Thermoplastic Pavement Marking material similar to the SHA I-70 application
  - VDOT Type B Class VI tape based on conversations with VDOT representatives for use on microsurfacing on limited access roadways

iv. For pavement marking removal by grinding the Wellington/Jacobs team will use micro-surfacing to fill any voids generated from removal of the striping and plowable raised pavement markers removal process.

v. The cross-slope variation between two adjacent travel lanes will be a maximum of 4.0% and the maximum rollover between the travel lane and the shoulder will be a maximum of 8.0% as per AASHTO.

vi. The Wellington/Jacobs Team proposes to implement the extension of the acceleration lane at Montrose Road using full depth reconstruction, and wedge and leveling at MD 28.

vii. As-built plans covering these sections of I-270 show the following pavement sections for outside shoulders along I-270:

- Montrose Road –
  - M 278-501-372 (I-270 from South of MD 28 to North of Montrose Road and MD 189 Interchange and Reconstruction of MD 189 from West of Ritchie Parkway to East of Maryland Avenue) - 9 inches of HMA on top of 16 inches of GAB for new construction and 4 inch overlay of existing shoulder. Plans dated 1986.
  - M 401-505-372 (I-270 from I-270 Spur to North of Montrose Road) - 9 ¾ inches of HMA on top of 16 inches of GAB for new construction and 5 ¼ inch overlay of existing shoulder. Plans dated 1987.
    - For the southbound outside shoulders, the GPR information shows the thickness of HMA ranging from 3.7 inches to 11.1 inches, with the average thickness for all readings of 9.2 inches for the southbound outside shoulders.

      A preliminary pavement section design was performed using the assumptions indicated in section D of this PTC. This preliminary design indicates a pavement thickness of 8 inches of HMA over 12 inches of GAB.

      Further review of the GPR data and comparison to the preliminary pavement design, indicates there are portions of the entire section that are less than 8 inches in thickness. The GPR data appears to be erratic laterally with the adjacent lane but it seems consistent longitudinally north and south with several changes in characteristics as summarized below.

Location by Stationing	Length	GPR Comment
158+70 to 161+00	230	GPR shows the outside shoulder to be less than 9 inches and the adjacent lane edge to be over 12 inches
157+00 to 158+70	170	GPR shows both the outside shoulder and adjacent lane edge to be less than 10 inches

154+00 to 157+00	300	GPR shows the outside shoulder to be more than 9 inches but the adjacent lane edge to be less than 10 inches
155+20 to 159+70	450	GPR data consistently less than 8 inches
160+30 to 161+00	70	GPR data consistently less than 8 inches

As indicated by the above table, there is expected to be areas with more than 8 inches of pavement and areas with less than 8 inches. Even though the design plans indicate the shoulders were overlaid in 1986 with 4.5 inches of HMA, we propose to reconstruct the length of the extension based on the GPR results with full depth reconstruction. If during the final survey and geotechnical investigation it is revealed that significant areas with GAB of more than 12 inches a hybrid section as summarized below could be used for project savings:

- Reconstructed using a hybrid pavement section that would:
  - Remove the existing asphalt
  - Remove a portion of the existing GAB (leaving at least 12 inches in place)
  - Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum of 11.5 inches of asphalt pavement, equal to the preliminary design pavement thickness.

Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. If pavement borings reveal adequate pavement thickness of greater than 8 inches we would work with SHA in the price savings through the OPCC and CAP process

- MD 28 –
  - M 278-501-372 (I-270 from South of MD 28 to North of Montrose Road and MD 189 Interchange and Reconstruction of MD 189 from West of Ritchie Parkway to East of Maryland Avenue) - 9 inches of HMA on top of 16 inches of GAB for new construction and 4-inch overlay of existing shoulder. Plans dated 1986.
    - GPR information for the outside shoulders along the southbound I-270 at MD 28 show the thickness of HMA ranging from 9.6 inches to 12.6 inches with the average thickness of all readings of 11.5 inches.

A preliminary pavement section design was performed using the assumptions indicated in section D of this PTC. This preliminary design indicates a pavement thick ness of 11.7 inches of HMA over 12 inches of GAB.

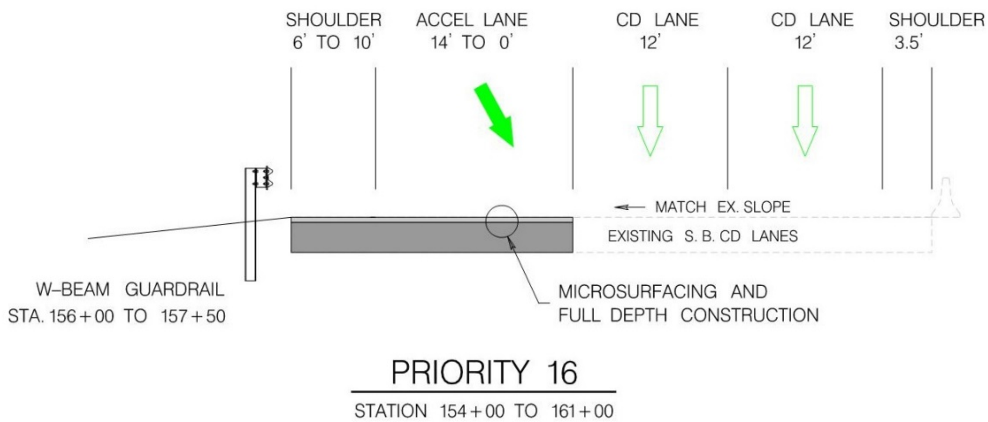
Review of available GPR data reveals all readings above 9.75 inches with most readings above 10 inches and several above 11 inches.

We propose to use this section as is with wedge and leveling performed to develop appropriate cross slopes. Therefore, the wedge and leveling process is expected to result in a pavement section of 11.7 inches or more of asphalt.

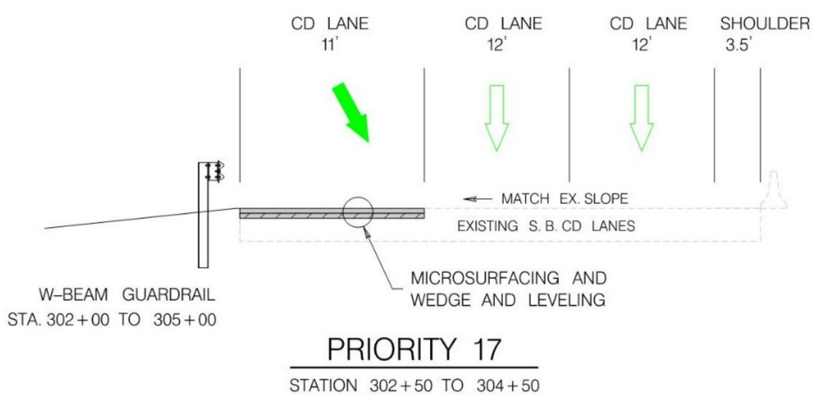
Pavement borings will be performed in accordance with SHA geotechnical guidelines to confirm the thickness of existing pavement after award. If pavement borings reveal inadequate pavement thickness of less than 11.7 inches we would reconstruct these lengths.

B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.
There are two interchanges where Wellington/Jacobs proposes to update acceleration lanes. Those locations include:

i. **Montrose Road** – Updates to acceleration lanes along the directional on-ramps in both northbound and southbound directions, Stations 154+00 to 161+00;



ii. **MD 28** – Updates to acceleration lane along the loop-ramp in southbound direction, Stations 301+50 to 304+50;



C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270.

The traffic operations analyses show that implementation of the improvements listed in PTC 6, when combined with the improvements in PTC 4, will have a significant effect on throughput along the corridor, along with travel time improvements. With these improvements in place, in 2040, during the AM peak hour, throughput along the SB I-270 CD will improve by 33 percent, and travel time along the SB I-270 CD will improve from 33.4 minutes to 8.6 minutes (a 74 percent improvement).

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – Updates to acceleration lanes will increase mobility by removing localized congestion caused by constrained merges along the I-270 corridor.

ii. **Safety** – The extension of acceleration lanes will increase safety by providing additional distance for speed changes and merge opportunities. The removal of congestion at ramp junctions has potential to decrease rear end and sideswipe crashes.

iii. **Operability / adaptive/ maintainable** – The interchange modifications will improve traffic operations and efficient flow of traffic along I-270. Since the proposed improvements will introduce new pavement (Montrose Road) and utilize existing shoulders as acceleration lanes (MD 28), the maintenance requirements will increase as the acceleration lanes lane will require more maintenance than the shoulder.

iv. **Well managed project** – The development, implementation and implementation of these proposed improvements will be coordinated and communicated with SHA and project stakeholders during design, pre-construction and construction phases of this project in order the develop a facility that addresses project goals and fulfills SHA's expectations.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with the options proposed as a part of this PTC.

ii. **Geotechnical** – We have reviewed available construction plans for past improvements along the I-270 Corridor and the GPR investigation performed along the shoulders of I-270 in 2015 to determine the existing pavement sections of the outside shoulders near the MD 28 and Montrose Road interchanges. As indicated in section A above, the data revealed:

- The pavement section for the outside shoulders was very similar for MD 28 and Montrose Road. Section consisted of 9 to 9 ¾ inch HMA on top of 16 inches of GAB.
- The GPR information resulted in similar thicknesses for MD 28, thickness of HMA ranging from 9.6 inches to 12.6 inches with the average thickness of all readings of 11.5 inches; and for Montrose Road the thickness of HMA ranging from 3.7 inches to 11.1 inches, with the average thickness for all readings of 9.2 inches for the southbound outside shoulders.

- The preliminary pavement design calculations reveled following required pavement sections for acceleration lane at Montrose Road and MD 28:
    i. Montrose Road
        1. Total # vehicles (20 years): 44,000,000
        2. Percent of vehicles in design lane: 100%
        3. Design 18-kip ESAL's: 2.8 million
        4. AASHTO Structural No. (SN): 4.4
        5. Minimum HMA thickness: 7.7" on 12" of GAB
    ii. MD 28
        1. Total # vehicles (20 years): 138,335,000
        2. Percent of vehicles in design lane: 100%
        3. Design 18-kip ESAL's: 8.9 million
        4. AASHTO Structural No. (SN): 5.7
        5. Minimum HMA thickness: 10.7" on 12" of GAB

Based on this data Wellington/Jacobs is proposing that at MD 28 the existing pavement will be left in place, wedge and leveling will be performed to address existing cross slope variations in order to provide the ramp improvements. For Montrose Road we are proposing full depth reconstruction where the running lane is proposed in the footprint of the existing shoulder and where widening is proposed to construct the improvements.

In areas where the geotechnical investigation reveals inadequate asphalt as listed above for shoulder use, but there is a thick layer of graded aggregate base (GAB), (e.g. more than 12 inches), we could use a hybrid pavement section in lieu of full depth reconstruction, as a cost savings through the OPCC and CAP process. The hybrid section will allow for the existing asphalt and a portion of the GAB to be removed and replaced with asphalt. The resulting asphalt/GAB section would be at least the HMA thickness listed above and 12 inches of base after reconstruction. The approach to a hybrid section will be as follows:

- Remove the existing asphalt
- Remove a portion of the existing GAB (leaving at least 12 inches in place)
- Replace the excavated GAB and removed asphalt with new asphalt to achieve a minimum depth of asphalt pavement as listed above.

iii. **Utilities** – There are no anticipated utility impacts associated with the options proposed for the Montrose Road and MD 28 interchanges.

iv. **Environmental Permitting -** There are no anticipated impacts to environmental resources associated with the options proposed under this PTC. Modifications to the acceleration ramps will not result in added capacity and will not require noise analysis and noise mitigations for these improvements.

v. **Local Community** – The proposed improvements will have minimal impacts on the local communities but drivers will be notified when the revised acceleration lanes will be open to traffic.

vi. **Safety** – The proposed modifications to the acceleration lanes will have a great impact on the safety along the corridor. One of the primary causes of traffic incidents is the speed differential and without adequate length of acceleration lanes the vehicles are forced to merge with the traffic before reaching the running speed of the mainline. The improvements proposed under this PTC will assist with the speed differential issue as well as provide additional merge opportunities at high volume locations along the I-270 corridor. AASHTO anecdotal data indicates that safety is not significantly impacted by reducing lane/ramp widths from 12 to 11 feet. In general, the greater the average daily traffic, and presumably the greater level of congestion during the "before" conditions, the more likely that the safety benefits from reduced congestion (resulting from an additional lane) will outweigh the potential safety issues associated with narrower ramp lane and shoulders

vii. **Life Cycle Project Infrastructure Cost –** Reconstruction of the acceleration lane at Montrose Road and wedge and leveling of the acceleration lane at MD 28 in order to implement improvements under this PTC will result in an up-front investment, but it will prolong the life of the pavement and will postpone SHA's required resurfacing/reconstruction activities.

viii. **Maintenance and Operation** - This PTC proposed minimal revisions to the existing conditions at either one of the locations. Along the extension of the acceleration lane at Montrose Road, a 6 foot outside shoulder would be provided and along the extension of the acceleration lane at MD 28 there is no existing shoulder and that configuration will not change as a part of this PTC.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

Extension of acceleration lanes in order to bring it up to AASHTO compliance, or to increase its length by restriping is a common method and not specific project is referenced.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. This Wellington/Jacobs proposed PTC would allow conversion of the outside shoulder to new ramp extensions/auxiliary lane use with few traffic restrictions during construction because we are using the shoulder section in-place with nominal resurfacing required for cross slope modifications. If more reconstruction is required, MOT would be more significant and in-place longer than initially anticipated. Wellington/Jacobs would work with SHA to provide adequate public information to ensure the public is well informed of anticipated construction sequencing.

ii. The Wellington/Jacobs team is proposing to install storm water management facilities where reconstruction is proposed as indicated in this PTC. If additional reconstruction is required based on final pavement investigations, Storm Water Management permitting would be required for these additional areas reconstructed.

iii. A condition study of existing drainage assets was not provided with the RFP materials for the Wellington/Jacobs team to assess the risk of deteriorating drainage assets but there are not drainage facilities located within the footprint of improvements proposed under this PTC. After award the Wellington/Jacobs team will perform an inventory and study of cross drainages to determine if there are any assets recommended to replace or otherwise mitigate, prior to preceding with final construction.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

i. Based on the available as-built and design drawings provided by SHA, the Wellington/Jacobs team is assuming the shoulders will be used for new ramp extensions/auxiliary lane use at MD 28 has sufficient sectional thickness to perform satisfactorily.

   At Montrose Road it is proposed to reconstruct portions of the new acceleration lane on the existing shoulder. The available GPR data along this section is variable, however the trend seems to indicate an insufficient section of asphalt along a portion (inside or outside) of the lane but not on the opposite portion (inside or outside). The Wellington/Jacobs team will perform a roadway geotechnical exploration after award in compliance with the SHA Pavement and Geotechnical Design Guide.

   If during grinding for removal of the pavement markings or grade control of the cross slope, the underlying pavement is found to be not stable, additional depths of grinding may be required.

ii. Geotechnical conditions in the widened area may not be suitable for subgrade for the widened section.

iii. Wellington/Jacobs will be required to obtain a design exception for several of the new ramp extension lengths that will not meet AASHTO recommended lengths for MD 28, and Montrose Road. We propose to team with SHA to have the design exceptions prepared soon after award to reduce potential impacts to the project schedule. If the design exception is rejected by FHWA in part or in full, Wellington/Jacobs will work with SHA to identify alternative approaches to achieve an acceptable ramp length. Design exceptions identified for this PTC are as follows:
   - Acceleration lane length – The improvements proposed under this PTC will not bring acceleration ramps into compliance with AASHTO but will improve traffic operation in this area.
   - Lane widths – The acceleration lanes proposed under this PTC are 11 foot wide.
   - The risk associated with obtaining SHA approval of the design exception prior to CAP agreement are minimal.
   - IAPA is not anticipated under this PTC, as extension of accelerations are not improvements identifies by FHWA as required of IAPA. Wellington/Jacobs will coordinate with SHA and FHWA to obtain concurrence on proposed improvements.

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

Improving acceleration lanes at two interchanges Montrose Road and MD 28 will alleviate congestion caused by speed differentials between entering and exiting traffic. In addition, lengthening the existing acceleration lanes will benefit high volume merges.

To avoid extensive widening and construction of retaining walls, all work will be done within the boundary of the existing pavement footprint. Minor widening is anticipated at the Montrose Road Interchange. The work for this PTC includes pavement reconstruction along with microsurfacing and pavement marking re-striping at both locations.

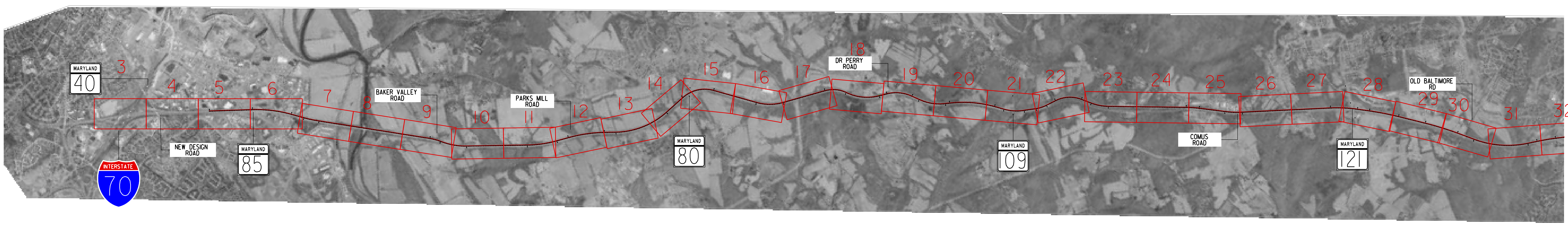
Each proposed locations can be completed in 5 months or less. As with the previous PTC's, except for minor widening, work will be performed within the existing pavement footprint. Significant cost and schedule benefits are realized from PTC 6.

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

None

Appendix 1

PTC Schematic Drawings



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

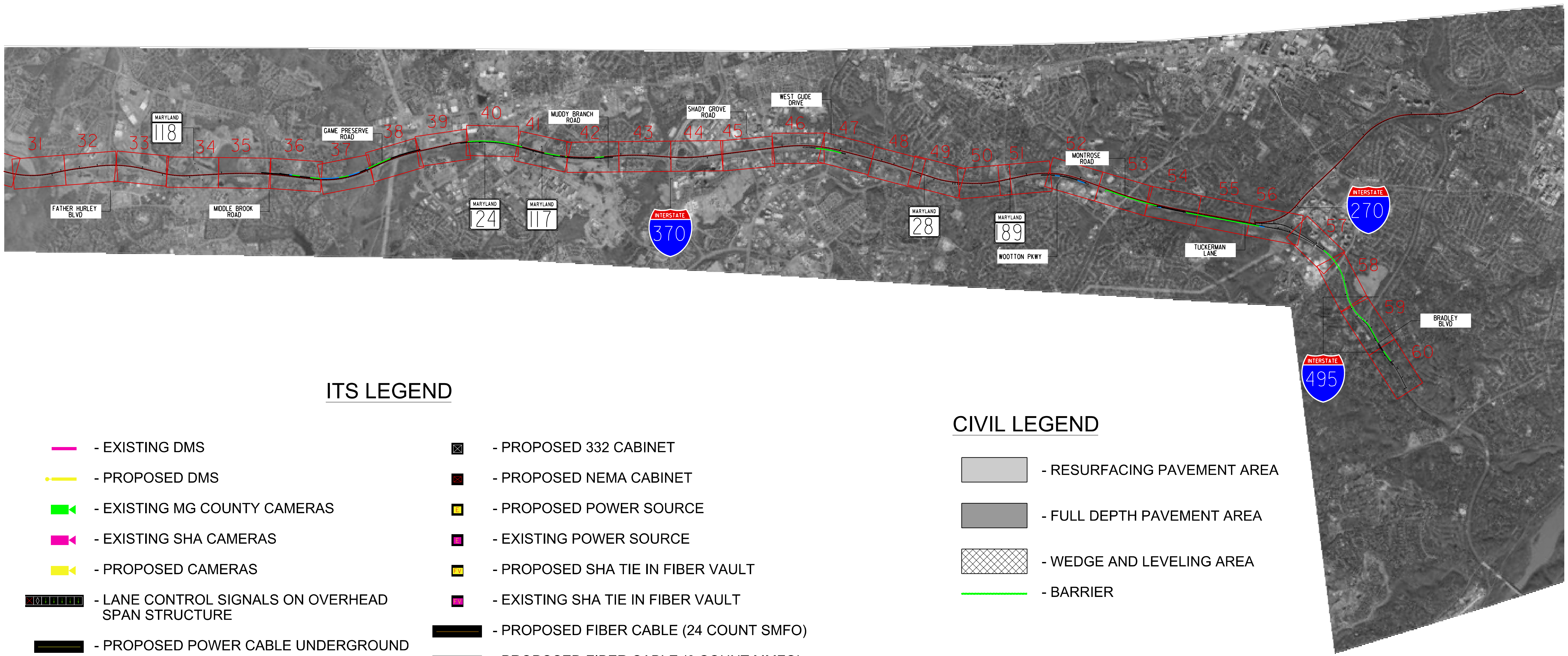
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO. OF 60

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

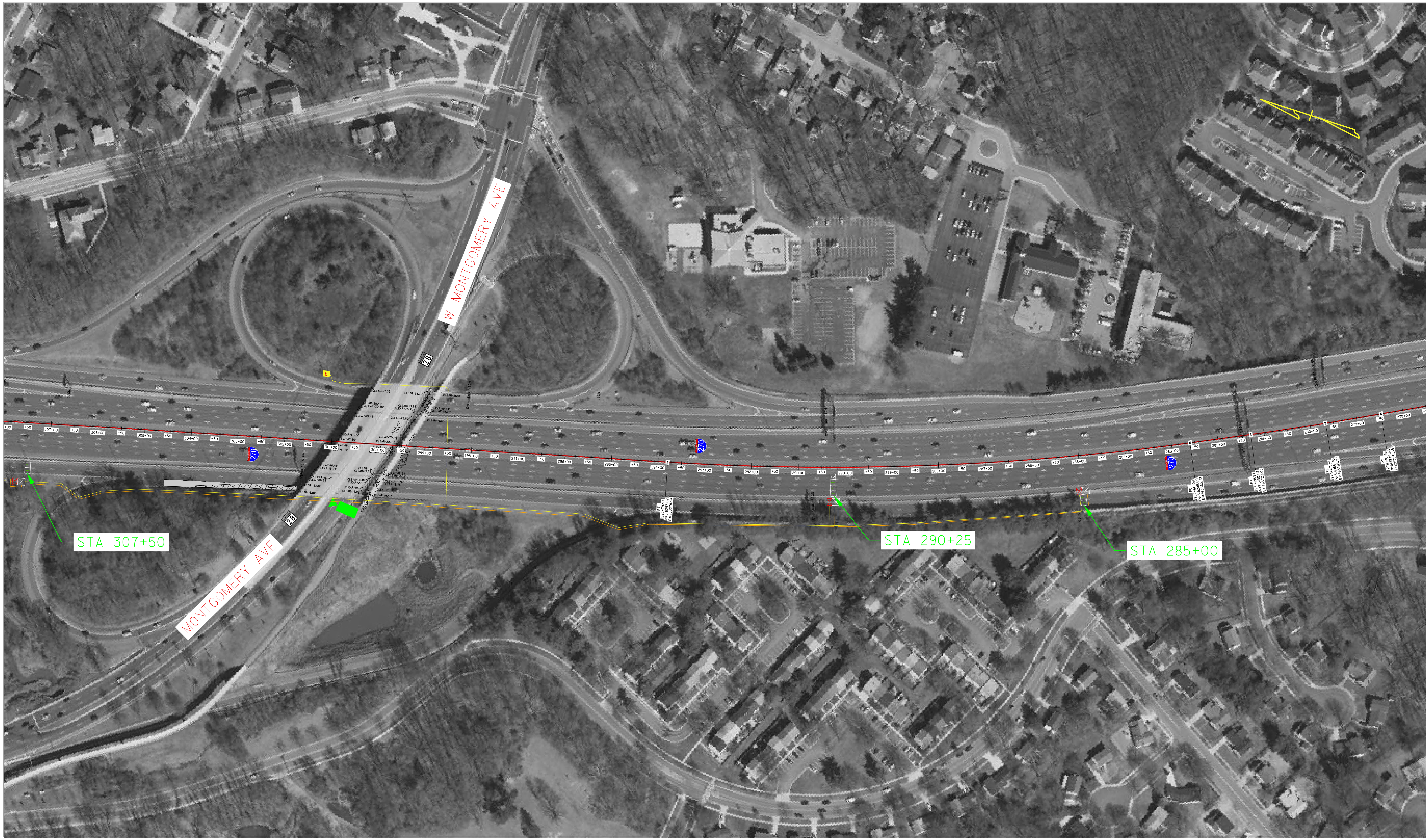
NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV | SHEET NO.
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000' | OF 60

SEE SHEET 48



SEE SHEET 50

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:08 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV | SHEET NO.

CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200' | OF 60

SEE SHEET 53

SEE SHEET 55

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:31 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. Page 480 OF 60

Larry Hogan, *Governor*
Boyd K. Rutherford, *Lt. Governor*

SHA State Highway Administration
Maryland Department of Transportation

Pete K. Rahn, *Secretary*
Gregory C. Johnson, P.E., *Administrator*

December 1, 2016

PTC-06: INTERCHANGE MODIFICATIONS

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 6 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract.
2. Section A, Description: The proposal should address alterations to operational procedures that might be necessary. Changes to shoulder areas will influence traffic incident management in the following ways:
   - Providing a safe buffer zone for emergency responders. Managed lanes can facilitate lane use and advanced warning, but full shoulders provide a work area for emergency responders which, by vehicular regulation and driver behavior, motorist don't use. Managed lanes can help, but positive guidance and physical barriers (e.g. cones) will be the only protection in a normally traveled lane (i.e. hard shoulder).
   - Use as a staging area for vehicle recovery. In Maryland, by policy and regulation in support of the towing and recovery industry, public agencies only relocate damaged and disabled vehicles to the shoulder, to stage them for final removal by industry towers. Limited shoulder availability would likely require new policies and procedures to minimize the blockage time impact while preparing for private towers to arrive.
   - Access to the incident scene. The CHART patrols, in Maryland, function as an extension of staff for the Maryland State Police, in the area of Traffic Incident Management. However, CHART patrols are not enforcement vehicles and do not have the authority of a "blue light" (police) or a "red light" (fire and rescue) emergency responders in traveling through traffic (even though they are equipped with lights and sirens). Consequently motorists may, or may not, yield right of way to CHART vehicles.

My telephone number/toll-free number is 410-545-8800 or 1-888-228-6971
Maryland Relay Service for Impaired Hearing or Speech 1.800.735.2258 Statewide Toll Free

Street Address: 707 North Calvert Street • Baltimore, Maryland 21202 • *Phone* 410.545.0300 • www.roads.maryland.gov

- Impacts of more complex incidents. Procedures and impacts need to be analyzed and addressed for more complex incidents that require more complex recovery procedures and other public safety impacts. Some of these complicating factors include: heavy/large vehicles, injuries, hazardous materials, fires, criminal activities, significant debris (e.g. a load of mulch) etc. Each of these scenarios requires different personnel and equipment on scene: fire trucks, ambulances, police vehicles, heavy equipment, etc. Shoulders provide the additional geometry to stage and maneuver these resources.

3. This PTC will require design exceptions. More detailed information related to impacts and costs of fully meeting AASHTO requirements, potential impacts to safety and operations for implementing the design exception, and mitigation, if any, which would be implemented as a result of the design exception(s) will be required for formal approval. The design exception(s) and a safety analysis must be approved prior to establishing a CAP.
4. Page 2, ii: Please clarify how the Design-Builder intends to narrow the lanes to 11 feet. Will ghost pavement markings be visible?
5. Page 2, iii: The placement of pavement markings on an interstate typically adhere to the attached Pavement Marking Material Selection Policy. Any deviation must be approved as noted in the policy.
6. Page 2, iv: Please clarify where the microsurfacing will be applied. Over the entire width of the PTS and mainline lanes that are being narrowed? Please note the use of microsurfacing will be subject to the condition of the existing surface course as specified in the MDSHA Pavement and Geotechnical Design Guide.
7. Page 3, xiii: What risk the Design-Builder wishes to share with the Administration in the last bullet is unclear. Design and Preconstruction Services Fee should be considered to be a "Guaranteed Maximum Price" or upset limit. Please refer to response 17 in the Questions & Responses document.
8. In general, typical sections would greatly improve communication of the Design-Builder's intent.
9. General comment related to risks. In the PTC, the Design-Builder in proposing to not consider many risks in its proposal which may come to fruition. In doing so, it reduces confidence that the proposal could be delivered within the fixed price. Please note that, per the adjectival ratings, the Administration will consider how well the Proposal mitigates risks and can provide its proposed improvements within the fixed price.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION POLICY

PAVEMENT MARKINGS - NEW PAVEMENT

PORTLAND CEMENT CONCRETE (PCC) PAVEMENTS AND BRIDGE DECKS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Principal Arterial-Other (R and U) Freeway & Expressway-Other (U)	Lane Lines: Contrast Patterned Tape with SRPMs Center Lines: Patterned Tape w/ SRPMs Edge Lines: Patterned Tape
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R&U)	Lane Lines: Contrast Patterned Tape Center Lines: Patterned Tape Edge Line: Patterned Tape
ASPHALT PAVEMENTS	
Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeways and Expressways-Other (U)	Lane Lines: Inlaid Patterned Tape with SRPMs Center Lines: Inlaid Patterned Tape with SRPMs Edge Lines: Inlaid Patterned Tape
Principal Arterial-Other (R and U)	Lane Lines: Durable Pavement Markings with SRPMs Center Lines: Durable Pavement Markings with SRPMs Edge Lines: Durable Pavement Markings
Minor Arterial (R and U) Collectors-Major and Minor (R and U) Local (R and U)	Lane Lines: Durable Pavement Markings Center Lines: Durable Pavement Markings Edge Lines: Durable Pavement Markings

(R) = Rural and (U) = Urban

Notes:

1. **Durable Markings:** Currently defined as all pavement marking materials other than waterborne paint. Patterned tape, thermoplastic, and epoxy are three options currently available to provide material selection options to the Engineer.
2. Other new durable marking materials (i.e. polyurea, methylmethacrylate) and approaches/processes (i.e. grooving) options are available and can be used by coordinating with the Office of Materials Technology.
3. All material replacement should follow Maryland specifications for pavement marking and the manufacturer's product recommendations.
4. Eradication procedures should be followed in accordance to the Maryland Specification 565 and manufacturer recommendations.
5. **SRPM**: Currently defined as a Snowplowable raised pavement marking (SRPM) includes:
   a. Housing and lens recessed in groove
   b. Housing and lens in metal holders
   c. Housing and lens in plastic holders

Any deviations from this policy shall require documented justification and must be approved by the MDSHA Statewide Pavement Marking Committee prior to application of marking material.

MARYLAND STATE HIGHWAY ADMINISTRATION

PAVEMENT MARKING MATERIAL SELECTION GUIDELINES

EXISTING PAVEMENT MARKINGS - RE-STRIPING

PORTLAND CEMENT CONCRETE- (PCC) PAVEMENTS AND BRIDGE DECKS	
Existing Roadway Designation	**Line Striping Material**
All Roadway Types	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A - Contrast pattern tape for lane lines (patterned tape for edge lines) Option 1B - Epoxy **Option 2**: Restriping over existing line, use waterborne paint
ASPHALT PAVEMENTS	
Existing Roadway Designation	**Line Striping Material**
Interstates (R and U) Freeway & Expressway-Other (U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1- 90-mil thermoplastic **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Principal Arterial-Other (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint
Minor Arterial (R and U) Collectors-Major & Minor (R and U) Local (R and U)	**Option 1**: Restriping with durable markings, eradicate existing markings with 80% removal of existing markings Option 1A – 40-mil thermoplastic Option 1B – Epoxy **Option 2**: Restriping over existing line, Option 2A- 40 mil thermoplastic only over thermoplastic or paint Option 2B- waterborne paint

(R) = Rural and (U) = Urban

Note: (The notes on page one of this policy & guideline pertain to both existing & new pavements).

TEMPORARY PAVEMENT MARKINGS

ALL PAVEMENT TYPES	
Roadway Designation	**Line Striping Material**
All Roadway Types	**(Options are in prioritized sequence)** **Option 1** – Removable Preformed Wet Reflective Tape **Option 2** – Removable Preformed Tape **Option 3A** – Paint **Option 3B** – 40 Mil Thermoplastic **Option 3C** – Epoxy

Notes:

1. Paint may be used for up to 60 day's duration. If a longer duration is needed, use durable markings such as 40 Mil Thermoplastic or Epoxy or replace paint after 60 days.
2. If Option 1 is not used, temporary RPMs should be used to provide better wet night visibility. Temporary RPM's should be used to provide better delineation at critical work zone locations such as lateral shifts, curved alignments and ramp gore areas.
3. For letters, symbols, numbers, use Removable Preformed Tape.

PTC 7. Off Corridor Improvements

A) Description: Detailed descriptive information and other appropriate information as appropriate such as conceptual drawings, production details, standards, specifications, and traffic operation analysis.

The Wellington/Jacobs Design Build Team (Wellington/Jacobs) is proposing improvements outside of the I-270 Corridor to address the source of delay and back-ups spilling onto the northbound I-270 CD lanes at the MD 117 interchange.

The existing loop ramp from the northbound I-270 CD to MD 117 experiences significant queuing during the PM peak period, which results in significant congestion along the CD lanes. The source of the congestion is not the ramp itself, nor the signalized intersection at its terminus, but queues and delays along westbound MD 117 resulting from the intersection of MD 117 and MD 124. The signal timings and signal coordination along the MD 117 corridor, in combination with a queue detector along the ramp from the northbound CD lanes to MD 117, will be used to allow westbound MD 117 queues to flush when congestion develops, to reduce the adverse effects this queue has on operations along the northbound I-270 CD.

B) Location: The locations where, and an explanation of how, the PTC will be used on the Project.

There is one location where the Off-Corridor Improvements are proposed. This location is:

i. **Along MD 117** from MD 124 to the Ramp from NB I-270– Modification of signal timing and coordination at the intersections of MD 124 and MD 117, MD 117 and Bureau Drive, and MD 117 at the Ramp from NB I-270.

C) Analysis justifying the use of the PTC including how it advances the project goals.

Traffic operations analyses were performed for the base year and horizon year (2040) using models developed in Vissim analysis software and provided by SHA. Congestion along the I-270 corridor is primarily southbound during the AM peak hour, and primarily northbound during the PM peak hour. Therefore, the AM peak hour models were used to develop improvement concepts for SB I-270 and the PM peak hour models were used to develop improvement concepts for NB I-270.

This congestion point (the signal at MD 117 and MD 124) along the NB I-270 CD, results in significant queues and delays along both mainline NB I-270 and the NB I-270 CD. It is proposed to alleviate the congestion by improvements to the arterial network beyond the I-270 corridor. Relief of this congestion point will result in improved throughput, eliminating a critical bottleneck that will allow the corridor to experience added benefit with this restriction to overall traffic flow mitigated.

The traffic operations analyses show that this improvement, in conjunction with an improvement that will alleviate the bottleneck at the north end of the NB I-270 Road, will allow travel time along the NB I-270 CD to reduce from 59.2 minutes to 21.7 minutes with an overall improvement in throughput of 23 percent during the PM peak hour in 2040.

The use of this PTC advances the 4 primary project goals as follows:

i. **Mobility** – The Off-Corridor Improvement will increase mobility along the I-270 Corridor by removing traffic back-ups that spill onto the CD lanes and eventually impact the I-270 mainline lanes, resulting in slower speeds, delays and un-safe conditions along the impacted I-270 lanes. Modification to the signal timings and coordination for intersections along MD 117 in the vicinity of I-270 will address queues and delays along MD 117 that affect operations along northbound I-270, and thereby increase the mobility along I-270.

ii. **Safety** – Removal of the back-up spilling onto the I-270 CD lanes will create safer conditions for the vehicles using the I-270 corridor and the vehicles exiting the I-270 corridor and entering the surrounding traffic network.

iii. **Operability / adaptive/ maintainable** – The Off-Corridor Improvement will improve operations along the Corridor by reducing congestion and traffic queues, by implementing queue detection along the ramp from NB I-270 to MD 117, which will trigger changes to the signal timing at intersection along MD 117 in the vicinity of I-270, including at the intersection of MD 124 and MD 117. The signal timing will be modified to maximize throughput along WB MD 117 to remove back-ups spilling onto I-270 lanes.

iv. **Well managed project** – The development and implementation of this proposed improvement will be coordinated and communicated with SHA and project stakeholders during design, pre-construction, and construction phases of this project in order to develop a facility that addresses project goals and fulfills SHA's expectations. The modification of the traffic signal timings along MD 117, including at the MD 124/MD 117 intersection will be coordinated with Montgomery County as the signal timing for all signals in Montgomery County, including signals along State roadways, are maintained by Montgomery County.

D) Potential Impacts: A preliminary analysis of potential impacts (both during and after construction) including but not limited to user impacts, Right-of-Way, geotechnical, utilities, environmental permitting, local community, safety, and life-cycle project and infrastructure costs, including impacts on the cost of repair, maintenance, and operation.

i. **Right of Way** – There are no anticipated Right of Way impacts associated with the Off-Corridor Improvement. The modification of the signal timing requires no right of way to implement.

ii. **Geotechnical** - There are no geotechnical impacts for this PTC.

iii. **Utilities** – The proposed Off Corridor Improvement will impact the timing of exiting signals along MD 117 at the intersections of MD 124 and MD 117, MD 117 and Bureau Drive, and MD 117 at the Ramp from NB I-270, and queue detector installation along the ramp from NB I-270 to MD 117.

iv. **Environmental Permitting -** There are no anticipated impacts to environmental resources associated with the Off-Corridor Improvement.

v. **Local Community** – The proposed improvement will have minimal impacts on the local communities.

vi. **Safety** – Removal of the back-up spilling onto the I-270 lanes will create safer conditions for the vehicles using I-270 corridor and the vehicles exiting the I-270 corridor and entering the local network. This improvement has the potential of limiting congestion-related rear-end crashes.

vii. **Life Cycle Project Infrastructure Cost –** This improvement will not have an impact on the life cycle infrastructure cost.

E) Other projects: A description of other projects on which the PTC has been used, the degree of success or failure of such usage, and the names and contact information (including telephone numbers and e-mail addresses) of owner representatives who can confirm such statements.

Adjusting signal timing is a common practice to improve traffic throughput and safety.

F) Administration Risk: A description of risk to the Administration or third parties associated with implementing the PTC.

i. Coordination with Montgomery County will be required to effectively implement this PTC. Signal timing and signal coordination modifications along MD 117 from MD 124 to the Ramp from NB I-270 will be critical for this PTC to maximize its benefits. The Wellington/Jacobs team will assist SHA with coordination and information sharing with Montgomery County.

G) Design-Builder Risk: A description of risk to the Design-Builder associated with implementing the PTC.

i. If Montgomery County refuses to allow adjustment of the signal timing the resulting improved throughput would not be realized. Montgomery County will benefit from this solution as it is motorists exiting I-270 to access Montgomery County roads that will benefit.

H) Cost/Schedule Benefits: Discussion of any cost of schedule benefits to this contract from usage of this PTC.

Signal modifications will relieve congestion by alleviating queues along the exit ramp from NB I-270 to MD 117.

I) Miscellaneous: Any additional information that would assist the administration in the review of this PTC.

None

December 1, 2016

PTC-07: OFF-CORRIDOR IMPROVEMENTS

RESPONSES / COMMENTS

Mr. Craig Robash
Wellington Power Corporation
117 Thorn Hill Road
Warrendale PA 15086

Dear Mr. Robash:

The Maryland Department of Transportation's State Highway Administration's (SHA) is in receipt of Proposed Technical Concept (PTC) No. 7 for the I-270 Innovative Congestion Management Progressive Design-Build contract (Contract No. MO0695172), submitted by your Design-Build Team on November 17, 2016. The SHA has completed our review of the PTC and offers the following comments for your consideration in the further development of your technical concepts and proposal:

1. Generally, the concept appears to be a reasonable solution to address the goals of this contract; however, as noted in Section F, Administration Risk, this solution will likely require Montgomery County buy-in to be successfully implemented.

Any questions or communications regarding the response to this PTC should be directed to Mr. Jason A. Ridgway, Director, Office of Highway Development at the project specific email address, MO069_IS_270@sha.state.md.us.

Sincerely,

Jason A. Ridgway, P.E.
Director, Office of Highway Development

cc: Mr. C. Scott Winters, Wellington Power Corporation

CONCEPT OF OPERATIONS

Active Traffic & Demand Management Concept of Operations

IS 270 – Innovative Congestion Management Contract
Montgomery and Frederick Counties

Maryland Department of Transportation - State Highway Administration

| Draft – Inclusion with Contract Proposal

January 19, 2017

Document history and status

Revision	Date	Description	By	Review	Approved
Internal Draft	10/17/16	Draft Concept of Operations for internal review	Randall		
Draft	11/16/16	Draft ConOps for submission to SHA with PTC	Randall		
Draft	1/19/17	Draft ConOps for Submission with Contract Proposal	Randall/VanDillen		

IS 270 – Innovative Congestion Management Contract

Project No:	E4X52401
Document Title:	Active Traffic & Demand Management Concept of Operations
Document No.:	
Revision:	Draft
Date:	January 19, 2017
Client Name:	Maryland Department of Transportation - State Highway Administration
Client No:	Client Reference
Project Manager:	Jeff Randall
Author:	Jeff Randall
File Name:	P:\E4X52400 I-270 ICM PDB Design\600DISC\611 ITS\ConOps\IS270 ATM ITS ConOps draft for PTC 111716.docx

Jacobs Engineering Group Inc.

100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
United States
T +1.410.837.5840
F +1.410.837.3277
www.jacobs.com

Contents

Acronyms

ARM	Adaptive Ramp Metering
ATM	Active Traffic Management
ATMS	Advanced Traffic Management System
CATT	Center for Advanced Transportation Technology
CCTV	Closed Circuit Television
CHART	Coordinated Highways Action Response Team
ConOps	Concept of Operations
COTS	Commercial-off-the-Shelf
COTSS	Commercial-off-the-Shelf Software
DMS	Dynamic Message Sign
DShoulder	Dynamic Shoulder Lanes
DSpeed	Dynamic Speed Limits
FHWA	Federal Highway Administration
ERU	Emergency Response Units
ETP	Emergency Traffic Patrol
FTE	Full-Time Equivalent
GP	General Purpose
GPS	Global Positioning System
HOV	High Occupancy Vehicle
HSR	Hard Shoulder Running
IP	Internet Protocol
IRT	Incident Response Team
I-270 ICM	I-270 Innovative Congestion Management Project
ITS	Intelligent Transportation System
LCD	Lane Control Display
LCS	Lane-use Control Signal
LED	Light Emitting Diode

MCDOT	Montgomery County Department of Transportation
MDOT	Maryland Department of Transportation
MDTA	Maryland Transportation Authority
MSP	Maryland State Police
MUTCD	Manual on Uniform Traffic Control Devices
NTCIP™	National Transportation Communications for ITS Protocol
O&M	Operations and Maintenance
PM	Preventive Maintenance
PS&E	Plans, Specifications and Estimate
QW	Queue Warning
RITIS	Regional Integrated Transportation Information System
RWIS	Roadway Weather Information Systems
SFVD	Side-Fire Vehicle Detectors
SOC	SHA Statewide Operations Center
SOP	Standard Operating Procedure
SOV	Single-Occupant Vehicle
STM	Surface Transport Management
TAR	Traveler Advisory Radio
TMC	Traffic Management Center
TMS	Transportation Management System
UPS	Uninterruptible Power Supply
US	United States

Executive Summary

Page intentionally left blank

1. Purpose of the Document

1.1 Identification

This document is the Concept of Operations Report (ConOps) for the Maryland State Department of Transportation - State Highway Administration (SHA) Active Traffic & Demand Management (ATDM) Proposed Technical Concept (PTC) for the IS 270 – Innovative Congestion Management Contract, Montgomery and Frederick Counties (I-270 ICM). Specific revision information can be found in the *Document history and status* Table at the front of this document.

1.2 Document Overview

This document provides a description of ATDM and its initial goals, vision, and high-level concepts. This document is written for readers of all levels and provides information on the project justification, stakeholder and operational needs, system overview, operations and maintenance budgeting and an overall concept of operations for the ATDM program.

The purpose of this document is to communicate the current understanding of the user needs associated with ATM and to provide insight into how these systems might be implemented and procured for the I-270 ICM Project. The descriptions contained within this document are at a high-level and do not include system details that will be provided by systems designers. System details will be captured and documented in the appropriate phases of the project. At the current time, there are no known security or privacy issues associated with the contents of this document. This document contains the following sections:

- **2.0 Scope of the Project** This section gives a brief overview of the I-270 system to be built. It includes its purpose and a high-level description. It describes what area will be covered and which agencies will be involved, either directly or through interfaces.
- **3.0 Referenced Documents** This section contains a list of any supporting documentation used and other resources that are useful in understanding the operations of the system.
- **4.0 Background** This is a brief description of the current system or situation, how it is used currently, and its drawbacks and limitations.
- **5.0 Concept for the Proposed System** This section describes the concept exploration including a list and description of the alternative concepts examined, and the evaluation and assessment of each alternative for justification. The operational concept for that selected approach is described here.
- **6.0 User-Oriented Operational Description** In this section, the document focuses on how the goals and objectives are currently accomplished. It includes who users are and what the users do. Specifically, it covers when, and in what order, operations take place, personnel capabilities, organizational structures, personnel & inter-agency interactions, and types of activities.
- **7.0 Operational Needs** Here is a description of the vision, goals & objectives, and personnel needs that drive the requirements for the system. Specifically, this describes what the system needs to do that it is not currently doing.

JACOBS

- **8.0 System Overview** This is an overview of the system to be developed. This describes its scope, the users of the system, what it interfaces with, its states and modes, the planned capabilities, its goals & objectives, and the system architecture.
- **9.0 Operational Environment** This section describes the physical operational environment in terms of facilities, equipment, computing hardware, software, personnel, operational procedures and support necessary to operate the deployed system.
- **10.0 Support Environment** This describes the current and planned physical support environment. This includes facilities, utilities, equipment, computing hardware, software, personnel, operational procedures, maintenance, and disposal. This includes expected support from outside agencies.
- **11.0 Operational Scenarios** Each scenario describes a sequence of events, activities carried out by the user, the system, and the environment. It specifies what triggers the sequence, who or what performs each step, when communications occur and to whom or what [e.g., a log file], and what information is being communicated.
- **12.0 Summary of Impacts** This is an analysis of the proposed system and the impacts on each of the stakeholders. It is presented from the viewpoint of each, so that they can readily understand and validate how the proposed system will impact their operations.
- **13.0 Appendices** This contains background material for any of the sections.

2. Scope of the Project

The section will present the purpose of the system being proposed, a brief overview of the system and its anticipated benefits, and a summary of the agencies involved.

2.1 Problem Statement

I-270 is the most congested freeway in the State. The I-270 Corridor links significant suburban residential concentrations with the major employment regions of Northern Virginia, downtown Washington, D.C., the Capital Beltway, and along the I-270 Corridor itself. As with most urban areas in the United States, the trend in the Metropolitan Washington, D.C. area has been that development expands outward from the city. However, most commuters in the I-270 Corridor are not heading into Downtown Washington, but to other suburban locations. Because of high-traffic volumes in the corridor, and the impact that incidents even outside the corridor can have on I-270 conditions, congestion has become a monumental problem. Further, it is brought to a complete stop in areas during an incident.

2.2 I-270 Innovative Congestion Management Project

The project is intended to address the following transportation goals:

- **Mobility** – Provide improvements that maximize vehicle throughput, minimize vehicle travel times, and create a more predictable commuter trip along IS 270.
- **Safety** – Provide for a safer IS 270 corridor.
- **Operability/Maintainability/Adaptability** – Provide improvements that minimize SHA operations and maintenance activities while being adaptable to future transportation technological advancements. [1]

This will be accomplished by improving the incident detection infrastructure with more detection to augment that which already exists, to provide better surveillance by providing full video coverage, and to implement Active Traffic Management strategies to reduce congestion and accidents. These strategies include dynamic shoulder use to improve capacity, and dynamic speed limits, dynamic junction control, dynamic lane use control, and queue warning to reduce congestion, delay and accidents.

The strategies, or subsystems, will include:

- Freeway management system
- Traveler information system
- Traffic surveillance and monitoring system

The components of these systems and their anticipated benefits are illustrated in the Table below.

[1] IS 270 – Innovative Congestion Management Contract, Request for Qualifications/Request for Proposals, Maryland State highway Administration, June 7, 2016

System	Components	Anticipated Benefits
Freeway Management System	Closed-circuit television, lane control signals, advisory speed signs, dynamic message signs; travel time signs	Reduced delay; provide smoother flow; larger pace population; fewer accidents, reduced travel time; queue warning; merge control
Traveler Information System	Dynamic message signs	Enhanced traveler information; reduced delay during incidents; inform motorists of expected travel time
Incident Management System	Vehicle detection on mainline; presence detection on temporary use shoulder; automated incident management	Reduced delay during incidents; faster detection of, diagnosis of, and response to incidents

Table 1: I-270 Corridor Subsystems

2.3 Project Limits

There are no defined project limits for the contract to improve I-270. The strategies, however, will be implemented along most of I-270 from I-70 to the north through the spurs and include the outer loop of I-495 to the American Legion Bridge.

2.4 Project Stakeholders

The users of the I-270

- Maryland State Highway Administration — Management of I-270 network and Park-n-Ride facilities along I-270.
- Montgomery County Department of Transportation (MCDOT) — Management of the county's arterial network, as well as the Ride On bus service.
- Maryland State Police — Enforcement, security, and accident investigations on I-270.
- Montgomery County Police — Enforcement, security, and accident investigations on I-270 and Montgomery County arterials.
- City of Rockville — Management of the arterial network in Rockville.
- City of Gaithersburg – Management of the arterial network in Gaithersburg.
- University of Maryland's Center for Advanced Transportation Technology (CATT) — Maintenance and operation of the Regional Integrated Transportation Information System (RITIS).

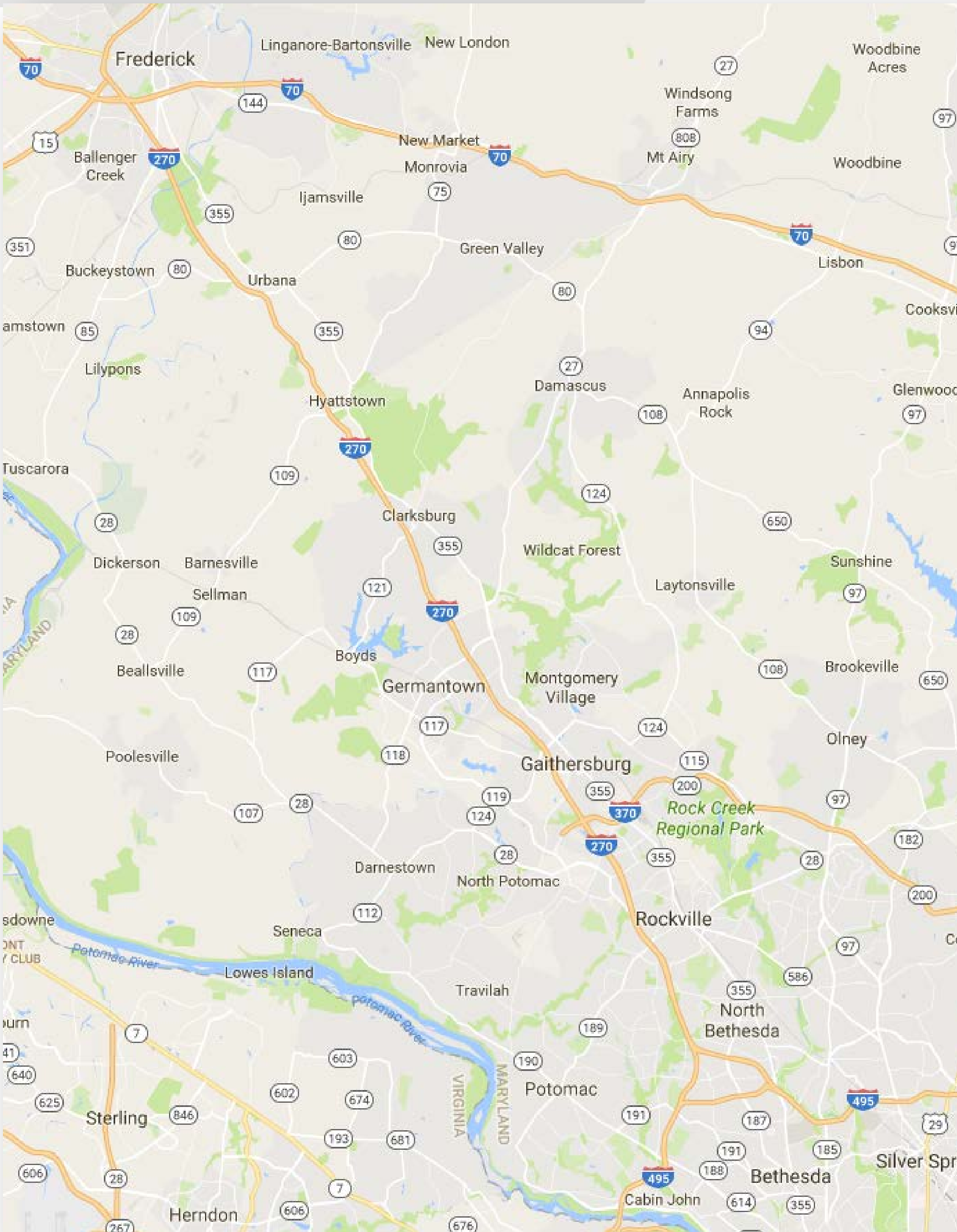


Figure 1: I-270 Corridor

3. Reference Documents

1. Request for Qualifications (RFQ) / Request for Proposals (RFP), I-270 – Innovative Congestion Management Contract - Montgomery and Frederick Counties, Contract, Contract No. MO0695172, Maryland Department of Transportation – State Highway Administration, June 2016
2. Systems Engineering for Intelligent Transportation Systems – An Introduction for Transportation Professionals, US Department of Transportation, January 2007.
3. Congestion Management Process: A Guidebook, US Department of Transportation, April 2011
4. Use of Freeway Shoulders for Travel – Guide for Planning, Evaluating, and Designing Part-Time Shoulder Use as a Traffic Management Strategy, US Department of Transportation, January 2016
5. “Long Range Strategic Deployment Plan”, Office of CHART and ITS Development, Maryland Department of Transportation - State Highway Administration, 2013
6. Concept of Operations for the I-270 Corridor in Montgomery County, Maryland, USDOT Integrated Corridor Management (ICM) Initiative, Maryland Department of Transportation, March 2008
7. 2014 Performance Evaluation and Benefit Analysis for CHART, University of Maryland, 2015
8. Maryland Transportation Systems Management and Operations (TSM&O) Strategic Implementation Plan, Maryland Department of Transportation - State Highway Administration, 2016

4. Background

4.1 Existing Conditions

I-270 runs north-south with two connections to I-495 at the south end; I-270 proper connecting to I-495 to the east in the Bethesda area at the MD 355 interchange, and the I-270 Spur connecting to I-495 to the south/west to and from the American Legion Bridge/Northern Virginia area. The east connection serves Washington DC, Bethesda, College Park, the I-95 corridor, US 50/Annapolis/Eastern Shore and Andrews AFB/Southern Maryland locales, while the south/west connection serves the Clara Barton and George Washington Parkways, Dulles Airport, I-66 and I-95 toward Richmond.

I-270, and the network of area arterials and major streets that serve as parallel routes and feeders that complement and support the I-270 function, is the economic life-stream of the businesses and communities that lie along the Washington-to-Frederick corridor. The Quality-of-Life for the 1.5 million residents of the affected corridor is hugely dependent upon effective/efficient highway transportation operations, accomplished in concert with ample, interconnected mass transit opportunities.

4.2 Traffic Management Program

The Coordinated Highways Action Response Team (CHART) is Maryland's operations element for the state's transportation program. Its mission is *to improve mobility and safety for the users of Maryland's highways through the application of ITS technology and interagency teamwork.* CHART is a joint effort of the Maryland Department of Transportation (MDOT), Maryland State Highway Administration (MDSHA), Maryland Transportation Authority (MDTA), and the Maryland State Police (MSP), in cooperation with federal, other state, and local agencies.

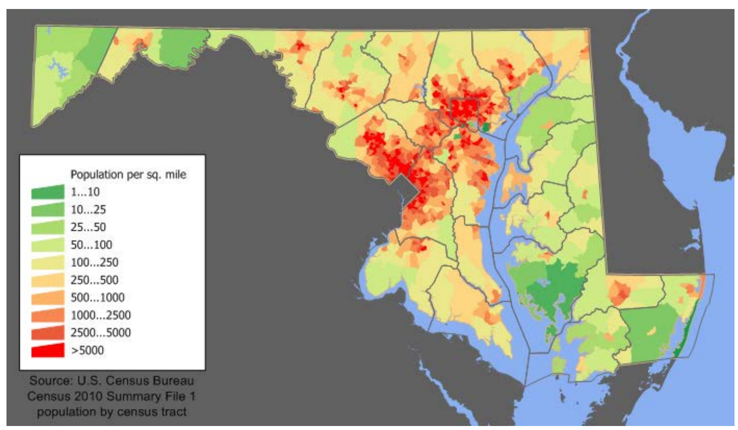


CHART accomplishes its mission by focusing on mitigation of non-recurring congestion that occurs due to events such as crashes, breakdowns, construction, weather, etc. According to the FHWA, non-recurring congestion is the cause of about 50 percent of highway congestion. Recurring congestion – generally caused by high volumes on highways with limited capacity – accounts for the other fifty percent[2].

At the heart of CHART is the Statewide Operations Center, which houses the central computing system that monitors the state highways in real-time, including I-270, and monitors and controls the ITS devices including detectors, closed circuit television cameras (CCTV), traveler advisory radios (TAR), dynamic message signs (DMS), and road weather information systems (RWIS). CHART's current functionality is in incident detection and management. It doesn't possess active traffic management functionality.

2 CHART Long Range Strategic Deployment Plan, Maryland State Highway Administration, 2013

4.2.1 ITS Infrastructure

Given the importance and operating condition of I-270 more ITS field infrastructure is necessary. The density of detection deployment is lacking to provide the level of incident detection necessary. Similarly, CCTV coverage leaves many gaps along I-270. Most notable is the fact that along the Spurs, only one CCTV camera exists.

There is much more CCTV coverage in the Montgomery County portion of I-270 although, it is still lacking. Further complicating the traffic management capabilities is the fact that these cameras are the property of Montgomery County DOT. While the images are shared with SHA - and they provide reasonable views of I-270 – SHA has not control. Should the SOC require a different view with the camera at any given time, they must contact MCDOT via telephone and request them to make the change.

4.3 Current Operating Conditions

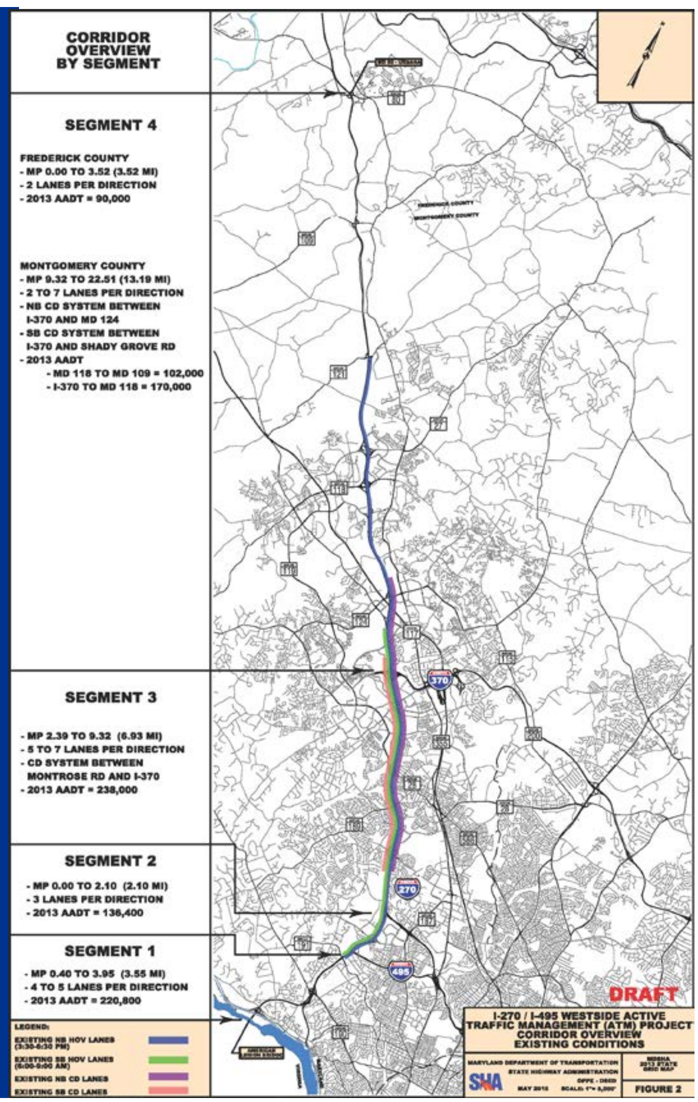
I-270 is one of the most travelled highways in the State with average daily traffic of about 240K in many segments. It is one of the most congested corridors in MD and the Washington, DC region with strong directional peaks. It operates with over-saturated conditions and extended peak periods that greatly impacts reliability. Much of the corridor is over capacity, and operates at

Segment 1: VA to I-270 Y
- 3.5 miles
- 4-5 lanes per direction
- 220,800 AADT

Segment 2: I-270 West Spur
- 2.1 miles - Existing HOV
- 3 lanes per direction
- 136,400 AADT

Segment 3: I-270 Y to I-370
- 6.9 miles - Existing HOV
- 5-7 lanes per direction - Existing CD
- 238,000 AADT

Segment 4: I-370 to MD 80
- 16.7 miles - Existing HOV (to MD 121)*
- 2-5 lanes per direction - Existing CD (to MD 124)*
- 90,000 to 170,000 AADT



unacceptable levels of service as shown in the following LOS stick maps of existing (2014) and future 2040 volumes.

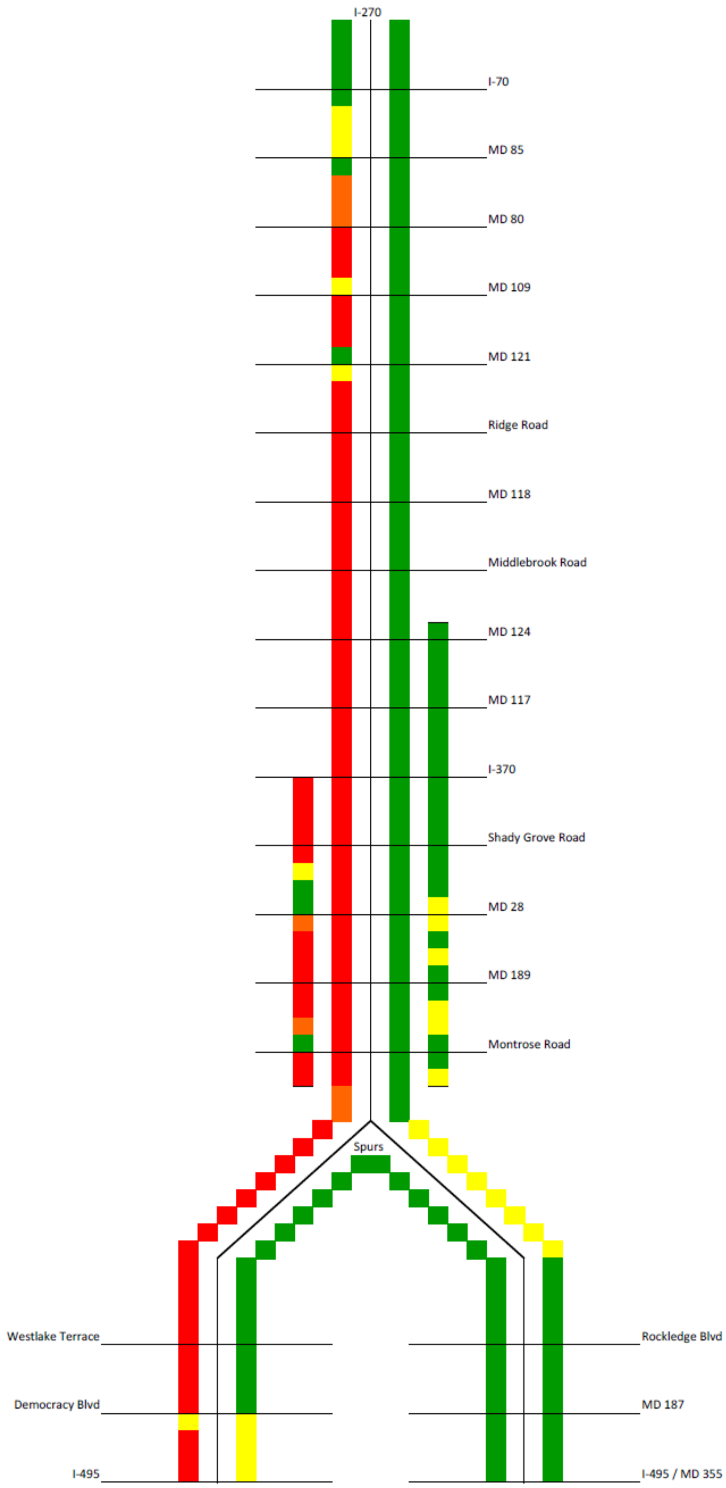


Figure 2: Existing 2014 AM Peak Hour Level of Service Along I-270

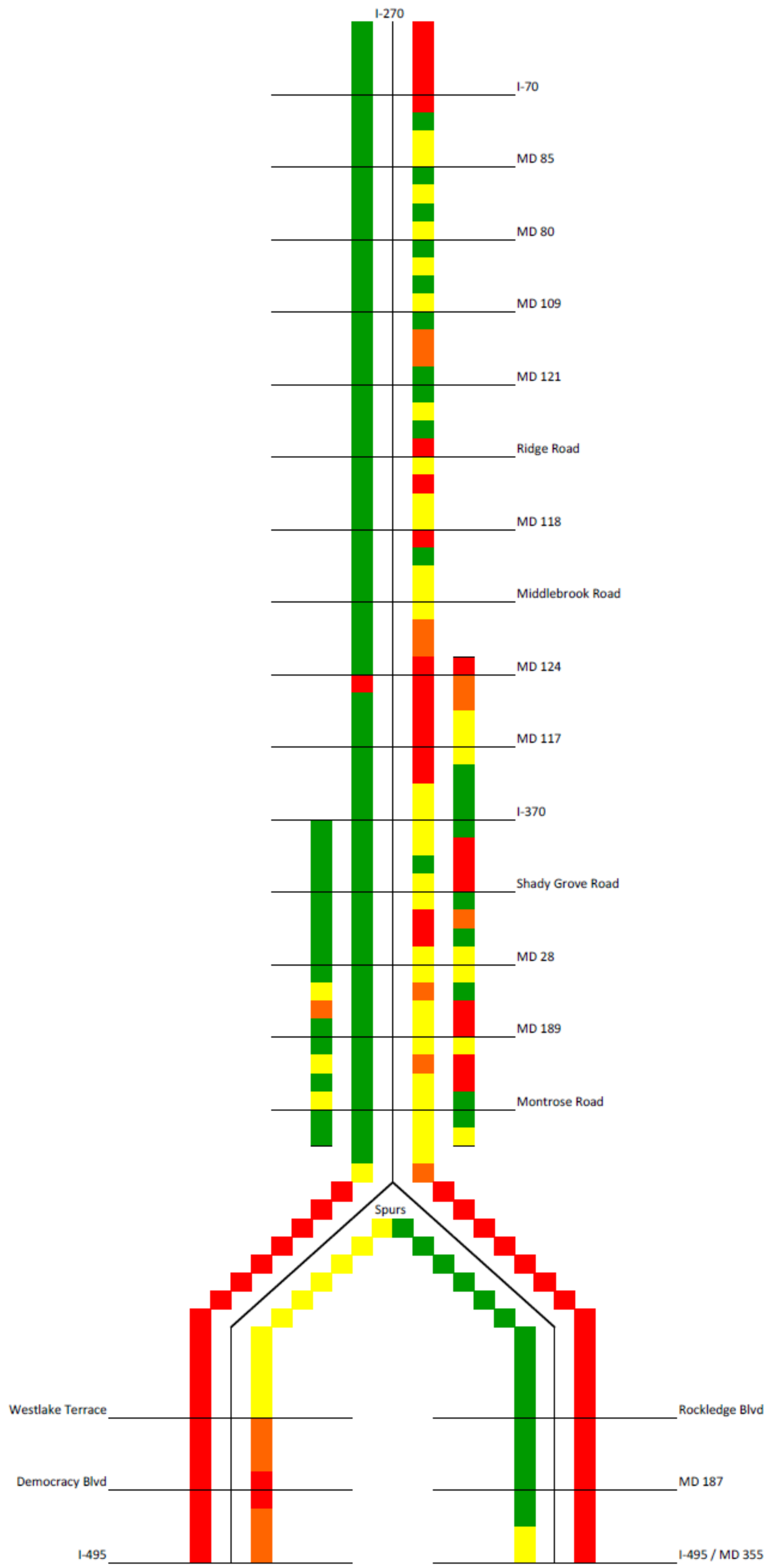


Figure 3: Existing 2014 PM Peak Hour Level of Service Along I-270

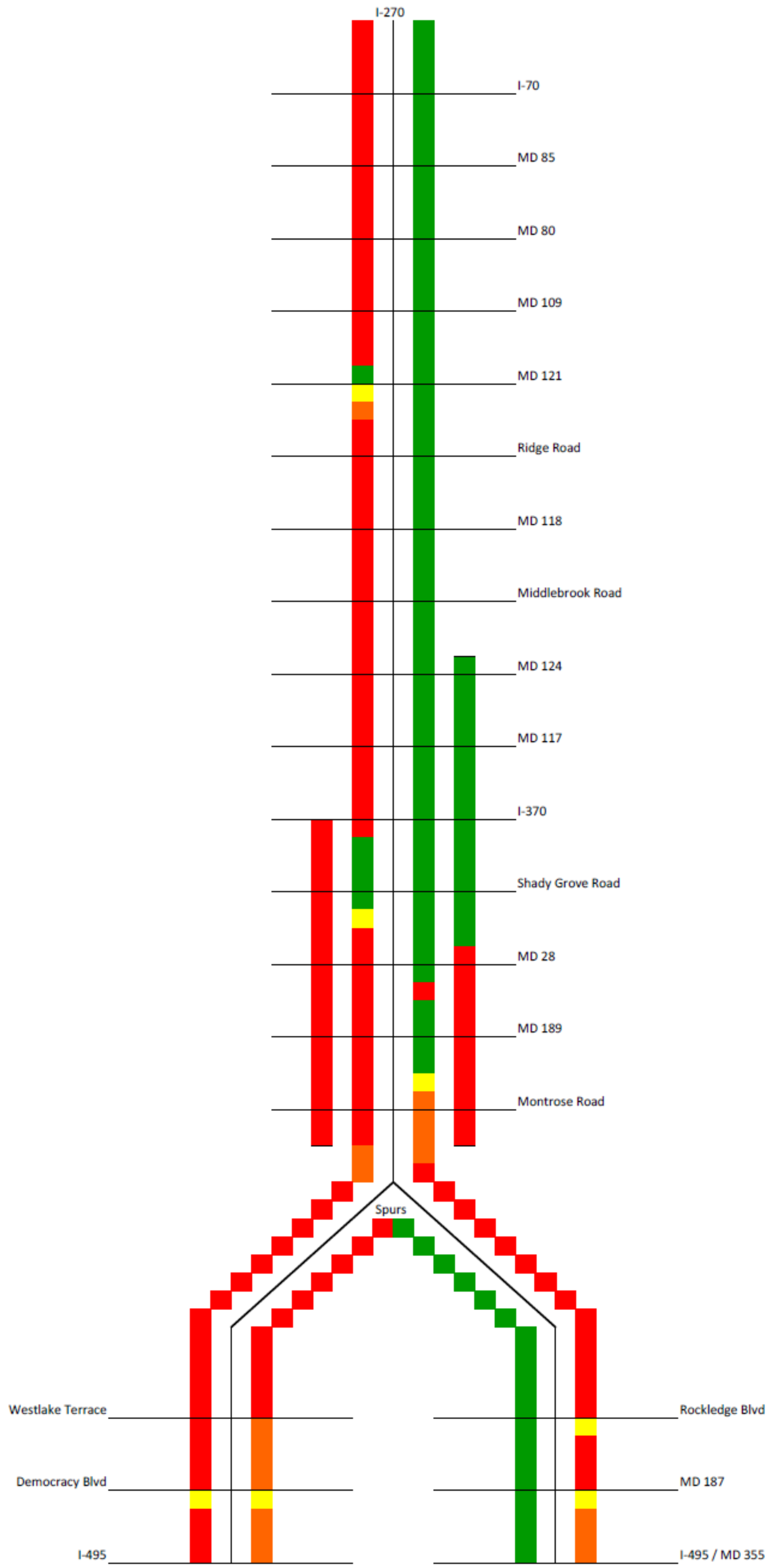


Figure 4: Projected 2040 AM Peak Hour Level of Service Along I-270

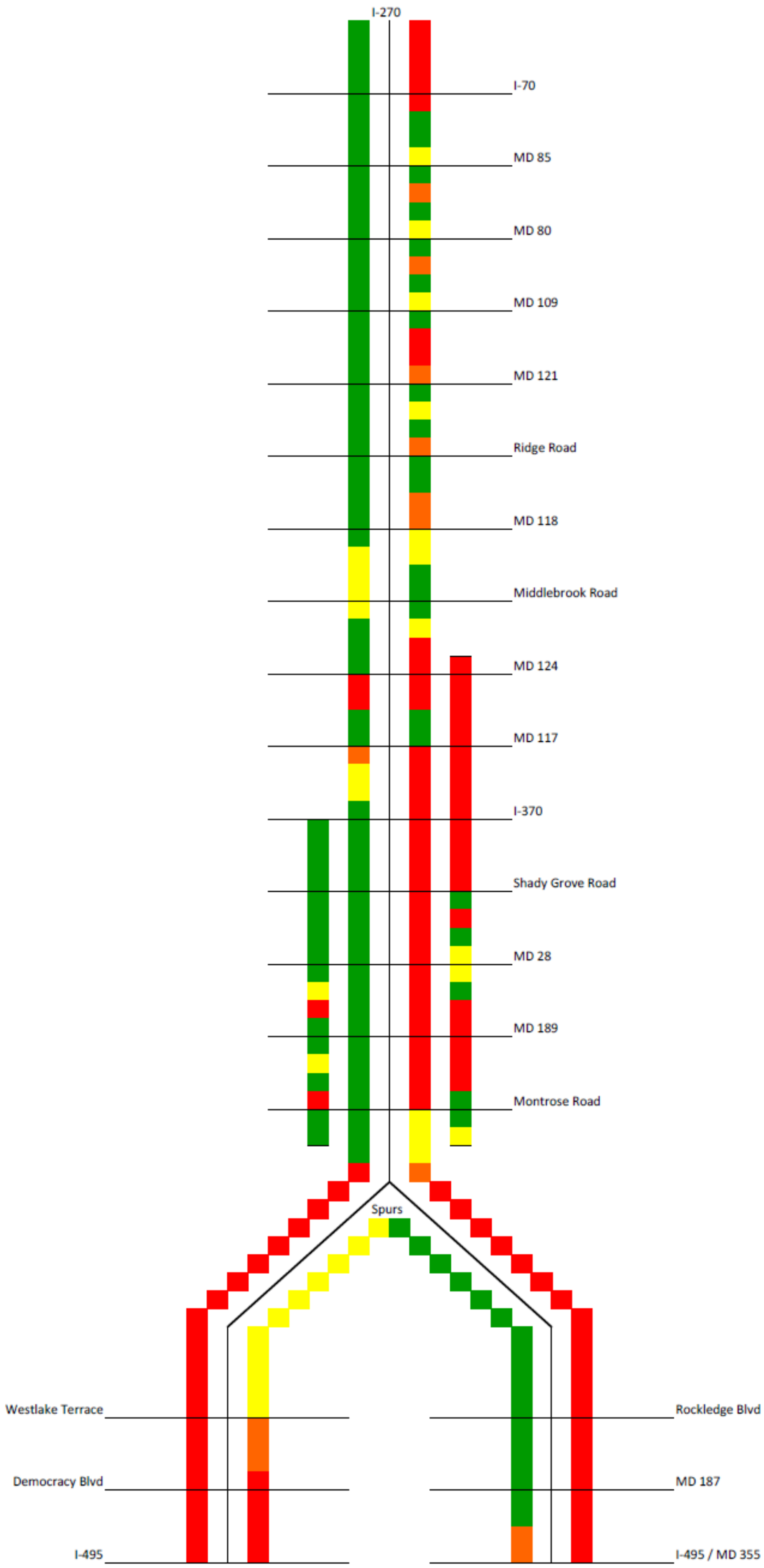
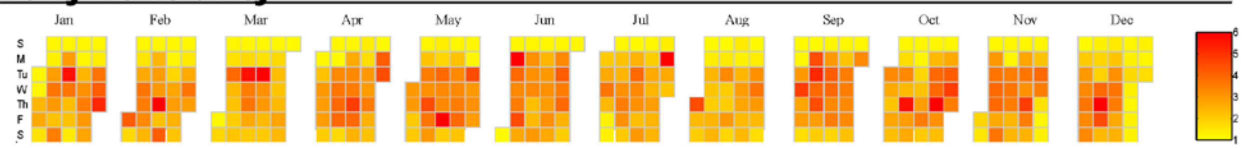


Figure 5: Projected 2040 PM Peak Hour Level of Service Along I-270

Daily Variability[e]



Top Bottlenecks[f]

2013 Rank	LOCATION	Direction	Number of Occurences Q1	Q2	Q3	Q4	Average Duration (minute)	Average Length (mile)	Impact Factor	2012 Rank	Change
6	I-270 Spur S @ I-270	Southbound	182	251	210	241	101	7.4	**5.9**	3	↑ 3
9	I-270 N @ MD-80/Exit 26	Northbound	64	90	127	76	101	9.8	**3.0**	2	↑ 7
10	I-270 Local N @ I-270/Washington National Pike	Northbound	162	156	128	159	126	4.3	**2.5**		↑ 10
14	I-270 N @ I-70/US-40	Northbound	85	106	81	128	83	8.1	**2.3**	7	↑ 7
15	I-270 S @ MD-109/Exit 22	Southbound	126	178	156	118	84	4.6	**2.1**	15	⇨ 0
25	I-270 N @ Middlebrook Rd/Exit 13	Northbound	98	91		83	104	6.0	**1.4**	11	↑ 14
46	I-270 N @ I-270	Northbound	138	155	151	120	120	1.6	**1.0**		↑ 46
67	I-270 N @ MD-85/Exit 31	Northbound	26	32	21	29	85	10.2	**0.8**	32	↑ 35
70	I-270 N @ MD-109/Exit 22	Northbound	288	263	213	190	41	3.0	**0.8**	62	↑ 8
77	I-270 S @ MD-121	Southbound	23	20	17	26	111	9.6	**0.7**	56	↑ 21

Figure 6: I-270 Daily Variability and Top Bottlenecks

Reliability in the corridor is a significant challenge throughout the year. Segments along I-270 are some of the most congested in the State. In the 2013 AM Peak Hour, 7 locations along I-270 are in top 30 most congested freeway segments, and 6 in the PM Peak Hour.

4.3.1 Traffic Analysis

Southbound I-270

The following discussion is based upon traffic operations observed during the AM peak period.

I-270 Spur at Democracy Blvd:

The first place where the I-270 corridor begins to break down during the AM peak is along the I-270 Spur approaching the Democracy Blvd interchange. On its departure from SB I-270, the Spur is comprised of 3 general purpose (GP) lanes. An HOV lane joins the Spur just north of the Westlake Terrace / Fernwood Road overpass. Approaching Democracy Blvd, the right-most GP lane along the Spur departs to Democracy Blvd, leaving 2 GP lanes and 1 HOV lane along the Spur. At this point the volumes are (AM Peak):

- 630 vehicles exit (1 lane)
- 4320 vehicles in 2 GP lanes (2160 per lane)
- 575 vehicles in the HOV lane

South of the Democracy Blvd overpass, a 2-lane ramp from Democracy Blvd adds 540 vehicles to the SB lanes, resulting in:

- 4860 vehicles in 2 GP lanes (2430 per lane)
- 575 vehicles in the HOV lane

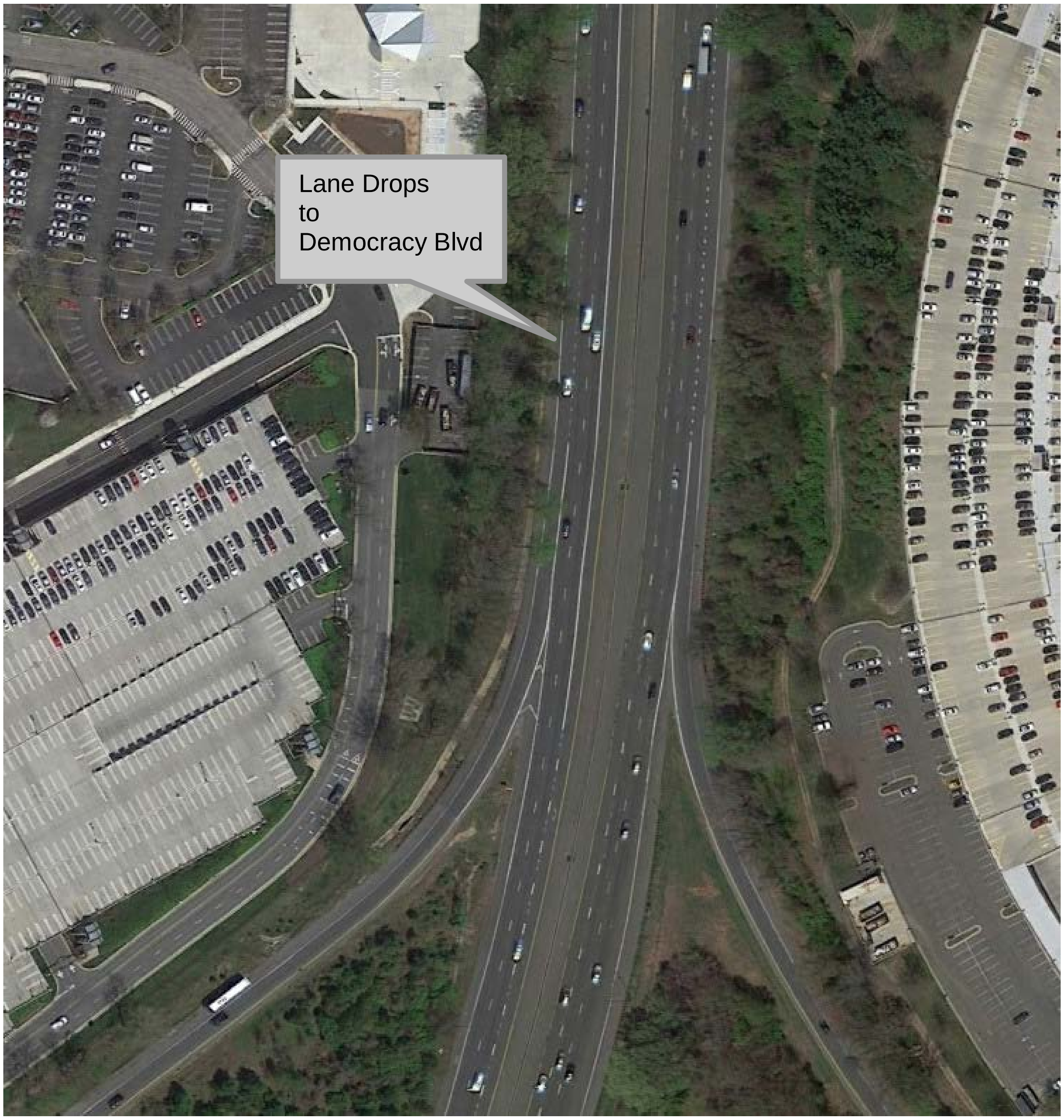


Figure 7: I-270 Spur, Just North of Democracy Blvd

I-270 Spur at I-495:

As the Spur approaches I-495, signs and pavement markings advise that the HOV lane traffic must merge into the GP lanes. The lane drop officially occurs exactly at the point that the Spur lanes meet the lanes from WB I-495. So, technically, at this point there are:

- 5435 vehicles in 2 GP lanes from the SB I-270 Spur (2718 per lane)
- 4480 vehicles in 3 lanes from WB I-495 (1494 per lane)

The SB I-270 Spur, approaching the WB I-495 lanes, begins to demonstrate congestion and delays just a few minutes after issues begin north of Democracy Blvd.

As the morning peak progresses, conditions worsen along the SB I-270 Spur long before issues begin along the WB I-495 approach to the merge.

Once congestion begins along SB I-495, south of the I-270 Spur / I-495 merge, congestion grows ever worse along the SB Spur, but never really emerges along the WB I-495 approach. This section of the I-270 corridor is also the last to clear at the end of the AM peak period.

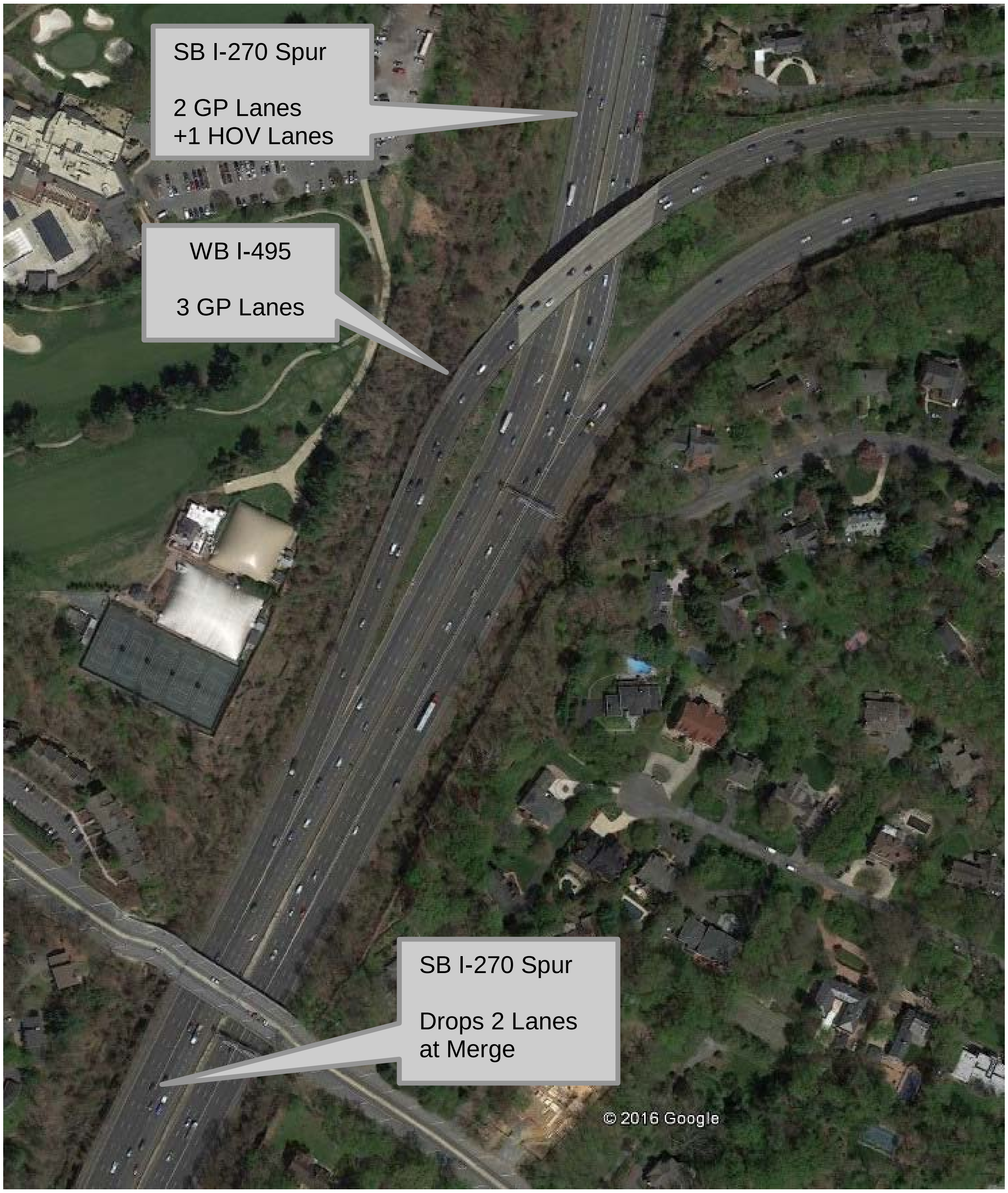


Figure 8: I-270 Spur at Merge with I-495

<u>MD 80 and MD 109 Interchanges</u>:

Even before the SB I-270 Spur begins to experience congestion, towards the north end of the corridor, where it is only 2 lanes wide, SB I-270 experiences significant congestion.

North of MD 80:

- 3120 vehicles in 2 lanes (1560 per lane)
- 250 vehicles depart to MD 80 (via a very low-speed ramp with less than 250 feet of decel)
- 670 vehicles almost immediately merge from MD 80 (likely at a relatively low speed and with less than 200 feet of accel lane)

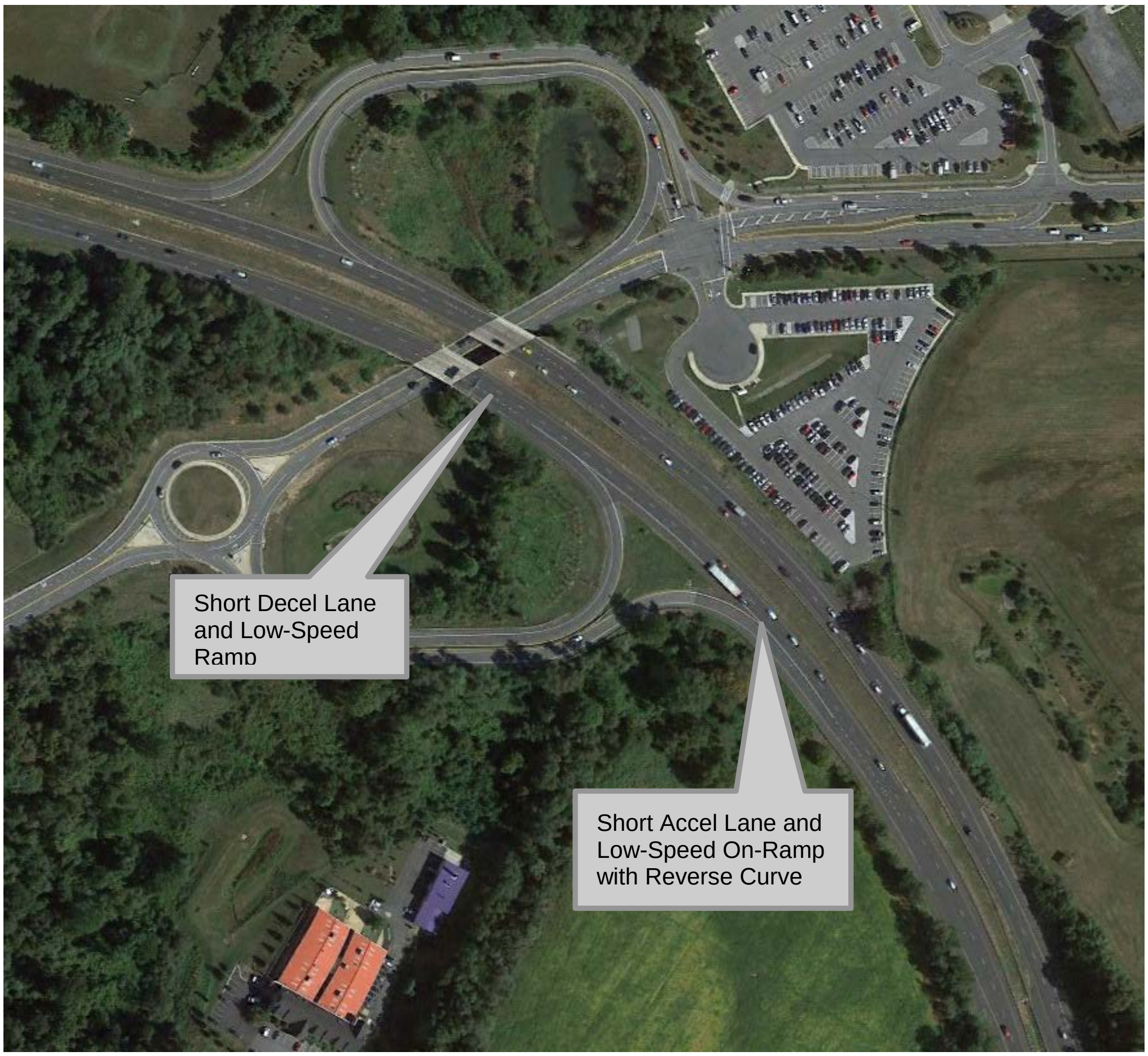


Figure 9: I-270 at MD 80 interchange

South of MD 80:

- 3520 vehicles in 2 lanes (1760 per lane)
- 55 vehicles depart to MD 109 (tight ramp, but reasonable decel distance)
- 465 vehicles merge from MD 109 (tight ramp and less than 300 feet of accel)

South of MD 109:

- 3930 vehicles in 2 lanes (1965 per lane)

A 2-lane cross section does not provide a lot of ability to maneuver, and the ramp speeds are likely very low, so there is no ability for mainline vehicles to bypass merging/diverging vehicles when volumes are relatively high. This results in congestion both approach and departing each interchange, as vehicles struggle to maneuver into desired lanes, and to accelerate after merging. And, per lane volumes are increasing as traffic moves south.

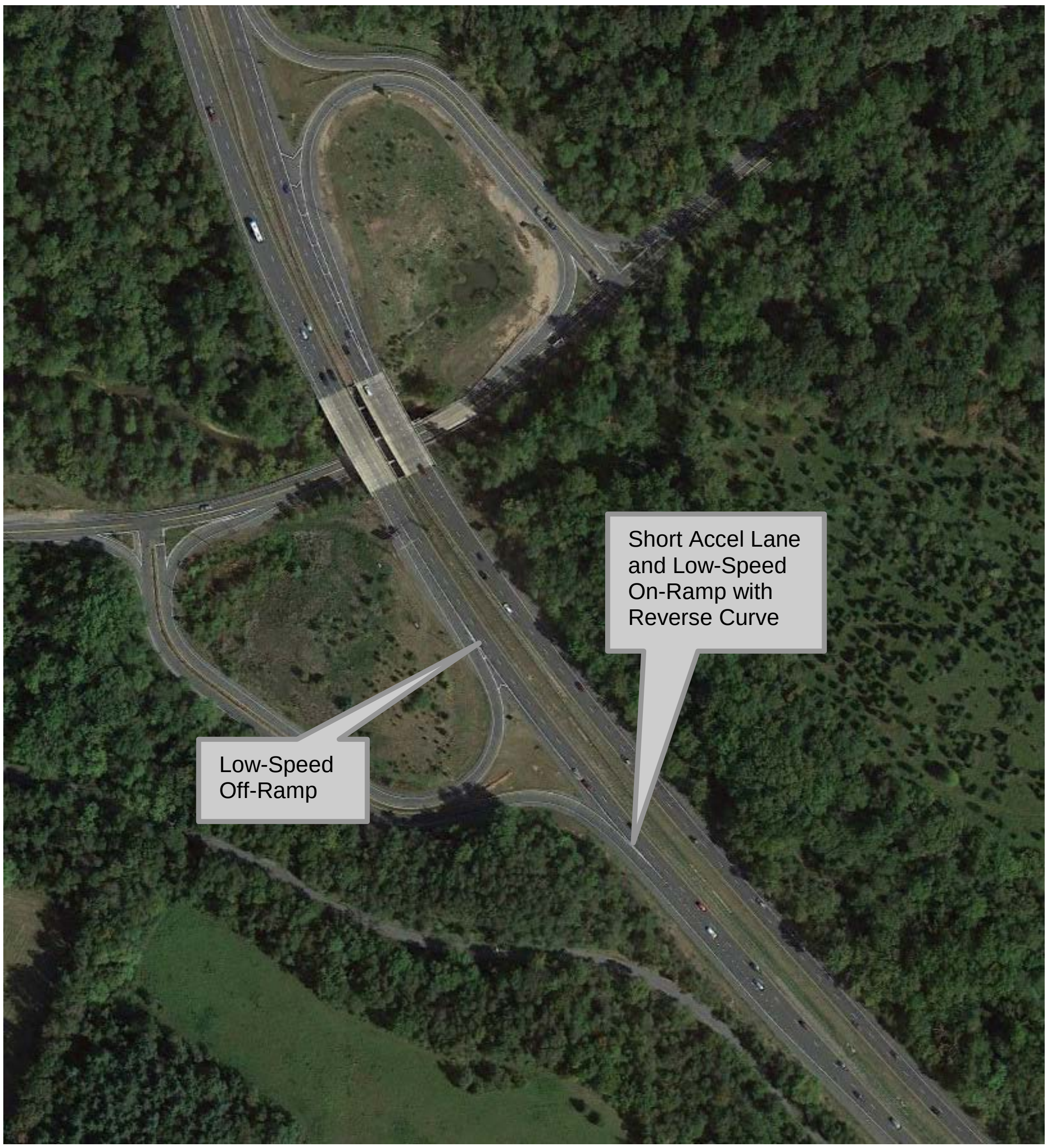


Figure 10: I-270 at MD 109 Interchange

JACOBS

Father Hurley Blvd / Ridge Road and Germantown Road (MD 118) Interchanges:

Also early in the AM peak period, vehicle speeds decrease significantly in the vicinity of the Germantown Road (MD 118) and the Father Hurley Blvd / Ridge Road interchanges.

Approaching the exit to Father Hurley Blvd:

- 4610 mainline vehicles in 3 lanes (1537 per lane)
- 1025 vehicles exit onto Father Hurley Blvd (decel is less than 450 feet long)
- 915 vehicles add from WB Father Hurley Blvd via a loop ramp with an accel lane less than 350 feet long
- Then another 440 vehicles add from EB Father Hurley Blvd via a directional ramp that becomes an auxiliary lane, dropping at Germantown Road, carrying 445 vehicles
- 300+590=890 vehicles enter SB I-270 from Germantown Road via 2 on-ramps, with approximately 250 feet of accel lane provided for each
- South of MD 118, SB I-270 carries 5385 vehicles in 3 lanes (1795 vehicles per lane)

The ramp volumes and interchange configurations would not necessarily be expected to result in poor operations. However, with a series of on and off ramps in relatively quick succession, and relatively short accel lanes (which may result in through vehicles being required to reduce speed to allow entering vehicles to merge), this section of roadway does experience poor operations through much of the AM peak period.

I-270, North of the Split:

As congestion and slowing occur along the SB I-270 Spur, the effect of that slowing shifts north, spreading along SB I-270 north of the Split. According to the Vissim model, the primary source of SB congestion in the AM peak period lies along SB I-270 between the end of the CD lanes and the I-270 Split. A significant weave occurs at this location.

The HOV lane, carrying 1800 vehicles, provides direct access to both SB I-270 (to the east) and the SB I-270 Spur (to the south), without requiring lane changes. These vehicles are therefore of no concern.

Just prior to the end of the CD system, volumes are as follows:

- 3645 vehicles in 2 CD lanes (1823 per lane)
- 5625 vehicles in 3 mainline lanes (1875 per lane)

After the end of the CD lanes, volumes are:

- 9270 vehicles in 5 GP lanes (1854 per lane)

This volume isn’t horrible. However, of these 9270 vehicles:

- 4950 vehicles are destined for the SB I-270 Spur (3 lanes – 1650 vehicles per lane)
- 4120 vehicles are destined for I-270 to the east (2 lanes – 2060 vehicles per lane)

And, they aren’t necessarily in the proper lanes to reach these destinations, so weaving will occur. With just over a mile between the end of the CD system and the split, sufficient distance is available, but if vehicles are moving slowly due to volumes near capacity, weaving becomes that much more difficult.

Montrose Road Interchange:

Because of the proximity of the Montrose Road interchange to the end of the CD system and the I-270 Split, vehicles originating from Montrose Road will have less time to position for the I-270 split.

- 1695 vehicles enter the SB CD system from Montrose Road. Any of these vehicles destined for the east must weave across a minimum of 2 lanes once the CD system ends.
- Of the 5625 vehicles in the mainline lanes, any destined for the south must weave right, against vehicles already in the right-most lanes who may wish to weave left.

Figure 11: I-270 at Montrose Road Interchange

Slip to Mainline, North of Montrose Road:

Approaching the Montrose Road interchange:

- The CD road carries 4325 vehicles in 2 lanes (2163 per lane)
- The mainline carries 4485 vehicles in 3 GP lanes (1495 per lane)

Then 940 vehicles exit the CD onto Montrose Road and 1695 vehicles enter the CD from Montrose Road.

Figure 12: I-270 North of Montrose Road Interchange

The CD road is already close to overloaded at this point, and won't be able to handle the net increase of755 vehicles. So, a slip lane allows 1435 vehicles to depart the CD and enter the mainline lanes prior to the interchange. This slip lane provides approximately 530 feet of accel lane. The resulting mainline volume is:

- 5920 vehicles in 3 GP lanes (1974 per lane)

This volume is not beyond capacity. But the merge distance is short. And, it's likely that, due to the upcoming end of the CD lanes and weave prior to the I-270 split, this merge may be more complex. Traffic slows substantially along the mainline lanes at this point, and the effects move north, extending beyond I-370.

I-370, MD 28 and Shady Grove Road Interchanges:

This section of SB I-270 experiences traffic operational issues a little later in the AM peak period, as congestion is building in the network at locations both north and south of this section.

The first locations within this section to experience slowing vehicles are the 2 SB slips from the CD to the mainline lanes between Shady Grove Road and MD 28.

Once it begins, congestion and slow travel speeds become systemic. The mainline lanes show slowing from I-495 to I-370. The CD lanes experience areas of slower speeds mixed with areas of better operations.

This section of the corridor experiences high ramp volumes and numerous slips both to and from the mainline lanes. However, mainline volumes appear to be within capacity. Review of the data seems to suggest that the slip connections are the primary source for localized congestion and slowing, primarily along the mainline sections of SB I-270 within this portion of the corridor.

Slips from the mainline lanes to the CD lanes include almost no deceleration lanes. Additionally, slips to the mainline lanes from the CD lanes include very short acceleration lanes (less than 300 feet).

South of Shady Grove Road, I-270 provides 3 slip lanes; 1 from the mainline to the CD followed by 2 from the CD to the mainline. The slip from the mainline to the CD occurs first, adding 780 vehicles to the CD lanes, increasing the volume on the CD to 3870 vehicles in 2 lanes (1935 per lane).

Along the CD lanes between Shady Grove Road and MD 28, a slip lane from the mainline lanes adds 550 vehicles, bringing the volume along the CD lanes to 3920 vehicles in 2 lanes (1960 vehicles per lane), which results in some slowing and congestion.

Figure 13: I-270 from Shady Grove Road to MD 28

<u>MD 117 and MD 124 Interchanges</u>:

The MD 117 interchange is partial, only providing access to and from the south along I-270.

The SB on ramp carries 1665 vehicles in a single lane, but adds that lane to the SB I-270 GP cross section, and should therefore have a minimal effect on traffic flow. Even so, speeds along that ramp, and the section immediately following the junction, are shown to be slow early in the AM peak period. Perhaps the nature of the junction makes drivers wary of sideswipes.

Figure 14: I-270 at MD 117 Interchange

The MD 124 interchange, located just north of the MD 117 interchange, includes a diverge that removes980 vehicles from the SB lanes, then a merge via a loop ramp that adds 1430 (probably slow moving) vehicles. The merge distance is approximately 700 feet long. Prior to the interchange the mainline volume is relatively high:

- 7165 vehicles in 4 lanes (1792 per lane)

After the interchange the mainline volume is:

- 7615 vehicles in 4 lanes (1904 per lane)

In theory, the departing 980 vehicles should leave good gaps for the acceptance of the 1430 merging vehicles. However, data shows early peak period slowing along SB I-270 both approaching and following the interchange. The heavy merging volume, approaching at relatively low speeds due to the loop ramp, is resulting in slowed operations along SB I-270, extending north beyond Father Hurley Blvd.

This condition may be helped by the addition of the Watkins Mill Road interchange to the north.

Figure 15: I-270 at MD 124 Interchange

The Corridor, in General:

As the AM peak period continues, and traffic volumes increase, congestion originating from each of the locations discussed above spreads along the corridor.

Northbound I-270

The following discussion is based upon traffic operations observed during the PM peak period.

North of MD 121:

NB I-270 drops from 3 lanes to 2 just north of MD 121. The spot where the lane drop occurs is the first location along the corridor to experience congestion / slowing during the afternoon peak period. The HOV lane also ends shortly before the lane drop, so that when the lane drop occurs, the merge / lane change behavior is that much more pronounced (1045 in the HOV lane versus 3620 in the other 2 lanes).

As the PM peak period continues, effects of the lane drop are felt at Father Hurley Blvd, and then back beyond Middlebrook Road. As the PM peak period progresses, congestion and slowing are experienced along the 2-lane section approaching the MD 80 interchange, and for a portion of the mainline roadway north of MD 80.

Within the 2-lane section, from north of MD 121 to the MD 85 interchange, the NB I-270 PM peak hour volume ranges from 4435 to 4665 vehicles per hour (2218 to 2333 vehicles per lane per hour), which is LOS E/F conditions.

I-270 Spur:

The next place to experience slowing is the I-270 Spur, from Democracy Blvd to the I-270 Split. Approaching Democracy Blvd the Spur is carrying:

- 4165 vehicles in 2 GP lanes (2083 vehicles per lane)
- 1100 vehicles in 1 HOV lane
- 535 vehicles exit to Democracy Blvd
- 2 successive merges add 225 vehicles then another 500 merges from Democracy Blvd

Just north of Democracy Blvd, Westlake Terrace adds 625 vehicles to the left side of the Spur; into the HOV lanes. Resulting volumes are:

- 4355 vehicles in 2 GP lanes (2178 vehicles per lane)
- 1725 vehicles in 1 HOV lane (while this is under capacity, it is almost the highest HOV lane volume seen)

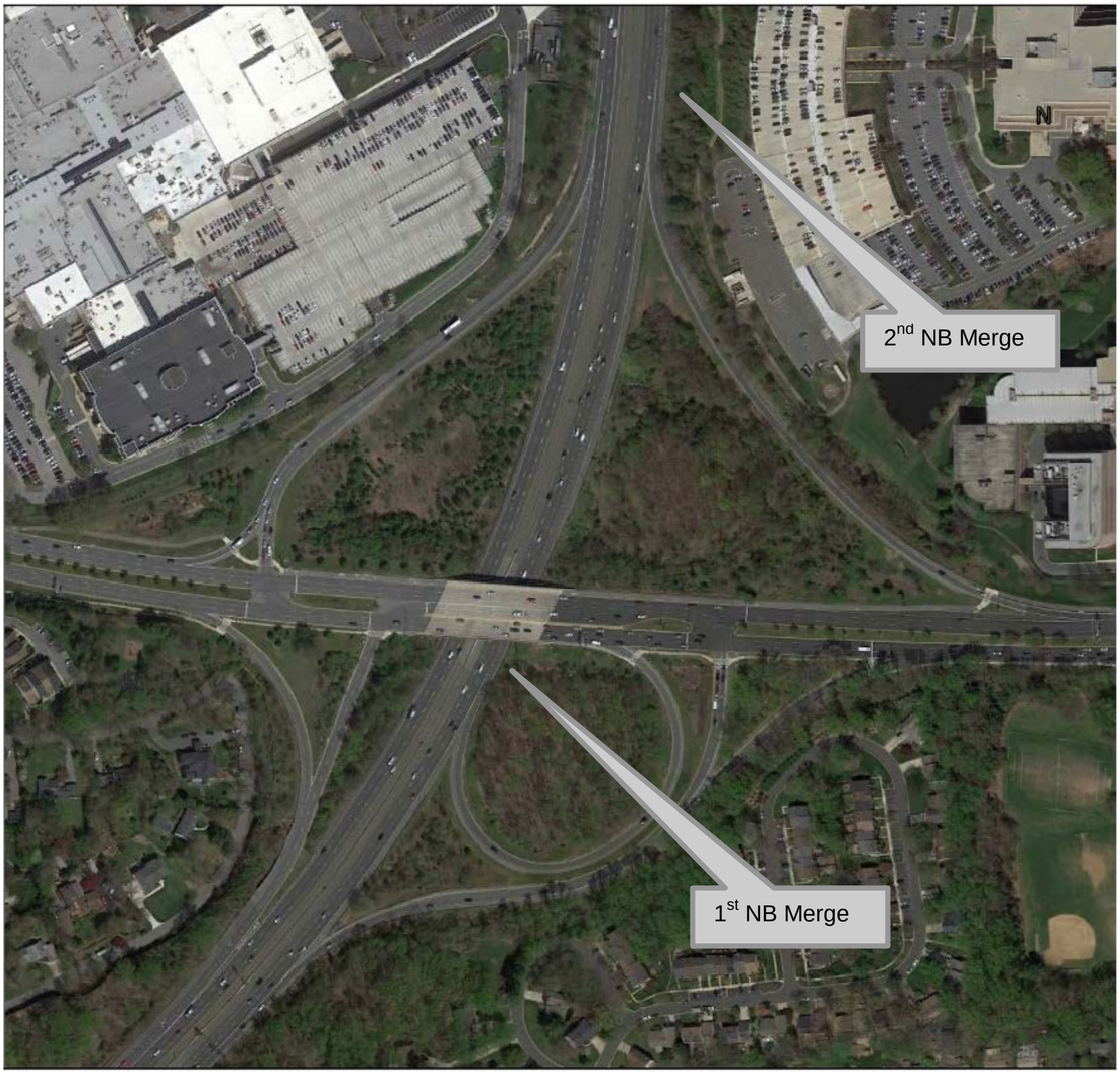


Figure 16: I-270 Spur at Democracy Blvd Interchange

As time passes, the congestion along the Spur intensifies at Democracy Blvd, and begins to extend back along the Spur to I-495 and along NB I-495 approaching the Spur.

Shady Grove Road and I-370 Interchanges:

The next place congestion / slowing is seen is along the NB CD lanes in the vicinity of Shady Brook Road.

Approaching Shady Brook Road:

- The CD Road is carrying 2315 vehicles in 2 lanes.
- The right lane, carrying 1515 vehicles, drops to Shady Grove Road, leaving 800 vehicles in a single lane along the CD.
- Shortly after the lane drop to Shady Grove Road the remaining 1 CD lane is joined by 2 lanes from the mainline on the left carrying 2280 vehicles

- And has to accept 675 vehicles merging along the right from the loop ramp from EB Shady Grove Road.
- Another merge occurs just beyond, adding 825 vehicles from WB Shady Grove Road resulting in 4580 vehicles in 3 lanes (1527 vehicles per lane)
- Then the 3rd CD lane slips back to the mainline carrying 515 vehicles, resulting in 4065 vehicles in 2 lanes along the CD road (2033 vehicles per lane).

To add complexity to the situation, many of the vehicles desiring to slip to the mainline are the 675+825=1500 entering the CD System from Shady Grove Road. Less than 1000 feet exists between where the 2nd ramp from Shady Grove Road enters on the right and the slip to the mainline departs on the left.

After about 600 feet without a ramp junction, the CD road widens to 3 lanes, with the center lane becoming a choice lane in the diverge to I-370

- 2810 vehicles exit via 1 ½ lanes
    - 1510 want to stay right to access EB I-370
    - 1300 want to stay left to access WB Sam Eig Highway (these vehicles will likely use the choice lane when exiting the CD road)
- 1255 vehicles will stay on the CD road in 2 lanes; although many will likely be in the left-most lane due to the heavy choice lane usage.
- The merge of 950 vehicles from EB Sam Eig Highway should be accepted into the CD lanes with relatively little strife

This is a lot of lane changing and weaving in a relatively short section of the CD road. As slowing along the CD road spreads, slowing begins to affect the mainline lanes approaching the slip to the CD road.

Figure 17: I-270 at Shady Grove Road Interchange

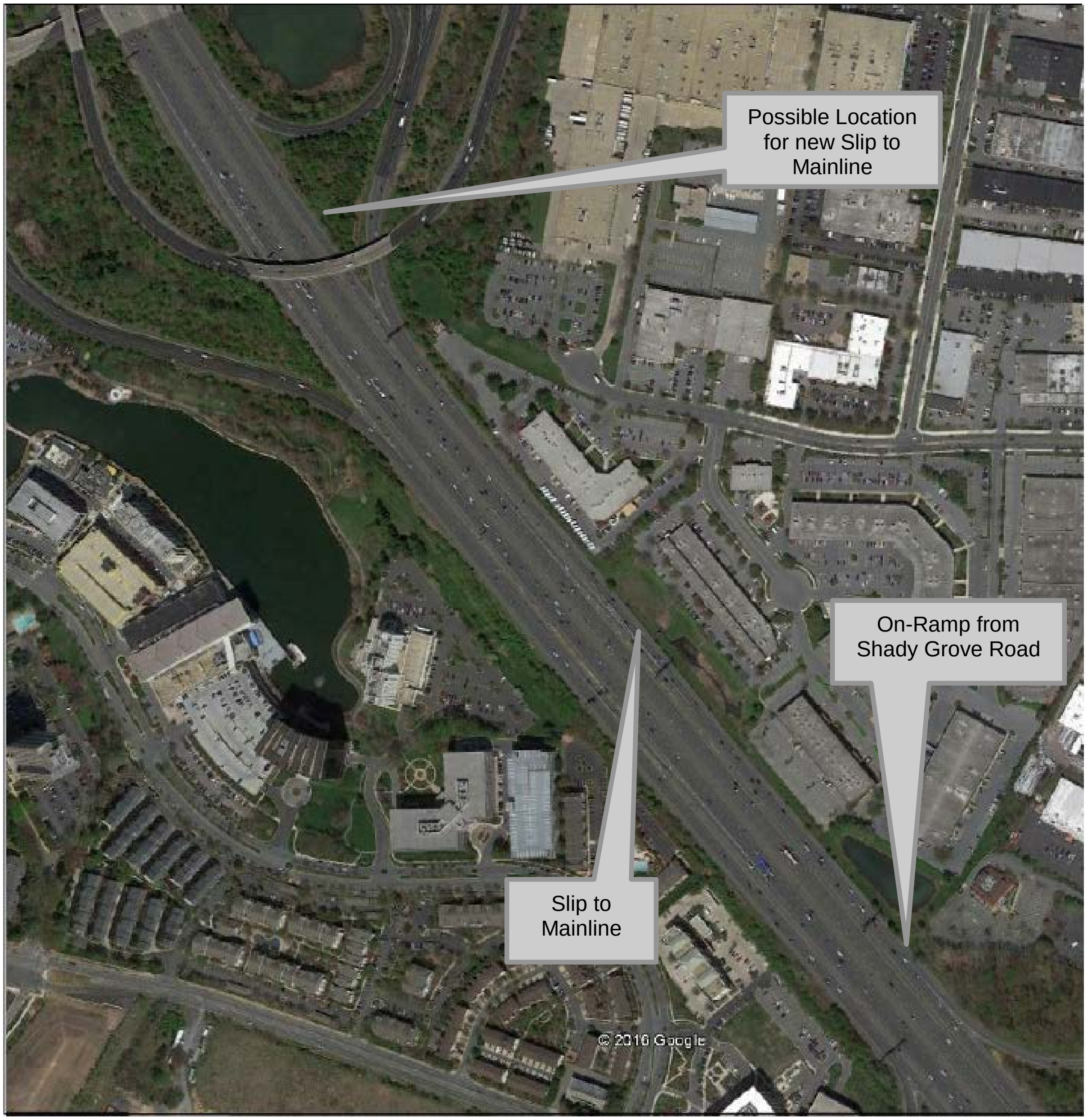


Figure 18: I-270 between Shady Grove Road and I-370 Interchange

MD 124 Interchange and the End of the NB CD System:

Before the CD System ends, just north of MD 124:

- 1200 vehicles in 1 HOV lane
- 5450 vehicles in 3 GP lanes (1817 vehicles per lane)
- 1600 vehicles in 1 CD lane

At its end, the CD System is given about 300 feet in which to merge, at which point there is

- 1200 vehicles in 1 HOV lane

- 7050 vehicles in 3 GP lanes (2350 vehicles per lane)

As the PM peak period progresses, congestion along this section encounters congestion originating to the north at the lane drop (3 to 2), then congestion originating from the south at Shady Brook Road, and operations along the overall corridor slow.

The I-270 Split:

At the Split:

- From I-270 (from the east)
    - 4250 vehicles in 2 GP lanes (2125 vehicles per lane) along the far right side
        - 1345 of these vehicles just merged in via 2 lanes from MD 187 / Rockledge Blvd
    - 1000 vehicles in 1 HOV lane along the left side
- From the I-270 Spur (from the south)
    - 4355 vehicles in 2 GP lanes (2178 vehicles per lane) along the middle/right side
    - 1725 vehicles in 1 HOV lane along the middle/left side

There is likely a lot of lane changing at this point, which is the cause for the slowing.

- Any HOVs from the Spur must move left 1 lane to merge into the new HOV lane, added from WB/NB I-270.
- Any vehicles from the Spur lanes that want to enter the CD system to access Montrose Road must weave right, and vehicles from I-270 that don't want to access the CD system must weave left.

Montrose Road Interchange:

At the north end of the interchange:

- 2065 vehicles in 2 CD lanes merges with
- 1480 vehicles in 1 ramp lane in about 300 feet

Shortly thereafter,

- 300 vehicles slip from the mainline lanes (accel lane is less than 300 feet long)

Figure 19: I-270, North of the Montrose Road Interchange

Between the MD 189 and MD 28 Interchanges:

At this location, along the CD:

- 3990 vehicles in 2 CD lanes (1945 per lane)
- 770 vehicles slip from the mainline via an auxiliary lane
- The auxiliary lane slips back to the mainline after 800 feet, carrying 1015 vehicles

Of the vehicles that may wish to slip to the mainline are 900 vehicles that just entered the CD System from MD 189 on the right side of the CD, which will need to move left to slip to the mainline lanes.

This is a high volume weave along the CD.

Along the mainline:

- 5765 vehicles in 3 lanes (1922 vehicles per lane) after the departure of 770 vehicles
- Then 1015 vehicles slip from the CD System
- Resulting in 6780 vehicles in 3 mainline lanes (2260 vehicles per lane)
- 2000 feet farther north 935 vehicles slip to the CD
- Resulting in 5960 vehicles in 3 lanes (1987 vehicles per lane)

Volumes throughout this section are at the limits of capacity, with high volume merges/diverges/slips.

Meanwhile, between MD 189 and I-370 the HOV lane carries less than 1100 vehicles.

MD 118 Interchange:

The lane configuration along the GP lanes from MIddlebrook Road through Father Hurley Blvd is somewhat complex, but does seem to meet the volume needs along almost every section of roadway. The one exception lies within the MD 118 interchange.

NB MD 118 provides 1 HOV lane and 3 GP lanes approaching the MD 118 interchange. The right-most lane is essentially used an exit staging area, providing access first to the directional ramp in the SE quadrant, then dropping at the loop ramp in the NE quadrant.

Volumes are as follows:

- 1085 vehicles in 1 HOV lane
- 5810 vehicles in 3 GP lanes (1937 vehicles per lane)
- 450+735=1185 vehicles exit NB I-270 via 2 successive ramps leaving 4625 vehicles in 2 GP lanes (2313 vehicles per lane)
- The On Ramp in the NE quadrant adds a 3rd lane and 670 vehicles, resulting in 5295 GP vehicles in 3 lanes (1765 vehicles per lane)

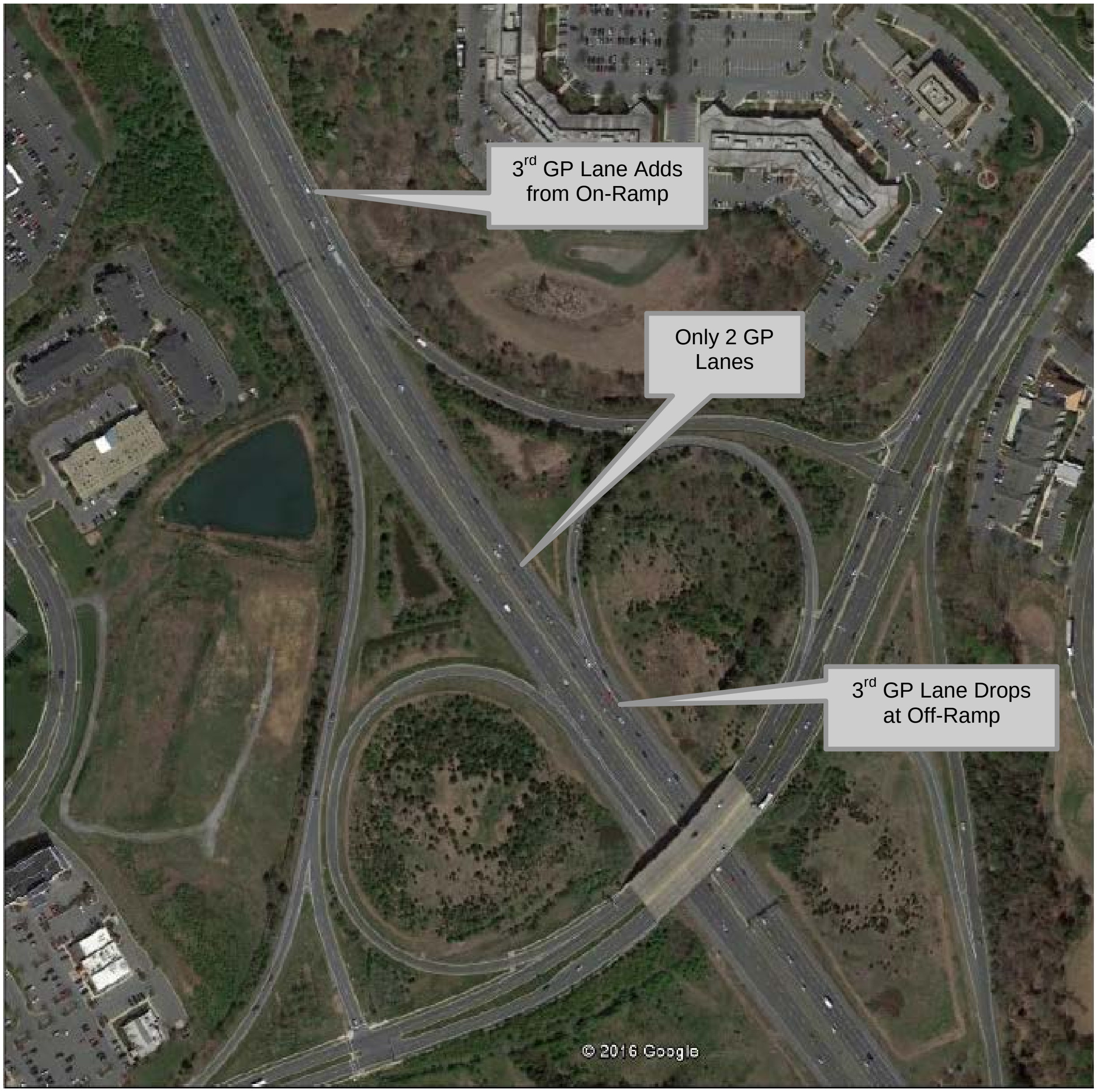


Figure 20: I-270 at MD 118 Interchange

4.3.2 Accident Analysis

Southbound I-270

Attached graphs show the number of crashes reported along SB I-270 and SB I-270Y, by location, for 2011 through 2013.

Review of these graphs shows that crash experiences tend to cluster around interchanges, and the crash rates are much higher between the I-270 Split and I-370 than areas farther north in the corridor. As expected, the locations where crash rates are the highest are also the locations with the highest number of vehicles, the highest number of lanes, and the highest interchange density along the corridor.

The crash types experienced most include:

- Rear End Crashes
- Sideswipe Crashes
- Fixed Object Crashes

The crash rates also show a distinct bias towards the AM peak period within roadway sections that experience high congestion during the AM peak period.

The highest number of crashes reported at any one mile point occurs at the Shady Grove Road overpass.

Northbound I-270

Attached graphs show the number of crashes reported along SB I-270 and SB I-270Y, by location, for 2011 through 2013.

Review of these graphs shows that crash experiences tend to cluster around interchanges, and the crash rates are much higher between the I-270 Split and I-370 than areas farther north in the corridor, although the crash rates for this section are lower than those experienced along SB I-270.

Compared to the SB I-270 crash experience, crash rates for the NB lanes are much higher north of MD 124, where the number of lanes first begins to drop. Both NB and SB I-270 experience similar crash rates within the Frederick County sections of the I-270 corridor.

As for the SB roadway, the crash types experienced most include:

- Rear End Crashes
- Sideswipe Crashes
- Fixed Object Crashes

The crash rates also show a distinct bias towards the PM peak period within roadway sections that experience high congestion during the PM peak period.

The highest number of crashes reported at any one mile point occurs at the MD 28 overpass

5. Proposed System Concept

This section describes the concept exploration. It starts with a list and description of the alternative concepts examined. The evaluation and assessment of each alternative follows and leads into the justification for the selected approach. The operational concept for the selected approach is also described.

To achieve the above improvements, we will implement a series of solutions that utilize both technology (ATDM) and Civil tools.

Active management of transportation includes multiple approaches spanning demand management and traffic management. These approaches and their associated tools are:

- Active Traffic Management (ATM)
  - ✓ Dynamic Speed Limits (DSpeed)
  - ✓ Queue Warning (QW)
  - ✓ Dynamic Lane Assignment (DLA)
  - ✓ Dynamic Shoulder Lanes (DShoulder)
- Active Demand Management (ADM)
  - ✓ Advance Traveler Information (ATI)

5.1 Active Traffic Management

This subsection provides a brief description of the individual ATM techniques considered for the I-270 ICM Project:

Dynamic Speed Limits

- Allow for the change of speeds based on road, traffic and weather conditions.
- Used in conjunction with vehicle detection and weather data to display optimal speed for current conditions.
- Speed harmonization studied along I-270 in St. Louis reduced total crash rate 4.5% to 8.0%.
- Highways England reported a 55.7% reduction in personal injury accidents on the M42 Managed Motorway in the 36 months that the dynamic speed system was installed

Queue Warning

- Allows for the detection of vehicles in a queue.
- Used to help manage the variability in vehicle flow and optimize system throughput.
- Warns motorists of downstream queues and directs traffic to alternate lanes, reducing the risk of speed differentials and collisions due to queuing.
- Can utilize existing detection technology for data collection.

Dynamic Lane Assignment

- Allows easy communication of lane closures due to accidents or disabled vehicles to motorists.
- Aids in the maximization of throughput on existing infrastructure.

- Allows safer responses to unexpected delays or congestion.

Dynamic Shoulder Lanes

- Utilizes the shoulder as a travel lane during peak travel periods.
- Allows for additional lanes of traffic with relatively minor to no expansion of existing infrastructure required.
- Decreases amount of space emergency vehicles have to get through traffic and refuge for damaged vehicles.
- Dependent on existing roadway cross section.

Ramp Metering

Ramp meters were assessed to see what effect application of ramp meters would have on the network. The analyses revealed that while some improvement in throughput and travel time could be gained, the improvements would be relatively minor compared to the expense of adding ramp metering to the system. Additionally, the review of the model outputs showed that the MD 80, MD 121, Father Hurley Boulevard, and MD 118 corridors would all be expected to experience significant increases in queues in delays in the vicinity of the I-270 interchanges due to the application of ramp meters. It was therefore determined that ramp metering would not be applied as part of this project. However, if desired, SHA may implement ramp metering along the corridor, as desired, at a later date.

5.1.1 Dynamic Speed Limits (DSpeed)

DSpeed is a method to reduce congestion and improve traffic performance. The strategy involves gradually lowering speeds before a heavily congested area in order to reduce the stop-and-go traffic that contributes to frustration and crashes. A key component in this speed harmonizing strategy is the ability of the system to warn drivers of downstream queues (see queue warning). The system can be automated or controlled by a traffic management center operator. It is accomplished by installing lane control signals over each travel lane and posting (advisory) speed limits on the signs over lanes that are slower than the posted speed. As drivers progress along I-270, the speeds reduce. The signs are typically installed on gantries over the travel way and the system begins reducing speeds between three and four gantries before an incident. The Manual on Uniform Traffic Control Devices (MUTCD) states that these signs shall be located such that a driver can always see at least one set of signs and preferably, two. A recent implementation in Virginia on I-66 has gantries spaced ½-mile apart.

It is typically deployed on roadways with high traffic volumes. Speed harmonization is also referred to as dynamic speed limits, and it is used to manage congestion during incidents and maintenance/construction projects. Others applications include management of traffic during adverse weather conditions (e.g. fog), while others have been used to create more uniform travel speeds. The lane control displays are used for incidents, maintenance and construction.

DSpeed Components

A DSpeed system includes the following components:

- Vehicle Detection Device - DSpeed requires vehicle detection for volume, speeds and/or occupancy along the corridor to operate in an automated manner. I-270 is currently outfitted with a sampling of microwave vehicle detection devices. The density of devices and reporting frequency is not currently sufficient to meet the DSpeed needs. Third party probe-based data available through RIITIS does not provide the necessary temporal or spatial resolution. Additional infrastructure-based detection will be required.

- Video coverage – Video coverage is not required, but is helpful in verifying and monitoring conditions back at the SOC.
- DSpeed Display Device – Typically a two-character matrix dynamic message sign. Many times these signs are combined with static speed limit signs, and some agencies, such as the New Jersey Turnpike Commission utilize larger, full-matrix DMS that are configured to mimic a static sign.
- DSpeed Support Structure – Typically, DSpeed devices are mounted on vertical posts or overhead gantries or sign structures.
- Power and Communications Infrastructure – DSpeed devices are low-power, low-bandwidth devices (in general) so the power and communications requirements are relatively minor. DSpeed systems can be powered by either solar or utility sources and can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Typically an ATMS software application. CHART currently does not support this capability in its functional menu.

DSpeed Applications

Studies on the use of DSpeed technology have shown that accident reductions of 10% to 30% can be expected through the implementation of DSpeed. DSpeed is a technology that has been widely deployed throughout Europe and parts of the United States. The application areas for DSpeed deployment typically cover one (1) of two (2) scenarios:

- The deployment of dynamic speed limit signs (not DSpeed which is advisory) along an entire corridor to completely replace static speed limit signing. Nearby examples of similar deployments include I-495 in Delaware and the New Jersey Turnpike. In these examples, DSpeed devices are typically located at regular intervals along the roadway. Research from Europe and the United States shows that a typical DSpeed device spacing is approximately one device per quarter to half mile.
- The deployment of DSpeed approaching high-crash locations (especially high frequencies of rear-end crashes), locations with recurring queuing (especially those with limited sight distance), locations overly susceptible to changing weather conditions (such as bridges, steep hills, and low-lying areas), and work zones. In these instances DSpeed devices are located in advance of the area of concern in order to provide advanced warning to motorists and allow for a safe distance to decelerate prior to the queue or hazard.

DSpeed Standards

DSpeed deployments are governed by the Manual on Uniform Traffic Control Devices (MUTCD), as advisory signage.

DSpeed Implementation along I-270

Due to the persistent and widespread daily congestion along I-270, as well as the high occurrence of rear-end crashes; it is recommended that DSpeed be deployed as a corridor-wide implementation. This would not necessitate the complete replacement of all static speed limit signs along I-270 within the project limits. The signs (on gantries) should be co-located with the nearest existing/proposed ITS device location in order to economize power and communications services.

Where that is not feasible, a new DSpeed support structure will be placed adjacent to the roadway and new hard-wire power and fiber connection installed. Due to the requirement to keep DSpeed operational 24 hours per day / seven days per week, solar power is not a recommended alternative. It is anticipated that all DSpeed devices can be integrated into the existing fiber communications network along I-270.

Additional static signing will need to be installed along I-270, in advance of the DSpeed section to notify motorists that speeds will be variable ahead. In addition, it is recommended that notification signing be installed at all interchange on-ramps within the limits of DSpeed deployment.

Expectation

DSpeed has the potential to smooth traffic, increase the number of vehicles that a roadway can handle, and improve safety by making it easier for drivers to change lanes when necessary. It also has the potential to reduce the number of rear-end crashes caused by drivers who do not brake early enough when they encounter slow-moving or stopped vehicles.

5.1.2 Queue Warning (QW)

QW's purpose is to inform motorists of the presence of downstream stop and-go traffic (based on real-time traffic detection) using warning signs and in some cases, flashing lights. Drivers can anticipate an upcoming situation of emergency braking and slow down, avoid erratic behavior, and reduce queuing related collisions.

Similar to dynamic speed limits, QW uses overhead lane control signals that provide indications of closed lanes ahead using symbols like green down arrows and red "X"'s to indicate open and closed lanes, respectively, and if all alnes are open, dynamic speed limits are displayed.. The system can be automated or controlled by a traffic management center operator. Work zones also benefit from queue warning with portable dynamic message signs units placed upstream of expected queue points.

QW Components

A typical QW system includes the following components:

- Vehicle Detection Device – These devices can utilize in-pavement sensors, radar sensors, video detection, probe data, or any other source to collect lane-based vehicle presence, speed, and occupancy. Vehicle detection devices are placed in strategic locations to locate the back of a queue of vehicles upstream of an incident or bottleneck in order to warn approaching motorist.
- Video coverage – Video coverage is not required, but is helpful in verifying and monitoring queue back at the SOC.

- Warning Display Device – These are the upstream devices that warn motorists to be aware that they are approaching slowed or stopped vehicles further down the roadway. These devices are typically dynamic but could include something as simple as a small blank-out sign to a full-size DMS. Many comprehensive ATM deployments utilize smaller DMS in conjunction with variable advisory speed and lane use control in order to warn motorists of obstructions in the roadway.
- Power and Communications Infrastructure – QW detection devices are low-power, low bandwidth devices in general so the power and communications requirements are relatively minor. Depending on the messaging device, more robust power may be required, however many detection devices can be powered by either hard wiring or solar. QW systems can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Back-end software is required for the operation of a corridor-wide queue warning system. Of specific importance is the algorithm used to generate the warning. A high frequency of false alarms will lead to less trust in the detection and thus reduce the effectiveness during a real scenario. The existing CHART software does not have the ability to provide queue detection. Existing functionality will be referenced during system design and any required modifications or enhancements to meet design requirements will be included in the capital project.

QW Applications

QW systems are commonly used throughout the United States, most frequently in construction areas as part of Smart Work Zone Deployments. The primary goal of implementing a QW is to reduce the occurrence of rear-end crashes as a result of vehicles entering the back of a queue at a high rate of speed. When deployed in conjunction with variable speed limits, QW can also help to harmonize speed in areas of stop-and-go traffic.

Throughout 2012 and 2013 Caltrans utilized a QW system to alert motorist to backups resulting on heavy traffic attempting to enter a mall facility during peak holiday travel. Compared to the prior years, they documented a 66% reduction in the number of queuing related crashes after installing the system.

In 2010, Illinois DOT installed a work-zone queue detection system along 30 miles of I-55 and installed warning devices (portable DMS) up to six miles in advance of the work zone. Over two (2) years, they documented a 14% reduction in the number of rear-end collisions compared to a similar project that did not have a QW system.

QW Standards

There are no known standards regarding the design or implementation of permanent QW systems. However, in January, 2014, the FHWA published the Work Zone Intelligent Transportation Systems Implementation Guide which provides guidance for the usage of QW systems as part of Smart Work Zone installations.

QW Implementation along I-270

The intent of QW systems is to reduce the rate of rear-end crashes. Based on the crash data on I-270, it can be expected that QW will help to reduce these rear-end accident.

Detection for the QW system will include existing side-fired video detection (SFVD) detection stations as well as the integration of the new detection proposed as part of the I-270 ICM Project.

In addition, all detection devices along the corridor should be re-calibrated to ensure that they are currently operating properly and collecting accurate and consistent data.

It is anticipated that probe vehicle data provided by RITIS (i.e. INRIX and HERE) will also be utilized to supplement point detector data in the data analysis algorithm for use when detectors malfunction as well as to collect and provide historical data for use by the algorithm.

QW signing is anticipated to be provided via a mix of existing full-size DMS as well as the installation of additional smaller-scale DMS to be utilized for queue warnings in advance of the areas of most need, as well as to provide any additional emergency notification or traveler information as required by the SOC.

Expectation

QW systems reduce primary and secondary crashes by alerting drivers to congested conditions; delay the onset of congestion, improving smooth and efficient traffic flow and trip reliability; provide environmental benefits through decreased emissions, noise, and fuel consumption.

Figure 21: Dynamic Speed Limit in Washington (Source: Washington DOT)

5.1.3 Dynamic Lane Assignments (DLA)

DLA is used to indicate lane closures that may be due to downstream congestion, accidents, work zones, or debris. In accordance with the MUTCD the signs can display green arrows indicating the lane is open, a red "X" indicating the lane is closed, or a yellow "X" indicating pending lane closure notifying motorist the need to merge out of the lane.

5.1.4 Dynamic Shoulder Lanes (DShoulder)

DShoulder also known as hard shoulder running or part-time shoulder use, is a dynamic measure designed to adapt roadway capacity to high traffic volumes on a temporary basis. By allowing vehicles on the shoulder, it is possible to serve a higher number of vehicles and avoid congestion, either totally or partially, during peak periods. The decision to implement shoulder use on a segment is taken by the operator in the traffic management center based on operating policies and volume considerations after a check for obstacles.

DShoulder Components

A DShoulder installation consists of a series of overhead gantries or roadside signs (depending on the scope of the application) that dynamically change to indicate whether the shoulder lane is open, or closed to traffic. A DShoulder system includes the following components:

- Vehicle Detection – DShoulder does not necessarily require a vehicle detection component, however a fully automated system would require that some feedback on traffic conditions be provided before opening or closing a certain lane.
- Video Coverage – For safety reasons, DShoulder installations will require full camera coverage of the area of implementation so that the absence of disabled vehicles or other debris can be verified prior to opening the shoulder to upstream traffic. Video coverage

will also assist operators to determine if the shoulders should be closed due to an incident to allow passage of emergency vehicles along the shoulder.

- DShoulder Display Device – Typically a character matrix dynamic message sign set below a static sign indicating that the dynamic sign is related to operations along the shoulder. These display devices are often centered over the shoulder to better notify drivers.
- DShoulder Support Structure – Support structures will typically span all mainline and ramp lanes if being utilized in conjunction with dynamic lane use control, variable speed limits, or other treatments. DShoulder only installations typically include a cantilever sign structure over the right shoulder.
- Emergency Refuge Areas – These are locations built outside the shoulder that provide disabled vehicles a place to pull over when the shoulder is in use.
- Power and Communications Infrastructure – DShoulder devices are low-power, low-bandwidth devices in general so the power and communications requirements are relatively minor. DShoulder systems can be powered by either solar or hard wired sources and can communicate via either Ethernet, serial, cellular, or leased line data.
- Back-end command and control system – Typically an ATMS software application. The CHART software currently does not provide the functionality necessary for this strategy.

DShoulder Applications

DShoulder has been applied in numerous applications throughout both the Untied Stated and Europe. In Massachusetts, shoulder lane use launched in 2002. A total of 45 miles were implemented with DShoulder, including I-93 and I-95. Traffic congestion was so bad that it was practically at a standstill during peak hours. The maximum speed limit on the shoulder is the same as the travel lanes. A 10-foot minimum shoulder width was required with 12-foot being desired. Emergency pull-off areas spaced every half a mile. This shoulder is only used for travel from 5:00 AM to 10:00 AM and 3:00 PM to 7:00 PM. Heavy trucks are not permitted to use the shoulder. Post-mounted signs show the availability of the shoulder. In addition, cameras and overhead DMS are used along with some sensors to monitor congestion and any issues that may arise. It was found that travel speeds improved in these facilities.

In Washington State, temporary shoulder usage on SR 0002 was launched in 2009. One (1) right shoulder is used for a 1.55 mile-long segment. This shoulder is opened Monday through Friday from 3:00 PM to 7:00 PM, and all vehicles are allowed to use it. The speed limit of the shoulder is 60 MPH. This segment was restriped for adequate shoulder use. Shoulder- or barrier-mounted manual flip signs are posted every 1,200 feet to alert motorists of the availability of the shoulder as a travel lane.

In Virginia, temporary shoulder use and HOV Lanes on I-66 launched in 1992. The right shoulder is opened for travel Monday through Friday from 5:30 AM to 11:00 AM in the eastbound direction and 2:00 PM to 8:00 PM in the westbound direction. There are 6.5 miles of dual HOV/Shoulder lane operations. I-66 is a major facility that connects Washington D.C. and North Virginia, and it has very heavy traffic with three (3) mainline lanes in each direction with a posted speed limit of 55 MPH. The three (3) mainline lanes are 12 feet, the left shoulder is eight (8) to 11 feet. The right shoulder is 12 feet wide. There are four (4) emergency areas in the eastbound direction and five (5) emergency areas in the westbound direction. An overhead lane control system is operational to indicate if the shoulder is open. Post-mounted signs provide notification as well as termination of restricted use and indicate where emergency areas are located. Virginia DOT hires a contractor to maintain the facility while VDOT handles ITS operations. Shoulder lanes are open to general-purpose traffic. The HOV lane is for vehicles with two (2) people or more.

Temporary shoulder use has been used in foreign applications and results appear to be positive. In the Netherlands, a capacity increase of 7% to 22% was reported during the implementation of a hard shoulder (depending on the usage levels) along 620 miles of highway throughout the country. In addition, traffic volumes increased up to 7% during congested periods along those highways in the Netherlands. Germany (who operates 125 miles of hard shoulder) reported a temporary increase of up to 25% in freeway capacity with the use of a shoulder as travel lane. On the M42 Motorway from J3A to J7, capacity increased by an average of 7% to 9%.

A study on A4-A86 in France shows that capacity increases by about 900 vehicles per hour with the use of dynamic shoulder lanes. Compared to the capacities of regular cross sections, dynamic shoulder lanes increased capacity of the two (2) lane highway by around 30%, and the three (3) lane highway from 22% to 27%.

DShoulder Standards

There are no known standards regarding the design or implementation of DShoulder, and Maryland does not currently have any DShoulder installations. However, it is anticipated that some form of waiver will be required to allow the use of the shoulder as a travel lane, on a temporary but recurring basis.

While not standardized, FHWA screening guidance does indicate the following criteria:

- Segment lengths should be a minimum of one (1) mile.
- Shoulder width should be 10 feet minimum, but 12 feet is desired.
- Mainline lane widths (e.g. restriping to accommodate DShoulder) should maintain 11 feet minimum.
- Emergency Refuge Areas should be placed every 0.5 to 1.5 mile.

Best practices originating in Europe have also noted the following as it relates to DShoulder design and installation:

- Safe havens should be provided for broken down vehicles. They should ensure a safe use, both length and width. The maximum distance between them should be 1000m.
- Road markings should be in line with general standards used for road sections without dynamic shoulder lanes.
- Quality surveillance and monitoring for traffic operators should be guaranteed
- Use dynamic message signs to indicate if the shoulder is opened/closed/clearing/ending for dynamic shoulder lanes.
- The applicable speed limit should be displayed.

DShoulder Implementation along I-270

I-270 cannot effectively handle current and future traffic demands. Recurring congestion occurs during both the AM and PM peak periods, and often during the off-peak periods. Multiple overlapping breakdowns in traffic or bottlenecks are difficult to analyze due to limitations in the Highway Capacity Manual (HCM) methodologies. Other tools such as simulation modeling are more appropriate in this instance.

Traffic counts indicate that I-270 is at or over capacity along much of the corridor. I-270 seems to handle as much as 2,300 vehicles per hour per lane. However, the shoulder lane would likely have a lower capacity range between 1,200 and 1,500 vehicles per hour due to limited lateral clearance. Regardless, this would still provide as much as a 15% increase in capacity per direction.

Even though the increased capacity provided by the shoulder usage may alleviate local congestion, the discharge from previous unmet demand could result in shifting of bottlenecks downstream and may increase overall network congestion. Careful consideration of DShoulder locations and limits must be analyzed to minimize operational consequences outside the study area. Traffic modeling is necessary to evaluate the effects DShoulder has on the overall network.

Improved traffic flow provided by DShoulder could significantly decrease the number of incidents caused by congestion, particularly rear-end accidents. The decrease in non-recurring congestion caused by incidents would significantly improve the operations of the overall corridor. Some segments along the study limits may provide an opportunity to implement DShoulder in a relatively short-term period:

Expectation

Part-time shoulder use can help postpone the onset of congestion. By increasing capacity and encouraging more uniform speeds, traffic flows more smoothly and efficiently, which can improve trip travel time reliability. Increased vehicle volume can be another benefit of temporary shoulder use by temporarily increasing capacity.

5.2 Active Demand Management Strategies

5.2.1 Advanced Traveler Information

An Advanced Traveler Information System (ATIS) acquires, analyzes, and presents information to assist travelers in moving from a starting location (origin) to their desired destination. An ATIS operates by using data supplied by the traffic management centers. Relevant information may include locations of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions.

Traveler information can be categorized as either pre-trip which provides travelers with current roadway and/or transit information prior to deciding upon the time, mode, and route of travel; or en-route traveler information which provides the traveler with current roadway and transit information while traveling en-route.

Dynamic Message Signs

DMS's provide traveler advisory information such as incidents, events, construction and maintenance, road closures, and travel time to en-route motorists. The primary function of the DMS is to provide real-time congestion or incident information to travelers so that they can make informed choices of their travel mode or route.

5.3 Other Intelligent Transportation Systems Strategies

5.3.1 Traffic Signal Synchronization

Traffic signal synchronization is a traffic engineering technique of matching the green phases for a series of intersections to enable the maximum number of vehicles to pass through, thereby reducing stops and delays experienced by motorists. Adaptive Signal Control Technology

(ASCT) is the most current synchronization tool used in the country, and its results are impressive (where properly implemented), ASCT is currently being examined in Montgomery County, and a pilot is expected in the next year.

The main benefits of synchronization and adaptive signal control technology (ASCT) over conventional signal systems are that it can, automatically adapt to unexpected changes in traffic conditions, improve travel time reliability, reduce congestion and fuel consumption, prolong the effectiveness of traffic signal timing, reduce the complaints that agencies receive in response to outdated signal timing, make traffic signal operations proactive by monitoring and responding to gaps in performance. Along I-270 corridor, better synchronization of arterials will improve interchange operations and ensure a better flow of traffic within the region. ASCT may also automatically detect and respond to ramp congestion impacts on the local arterial roads, or increase volumes as a result of traffic being diverged from I-270 resulting from an incident.

5.3.2 Vehicle Detection

In a traffic management system, the detection and surveillance component supports the process in which data are collected to describe or characterize traffic flow conditions on the highway. The data are used to supply information about conditions on the roadway to other system components. Thus, detection and surveillance provide the information needed to perform the following traffic management functions including: Measuring traffic flow and environmental conditions, formulating control decisions, disseminating traveler information, monitoring and evaluating system performance, supporting other freeway management and operations functions such as incident detection and verification, planned special event and emergency management, ramp management, and transportation planning.

Vehicle detection, aside from improving incident detection, is used as a surveillance tool for the implementation of dynamic shoulder running. Typically, shoulders – where part-time shoulder usage is implemented, is outfitted with detection to immediately know when there is a blockage or other dangerous situation on the shoulder. Most commonly, Video Image Detection (VID) is used.

Vehicle detection on the mainline and (part-time) shoulder locations will provide faster detection of incidents while improving safety

5.3.3 CCTV Surveillance

Closed circuit television (CCTV) systems have been used for many years to provide visual surveillance of I-270 system. Control centers typically use CCTV systems for detecting and verifying incidents, monitoring traffic conditions, monitoring incident clearance, verifying message displays on changeable message signs, and monitoring environmental conditions (e.g., visibility distance, wet pavement). On critical freeways, like I-270, full video coverage is a necessity to allow control room personnel to visually monitor sections of roadway and to react directly to the actual conditions on the roadway.

5.3.4 Travel Time Signs

Signs along the highway display the amount of time it will take to get to specific destinations. Some of the signs provide times for alternate routes to the same destination, allowing the driver to choose which route to take. Travel Times can be displayed on DMS or on purpose-built signs

Travel times are calculated based on information collected from various sources either directly or indirectly measuring vehicle flow. Traditional infrastructure-based detection is able to detect and measure traffic parameters at a given point and derive speed and travel time information. Other more advanced probe-based technologies using Wi-Fi, Bluetooth, or GPS-based applications provide a direct measure of travel time between two points, but only for a sampling of the traffic. With Wi-Fi and Bluetooth readers installed along roadways are used to detect vehicles (actually vehicle inhabitants with mobile phones or other devices) using Bluetooth or Wi-Fi. As devices are detected by successive readers, the system compiles aggregate data on average speeds, travel times, and the number of non-arriving vehicles (vehicles expected but not yet detected by the next reader downstream). Commercial GPS probe-based solutions, such as INRIX and HERE, relay on smart phone applications to constantly and anonymously report back device position information which is then used as a surrogate to calculate travel time of the occupant in the vehicle. A large sample set will accurately represent the actual travel time conditions on the roadway. CHART currently uses an aggregation of all these data sets provided through RITIS to determine appropriate travel times to be displayed throughout the state. Travel time signs provide motorists knowledge of their future trip duration which aids in providing trip predictability.

5.4 System Operational Concept

This section describes the I-270 ICM Project operational concept.

5.4.1 Corridor Goals and Objectives

The operational goals of the I-270 ICM Project are:

- **Mobility** – Provide improvements that maximize vehicle throughput, minimize vehicle travel times, and create a more predictable commuter trip along IS 270.
- **Safety** – Provide for a safer IS 270 corridor.

The operational concept of the I-270 ICM Project is presented in the Table below.

Goal	Objective	ATM / ITS Strategy
Mobility	• Maximize vehicular throughput • Reduce overall trip and travel time through the corridor • Improve travel predictability • Maximize the efficient use of any spare corridor capacity, such that delays on other saturated networks may be reduced.	• Dynamic Shoulder Use (Hard Shoulder Running) • Advanced Traveler Information • Traffic Signal Synchronization • Speed Harmonization • Dynamic Lane Assignment • Vehicle Detection • CCTV Surveillance
Safety	• Obtain accurate real-time information on the current operational status of the corridor • Detect incidents and locations • Expand coverage and availability of ATIS devices	• Speed Harmonization • Dynamic Lane Assignment • Queue Warning • Vehicle Detection • CCTV Surveillance

	(e.g., to warn of accident or lane closures ahead) • Provide (lane use) traveler information in a consistent manner (e.g., display formats, terms and their meanings.	

Table 2: Operation Concept of the I-270 ICM System

6. User-Oriented Operational Description

This section contains a description of each ATM/ITS technique from a user vantage point. Each individual technique is discussed separately, then a description of the proposed combined system is presented. This section also explains how organization/system-specific goals and objectives are accomplished. Emphasis is placed on who the users are and what the users do.

6.1 Stakeholders

Numerous stakeholders exist along the I-270 Corridor. The stakeholders that are discussed in this section can be broken into 3 categories:

- Owner / Operator / Maintainer
- Users
- Partners

6.1.1 Owner / Operator / Maintainer

The Owner / Operator / Maintainer category includes those transportation agencies that have responsibility for operating and/or maintain the I-270 corridor network.

Maryland State Highway Administration (SHA)

The Maryland Department of Transportation (MDOT) is an organization comprised of five business units and one Authority. They are: The Secretary's Office, State Highway Administration, Maryland Transit Administration, Motor Vehicle Administration, Maryland Port Administration, Maryland Aviation Administration and the Maryland Transportation Authority.

SHA is responsible for the development, operations and maintenance of the state roadway network. It is comprised of seven Engineering Districts (comprised of Counties) across the state. I-270 traverses both Montgomery County (District 3) and Frederick County (District 7). Along I-270, SHA will be responsible for management of I-270 network and Park-n-Ride facilities.

Other Offices within SHA that will have a role in operating and maintaining I-270 include:

Office of CHART and ITS Development (CHART) – CHART's responsibility, in cooperation with the Maryland State Police and the Maryland Transportation Authority, is to provide real-time operations along the SHA network. CHART will ultimately have responsibility for the ATM / ITS network to be installed as part of the I-270 ICM Project. Emergency Response Units (ERU) are on-road responders that survey the highway and respond to incidents or disabled vehicles. They operate 24 hours per day. Only two ERUs exist along the entire corridor.

Office of Traffic and Safety (OOTS) – OOTS develops and implements traffic systems management and operational strategies on the state highway network.

Office of Maintenance (OOM) – OOM maintains the communications network for SHA.

Districts 3 and 7 – the districts are responsible (ultimately) for the operation, construction and maintenance of all state highways in the Montgomery and Prince George's Counties (District 3) and Frederick, Howard and Carroll Counties (District 7). Emergency Service Patrols (ESP) from the District's maintenance shops augment the ERUs during peak periods. These patrols assist with disabled vehicles.

Montgomery County Department of Transportation (MCDOT)

MCDOT is responsible for the management of the county's arterial network, as well as the Ride On bus service. Under contract to SHA, they also operate and maintain signalized SHA intersections in the County.
The County manages all of its on-line signals from the Transportation Management Center (TMC) using a modern distributed Traffic Signal System (TSS) that operates as part of a larger Advanced Traffic Management System (ATMS). The TMC is located at the Public Safety Communications Center (PSCC) in Gaithersburg, Maryland. The County primarily relies on a network of closed-circuit television (CCTV) cameras, and other sources such as computer-aided dispatch systems and bus operators to relay real-time traffic surveillance information. The county is able to share CCTV video with SHA. Even though the TMC operates 7x19x365 (typically not staffed 00:30 - 05:30 daily) key operations staffing is centered on the peak weekday AM/PM peaks and special events. Off-peak monitoring coverage is limited leaving possible gaps in the ability to detect and respond to real-time traffic demand needs..

Maryland Transit Administration (MTA)

Along I-270, MTA operates the MARC train service from Frederick to the Shady Grove Metro Station. MTA also operates several local and express bus routes.

Washington Metropolitan Area Transit Authority (WMATA)

WMATA operates and maintains the transit networks Metrorail (subway) and Metrobus (bus) which run between the county and Washington, DC and Virginia. They also manage the parking facilities at their stations.

City of Rockville

The City of Rockville, MD is responsible for general roadway maintenance, pavement signing/marking, pedestrian safety efforts, and maintains direct operational management responsibility of its downtown signals using a separate field master type traffic control system (Econolite Aries). These signals are not tied into the County TMC. Operations need to be closely coordinated at signal boundary points to ensure common cycles and progression is maintained. The City does not currently monitor other County signal operations..

City of Gaithersburg

The City of Gaithersburg, MD is responsible for general roadway maintenance, pavement signing/marking, and pedestrian safety efforts. The City owns a few traffic signals within its jurisdiction; however, signal operations and maintenance is performed by the County.

6.1.2 Users

This group describes those stakeholders that benefit from the system but do not participate in the oversight, operation or maintenance of the system.

Media

Media, including local radio, ISPs and TV stations, collect traffic data from a central source and distribute and broadcast the information to the public.

TrafficLand

TrafficLand is a third-party provider that packages the real-time traffic conditions and transmits as part of SHA's 511 system.

6.1.3 Private Vehicle Operators

Private vehicle operators are the largest group of users of the corridor. Their use of the corridor is expected to grow in the future.

Private vehicle operator role and responsibility is limited to:

- Operating within the corridor; and
- Consuming information.

6.1.4 Commercial Vehicle Operators

Trucks and other heavy vehicles use I-270 to move goods between Washington, DC and other parts of Maryland and the country.

Commercial Vehicle Operation (CVO) role and responsibility is limited to:

- Operating within the corridor; and
- Consuming information.

Pedestrians

Pedestrians travel on the arterial corridors in the project area. This group needs to be included when introducing improvements on the arterials, in particular, traffic signal synchronization.

Pedestrian roles and responsibilities are limited to:

- Operating within the corridor; and
- Consuming information.

Bicyclists

Bicyclists travel on the arterial corridors in the project area. This groups needs to be included when introducing improvements on the arterials, in particular, traffic signal synchronization.

Bicyclist roles and responsibilities are limited to:

- Operating within the corridor; and
- Consuming information.

6.1.5 Partners

Maryland State Police (MSP)

MSP is responsible for enforcement, security, and accident investigations on freeways.

Montgomery County Police (MCP)

MCP is responsible for enforcement, security, and accident investigations on Montgomery County arterials. They also respond to accidents/incidents along I-270.

University of Maryland's Center for Advanced Transportation Technology (CATT)

CATT is responsible for the maintenance and operation of the Regional Integrated Transportation Information System (RITIS).

6.2 Current Capabilities

Current traffic and incident management practices along I-270 do not meet the I-270 ICM Project goals.

6.2.1 Freeway Management

SHA CHART, and to some extent, Districts 3 and 7 traffic groups, are responsible for coordinating much of the activity that occurs on I-270 as part of its role in managing all freeways located within the project area.

Events and incidents are detected through the SOC operator monitoring CCTV images or interfacing with MSP, MCP or District maintenance staff. This is currently a reactive approach to incident detection. In the event of an event or incident, the SOC will coordinate a response with an appropriate group, such as the MSP, ERUs, ESPs and emergency responders.

Demand onto I-270 is managed through traveler information and by controlling the traffic signals at the base of freeway on-ramps. Fixed and moveable Dynamic Message Signs (DMS) and Traveler Advisory Radios (TAR) provide information on upcoming events and freeway incidents.

Lane control is managed through static signage, striping, and police or maintenance personnel. HOV lane restrictions are communicated to drivers by static signs on I-270 shoulder and via diamond markings on the roadway. HOV lanes operate in both directions during specified times. Changes to lane use as dictated by incidents or maintenance activities are managed by some or all of the following activities:

- MSP/MCP vehicles slowing down traffic;
- MSP/MCP or maintenance personnel placing flares on I-270 to indicate the closing of a lane;
- MSP/MCP or maintenance personnel placing cones on I-270 to indicate the closing of a lane; and
- A temporary DMS is set-up on I-270 shoulder.

Vehicle speed is managed through static signs located on the right shoulder of I-270. In the event that an advisory speed needs to be temporarily modified, a temporary sign is erected and the permanent sign is covered.

6.3 Arterial Management

In Montgomery County, time of day signal coordination is accomplished by the County on all arterials. In Frederick County, the coordination is accomplished by SHA forces (District 7) on state highways and County of Frederick staff on county roads.

In the event of an incident along the corridor, each jurisdiction modifies its own signal timing. There is little interaction between agencies to assist with traffic signal coordination. Improving this coordination between agencies requires upgrades in many cities signal systems.

When incidents do happen on I-270 that increase the vehicle load on the arterial, there is little each jurisdiction can do to quickly direct vehicles that have diverted onto the arterial back onto I-270 downstream of an incident. There is no arterial signage to identify to the drivers where an incident is and how to get back onto I-270 beyond the incident. As a result vehicles may have a tendency to stay on the arterial longer than required, thus unnecessarily increasing the load on the arterials downstream of the incident.

Montgomery County has significant CCTV coverage along their arterials (and the state roadways they manage), however, Frederick County has little in the way of arterial coverage, so they are not able to verify the conditions quickly.

6.4 Incident Management

Freeway incident management is coordinated through the CHART SOC. Incidents are reported to the SOC operator by MSP/MCP, ERUs, ETP's or maintenance teams. The SOC operator will then coordinate a response with the appropriate CHART team and/or the MSP. In addition, the SOC operator can post information to DMS and TAR if necessary. The SOC operator will also use CCTV camera feed, when available, to assist with assessing and managing the incident.

Lane control around an incident is controlled by jurisdiction on-site. MSP will use flares, hand signals and cones to indicate which lanes are open and closed. CHART ETPs and ERUs support the police on scene with their arrow board-mounted trucks.

6.5 Traffic Surveillance and Monitoring

Closed circuit television (CCTV) cameras are installed on I-270 for surveillance. In Montgomery County, most of the cameras are owned and operated by the County. The images are streamed to the SOC, but CHART has no control. The CCTV cameras provide some coverage, but they do not provide a very detailed view of the corridor. There are many gaps in the coverage. However, the images that are available are streamed back to the SOC and used by the operators to view the traffic conditions. In addition, these images are made available to other agencies through the Maryland State Network and to the public via the web to allow them to view the images when the cameras are not being used by CHART for an incident. In the event that CHART deems the images seen on the video unsuitable for public consumption, access to the images can be interrupted.

SFVD microwave detectors are installed on I-270 for traffic monitoring. These detectors provide some coverage, and with a density and data polling frequency suitable for basic traffic flow information reporting, but not sufficient for active traffic management purposes. The CHART system to which they connect also does not provide any support for automated incident detection. As a result the detector station data is not used for much real-time traffic responsive operational decisions.

6.6 Traveler Information

Traveler information is provided via DMS, TAR, telephone (511) and the Internet. DMS and TAR systems are used to provide real time information and directions to the driver, plus they are used to advise about upcoming events. These systems are controlled from the CHART SOC. The Internet is used to provide more detailed information to the public.

The primary method of sharing information on the Internet and the telephone is via the MDOT 511 system (md511.org). The 511 system receives real time information from RITIS, CCTV cameras and from some management applications. This information is then analyzed and used to display meaningful, up to the minute information.

6.7 Commercial Vehicle Operation

Many commercial vehicle trips are completed into and through the corridor. Many of the commercial vehicle trips focus on trips to/from the Washington, DC metropolitan area and the southern end of the I-270 corridor. There is a scales/inspection station along the southbound portion of I-270 in Frederick County. There is little real -time information provided to the commercial vehicles and there are no restrictions to the commercial vehicle operation.

6.8 Summary

The applications being considered for implementation along the I-270 corridor through the IS 270 ICM Project have the potential to significantly impact mobility and safety along the corridor. The table below provides a summary of how each application would help achieve the Project Goals identified in Section 2.2.

Application / Project Goal	Dynamic Speed Limits	Queue Warning	Dynamic Lane Assignment	Dynamic Shoulder Use	Advanced Traveler Information
Mobility – Maximize Vehicle Throughput	X		X	X	
Mobility – Minimize Vehicle Travel Time	X	X	X	X	
Mobility – Create a more Predictable Commuter Trip	X		X	X	X
Safety – Provide a Safer IS 270 corridor	X	X	X	X	X

Table 3: ATM Application Summary Impacts

7. Operational Needs

This section describes what is required by the I-270 corridor freeway managers that the current system does not provide.

7.1 I-270 Vision

The health of the area's economy and community life is heavily dependent on the state's infrastructure networks. The quality of these networks is vital to the viability of business, as well as effective community services.

The vision for the I-270 ICM Project is to deliver a safe, efficient, maintainable roadway using innovative traffic management techniques.

The I-270 ICM Project will provide:

- a mechanism to manage mainline speeds to reduce turbulence,
- sufficient density of traveler information,
- easy lane control and incident warning,
- ability to accommodate peak period capacity increases,
- consistent real-time travel times at major decision points, and
- flexible lane use and control that would be appropriate for the varying conditions of the corridor

7.2 Staffing

The ATM can operate in fully-automated mode – requiring no operator confirmation before implementing a response plan; semi-automatic – requiring operator confirmation before implementing a plan; or fully manual – allowing the operator to control individual devices or select and implement a particular plan. Regardless of the mode of operation, the move to incorporate ATM into the operational structure will require additional operations staffing or at least a dedicated operator to monitor the corridor. Twenty-four hour staffed operation currently exists at the SOC in order to activate the techniques whenever they are needed.

Additional equipment will require an increase in maintenance efforts. The additional maintenance would pertain to structural inspections of the gantries and regular maintenance for the data stations, detectors, DSpeed and DMS displays, and associated utilities.

7.3 Data Support and Communications Structure

ATM techniques such as variable speed limits require a higher density of detectors than presently available. In addition, the ATM control algorithms may need detector data by lane. Current control algorithms require detectors across all lanes at a single location be grouped as a station of detectors. Furthermore, because the operational responses will likely include freeway and arterial coordination, there is a strong need for center-to-center communications. This requires data sharing between the SOC and the counties TMCs. There will be tremendous amounts of data coming into the SOC which will need to be archived. The current archive will continue to maintain and store the data, as well as post the data on the internet for public use.

7.4 Business Requirements

There are requirements within the system engineering framework that must be used for the development of the I-270 ICM system. The following subsections identify the requirements that, when satisfied, will allow SHA to achieve its objectives. These requirements, referred to as

Business Requirements, permit the development of this concept of operation. The requirement hierarchy is:

- Business Requirements – identify the stakeholder's goals and objectives of the system.
- User Requirements – identify the characteristics of the system that need to be in place for the operators to perform their assigned responsibilities.
- Functional Requirements – at a high level, identify many of the elements, subsystems and data inputs and outputs of the system.

All requirements must satisfy a higher level requirement and must be satisfied by a lower level requirement. All Business requirements must be satisfied by a User requirement. All User requirements must satisfy a business requirement.

7.4.1 Vehicle Impact

1. Shall allow safe movement of vehicles in the corridor.
2. Shall allow efficient movement in the corridor.
3. Shall permit reliable movement of vehicles in the corridor.
4. Shall reduce incident rate.
5. Shall decrease impact of incidents.
6. Shall reduce driver frustration.
7. Shall balance the needs of long distance commuters with the needs of people making short trips.
8. Shall reduce the number of bottlenecks.
9. Shall decrease number of vehicle delay hours along the corridor.
10. Shall provide a reliable trip on I-270

7.4.2 Vehicle Occupancy

1. Shall increase passenger per vehicle volume on corridor.
2. Shall balance traffic flow between single occupancy vehicles and HOV.
3. Shall maximize passenger volume through the corridor.
4. Shall improve the utilization of transportation resources.

7.4.3 Incident Response and Management

1. Shall minimize diversion of freeway traffic to county roads.
2. Shall improve incident response times.
3. Shall improve Incident Management and clearance times.

7.4.4 User Satisfaction

1. Shall improve the level of information available to travelers.

JACOBS

7.4.5 System Management

1. Shall improve information distribution between agencies.
2. Shall improve the operations and maintenance of the I-270 corridor.
3. Shall institute agreements to help with project implementation.
4. Shall coordinate solutions and operations between all agencies operating along corridor.
5. Shall allow each agency to continue to plan, develop implement and operate its own Traffic Management System.
6. Operational procedures shall be developed to ensure continued uniform operation of the environment. This will be done outside this project, but is necessary for the I-270 ICM Project's success.
7. Agencies shall maintain ownership and operation of all components located within their jurisdiction.
8. Project shall be a coordinated approach by all corridor agencies.

7.4.6 Other

1. Shall use ITS standards

8. System Overview

This section describes the concepts of the proposed ATM system. The subsections that follow contain high-level descriptions and discussions of the operational features with explanations of how the proposed system will operate. Items discussed in this subsection include:

- Integration with Current ITS Infrastructure and Programs
- Major System Components
- Interfaces to External Systems
- Proposed Capabilities or Functions

8.1 Project Scope

The I-270 ICM Project will involve applying ATM and ITS techniques along the length of I-270 and on a segment of I-495 (Capital Beltway). The strategies or subsystems include:

- Freeway management system
- Traveler information system
- Traffic surveillance and monitoring system

The components of these systems and their anticipated benefits are illustrated in the table below.

System	Components

Freeway Management System	• Advanced traffic management system
	  o Dynamic speed limits
	  o Lane use signals
	  o Vehicle detectors
	• Queue warning
	• Travel time information
	• Surveillance (closed-circuit television)
	• Dynamic message signs
	• Traffic signal synchronization

Traveler Information System	• Dynamic message signs • Travel times
Traffic Surveillance and Monitoring System	• Traffic detection on mainline • Video image detection (VID) on temporary use shoulder • Closed-circuit television (CCTV) cameras

Table 4: I-270 System Components

The ATM implementation addresses a number of issues, focusing on congestion mitigation and incident management. Strategies that will be employed include:

- Part-time shoulder use (Dynamic Shoulder Use) along the western I-270 Spur southbound from south of Westlake Terrace overpass to the HOV termination point on I-495. During AM peak periods, this shoulder will be the designated HOV lane. Lane-use control signals on an overhead gantry will indicate the staus of the shoulder lane, i.e., open to all traffic (green down arrow), closed (red “X”), or HOV (white diamond).
- Queue Warning along southbound I-270 from Watkins Mill Road to the outer loop of I-495 (north of River Road)
- Dynamic Speed Limits along southbound I-270 from Watkins Mill Road to the outer loop of I-495 (Bradley Blvd.)
- Dynamic Lane Assignments along southbound I-270 from Watkins Mill Road to the outer loop of I-495 (Bradley Blvd.)
- Queue Warning along the entire length of the southbound C/D lanes
- Dynamic Speed Limits along the entire length of the southbound C/D lanes
- Dynamic Lane Assignments along the entire length of the southbound C/D lanes

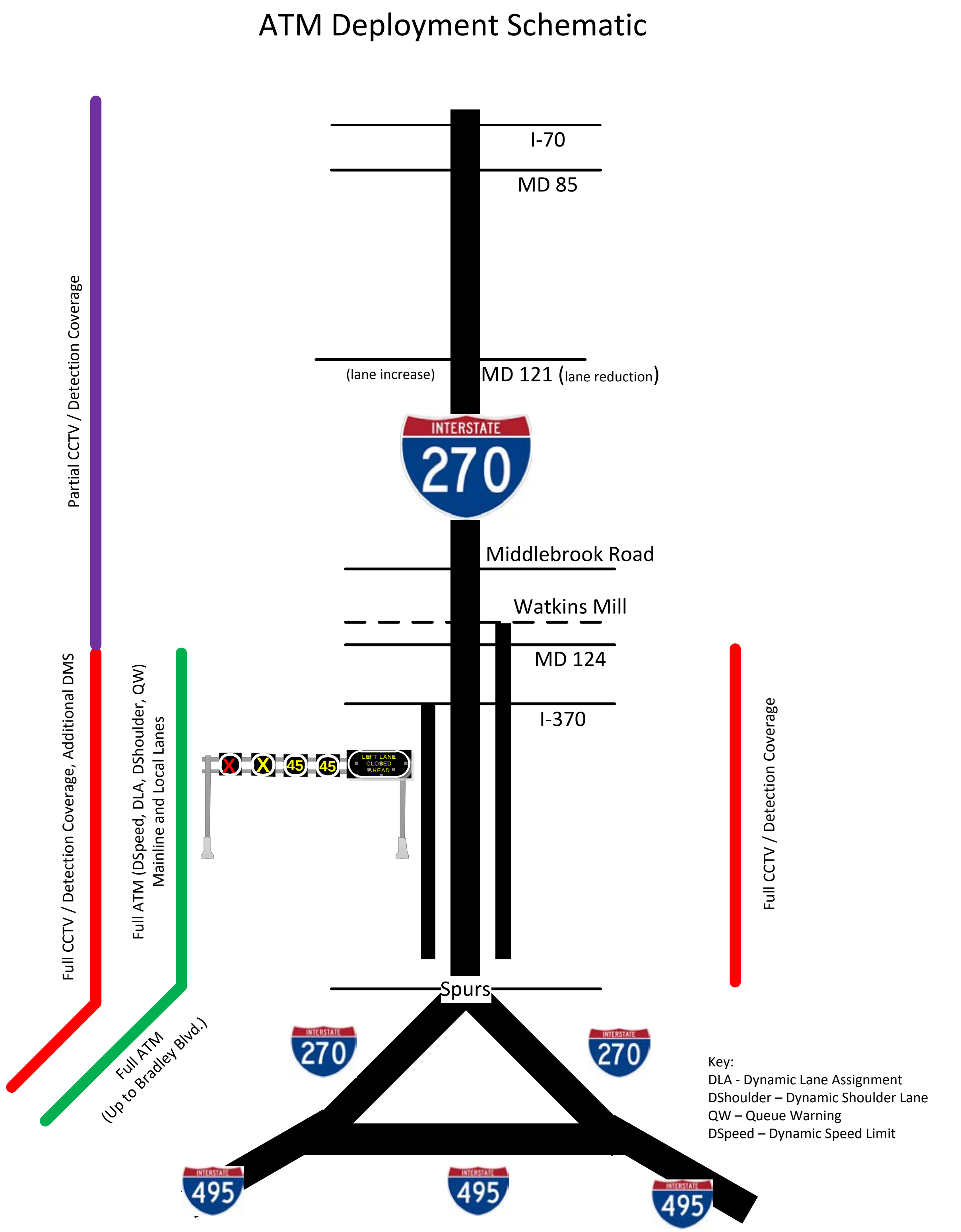


Figure 22: ATM Deployment Schematic

8.2 Integration with Current ITS Infrastructure and Programs

The ATM techniques discussed in this document are consistent with the SHA traffic management philosophy. They provide SHA with another set of tools to help them actively manage traffic conditions.

A new third party COTS Surface Transport Management (STM) platform will be used to support the ATM and ITS techniques described in this document. The system workstation operator interface will be located at the SOC with the supporting server functionality located in a cloud-hosted facility and/or at the SHA primary and backup data centers. The system has the ability to exchange and share information with other third party centrals and will integrate with CHART and RITIS consistent with the ITS regional architecture. However, its operation of ATM and ITS field elements is not dependent upon these external interfaces. The figure below shows the initial conceptual architecture with final architectural decision on the external interface to be developed during design. It is envisioned that a new STM / CHART ATMS Interface Web Services component will be developed as an adaptation layer between STM and CHART. The new Web Services component will allow STM integration with CHART existing capabilities in event/incident management, DMS and CCTV control, without needing to change the way CHART operates and while keeping CHART as the primary “top level” tool for statewide freeway operations.

The I-270 STM application will control each system, based on the current corridor conditions. Primarily the system will be operating automatically, without the requirement for user intervention (however it is likely that upon initial turn-on the system will operate with operator confirmation). In this way the system will be able to quickly react to the prevailing conditions. The system will not need to wait for an Operator (or other user) to evaluate the existing conditions and determine the best course of action. This places the onus for managing the corridor on those users responsible for planning coordinated responses, and away from the Operator who may also have multiple tasks to manage. The system will respond to condition changes as simple as changing congestion levels to as complex as a major incident that requires emergency response and that causes vehicles to seek alternate routes.

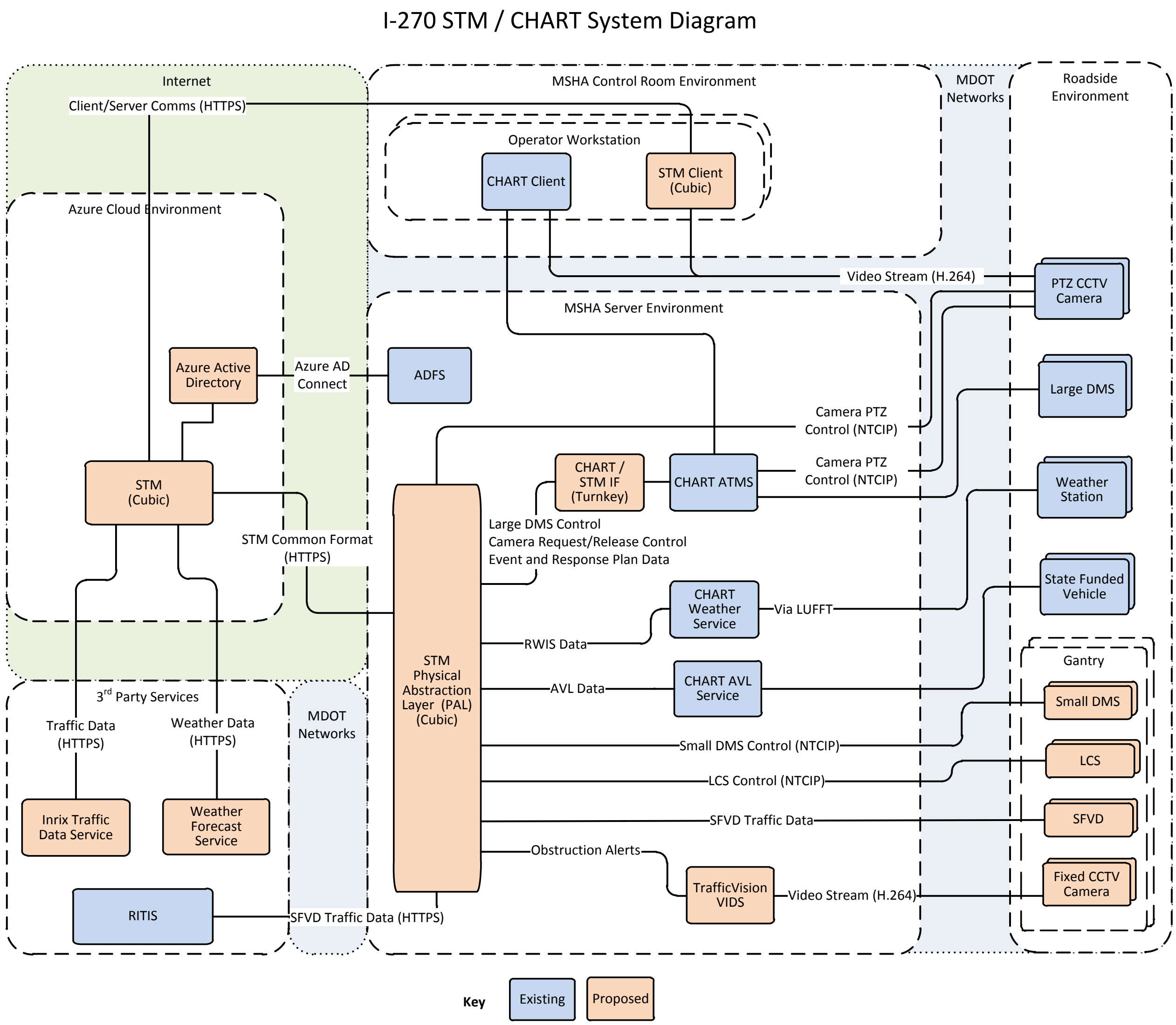


Figure 233: STM / CHART System Architecture

8.3 Integration with Existing MDOT Communications Network

The SHA has made available four (4) fiber strands from the Level3 Fiber cable running along the I-270 corridor. This cable has MDOT lateral cable tie-ins to the Frederick County Law Enforcement Center (Lawmall) on the northern end and to MDOT District 3 and 5 on the southern end. It may also be possible to construct an alternate tie-in point at the I-270 and I-370 interchange with the Intercounty Connector MDTA fiber cable. These tie-in points provide the means to eventually access the MDOT network over which the field communications will connect to the various servers/services at MDOT data centers, third-party cloud-hosting, the SHA Statewide Operations Center (SOC), and other locations that support this operation. Only one tie-in point with MDOT network access is necessary to support the project. However, secondary and possible tertiary tie-ins will provide desired redundancy to ensure a robust solution. This project assumes the use of two (2) tie-in locations. The initial network system diagram is shown below.

The Level3 cable is under a resource sharing agreement (RSA) where MDOT has been allocated 24 total strands, with four (4) of those strands being available for this project. Level3 Access Vaults are typically located every ½ mile. However, under the RSA terms, vault access by SHA is limited (sequential vault access is prohibited) so that effective access is actually about every 1 mile. The SHA standard buildout is to construct a tie-in vault alongside the Level3 vault with the entire 24 strand cable looping through the SHA vault as shown in figure 2 via a 48ct tie cable. This approach limits Level3 vault access to only the initial build out and provides a convenient means for SHA to manage its own fiber cable access and configuration in the future. Approximately half of the locations are already equipped with the SHA tie-in vaults. The remaining required access locations will be equipped with the tie-in vault.

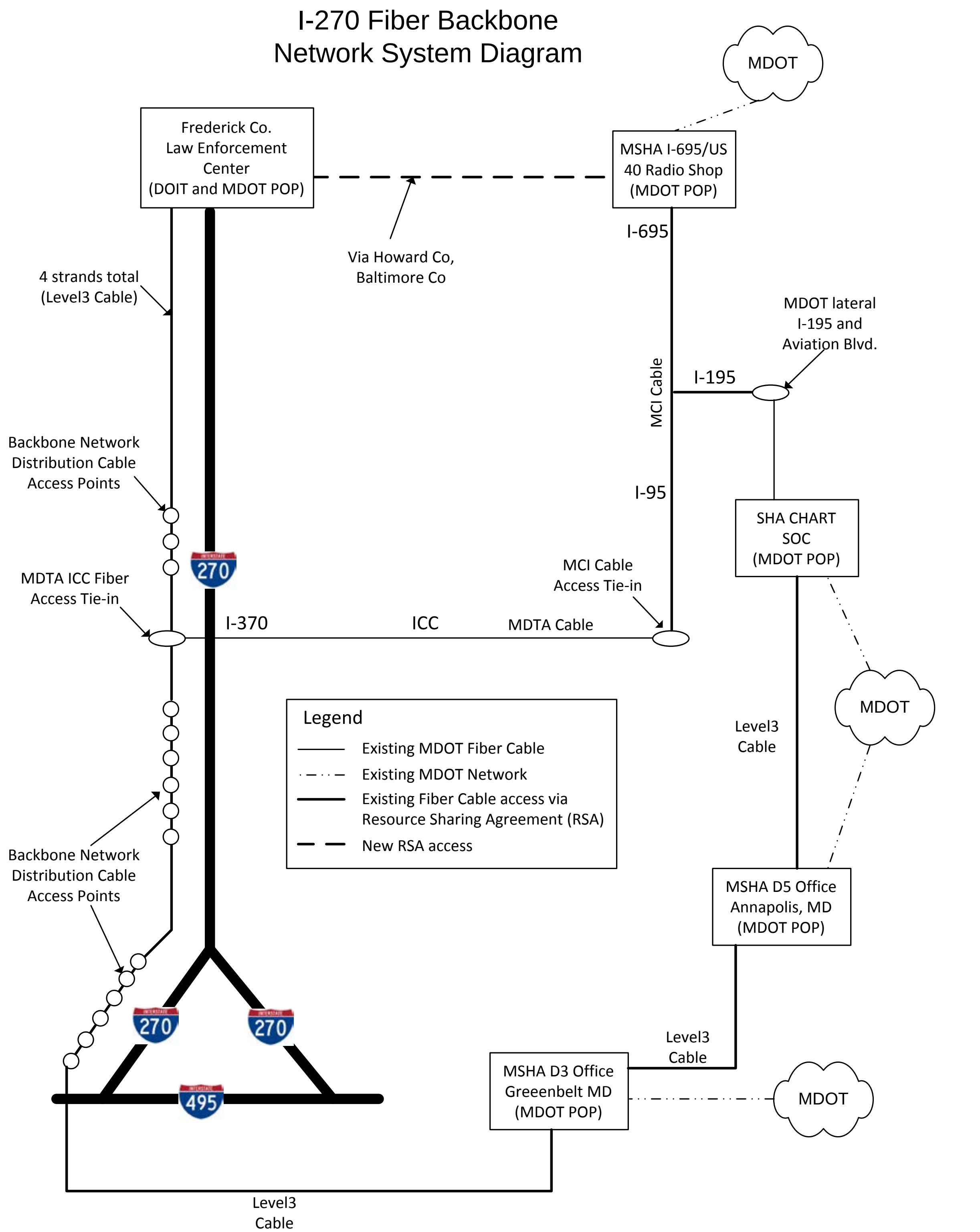


Figure 24: Network System Diagram Concept

The initial field network conceptual design is based on a hierarchical design consisting of a Layer 2 switched network connecting field devices to Layer 3 routed aggregation switches as shown in the figure below. Local switches may be used to connect multiple local equipment cabinets to the distribution network distribution switch. Each distribution ring and interconnected backbone

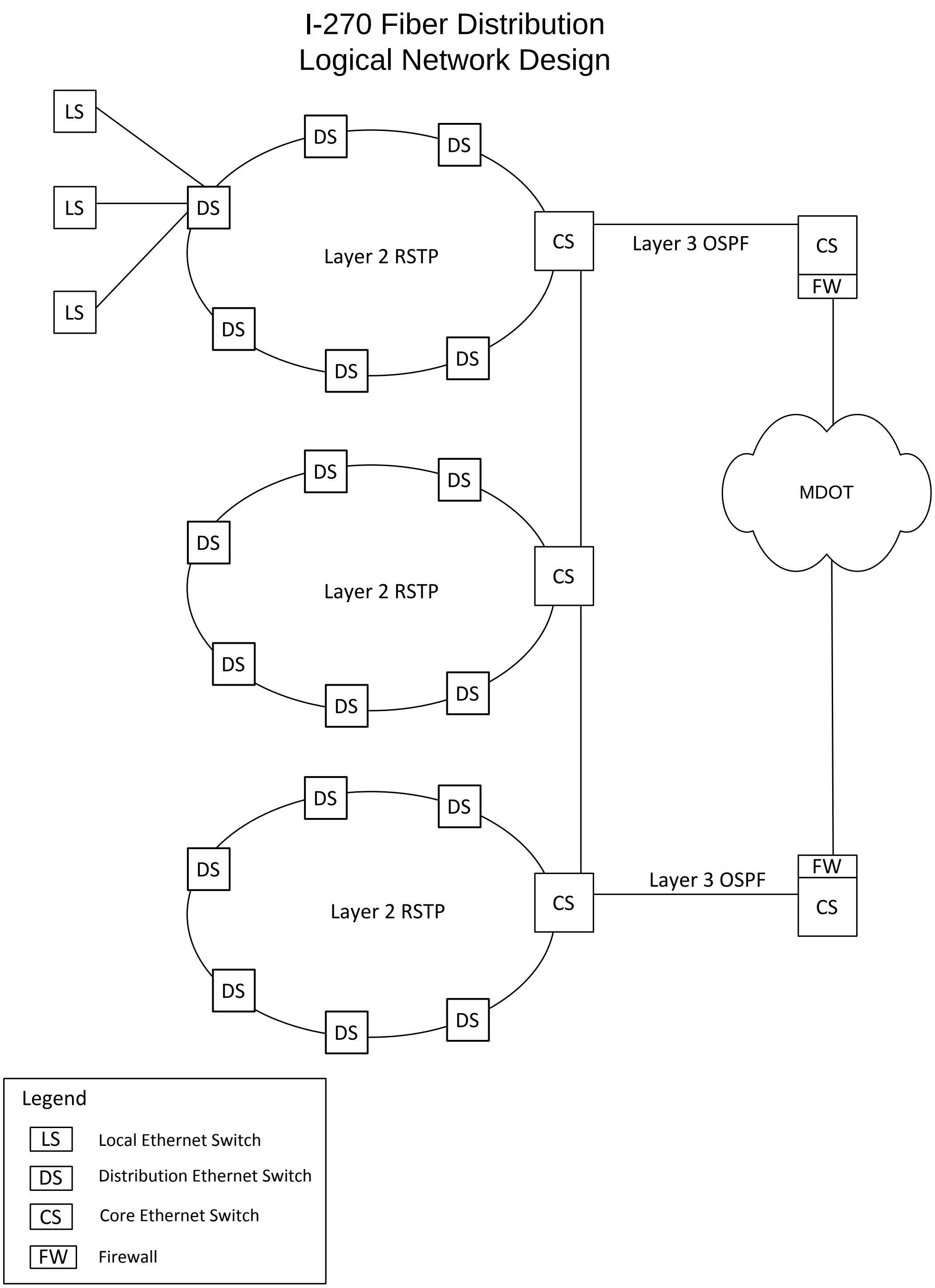


Figure 255: Logical Network Design Concept

core ring operate as separate segments with redundancy to protect against single point failure between field elements and backend facilities supporting data processing elements, system servers, and workstations. The MDOT core network is isolated and protected from the field network through firewalls at each MDOT tie-in location. It is anticipated that the existing MDOT Network Operations Center (NOC) will be used to also manage these additional network devices.

8.4 Surface Transport Management (STM)

The I-270 STM consists of a number of subsystems that are supported by field devices. These devices play a vital role in improving freeway operation.

The STM will implement the following strategies to support ATM operations:

- Lane control and Dynamic Speed Limits (DSpeed) will be focused on the southern section of the corridor along the HOV segments
- DMS will be installed at locations with lane and DSpeed controls to provide supplemental traveler information along the corridor
- Full CCTV coverage will be installed along the corridor for typical surveillance requirements, but also to view and verify lane control signal displays
- Vehicle detection will be expanded to provide significantly more coverage along I-270
- Video image detection will be installed at all locations where temporary shoulder use will be implemented.

8.4.1 Major STM Components

The STM will be composed of several different ITS components. Each component provides specific capabilities required to meet the operational needs of the system.

- Dynamic message signs (DMS) capable of displaying advisory and lane status notifications to supplement lane control signal status. These are traffic management specific messages displayed on smaller signs co-located with lane use signals
- Lane control signals displaying lane status and advisory speed
- Traffic detectors gathering speed, volume and occupancy at ½ - mile spacing. Non-intrusive side fire radar (“by-lane”) configuration is proposed.
- CCTV cameras able to respond to preposition control commands and camera video selection and display in response to an incident.
- Communication systems to monitor and control these devices

8.4.2 Interfaces to External Systems

The STM external systems interface will support the following data exchanges. These are two-way exchanges so that information derived from field devices connected directly to the STM can be shared with the CHART/RITIS environment, and information derived outside of the STM may be used by the STM in making control decisions.

- Vehicle Detection: Vehicle volume, occupancy, speed and classification by lane and by time interval. Reporting intervals can vary but are typically 15 seconds from the field for congestion/incident detection and may be aggregated to longer intervals such as 5-15 minutes for status reporting. Aggregated records may be shared with RITIS for general condition reporting.

- Events: these may include incident detection events automatically detected by the STM; response plan activations; lane control, and dynamic speed limits activations. External data exchange logic and message content can be configured to adapt to the capabilities and needs of the external systems. STM originated events and response plans may be linked to CHART events for overall management and situational awareness.
- DMS messages: Traveler information messages initiated by STM as part of response plan may be shared with CHART for display on full size CHART DMS.

Center-to-center data exchanges with other jurisdictions, such as Montgomery County, may be supported through RITIS consistent with the ITS regional architecture. Although Montgomery County does not currently support a center-to-center interface it may in the future. The ability of the county to coordinate arterial operations with the I-270 operation would be dependent upon the county completing this capability.

8.5 Proposed ATM Elements

The following sections describe the various elements and illustrate their proposed locations.

8.5.1 Active Traffic Management – Lane-use Control Signals

The LCS will be used to advise the travelers which lanes are open for use, under what conditions they are open for use and to display the Dynamic speed limits. These signs will be placed on full span sign structures directly above each lane, as shown in the figure below. The LCS on the structure will be a full matrix DMS.

LCS will be installed on I-270 as per the design alternative selected. The preliminary proposed locations of the sign structures are provided in the Appendix. In addition, the LCS can display the Dynamic speed limits (DSpeed) as illustrated in the figure below.

The information provided by the LCS will reduce the likelihood that travelers will be surprised by events ahead, thereby decreasing the chance of a sudden change in speed or lane change.

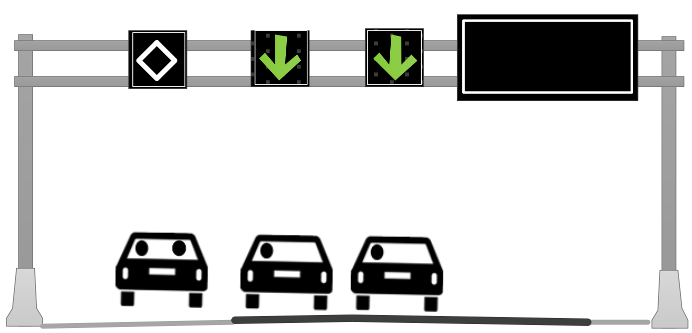


Figure 263: Typical Full-Span with Lane Use Control Signals (during temporary shoulder use)

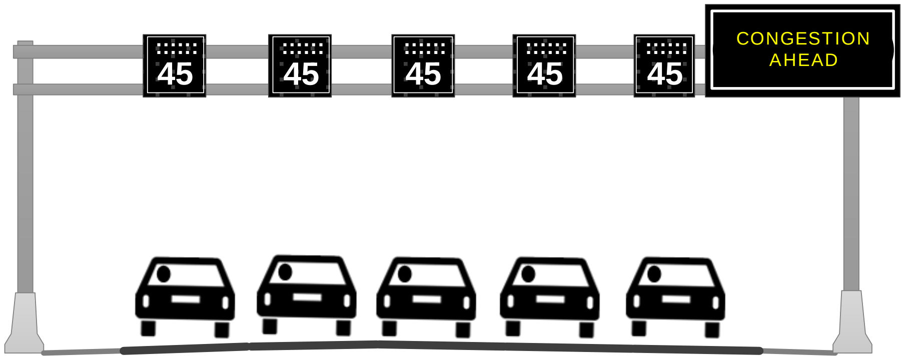


Figure 274: Typical Full Span ATM Sign Structure with DSpeed Displays

These signs will be:

- Full matrix DMS
- Full Color

8.5.2 Traveler Information System

Information will be provided in real time to motorists on I-270 via DMS, TAR, Internet, and telephone. This information may decrease congestion since it encourages travelers to use transit options and/or travel when congestion is lower.

Presenting traveler information during an incident could assist SHA with controlling the flow of vehicles. The information provided could inform drivers about the severity of any congestion or incident, and encourage these motorists to stay on I-270.

8.5.3 Dynamic Message Signs – Small Supplemental

Smaller supplemental DMS along the ATM section of I-270 will be directly controlled by STM and be used to provide supplemental information when the LCS is active. These DMS will be located on each LCS gantry and provide information supporting the active ATM scheme. The DMS messages will automatically be updated as part of the ATM response plan. When the ATM is not active the DMS along with LCS will be dark so as not to distract the driver. Proposed signs are to be full color full graphic matrix signs.

Example messages may include:

- Congestion, Reduce Speed;
- Construction, Right Lane Closed;
- Resume Normal Speed;

8.5.4 Dynamic Message Signs – Large Roadway

Existing full size DMS along I-270 and approach corridors will be used to support the Active Traffic Management (ATM) regime. The DMS messages will be updated as part of the procedure for responding to any event affecting the ATM devices. In addition, DMS may be used to provide general information in accordance with SHA standard procedures. The DMS will continue to be controlled through CHART.

Any new signs are proposed to be full color full graphic matrix signs. The alphanumeric messages on these signs will meet all current standards, including those for visibility and legibility distances.

These signs will be used to display a variety of information, including:

- Warnings and alerts;
- Vehicle Travel Times;
- Available parking spaces at park and ride facilities;

8.5.5 CCTV Cameras

CCTV cameras will be used to fill in the gaps along all of I-270 to monitor traffic conditions. A total of 50 additional CCTV locations will be added along the corridor. See Appendix for existing and proposed camera location information. Cameras may also be placed on incident management routes to observe trailblazer detours and signal flush plans.

8.5.6 Detection

- Detection will be situated along I-270 in the densest portions to run incident detection algorithms and to supply condition data to the I-270 STM software.
- Video image detection will be installed to monitor the temporary shoulders.

8.5.7 Traffic Surveillance and Monitoring System

Traffic surveillance and monitoring system will be used to provide information to all the other systems. This system will allow the operators of the I-270 corridor to make informed decisions about how to best operate the I-270 corridor to achieve their objectives; it will also allow users to make informed decisions about traveling within the corridor.

8.5.8 Traffic Surveillance System

Color CCTV cameras, both fixed and Pan/Tilt/Zoom (PTZ) will be located along I-270. These cameras will be placed at strategic locations to assist SHA and local agencies with monitoring and managing traffic, incidents and events. The cameras will be mounted either on sign structures or on standalone poles.

The corridor has existing CCTV cameras. The specifications of the existing CCTV cameras are sufficient for the surveillance needs of this project; hence, they will not require any replacement. The addition of new CCTV cameras, supplementing the existing CCTV cameras, will provide a wider coverage area, thereby increasing the speed of incident detection.

The surveillance system will be managed and operated via the CHART SOC. The video stream from the cameras will be available to operators in the I-270 TMC, the public via websites and other stakeholders, as required.

9. Operational Environment

This section contains information about the system, operations, and maintenance costs.

9.1 System Costs

Conceptual cost estimates were completed for each ATM element. The following factors were considered:

- Analysis – if required
- Design
- Utilities
- Right-of-Way
- Maintenance and Protection of Traffic
- ITS Devices
- ITS Integration and Software
- Roadway Enhancements
- Structures
- Drainage
- Storm Water
- Erosion and Sedimentation Control
- Landscaping
- Construction Management and Construction Inspection

The following tables provide a high-level summary cost estimate for each strategy. THESE TABLES HAVE BEEN INTENTIONALLY LEFT BLANK.

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 5: ATM Cost Estimate (including LCS, small DMS and structure)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 6: Traffic Surveillance Cost Estimate Along Entire Corridor (full pan, tilt, zoom)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 7: Detection Cost Estimate (outside ATM-deployed area)

Location	Construction Cost	Design Cost	CM/CI Cost	Total System Cost

Table 8: Traveler Information Cost Estimate

9.2 Maintenance Costs

CHART will be the primary operator and maintainer of the ATM enhancements. All ITS devices and systems will have to be included in the existing CHART maintenance program. That includes an operational test period as part of device installation as well as an ongoing support period following construction. The durations for these periods range from 60- days to 6-months, and 6-months to 2-years, respectively. Following the completion of the project's support period, the devices will most likely be integrated into the CHART's existing ITS maintenance contract. Below is a high level analysis of the devices associated with each of the ATM deployment concepts, their lifecycle and anticipated maintenance costs. Annual maintenance costs were derived the FHWA's 2010 Cost Elements Database. THIS TABLE HAS BEEN INTENTIAONALLY LEFT BLANK

Concept / Component	Lifecycle (years)	Number of Devices	Annual Maintenance Cost of Device	Total Annual Maintenance Cost
DSpeed				
Queue Warning				
Detection				
Signs				
Dynamic Lane Assignment				
Signs				
Structures				
Dynamic Speed				
Signs				
Structures				
Dynamic Junction Control				
Signs				
Structures				

Table 9: Life Cycle Cost Estimate

10. Support Environment

This information is provided to allow all affected organizations to prepare for the changes that will be brought about by the ATM system and to allow for planning of the impacts on SHA, user groups, and the support maintenance organizations during the development of, and transition to the new system.

The support environment for the ATM System will be one that compliments the existing support environment processes and capabilities of the client. Hardware and central software components will be replaced as determined by the support staff. Development and deployment of new components for the ATM System will be coordinated with the assigned support staff. Support of the system is anticipated to require additional SOC maintenance support and must be considered for the full life of the ATM Project.

10.1 Impacts during Development

This subsection describes the anticipated impacts on the operations and maintenance staff during the retrofit process for the proposed system. Other impacts during development may be discovered during the remaining phases of the system lifecycle. The currently identified impacts during the retrofit process include the following:

- Involvement in studies, meetings, and discussions – In order to ensure the success of the project, there will be a need for client involvement in all aspects of the system lifecycle. This will necessarily require involvement in studies, meetings, and discussions that will occur throughout the development of the system.
- User and support involvement – There will also be a need for increased involvement by the user and support groups. This involvement will include participation in reviews and demonstrations, evaluation of initial operating capabilities and evolving versions of the system, development or modification of databases, and required training.

10.2 ATM Strategies

10.2.1 DSpeed

Dynamic speed limits should address traffic congestion before or during a breakdown in operations. Breakdowns in traffic can be caused by several factors including high demand, weather, work zones and incidents. Dynamic speed limits reduce rear-end collisions due to speed differentials due to these breakdowns. In order to be deployed successfully, the operational needs for the DSpeed subsystem are at a minimum:

- Coordination with regulators and MSP to confirm DSpeed operational usage and enforcement.
- Static speed limit signs may need to be removed from the project area
- DSpeed signs need to be placed in a location such that speed limits are visible to all motorists.
- DSpeed signs need to be placed in a location viewable from a local CCTV camera in order to manually verify operation.
- DSpeed devices need to have a redundant power supply in order to assure continuous display of speed limits.

- Ensure a consistent supply of accurate and reliable traffic data to feed DSpeed algorithms.
- Archiving of vehicle speed data to identify areas where DSpeed enforcement is needed.
- Integration into existing SHA communications network to ensure connectivity to field devices.
- Implementation of a DSpeed software system at the SOC.
- Archiving of DSpeed data and generation of performance measures to evaluate the system.
- MSP Workstation at SOC – archiving speed limit information for use in court cases and for use by on-site MSP personnel.

10.2.2 QW

Queue Warning installations should support the reduction in rear-end collisions throughout the corridor by providing advanced warning of downstream queues. In order to be deployed successfully, the operational needs for the QW subsystem are at a minimum:

- Ensure that proper detection coverage is in place to ensure the collection of data at locations with persistent queueing.
- Ensure that all detection devices are properly working and calibrated.
- Ensure that the queue detection algorithm is sufficiently calibrated to minimize the amount of false alarms.
- Ensure that dynamic signage is located sufficiently in advance of the queueing area to provide advanced warning and that signs are oriented and sized sufficiently to provide to provide clear and consistent messages
- QW installation needs to be coordinated with dynamic speed limits in order to better harmonize speeds approaching queuing traffic.
- QW detection and signage will require a redundant power supply in order to assure continuous display of available lane usage.
- Implementation of a Queue Warning software module at the SOC. This software module should automatically generate and post queue detection warnings and provide an alarm to SOC operators.

10.2.3 DShoulder

Dynamic shoulder lane installations should address areas of persistent congestion due to demand exceeding roadway capacity by opening up use of the shoulder to through moving vehicles. In order to be deployed successfully, the operational needs for the DShoulder subsystem are at a minimum:

- Coordination with regulators and MSP to confirm shoulder usage, lane striping, signing, DShoulder operational usage and enforcement.
- Geometrical and structural improvements need to be made to provide the cross section and vertical clearances needed to safely operate DShoulder.
- Emergency pull-off areas need to be provided to allow refuge for disabled vehicles.

- DShoulder signage must be clear to ensure that motorists have the time necessary to safely make all lane changes.
- Full video coverage of the DShoulder operation area must be provided to ensure that the shoulder is clear of debris and stopped vehicles prior to opening the shoulder.
- DShoulder installation needs to be coordinated with lane assignment, junction control, dynamic speed limit and other ATM deployments in order to ensure an efficient operation of the corridor.
- DShoulder devices will require a redundant power supply in order to assure continuous display of available lane usage.
- Implementation of a DShoulder software system of modification of the existing DMS module at the SHA SOC.
- DShoulder implementation will require addition resources from SHA ETPs or Maintenance to clear debris from the shoulders.

10.3 MDOT Communications System

The communications network should serve both the current needs of the devices and future expansion of the system.

More specifically, the operational needs for the communications subsystem are at a minimum:

- Provide highly reliable high-speed data and video links between field devices / communications hubs and the SOC to support data and high-resolution full motion video.
- Provide the ability for high-speed connections to control centers of stakeholders.
- Provide compatibility with existing SHA communications infrastructure and protocols.
- Provide communications network redundancy where feasible.
- Provide capability of transmitting multiple networks.
- Provide capability to integrate and connect with adjacent ITS deployments.
- Provide necessary bandwidth to support future ATM and connected vehicle initiatives.

10.4 SOC

10.4.1 Staffing

Even though many of the functions of ATM are intended to be automated, there will be a significant verification and asset management component to their operations which will place additional responsibilities on SOC operators. For example, SOC operators will need to visually verify that there are no roadway obstructions prior to manually implementing, or allowing the automated implementation of lane use control, or dynamic shoulder lanes.

Additionally, due to the safety issues that could arise as a result of long-term outages of warning and channelizing devices associated with some ATM enhancements, the asset management and maintenance of these devices is more critical. Therefore, device operational status will need to be verified on an ongoing basis and maintenance will require more attention on behalf of operators and/or SHA SOC staff.

It is envisioned that the ultimate deployment of ATM enhancements recommended in this report will require at a minimum one (1) additional SOC Operator per daytime shift and potentially an additional SHA SOC engineer to facilitate maintenance and operator supervision. In addition, all SOC Operators and SHA staff will require additional training in all ATM components, their operations, and maintenance.

Due to the response time that is required to address field issues on lane use control, dynamic shoulder lane, junction control, and dynamic speed limit equipment, it is recommended that an additional ITS field maintenance personnel position be created within the SOC.

It is also anticipated that additional responsibilities for clearing the shoulders of debris will be the responsibility of the SOC staff (ESPs) and/or Maintenance.

10.4.2 Hardware

No additional hardware is anticipated at the SOC to support the ATM enhancements. The STM workstation operator user interface functions as a thin client that can operate on any existing workstation platform. It is envisioned that the STM user interface will operate alongside the CHART interface on the same platform. The STM server environment can be supported on premise with dedicated server hardware or in a virtualized environment, or off premise in the cloud. It is envisioned that the system would be deployed in a virtualized environment with front end processing hosted within the SHA primary and backup data centers, and backend application services hosted in the cloud. A standard Internet Protocol (IP) network is used to communicate between server hardware, field devices and operator workstations. It is envisioned that the MDOT/SHA network would be utilized for this purpose.

10.4.3 Software

Client server software architecture is utilized by the STM to support the necessary ATM enhancements. Server components are supported in a standard Microsoft Windows environment with all system data maintained in a standard SQL-based database platform. The operator workstation environment utilizes a standard browser-based thin client interface and is therefore available from any authorized workstation without the need for additional local software.

10.5 Enforcement

If ATM strategies are not actively enforced and adhered to by motorists, it can create significant safety concerns. At this time, it is not anticipated that any ATM enhancements will include an automated enforcement component (i.e. automatically generating speeding violations for motorists not adhering to dynamic speed limits). As a result, there will be a need to closely coordinate with MSP for the manual enforcement of speed limits and lane use. In order to effectively enforce ATM operations, the following two (2) requirements must be met:

1. Officers in the field will need to have a real-time awareness of what ATM operations are in place and how they are being used. Examples include what the current posted speed limit is and what lanes are open to what traffic. The optimal deployment of this information would be directly through a data feed to the patrol vehicle in real time. A more low-tech approach could include posting information on the back of signage as well, so an officer can see the information regardless of where they are posted in relation to the device.
2. In order for traffic citations to be defended in court, accurate records must be kept for a period of time and available to the state police for use in court. Records must indicate what ATM operations were in place, what the speed limits were along the roadway, and when they changed. Records must be stored for a sufficient time in order to ensure they

are available for court. This could be achieved through a direct data feed to MSP or by having SHA store and provide the data to the police upon request.

In regards to both requirements, close coordination with the MSP will be required at a regional or statewide level to put policies and procedures in place for the provision of ATM data to law enforcement officers, the enforcement of ATM operations, and the storage of ATM data for further law enforcement use.

10.6 Public Outreach and Education

It is widely accepted throughout the industry that ATM applications have the potential to provide significant benefits to the traveling public. Certain benefits, like the reduction in rear end collisions as a result of queue detection and dynamic speed limits may not be as perceptible to the driver day-to-day, while the capacity enhancements provided by opening the shoulder during peak periods will provide noticeable benefits. Certain enhancements such as lane use control may be seen as prohibitive by some motorists, as some public comments have already been documented related to passage of emergency vehicles in conjunction with DShoulder, underlying the need to properly inform and educate the public prior to implementation.

Engaging in public outreach can also have operational benefits. One of the lessons-learned during the re-activation of ramp metering devices along I-476 in 2010 was that it took motorists a few weeks to learn how the meters operated and the most effective way to queue and proceed through the signal. Once motorists were sufficiently educated, the operation of the ramps became much more efficient.

This ConOps, as well as schedule and funding constraints, will require that the recommended ATM enhancements be implemented incrementally over a period of two (2) to 10 years. SHA is also pursuing ATM deployments along other interstates within the region, which may be deployed in advance of those on I-270. This staged approach will allow motorists to become familiar with ATM operations over a period of time beginning with queue detection/warning and dynamic speed limits in the first phase. In any event, it is recommended that prior to any new ATM deployment becoming operational, that the Department engage directly with media outlets, develop press releases and educational materials, and provide notification on regional DMS noting the upcoming changes in traffic operations. Engagement with the media and through press releases and educational materials should stress education and highlight the overall benefits of the ATM strategies being deployed.

11. Operational Scenarios

Operational Scenarios describe how ATM strategies will operate under different circumstances. The scenarios presented do not represent every possible condition of the roadway but reflect typical events the ATM system will encounter. This should provide a better understanding of how the various ATM strategies, traffic operators and patrol units work together to resolve issues and improve traffic conditions.

Traffic operators will play a key role in determining the appropriate utilization of certain ATM strategies such as DShoulder. Operators will rely on communication with patrol units or CCTV to make sure the shoulders are clear for DShoulder activation. Furthermore, operators will be able to submit changes to the proposed ATM plan, input additional data, and approve the ATM plan before implementation. The extent of operator involvement will vary based on how much information is necessary for the given scenario.

The six (6) scenarios used in this section represent typical conditions the ATM system will encounter:

1. Free flow – No congestion or adverse conditions. Represents how ATM strategies will operate/display during normal conditions
2. Recurrent congestion (AM/PM) - occurs as use increases, and is characterized by slower speeds, longer trip times, and increased vehicular queueing. Represents how ATM strategies will operate during AM/PM rush hour.
3. Lane Restriction – Lane closure due to work zone, accident, debris, etc.
4. Weather conditions – Represents how ATM strategies will operate in reaction to weather conditions impacting the roadway (i.e. ice, snow, heavy rain, flooding, or fog).
5. Complete closure – Full closure of all traffic lanes.
6. Non-recurrent congestion – Represents how ATM strategies will operate when the roadway is congested during hours that typically have free flow traffic.

The following sections will describe each phase of the system, and how it is intended to respond individually to each of the six (6) representative scenarios:

- Dynamic Speed Limit & Queue Warning
- Dynamic Lane Assignment
- Dynamic Shoulder Lanes
- Full Implementation

At the end of each section, a graphic is presented showing the progression of ATM operations beginning in advance of the situational areas, progressing through the area, and then returning to normal operations. It should be noted that a dynamic message sign (12 characters by 3 lines) is proposed for each gantry. The figures that follow illustrate just a single DMS introducing the issue. When no issue exists, the signs would be blank or project travel times.

11.1 Dynamic Speed Limits & Queue Warning

DSpeed signs and the QW system work to reduce speed differentials that cause unanticipated speed reductions. This system steadily reduces the speed of traffic as it approaches a congestion area and warns drivers of congestion ahead. With this system, drivers anticipate reduced speeds, rather than unexpectedly coming upon congested, slow moving traffic.

Differential speeds can cause rear-end collisions or sideswipes that cause further traffic congestion. The QW system utilizes the DMS to display warning messages to drivers.

11.1.1 Free Flow

During free flow conditions, DSpeed signs may either be left blank or display the normal posted speed limit (55 mph).

The DMS will be left blank or display travel time information.

11.1.2 Recurrent Congestion

During recurrent congestion, DSpeed signs will display speeds that ease upstream traffic speeds to that of speed in the congestion area, by reducing speeds in a step-pattern. Upstream from the congestion, the DSpeed signs will display the normal speed limit. Closer to the congestion area, signs will start to display lower speeds (e.g. 55, 45, 40, etc.). After the congestion, DSpeed signs will display increased speed limits to bring the traffic flow up to the normal speed limit. If the congestion occurs again downstream, DSpeed signs will display a speed limit between the congestion area reduced speed and the normal speed limit (between 40 and 50 for example). As traffic approaches the new congestion area, the DSpeed signs will again display a reduced speed.

DMS will display a queue advisory upstream from the congestion area. Near the congestion area, DMS will display an imminent warning message.

11.1.3 Lane Restriction

When a lane restriction is in place, DSpeed signs will react similar to a congestion scenario by gradually reducing traffic speeds upstream of any queues that form due to reduced road capacity.

In general, the DMS will display a lane closure warning and queue warning upstream of the lane closure. The DMS may display a more specific message depending on the type of lane restriction (i.e. work zone, accident, debris, etc.).

11.1.4 Weather Conditions

Adverse weather conditions may necessitate reduction of speeds, even if expressway flow is less than capacity for safety. If the system detects reduced speeds downstream, DSpeed signs will gradually slow down traffic similar to the recurrent congestion scenario.

DMS signs will display weather advisory messages throughout the corridor or in areas where adverse conditions are known to occur.

11.1.5 Complete Closure

In the event of a complete road closure, DSpeed and DMS can be left blank or display a speed limit and “Road Closed” message respectively.

DMS located outside of the project limits, but approaching I-270 will need to notify motorists of the closure and provide detour information.

11.1.6 Non-recurrent Congestion

During non-peak hour congestion, the system will detect the reduced speed of traffic and react to the situation similar to how it would approach the recurrent congestion scenario by reducing speeds gradually in a step-pattern and warning drivers of imminent queues.

11.2 Dynamic Lane Assignment

DLA will be activated to manage lane access typically in advance of a lane closure as a result of incident, construction, roadwork, or maintenance activities. By communication lane closure activities ahead of an obstruction allows traffic to merge in a more coordinated fashion and thereby improving traffic flow.

11.2.1 Free Flow

Under normal conditions, the DLA sign will normally be dark. If any of the adjacent lane signs are activated then the DLA will display a green downward Arrow indicating that the lane is open.

11.2.2 Recurrent Congestion

DLA will not be activated during normal recurrent congestion.

11.2.3 Lane Restriction

During a lane restriction, the DLA may be active to move vehicles out the lane with the lane blockage. DLA may be useful in moving vehicles onto a normally operating lane ahead of the restricted area.

11.2.4 Weather Conditions

DLA will be inactive in adverse weather conditions unless these conditions result in a lane restriction.

11.2.5 Complete Closure

In the event of a complete road closure, DLA signs will display the normal red “X”.

11.2.6 Non-recurrent Congestion

Activation of DShoulder during non-recurrent congestion would typically be in response to an incident verified by the SOC operator using CCTV cameras or possibly service patrols. An incident such as a disabled vehicle may be blocking a particular lane.

11.3 Dynamic Shoulder Lanes

DShoulder will be activated to increase roadway capacity during recurrent congestion periods and appropriate non-recurrent congestion scenarios. Traffic flow will increase by increasing the roadway capacity, reducing travel times for drivers.

11.3.1 Free Flow

Under normal conditions, the DShoulder sign will display a red "X" indicating that the shoulder will be used for emergency stopping only.

11.3.2 Recurrent Congestion

DShoulder will be activated to increase capacity and reduce traffic congestion in the normal traffic lanes.

The DShoulder sign will display a green arrow notifying drivers that the shoulder lane is open to traffic. DShoulder should activate at set times during the week that would classify as peak hour.

11.3.3 Lane Restriction

During a lane restriction, DShoulder will be inactive to allow emergency vehicle access or refuge for disabled vehicles. In the event that the lane blockage is contained to the left lane, and cannot be moved to the shoulder for some time, DShoulder may be useful in clearing queues from the right or pushing all traffic onto the shoulder to allow the staging of response vehicles in the right travel lane.

11.3.4 Weather Conditions

DShoulder will be inactive in adverse weather conditions to allow emergency vehicle access or refuge for disabled vehicles. Any snow accumulation is likely to be pushed into the shoulder by snowplows. This snow will likely reduce the shoulder width and make DShoulder unsafe.

11.3.5 Complete Closure

In the event of a complete road closure, DShoulder signs will display the normal red “X”.

11.3.6 Non-recurrent Congestion

Activation of DShoulder during non-recurrent congestion would require the authorization of an SOC operator. The SOC operator would utilize CCTV cameras and service patrols to make sure the shoulders are clear. A disabled vehicle may be stopped in the shoulder, or an emergency vehicle may need to utilize the shoulder. If the SOC operator can verify that the shoulders are clear, then they can activate DShoulder to alleviate traffic congestion.

11.4 Full Implementation

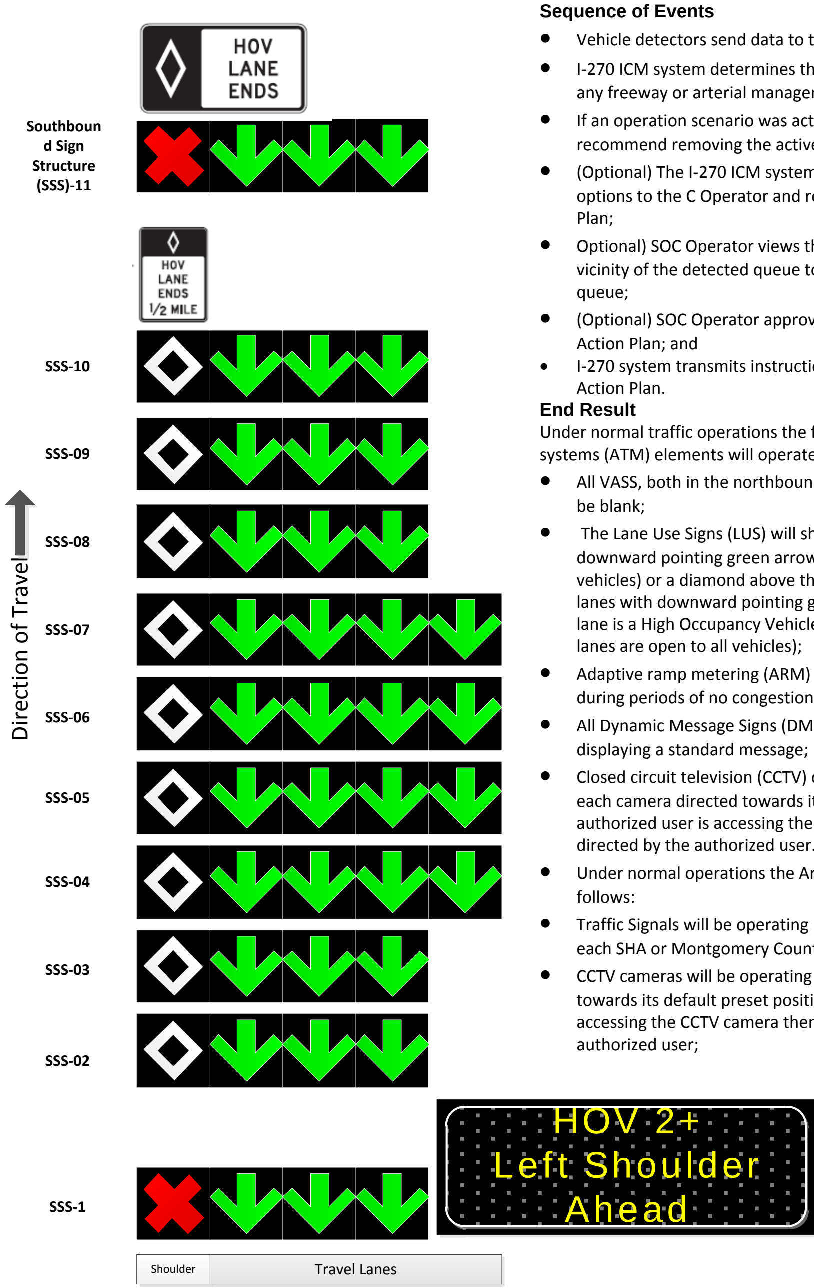
The following figures show representative operational diagrams for each of the six (6) scenarios.

These diagrams show how a full implementation of the system could work to respond to each scenario. The graphics show a conceptual configuration for the ATM devices.

11.5 Free Flow Scenario

The objective of this scenario is to manage traffic on the project corridor under Normal Operation conditions.

- No freeway congestion exists;
- No crashes have occurred on the freeway;
- No construction or maintenance activities are being carried out on the freeway;
- No debris is present on the freeway; and
- No other event has occurred that reduces the freeway level of service.



Sequence of Events

- Vehicle detectors send data to the I--270 ICM system;
- I-270 ICM system determines that there is no need to implement any freeway or arterial management strategies;
- If an operation scenario was active then the I-270 ICM system will recommend removing the active strategy;
- (Optional) The I-270 ICM system presents the recommended options to the C Operator and requests approval for the Action Plan;
- Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan; and
- I-270 system transmits instructions to each sub system, as per the Action Plan.

End Result

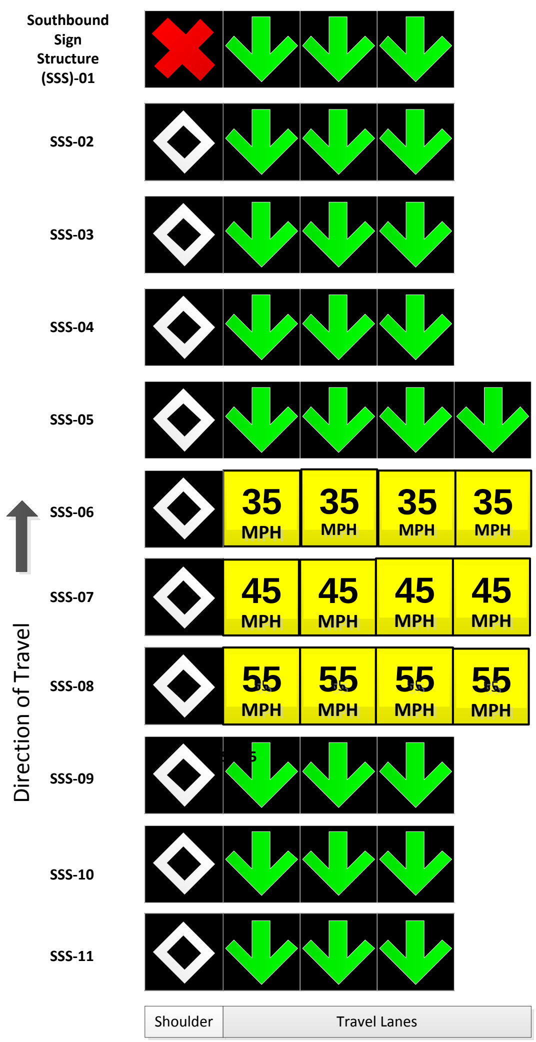
Under normal traffic operations the freeway active traffic management systems (ATM) elements will operate as follows:

- All VASS, both in the northbound and southbound directions, will be blank;
- The Lane Use Signs (LUS) will show either all lanes with downward pointing green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a High Occupancy Vehicle (HOV) lane and the rest of the lanes are open to all vehicles);
- Adaptive ramp metering (ARM) may or may not be operating during periods of no congestion.;
- All Dynamic Message Signs (DMS) on I-270 will be blank or displaying a standard message;
- Closed circuit television (CCTV) cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then focused as directed by the authorized user.
- Under normal operations the Arterial system will operate as follows:
- Traffic Signals will be operating using normal timing plans, as per each SHA or Montgomery County normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then focused as directed by the authorized user;

11.6 Recurrent Congestion

The objective of this scenario is to manage traffic on I-270 under Recurrent Congestion conditions. Recurrent Congestion is defined as congestion that occurs routinely and is not caused by crashes, events, weather or construction.

Under recurrent congestion, the volume of traffic entering the freeway will gradually increase until speeds are affected and the volume approaches the level that produces unstable flow at bottleneck locations. This congestion usually occurs during the AM and PM peaks on weekdays and at other times of the day on weekends.



Sequence of Events

During Recurrent Congestion, the I-270 ICM system will respon follows:

- ARM will be operational during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM Management Application;
- I-270 ICM System determines that a queue has formed on t freeway;
- (Optional) SOC Operator views the CCTV camera feed fror vicinity of the detected queue to determine the cause of the queue;
- The I-270 ICM system selects an Action Plan. The Action P may:
  - Reduce the advisory speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations;
  - Display the VAS speed on certain LUS; and
  - Display an end of queue warning message on specific D
- (Optional) The I-270 ICM system presents the recommende options to the SOC
- SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modi the Action Plan; and
- I-270 System transmits instructions to each sub system, as the Action Plan.

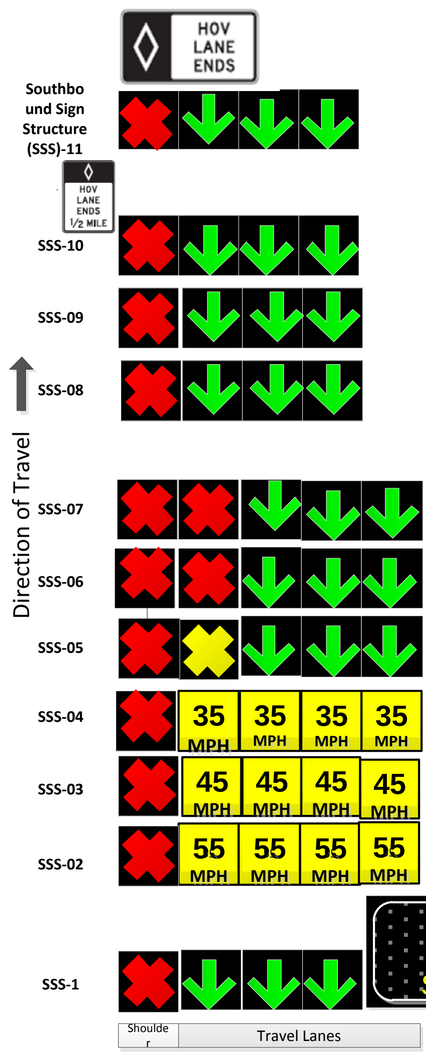
End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively re the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will blank;
- LUS will show either all lanes with downward pointing greer arrows (indicating all lanes open to all vehicles) or a diamor above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a HOV lane the rest of the lanes are open to all vehicles);
- ARM will be turned on. When appropriate, metering rates m be adjusted to prevent queue backups onto the arterials;
- All DMS on I-270 will show standard advisory messages or predefined messages for recurrent congestion,
- CCTV cameras will be turned on with each camera directec towards its default preset position, or if an authorized user i accessing the CCTV camera then it will be focused..

11.7 Lane Restriction on I-270

The objective of this scenario is to manage traffic on the project corridor when there is a minor incident. This is a non-recurring, non-planned event.



Sequence of Events

During a minor crash on I-270, the I-270 ICM system will respond as follows:

- ARM will be operational if event occurs during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM system;
- I-270 ICM system determines that a queue has formed on the freeway;
- (Optional) SOC Operator receives information from an external source that debris is present on the freeway;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- (Optional)SOC Operator inputs details of crash into the I-270 ICM system;
- The I-270 ICM system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations or turn on the ARM;
  - Display the VASS posted speed at certain LUS locations;
  - Use the LUS to close the affected lane(s) via displaying a yellow arrow, yellow x or red x;
  - Display an end of queue warning message on appropriate DMS;
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan;
- I-270 System transmits instructions to each sub system, as per the Action Plan; and
- SOC Operator will liaise with emergency services personnel as required.

End Result

In reaction to the minor accident:

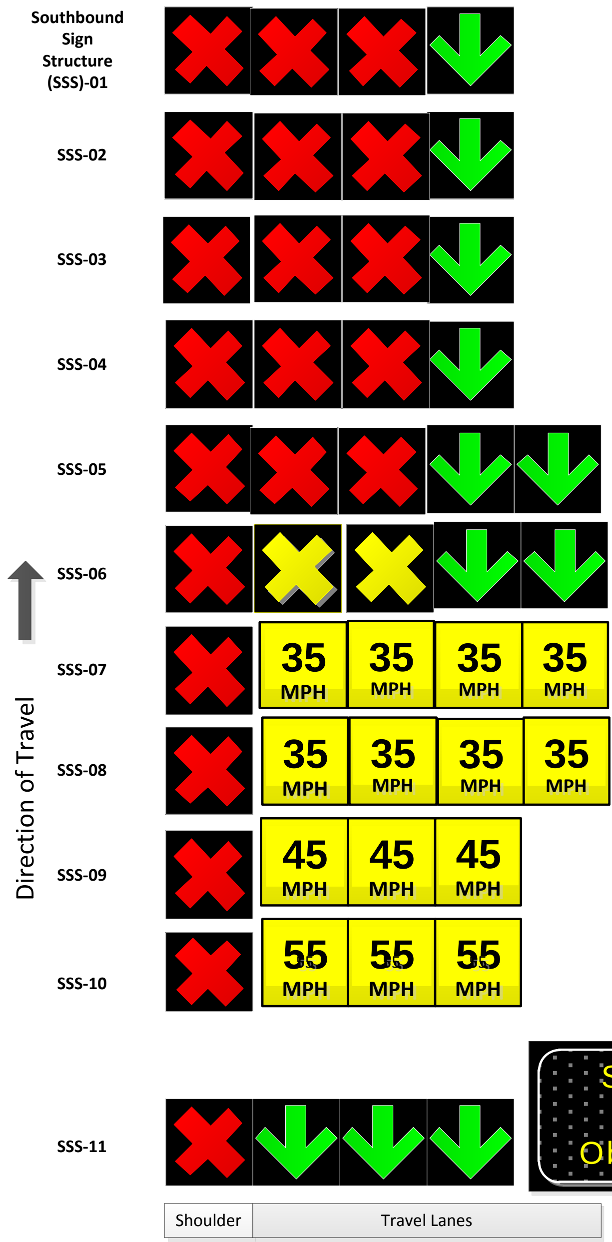
- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- ARM may be turned on if the crash results in a level of congestion that meets CHART congestion criteria for turning on the ARM;
- LUS will show green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- The DMS's upstream of the accident on the freeway may display a message identifying the location of the
- crash and/or advising the motorists to expect delays. If they do not display a specific message they will display a standard advisory message, as per current SHA practice.
- HAR may broadcast a message identifying the location of the crash and/or advising the motorists to expect delays. If it is not broadcasting a specific message it will be either turned on with a general statement or turned off; and
- The system may automatically detect that a crash has occurred and automatically focus the CCTV cameras in the vicinity onto the crash. The CCTV monitors will automatically display the video stream from these CCTV cameras. All other CCTV cameras will either be directed to their default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

Under minor crash congestion operations the arterial and transit systems will operate as follows:

- Traffic signals will be operating using normal timing plans, as per each agency's normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.8 Weather Condition

The objective of this scenario is to manage traffic on I-270 during snow operations.



Sequence of Events

During Snow Removal Operation, the I-270 ICM system will respond as follows:

- ARM will be non-operational during period of scheduled ARM operation;
- OOM and Contract snow plows will report their location and removal plan to EOC and SOC;
- (Optional) SOC Operator views the CCTV camera feed in the vicinity of the vicinity of the operation to confirm location of snow plow;
- The SOC Operator selects an manual Action Plan from I-270 ICM system. The Action Plan may:
  - Reduce the advisory speed on the VASS in the mile upstream of the operation;
  - Display the VAS speed on certain LUS; and
  - Clsoe appropriate lanes where plowing is underway
  - Display a lane closure warning message on specific DMS;
- I-270 System transmits instructions to each sub system, as per the Action Plan.

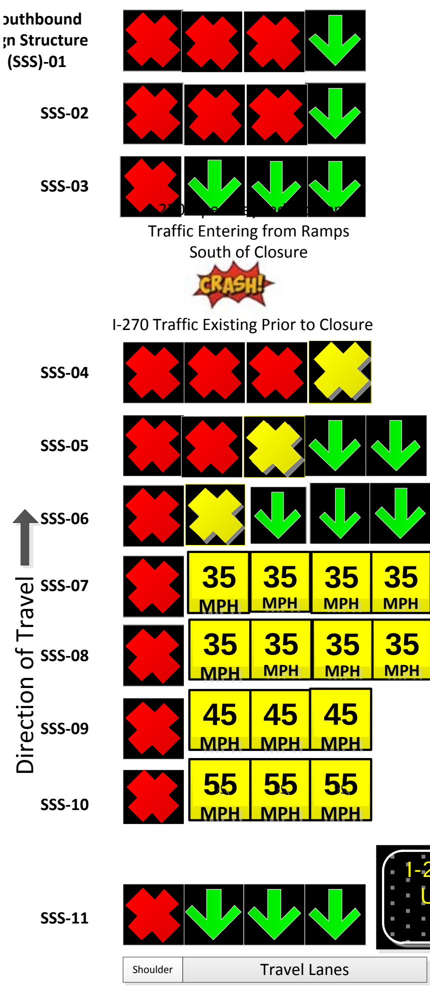
End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- LUS will show successive yellow “x” and red “x”to indicate lanes closing and closed, respectively.
- ARM will be turned on. When appropriate, metering rates may be adjusted to prevent queue backups onto the arterials;
- All DMS on I-270 will show standard advisory messages or predefined messages for snow operation,
- CCTV cameras will be turned on with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.9 Complete Closure

The objective of this scenario is to manage traffic on the project corridor when there is a major incident on I-270 requiring a complete closure. This is a non-recurring, non-planned event.



Sequence of Events

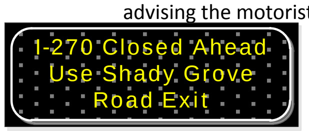
During a major incident requiring full closure of I-270, the I-270 ICM system will respond as follows:

- ARM will be operational if event occurs during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 ICM system;
- I-270 ICM system determines that a queue has formed on the freeway;
- SOC Operator receives information from an external source that incident is present;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- SOC Operator inputs details of incident into the I-270 ICM system;
- The I-270 system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations or turn on the ARM if it is not already active;
    - Display the VASS peed at certain LUS locations;
    - Use the LUS to close the affected lane(s) via a yellow or red;
    - Display an end of queue warning message on appropriate DMS;
    - Broadcast a message on the HAR;
    - Activate a flush plan on the arterials long the incident route.
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves or modifies the Action Plan;
- I-270 system transmits instructions to each sub system; and
- SOC Operator will liaise with emergency services personnel as required.

End Result

In reaction to the closure:

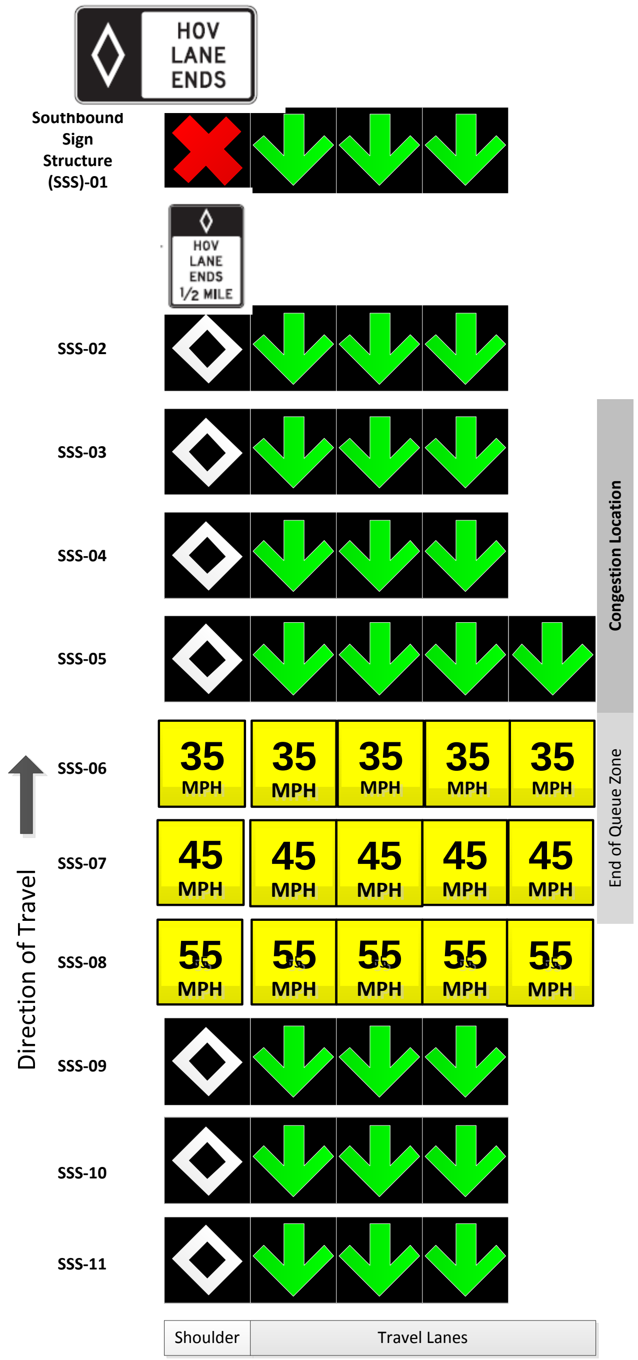
- The VASS upstream of the congestion will progressively reduce the Advisory speed to 35 mph as vehicles approach the congestion;
- ARM may be turned on if the crash results in a level of congestion that meets CHART congestion criteria for turning on the ARM;
- LUS will show green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- The DMS's upstream of the incident on the freeway may display a message identifying the location of the crash and/or advising the motorists to expect delays. If they do not display a specific message they will display a standard advisory message;
- TAR may broadcast a message identifying the location of the crash and/or advising the motorists to expect delays; and



- The system may automatically detect that an incident has occurred and focus the CCTV cameras in the vicinity of the crash onto the crash. All other CCTV cameras will either be directed to their default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

11.10 Recurring Congestion

The objective of this scenario is to manage traffic on the project corridor under Recurrent Congestion conditions. Recurrent Congestion is defined as congestion that occurs routinely and is not caused by incidents, events, weather or construction. Under recurrent congestion, the volume of traffic entering the freeway will gradually increase until speeds are affected and the volume approaches the level that produces unstable flow at bottleneck locations. This congestion usually occurs during the AM and PM peaks on weekdays and at other times of the day on weekends.



Sequence of Events

During Recurrent Congestion, the I-270 ICM system will respond as follows:

- ARM will be operational during period of scheduled ARM operation;
- Vehicle detectors send data to the I-270 system;
- I-270 system determines that a queue has formed on the freeway;
- (Optional) SOC Operator views the CCTV camera feed from the vicinity of the detected queue to determine the cause of the queue;
- The I-270 system selects an Action Plan. The Action Plan may:
  - Reduce the posted speed on the VASS in the mile upstream of the end of queue;
  - Adjust the ARM rates at certain locations;
  - Display the VASS advisory speed on certain LUS; and
  - Display an end of queue warning message on specific DMS;
- (Optional) The I-270 ICM system presents the recommended options to the SOC Operator and requests approval for the Action Plan;
- (Optional) SOC Operator approves the Action Plan or modifies the Action Plan; and
- I-270 ICM transmits instructions to each sub system, as per the Action Plan.

End Result

Under recurrent congestion:

- The VASS upstream of the congestion will progressively reduce the advisory speed to 35 mph as vehicles approach the congestion. At the location of the congestion, the VASS will be blank;
- LUS will show either all lanes with downward pointing green arrows (indicating all lanes open to all vehicles) or a diamond above the left lane and the rest of the lanes with downward pointing green arrows (indicating the left lane is a HOV lane and the rest of the lanes are open to all vehicles);
- ARM will be turned on. When appropriate, metering rates may be adjusted to prevent queue backups onto the arterials;
- All DMS on the freeway will show standard advisory messages or predefined messages for recurrent congestion, as per current CHART practice;
- TAR will be either turned on with a general statement, as per CHART practice, or turned off;
- CCTV cameras will be turned on with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

Under recurrent congestion operations the Arterial and Transit system will operate as follows:

- Traffic Signals will be operating using normal timing plans, as per each agencies normal operating procedures;
- CCTV cameras will be operating with each camera directed towards its default preset position, or if an authorized user is accessing the CCTV camera then it will be focused as directed by the authorized user.

12. SUMMARY OF IMPACTS

This chapter provides an analysis of the proposed system and the impacts on each of the stakeholders. It is presented from the viewpoint of each, so that they can readily understand and validate how the proposed system will impact their operations. Any major constraints on system development are documented.

Metrics for assessing system performance are also included.

12.1 Stakeholders

The stakeholders of the I-270 ICM Project must fully commit to active operation of the project concept elements. The technologies that will be deployed will not achieve the goals of the project unless they are actively used by all agencies to manage traffic. In order to have the system operate efficiently, stakeholders must collectively commit staff and budget to operate the system.

12.1.1 Maryland State Highway Administration

This project will provide SHA with new equipment to operate and maintain. Equipment included on this project that will be under SHA's control includes:

- additional closed circuit television (CCTV) cameras;
- additional vehicle detection;
- additional dynamic message signs (DMS);
- overhead sign structures;
- lane-use control signals (LCS);
- variable advisory speed (DSpeed) signs; and
- I-270 Active Traffic Management STM Application.

During the construction phase SHA will need to approve and permit the construction activities to occur at a rate that will meet the project timetable. The construction activities will require lane closures at various times to permit the installation of some of the equipment. SHA will need to assist in the coordination of the lane closures.

SHA must contribute to the I-270 ICM Operation and Maintenance (O&M) cost. Without the appropriate O&M funding the I-270 ICM system will not be able to operate efficiently.

12.1.2 Montgomery County Department of Transportation (MCDOT)

MCDOT will be involved in developing the operation plans, incident management plans and defining any other criteria required for the operation of the I-270 ICM system as it pertains to county-maintained roads.

These plans include the strategies and configuration of:

- Incident management plans
- Flush plan implementation on the arterial

12.1.3 Maryland State Police / Montgomery County Police

The MSP/MCP are responsible for the enforcement of the Maryland Vehicle Code and has the legal authority and responsibility for incident management on I-270.

With the assistance of the I-270 ICM SOC operator, the MSP/MCP could close lanes without the need for squad cars to travel out to the beginning of the lane closure. This would allow quicker response for the MSP/MCP and help to reduce the chance of secondary crashes after an incident on I-270. These lane closures could also assist the MSP/MCP in clearing a path for emergency vehicles responding to a crash.

MSP/MCP will have the ability to view the status of the corridor through the traffic surveillance and monitoring systems. Through this system the dispatch center will be able to view the CCTV cameras along the length of the corridor. This will allow the MSP/MCP to confirm the presence of a crash; hence, they will be able to quickly coordinate an appropriate response. In addition, crashes will be identified quicker via the incident detection system alerting the operator to a potential crash location.

MSP/MCP will be partners in the development of the corridor incident management strategies.

12.1.4 City of Rockville/City of Gaithersburg

The cities will be involved in developing the operation plans, incident management plans and defining any other criteria required for the operation of the I-270 ICM system as it pertains to city-maintained roads.

These plans include the strategies and configuration of:

- Incident management plans
- Flush plan implementation on the arterial

12.1.5 University of Maryland Center for Applied Transportation Technology

The University of Maryland CATT lab is responsible for operating and maintaining the regional ITS architecture computing infrastructure (RITIS) necessary to exchange information between various regional transportation management systems. The RITIS system enables key data exchange between CHART, Montgomery County, the I-270 ATM STM, and other regional systems. The CATT lab also maintains various tools that may be suitable for reporting and analyzing key performance metrics related to the I-270 corridor operation.

12.1.6 Private Vehicle Operators

Private vehicle operators will experience an improved level of service for their travels through the I-270 ICM corridor.

In the event of a crash, the people involved in the crash will receive assistance faster and those who are not involved in the crash will experience a reduced impact on their travel time through the corridor. If the crash occurs on I-270, lanes may be closed and the advisory speed may be lowered.

If a vehicle exits I-270 in order to avoid the crash, the vehicle will be directed along the arterial road and back to I-270 at the earliest convenient site downstream of the crash.

Travel information will be improved for traveling in the corridor. The traveler will be able to access this information as they currently do through the 511MD website and phone services.

Additional information will be provided on the many new DMSs and overhead sign structures that will be installed in the corridor.

A variety of new equipment will be installed in the corridor. Some of the devices installed will be new to the area, such as the LCS and DSpeed. Private vehicle operators will have to adapt to these new devices.

Signals are already coordinated, but local drivers may be more impacted when there is a flush plan in operation.

Improvements made in the corridor will make transit travel more accessible. Additional signs providing information about parking and transit will provide private vehicle operators the opportunity to switch to transit travel for their journey into or through the corridor. These signs, coupled with DMS displayed corridor travel times, will allow private vehicle operators to make an informed decision about the travel advantage of using transit options for completing their journey.

With the implementation of DSpeed and LCS, travel along I-270 will be safer with more consistent travel times. With the implementation of the Traveler Information System, the travel times and conditions will be more easily determined by the private vehicle operator. All of this combined will lead to more satisfied private vehicle operators.

12.1.7 Bicycles and Pedestrians

Pedestrians and bicycles will continue to operate in the corridor unaffected by the changes.

12.1.8 Commercial and Transit Vehicle Operators

Commercial and transit vehicles will continue to operate in the traffic stream along with private vehicles. The conditions and benefits described above for private vehicles operators will also apply to commercial vehicle operators.

12.2 System Constraints

System must be developed within the time and budget dictated by the terms and conditions of the project funds. System should use existing infrastructure as much as feasible.

12.3 Required Agreements

The I-270 ICM system crosses multiple jurisdictional boundaries and will require inter-agency coordination to effectively manage the system and to coordinate response to incidents or traffic congestion. The foundation of this cooperation will be a Memorandum of Understanding for the I-270 ICM Project that addressed the transportation management of the I-270 Corridor. The following agreements should be developed or modified:

- Video Access and Control;
- Interagency Agreement and Standard Operating and Maintenance Procedures;
- Incident Management Agreements; and

12.4 Video Access and Control

The purpose of this agreement is to define the terms of sharing video images and controlling camera operation. This agreement will be between SHA and Montgomery and Frederick Counties with the intent to provide video image access to all agencies. This functionality will include individual agency-definable security on a per camera, per agency and per person basis to allow an agency to define which cameras are available to which users, pre-set views (if any) and to allow for an agency to maintain priority control of the cameras in their ownership. An interagency operating agreement would include the parameters of allowable use by each agency that owns CCTV cameras, including SHA.

12.4.1 Interagency Agreement and Standard Operating and Maintenance Procedures

This agreement will outline procedures for normal operations of the project. This will include operation of CCTV cameras, maintenance of equipment, and signal coordination.

12.4.2 Incident Management Agreements

This agreement will outline incident management procedures including operations of trailblazers and incident response routes and initiation and termination of signal flush plans. The agreement will stipulate that the local agencies delegate operation of the trailblazers to provide a unified response to an incident.

These agreements will also specify the implementation and operations of the signal flush plans.

12.5 Performance Measures

Performance measures are important for determining the extent to which the system achieves the project's goals and objectives. The performance measures can be either quantitative or qualitative. Each business requirement should be associated with a measurable metric that allows the stakeholders to assess whether or not the requirement has been met, or continues to be met, by the system.

In addition to system performance measures, it will be appropriate to measure the efficiency and effectiveness of the stakeholders through measures of agency performance. These metrics will quantify the extent to which each organization performs the tasks for which it is responsible.

As the system is developed, metrics will be defined that quantify the performance of the transportation system. As far as possible, these metrics should rely on data that will be automatically collected by the system. However, if they need to be supplemented by separate surveys, these will be identified and explicit test or evaluation plans developed.

As operation and maintenance plans are developed, each stakeholder will agree on their roles and responsibilities for both day to day operation and routine and preventative maintenance. Specific metrics will be prepared and incorporated into agreements, as appropriate.

12.5.1 Performance Metrics

The exact metrics that will be used as performance measures will be dependent upon the availability of data. The metrics that may be used include:

- Incidents
- Time to respond to incident after detection;
- Time to clear incident;
- Extent of congestion on freeway as a result of incident;
- Extent of diversion of traffic from freeway as a result of incident;
- Changes in traffic conditions on arterials as a result of incident;
- Crash patterns and causes;
- Frequency, type, and severity of primary and secondary incidents;

- Changes in transit patronage during incidents; and
- Changes in emergency vehicle travel times while responding to incident

Recurrent Congestion

- Throughput at bottlenecks;
- Average travel time or speed;
- Variability in travel time or speed;
- Time of onset of flow breakdown at bottlenecks;
- Extent and duration of queuing at bottlenecks;
- Traffic volumes on arterial roads; and
- Delays at on-ramps.

Traveler information

- Reliability of traveler information; and
- Effect of traveler information on travel choices (mode, route and time of travel).

Agency performance measures will be prepared to measure the extent to which each stakeholder achieves the efficiency and effectiveness agreed to for their respective responsibilities. These will include such items as:

<u>Operation</u>

- Time to take requested action when requested by another agency or by the incident management software;
- Time to respond to requests for changes to operational plans (such as incident management plans; traffic signal flush plans); and
- Tracking operators' response to detection or notification of incidents.

<u>Maintenance</u>

- Time to respond to equipment faults of various types;
- Time to repair equipment faults; and
- Time to respond to requests for changes to system configuration.

CONCEPT EVALUATION TEMPLATE

I-270 – Innovative Congestion Management Contract,
Montgomery and Frederick Counties

Traffic Operations Analysis – Methods and Approach

The Build condition Vissim models used for this study are based upon the Vissim traffic models provided by SHA for 2015 and 2040 No Build conditions, and were run using the following simulation parameters and random seeds, as provided by SHA:

- The Vissim models were run using Vissim 7.00-13 (32 bit).
- AM peak hour models were simulated for 9000 seconds, of which the last 3600 seconds were recorded for outputs.
- PM peak hour models were simulated for 5400 seconds, of which the last 3600 seconds were recorded for outputs.
- Simulation resolution = 8 time steps / simulation second.
- Random seed = 8
- Number of runs = 5
- Random seed increment = 27
- Simulation speed = maximum
- Result attributes were kept for the current multi-run only
- The averages of the 5 simulation runs for each model were used to produce the outputs entered into the Concept Evaluation Template provided by SHA.

Parameters modified to incorporate the Build concepts include:

- Adjustment to the number of lanes on a particular link, the alignment of connectors, and/or the length of a link (to extend merge distances) were incorporated to input geometric improvements.
- Additional data collection points were added to individual links, adjacent to existing data collection points, to provide coverage for new lanes in the system. These data collection points were added to the data collection measurements.
- Signal timings were adjusted in the vicinity of the I-270 / MD 117 interchange and the I-270 / Watkins Mill Road interchange during the PM peak hour of both the Base and 2040 conditions, as appropriate. No other signal timing adjustments were made in the Build models.
- Lane change distances were adjusted prior to merges and diverges in the vicinity of proposed improvements to incorporate modified driver behavior in reaction to geometric improvements.
- Link behavior types were adjusted for links in the vicinity of geometric improvements to more accurately represent behaviors expected once the geometric improvements were installed, including
  - along segments that are expected to experience reduced congestion due to implementation of capacity improvements downstream, and
  - along segments that are expected to experience significant increases in traffic volumes due to capacity improvements installed along the approaching roadway.

- (Link behavior types were modified only after test-runs indicated that congestion levels would significantly change along affected links due to the implementation of upstream or downstream capacity improvements.)
- No link behavior types were adjusted along the interchanging roadways, or along sections of the I-270 corridor that were not expected to be affected by geometric improvements.

No adjustments to vehicle inputs, vehicle routes, driving behavior, speed distributions, or speed decisions were made in the Build models.

I-270 Concept Evaluation Templates

Whitman, Requardt & Associates, LLP
Engineers · Architects · Environmental Planners Est. 1915

I-270 Concept Evaluation (VISSIM Results)

Table of Contents

2015 Conditions

AM Peak

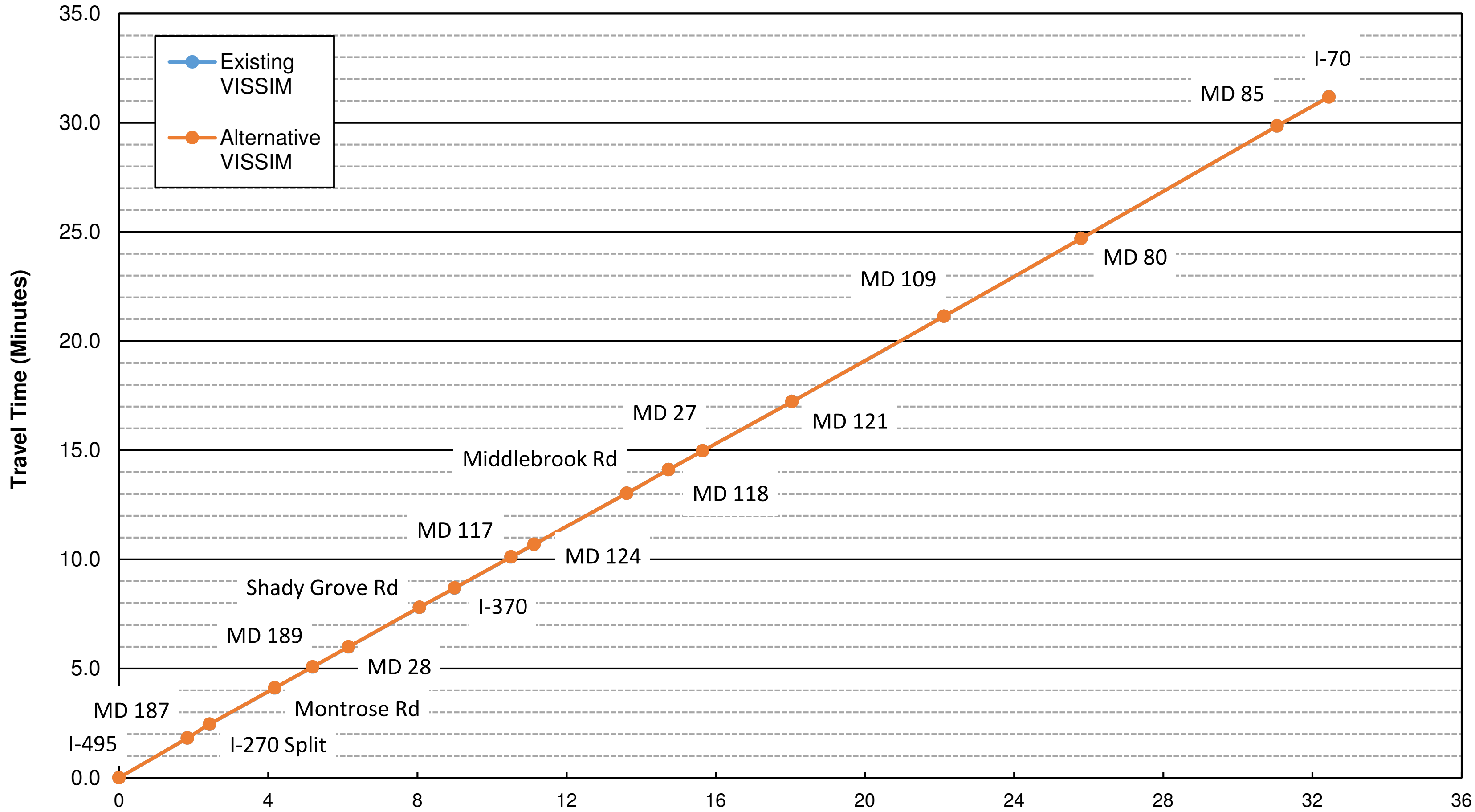
Table A.1: AM Peak - Existing - I-270 Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From I-495 interchange					From I-70				
to MD 187	1.8	109.0	109.2	0%	to MD 85	1.7	97.0	97.0	0%
to I-270 Split	0.6	37.5	37.7	0%	to MD 80	5.4	414.5	324.7	-22%
to Montrose Rd	1.8	100.1	100.2	0%	to MD 109	3.7	390.6	472.6	21%
to MD 189	1.0	57.6	57.6	0%	to MD 121	3.6	273.2	283.1	4%
to MD 28	1.0	55.1	55.2	0%	to MD 27	2.5	267.9	172.6	-36%
to Shady Grove Rd	1.9	108.4	108.5	0%	to MD 118	1.1	241.4	74.3	-69%
to I-370	0.9	53.0	53.0	0%	to Middlebrook Rd	1.1	211.7	78.5	-63%
to MD 117	1.5	85.5	85.5	0%	to MD 124	2.2	480.5	154.8	-68%
to MD 124	0.6	34.5	34.5	0%	to MD 117	0.9	148.4	62.0	-58%
to Middlebrook Rd	2.5	140.9	140.4	0%	to I-370	1.0	90.2	69.3	-23%
to MD 118	1.1	64.8	64.7	0%	to Shady Grove Rd	1.5	190.3	103.0	-46%
to MD 27	0.9	51.8	51.9	0%	to MD 28	1.9	431.1	131.0	-70%
to MD 121	2.4	135.3	135.3	0%	to MD 189	1.0	227.1	68.3	-70%
to MD 109	4.1	234.5	234.6	0%	to Montrose Rd	1.0	276.2	72.1	-74%
to MD 80	3.7	213.8	213.9	0%	to I-270 Split	1.9	250.6	131.0	-48%
to MD 85	5.3	309.0	308.8	0%	to MD 187	0.4	30.0	30.5	2%
to I-70	1.4	79.9	79.8	0%	to I-495 interchange	1.9	131.8	133.9	2%
I-270 Total (miles/minutes)	**32.4**	**31.2**	**31.2**	**0%**	**I-270 Total (miles/minutes)**	**32.7**	**69.2**	**41.0**	**-41%**
I-270 Spur Northbound					**I-270 Spur Southbound**				
From Cabin John Pkwy					From I-70				
to MD 190	0.5	32.2	32.2	0%	to I-270 Split	30.3	3,990.6	2,294.1	-43%
to I-495	1.1	66.7	66.6	0%	to Democracy Blvd	0.7	88.4	51.7	-42%
to Democracy Blvd	1.4	91.2	90.2	-1%	to I-495	1.3	183.1	103.5	-43%
to I-270 Split	0.9	51.0	51.0	0%	to MD 190	1.3	92.2	130.2	41%
to I-70	30.0	1,724.3	1,723.8	0%	to Cabin John Pkwy	0.6	35.0	35.5	1%
I-270 Spur Total (miles/minutes)	**34.0**	**32.8**	**32.7**	**0%**	**I-270 Spur Total (miles/minutes)**	**34.2**	**73.2**	**43.6**	**-40%**

Table A.2: AM Peak - Existing - I-270 Local Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From C-D start					From C-D start				
to Montrose Rd	0.8	51.6	51.6	0%	to Shady Grove	1.3	322.1	100.2	-69%
to MD 189	1.3	79.3	79.3	0%	to MD 28	1.8	264.8	123.3	-53%
to MD 28	1.0	60.7	60.7	0%	to MD 189	1.1	249.5	77.5	-69%
to Shady Grove	2.0	119.1	117.9	-1%	to Montrose	1.2	259.4	88.2	-66%
to I-370	1.0	56.3	56.3	0%	to I-270 mainline	0.9	144.4	65.6	-55%
to MD 117	1.2	72.3	72.8	1%					
to MD 124	0.8	52.1	57.5	10%					
to I-270 mainline	0.4	21.4	21.3	0%					
I-270 Local Total (miles/minutes)	**8.5**	**8.5**	**8.6**	**1%**	**I-270 Local Total (miles/minutes)**	**6.3**	**20.7**	**7.6**	**-63%**

Figure A.1: AM Peak - Existing
I-270 Travel Time Graph - Northbound



Miles Along Corridor / *Direction of Traffic Flow* ↑

Figure A.2: AM Peak - Existing
I-270 Travel Time Graph - Southbound

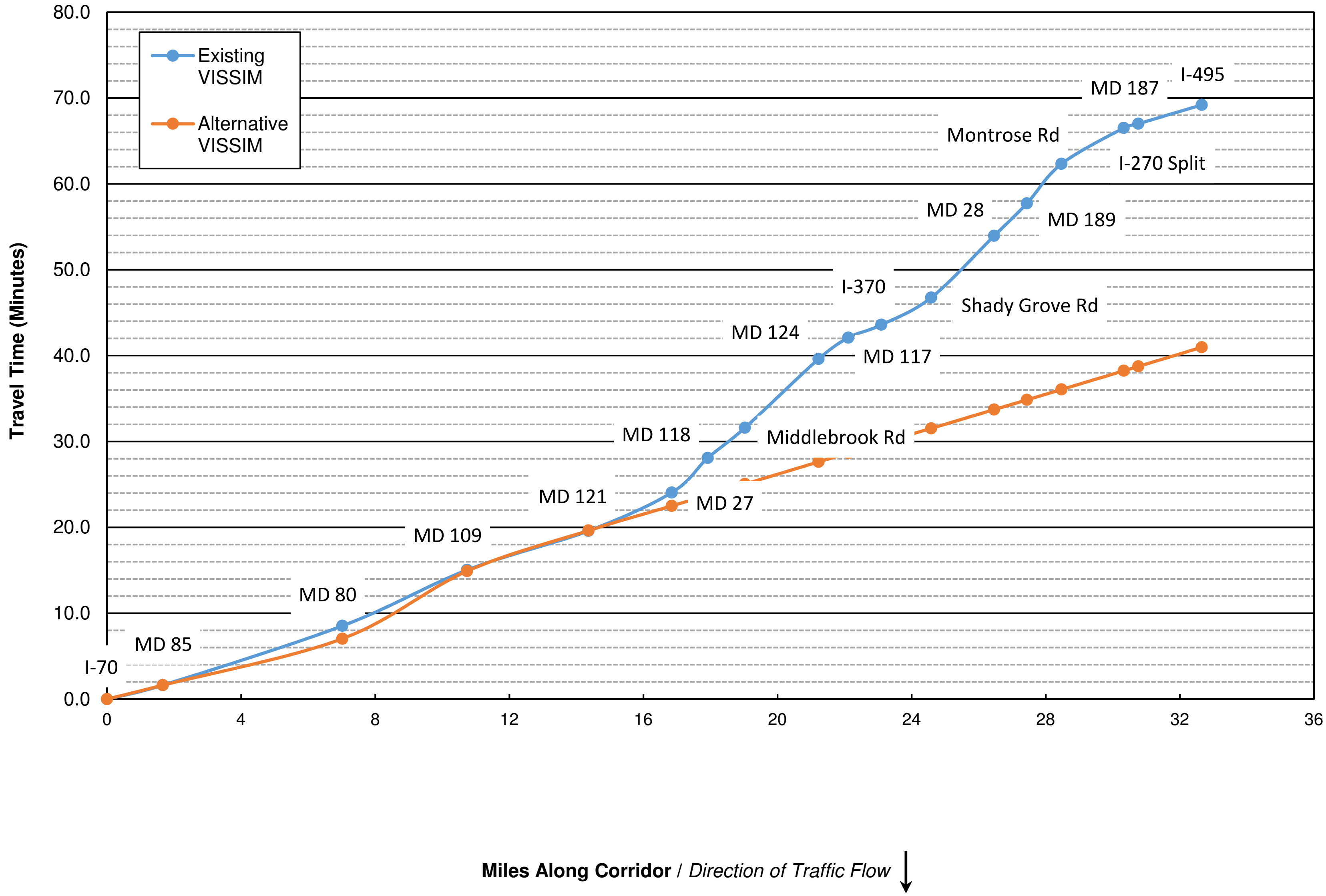


Figure A.3: AM Peak - Existing
I-270 Spur Travel Time Graph - Northbound

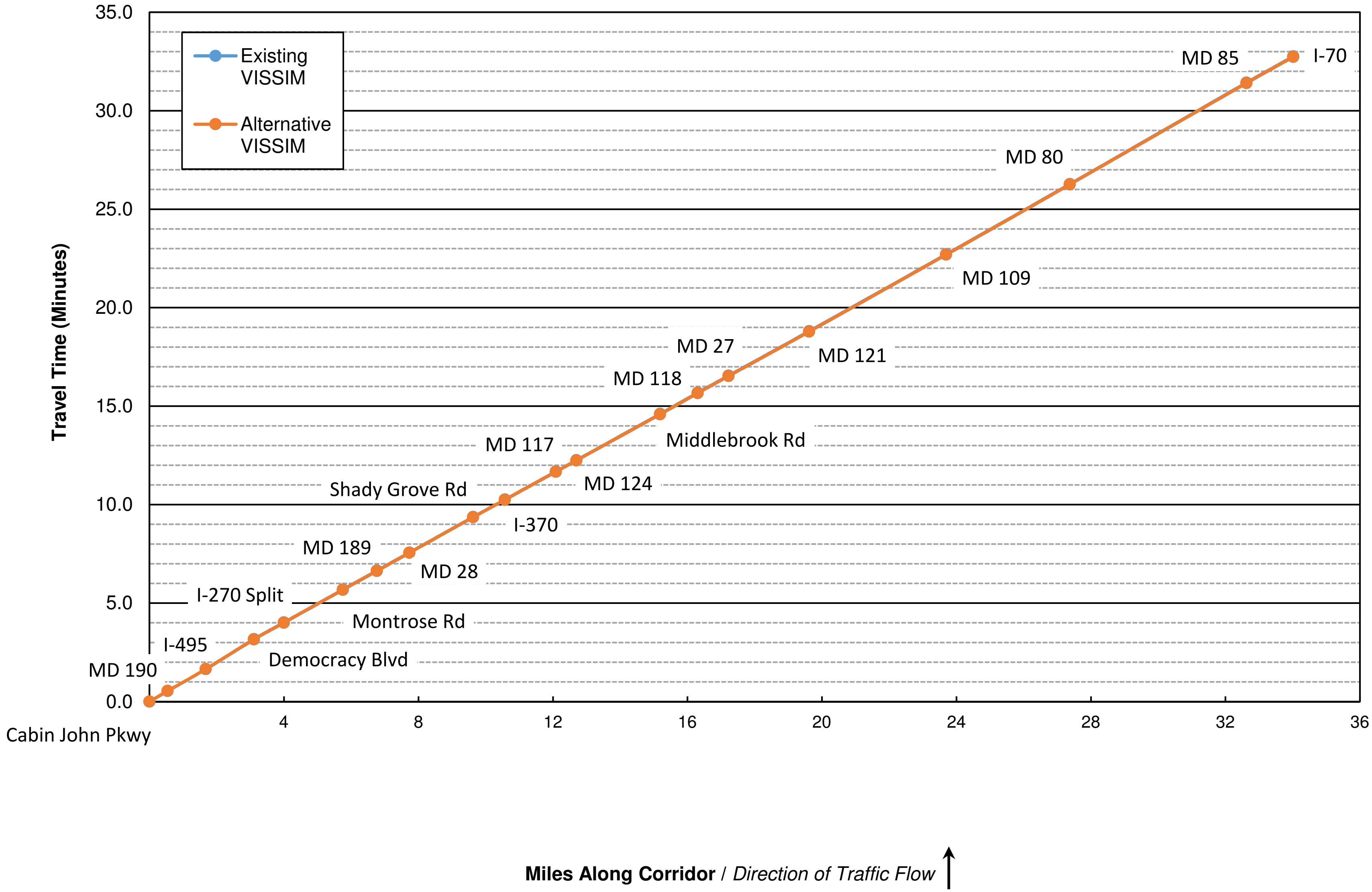
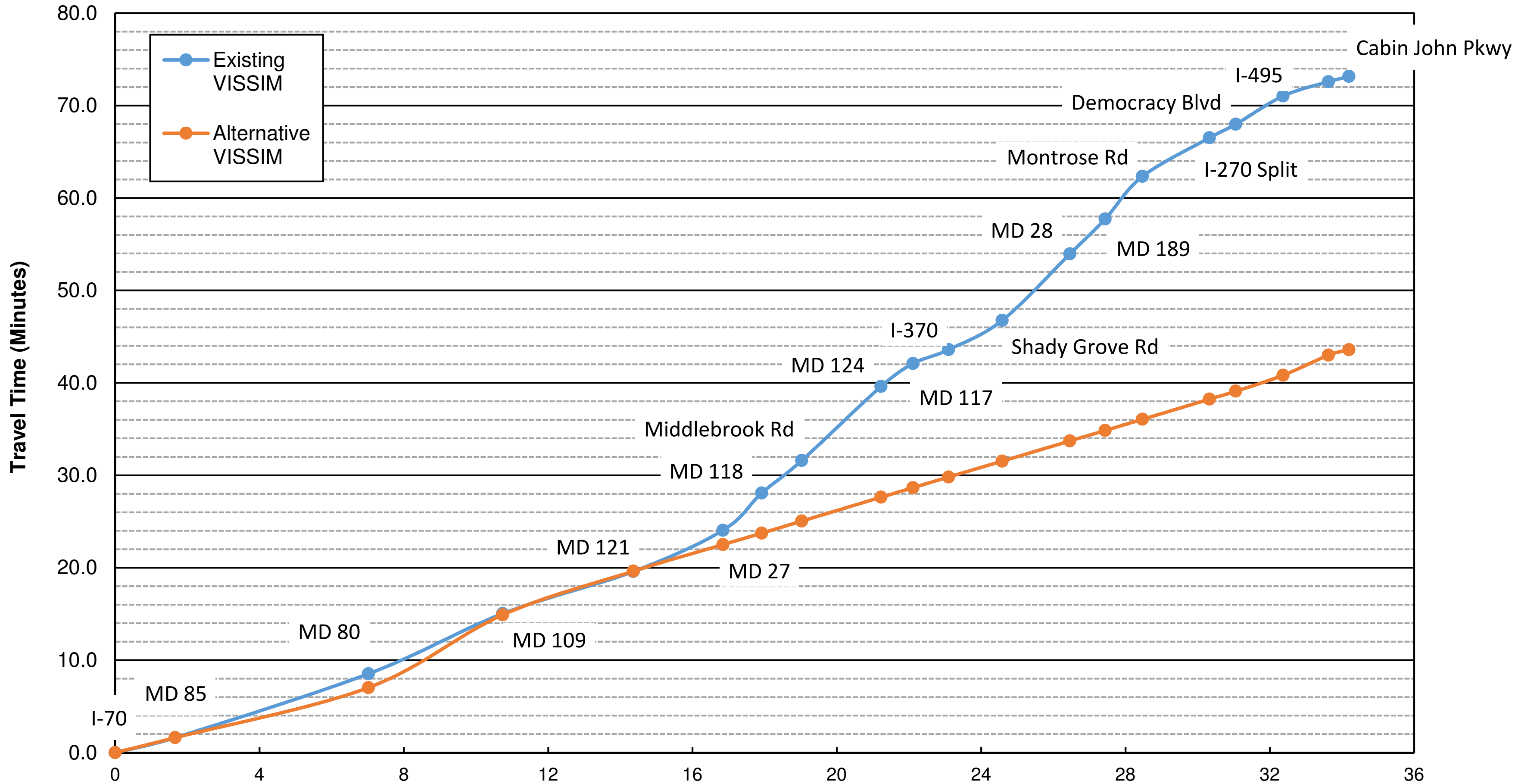


Figure A.4: AM Peak - Existing
I-270 Spur Travel Time Graph - Southbound



Miles Along Corridor / *Direction of Traffic Flow* ↓

Figure A.5: AM Peak - Existing
I-270 Local Travel Time Graph - Northbound

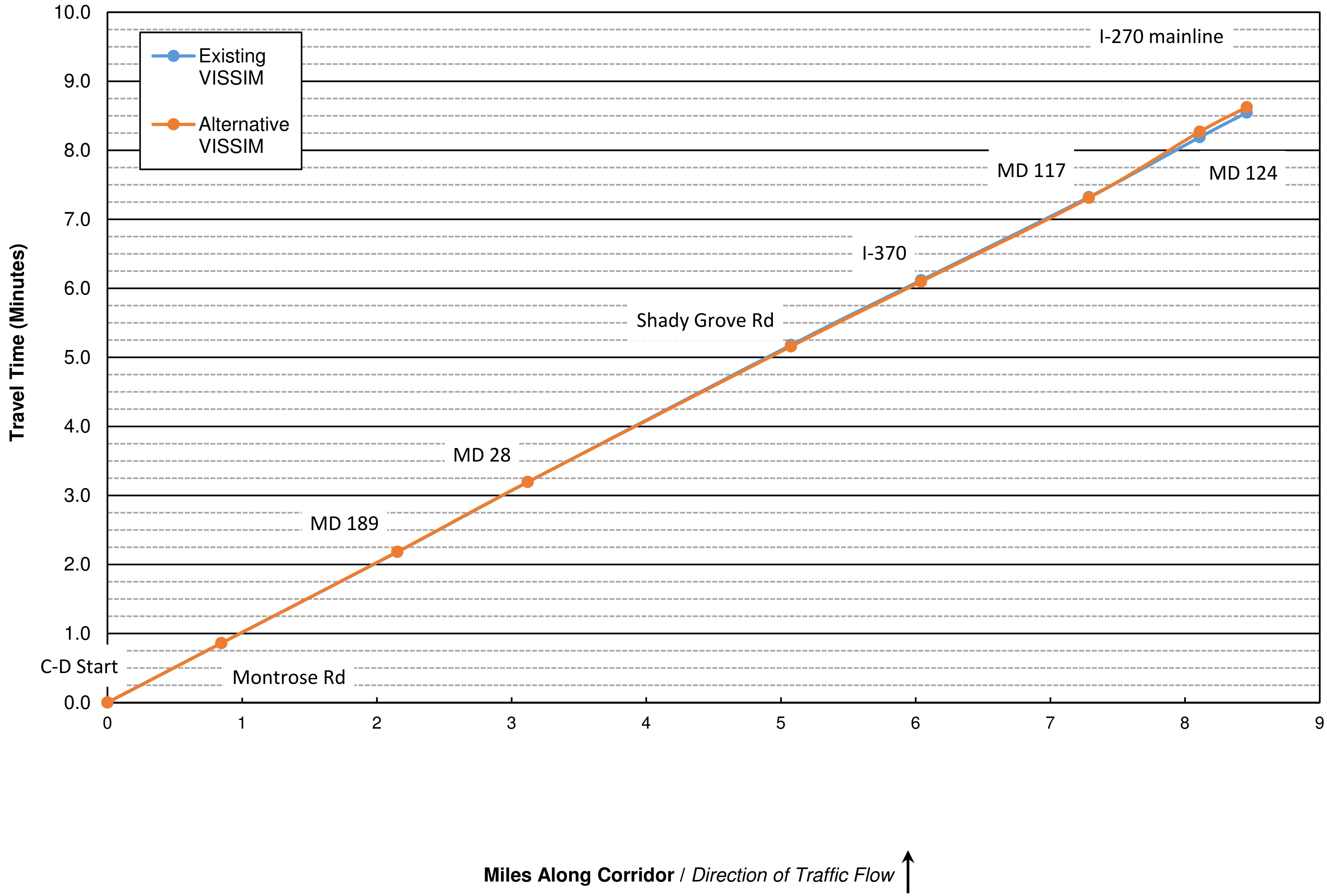


Figure A.6: AM Peak - Existing
I-270 Local Travel Time Graph - Southbound

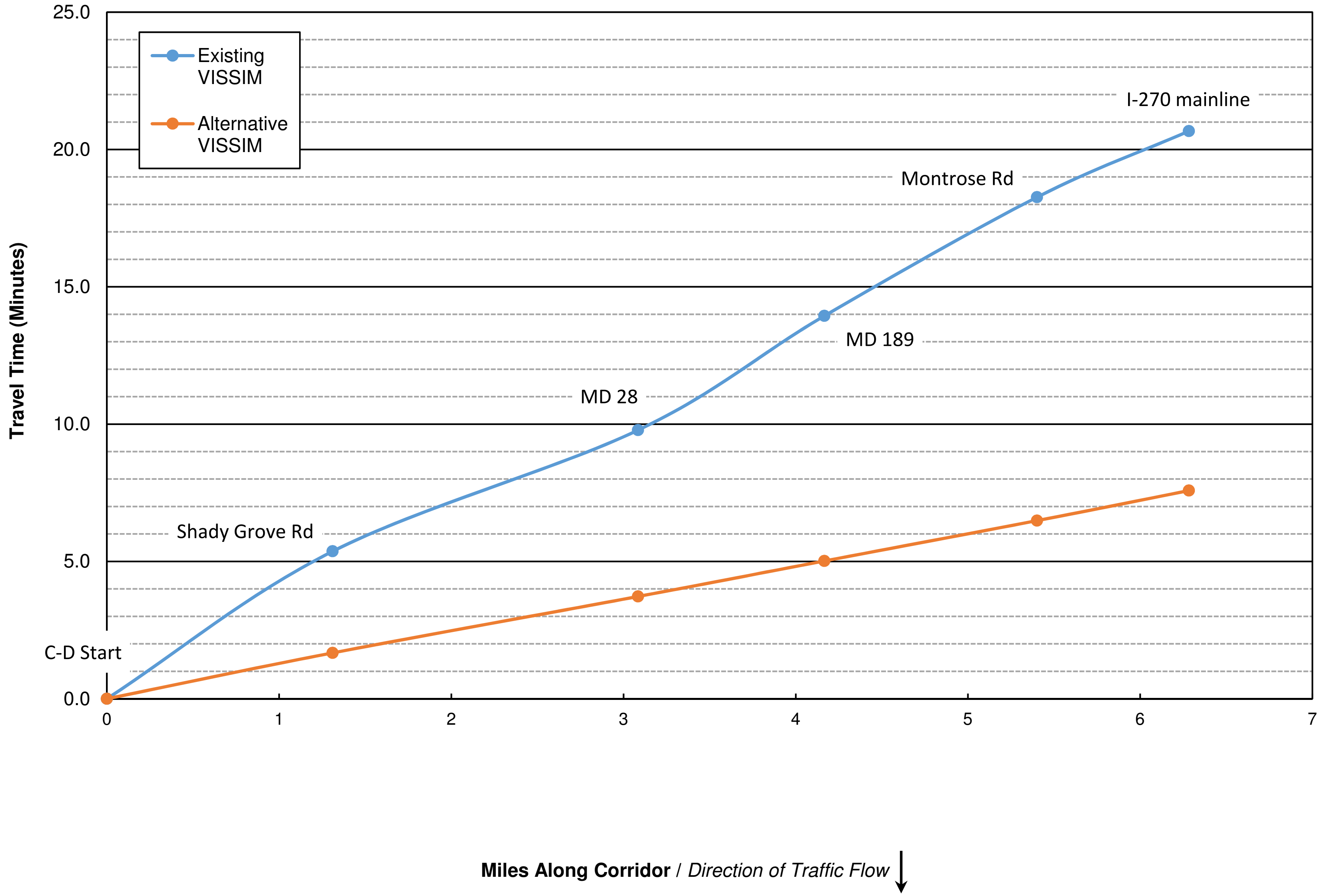


Table A.3: AM Peak - Existing - I-270 Vehicle Speed

I-270 Northbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From I-495 interchange				From I-70			
to MD 187	60.5	60.4	0%	to MD 85	61.7	61.7	0%
to I-270 Split	56.7	56.4	0%	to MD 80	46.5	59.4	28%
to Montrose Rd	63.0	63.0	0%	to MD 109	34.3	28.3	-17%
to MD 189	63.3	63.3	0%	to MD 121	47.7	46.0	-3%
to MD 28	62.9	62.9	0%	to MD 27	33.4	51.8	55%
to Shady Grove Rd	63.0	63.0	0%	to MD 118	16.0	52.0	225%
to I-370	64.1	64.1	0%	to Middlebrook Rd	18.9	51.0	170%
to MD 117	63.8	63.8	0%	to MD 124	16.5	51.1	210%
to MD 124	63.9	64.0	0%	to MD 117	21.5	51.4	139%
to Middlebrook Rd	63.6	63.8	0%	to I-370	39.3	51.2	30%
to MD 118	62.3	62.4	0%	to Shady Grove Rd	28.1	52.0	85%
to MD 27	63.6	63.6	0%	to MD 28	15.7	51.6	229%
to MD 121	63.7	63.7	0%	to MD 189	15.5	51.5	233%
to MD 109	62.6	62.6	0%	to Montrose Rd	13.5	51.6	283%
to MD 80	61.9	61.9	0%	to I-270 Split	26.7	51.1	91%
to MD 85	61.2	61.3	0%	to MD 187	52.3	51.4	-2%
to I-70	62.7	62.7	0%	to I-495 interchange	51.7	50.8	-2%
I-270 Spur Northbound				**I-270 Spur Southbound**			
From Cabin John Pkwy				From I-70			
to MD 190	60.3	60.3	0%	to I-270 Split	27.4	47.6	74%
to I-495	61.2	61.2	0%	to Democracy Blvd	29.8	50.9	71%
to Democracy Blvd	56.6	57.2	1%	to I-495	25.8	45.6	77%
to I-270 Split	62.9	62.9	0%	to MD 190	48.9	34.7	-29%
to I-70	62.7	62.7	0%	to Cabin John Pkwy	58.6	57.8	-1%

Table A.4: AM Peak - Existing - I-270 Local Vehicle Speed

I-270 Northbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From C-D start				From C-D start			
to Montrose Rd	59.0	58.9	0%	to Shady Grove	14.6	47.1	222%
to MD 189	59.3	59.3	0%	to MD 28	24.1	51.8	115%
to MD 28	57.4	57.4	0%	to MD 189	15.6	50.2	222%
to Shady Grove	59.1	59.7	1%	to Montrose	17.1	50.4	194%
to I-370	61.7	61.7	0%	to I-270 mainline	22.0	48.4	120%
to MD 117	62.1	61.6	-1%				
to MD 124	56.8	51.5	-9%				
to I-270 mainline	58.9	59.1	0%				

Figure A.7: HCM 2010 Density Level of Service Criteria (pc/mi/ln)

HCM 2010 Freeway LOS	
< 11	A
> 11 - 18	B
> 18 - 26	C
> 26 - 35	D
> 35 - 45	E
> 45	F
HCM 2010 Freeway Merge and Diverge Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 Freeway Weaving Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 C-D Weaving Segment LOS	
< 12	A
> 12 - 24	B
> 24 - 32	C
> 32 - 36	D
> 36 - 40	E
> 40	F

Table A.5: AM Peak - Existing - I-270 Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270	Freeway	25	C	16	B	-38%	I-270	Freeway	20	C	20	C	0%
I-270 Diverge to MD 187	Diverge	19	B	25	C	32%	I-270 Merge from WB I-70	Merge	13	B	13	B	0%
I-270	Freeway	22	C	3	A	-86%	I-270	Freeway	24	C	24	C	0%
I-270 Diverge to Rockledge Rd	Diverge	19	B	25	C	32%	I-270 Merge from EB I-70	Merge	20	B	20	B	0%
I-270	Freeway	19	C	25	C	36%	I-270	Freeway	28	D	28	D	0%
I-270 Weave from MD 187 to I-270 HOV	Weave	10	B	19	B	82%	I-270 Diverge to SB MD 85	Diverge	31	D	93	F	201%
I-270 Lane Drop	Merge	15	B	15	B	0%	I-270	Freeway	27	D	27	D	0%
I-270	Freeway	27	D	21	C	-22%	I-270 Diverge to NB MD 85	Diverge	15	B	15	B	0%
I-270 Merge from I-270 Spur	Merge	24	C	9	A	-62%	I-270	Freeway	23	C	23	C	0%
I-270 Weave from I-270 HOV to I-270 C-D	Weave	27	C	23	C	-16%	I-270 Merge from MD 85	Merge	14	B	14	B	0%
I-270	Freeway	23	C	24	C	3%	I-270	Freeway	36	E	27	D	-27%
I-270 Diverge to C-D (MD 189)	Diverge	21	C	6	A	-70%	I-270 Diverge to MD 80	Diverge	39	E	31	D	-21%
I-270	Freeway	18	B	13	B	-26%	I-270	Freeway	75	F	39	E	-48%
I-270 Diverge to C-D (MD 28)	Diverge	19	B	8	A	-59%	I-270 Merge from MD 80	Merge	85	F	36	E	-57%
I-270	Freeway	15	B	17	B	18%	I-270	Freeway	55	F	40	E	-27%
I-270 Merge from C-D (MD 189)	Merge	18	B	23	C	30%	I-270 Diverge to MD 109	Diverge	33	D	43	F	31%
I-270 Diverge to C-D (Shady Grove Rd)	Diverge	26	C	16	B	-38%	I-270	Freeway	66	F	90	F	36%
I-270	Freeway	14	B	23	C	66%	I-270 Merge from MD 109	Merge	55	F	55	F	0%
I-270 Weave from C-D (MD 28) to C-D (Shady Grove Rd)	Weave	13	B	8	A	-38%	I-270	Freeway	47	F	47	F	0%
I-270	Freeway	11	B	13	B	11%	I-270 Diverge to SB Weigh Station	Diverge	19	B	20	B	0%
I-270 Merge from C-D (Shady Grove Rd)	Merge	10	B	9	A	-8%	I-270	Freeway	39	E	41	E	4%
I-270	Freeway	13	B	16	B	25%	I-270 Merge from SB Weigh Station	Merge	20	C	21	C	5%
I-270 Merge from C-D (I-370)	Merge	11	B	9	A	-17%	I-270	Freeway	41	E	38	E	-8%
I-270 Diverge to C-D (MD 117)	Diverge	16	B	16	B	-3%	I-270 Diverge to MD 121	Diverge	20	C	16	B	-21%
I-270	Freeway	13	B	10	A	-26%	I-270	Freeway	31	D	26	D	-15%
I-270 Merge from C-D (MD 124)	Merge	14	B	23	C	59%	I-270 Merge from MD 121	Merge	32	D	3	A	-90%
I-270	Freeway	17	B	36	E	119%	I-270	Freeway	53	F	33	D	-38%
I-270 Diverge to EB Middlebrook Rd	Diverge	11	B	6	A	-43%	I-270 Diverge to MD 27	Diverge	55	F	22	C	-59%
I-270	Freeway	15	B	14	B	-11%	I-270	Freeway	80	F	25	C	-68%
I-270 Diverge to WB Middlebrook Rd	Diverge	10	A	12	B	17%	I-270 Merge from WB MD 27	Merge	83	F	23	C	-72%
I-270	Freeway	14	B	10	A	-30%	I-270	Freeway	78	F	33	D	-58%
I-270 Diverge to EB MD 118	Diverge	11	B	14	B	25%	I-270 Weave from EB MD 27 to MD 118	Weave	76	F	25	C	-68%
I-270 Diverge to WB MD 118	Diverge	14	B	13	B	-13%	I-270	Freeway	89	F	32	D	-64%
I-270	Freeway	13	B	14	B	3%	I-270 Merge from WB MD 118	Merge	70	F	23	C	-66%
I-270 Weave from MD 118 to MD 27	Weave	13	B	13	B	1%	I-270	Freeway	85	F	35	D	-59%
I-270	Freeway	12	B	15	B	25%	I-270 Merge from EB MD 118	Merge	70	F	28	C	-61%
I-270 Merge from EB MD 27	Merge	13	B	13	B	1%	I-270	Freeway	75	F	38	E	-49%
I-270	Freeway	13	B	15	B	14%	I-270 Merge from Middlebrook Rd	Merge	99	F	38	E	-61%
I-270 Merge from WB MD 27	Merge	10	A	9	A	-4%	I-270	Freeway	107	F	21	C	-81%
I-270	Freeway	14	B	12	B	-12%	I-270 Diverge to MD 124	Diverge	93	F	24	C	-74%
I-270 Diverge to MD 121	Diverge	10	A	12	B	24%	I-270	Freeway	92	F	32	D	-65%

Table A.5: AM Peak - Existing - I-270 Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Southbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270	Freeway	12	B	13	B	7%	I-270 Merge from WB MD 124	Merge	119	F	27	C	-77%
I-270 Merge from EB MD 121	Merge	9	A	9	A	4%	I-270	Freeway	47	F	30	D	-37%
I-270 Lane Drop	Merge	13	B	14	B	12%	I-270 Merge from MD 117	Merge	46	F	34	D	-26%
I-270	Freeway	18	C	14	B	-23%	I-270	Freeway	48	F	21	C	-56%
I-270 Diverge to NB Weigh Station	Diverge	10	A	8	A	-19%	I-270 Diverge to I-370	Diverge	43	F	28	D	-35%
I-270	Freeway	20	C	9	A	-53%	I-270	Freeway	51	F	34	D	-32%
I-270 Merge from NB Weight Station	Merge	10	B	12	B	18%	I-270 Diverge to I-270 C-D	Diverge	81	F	30	D	-63%
I-270	Freeway	20	C	5	A	-74%	I-270	Freeway	36	E	23	C	-36%
I-270 Diverge to MD 109	Diverge	11	B	12	B	10%	I-270 Merge from I-270 (I-370)	Merge	94	F	18	B	-81%
I-270	Freeway	19	C	15	B	-21%	I-270 Diverge to I-270 C-D (Shady Grove Rd)	Diverge	87	F	30	D	-66%
I-270 Merge from MD 109	Merge	10	B	9	A	-6%	I-270	Freeway	90	F	26	C	-71%
I-270	Freeway	20	C	14	B	-28%	I-270 Merge from I-270 C-D (Shady Grove Rd Northern)	Merge	102	F	36	E	-65%
I-270 Diverge to MD 80	Diverge	12	B	20	C	73%	I-270	Freeway	86	F	28	D	-68%
I-270	Freeway	18	B	20	C	13%	I-270 Merge from I-270 C-D (Shady Grove Rd Southern)	Merge	107	F	22	C	-79%
I-270 Merge from MD 80	Merge	12	B	11	B	-14%	I-270 Diverge to I-270 C-D (MD 189)	Diverge	89	F	18	B	-80%
I-270	Freeway	22	C	12	B	-45%	I-270	Freeway	100	F	29	D	-71%
I-270 Diverge to Scenic View	Diverge	11	B	7	A	-35%	I-270 Merge from I-270 C-D (MD 189)	Merge	123	F	28	D	-77%
I-270	Freeway	22	C	61	F	173%	I-270	Freeway	83	F	28	D	-66%
I-270 Merge from Scenic View	Merge	11	B	13	B	20%	I-270 Merge from I-270 C-D	Merge	41	F	23	C	-45%
I-270	Freeway	22	C	24	C	5%	I-270 Diverge to I-270 HOV Lane	Diverge	21	C	8	A	-60%
I-270 Diverge to NB MD 85	Diverge	12	B	22	C	74%	I-270 Diverge to I-270 Spur	Diverge	40	E	7	A	-81%
I-270	Freeway	21	C	16	B	-21%	I-270	Freeway	24	C	36	E	52%
I-270 Diverge to SB MD 85	Diverge	16	B	13	B	-14%	I-270 Diverge to Rockledge Dr / MD 187	Diverge	16	B	3	A	-79%
I-270	Freeway	17	B	20	C	14%	I-270	Freeway	25	C	6	A	-74%
I-270 Weave from MD 85 to I-70	Weave	11	B	10	A	-16%	I-270 Merge from Rockledge Dr	Merge	20	B	13	B	-36%
I-270	Freeway	15	B	21	C	40%	I-270	Freeway	25	C	14	B	-43%
							I-270 Merge from Rockledge Dr / MD 187	Merge	22	C	61	F	176%
							I-270	Freeway	27	D	19	C	-30%

Table A.6: AM Peak - Existing - I-270 Spur Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Spur Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270 Spur	Freeway	34	D	31	D	-10%	I-270 Spur	Freeway	48	F	24	C	-49%
I-270 Spur Merge from Clara Barton Parkway	Merge	24	C	31	D	30%	I-270 Spur Weave from I-270 HOV to Democracy Blvd	Weave	53	F	18	B	-66%
I-270 Spur	Freeway	37	E	26	D	-28%	I-270 Spur	Freeway	52	F	14	B	-74%
I-270 Diverge to MD 190	Diverge	27	C	30	D	12%	I-270 Merge from Democracy Blvd	Merge	28	D	25	C	-10%
I-270 Spur	Freeway	32	D	12	B	-64%	I-270 Spur Lane Drop	Merge	52	F	9	A	-83%
I-270 Spur Merge from Cabin John Parkway	Merge	23	C	23	C	-3%	I-270 Spur	Freeway	72	F	11	B	-84%
I-270 Spur Merge from MD 190	Merge	23	C	55	F	141%	I-270 Spur Merge from I-495	Merge	37	E	13	B	-65%
I-270 Spur	Freeway	30	D	61	F	103%	I-270 Spur	Freeway	39	E	6	A	-85%
I-270 Spur Diverge to I-495	Merge	32	D	53	F	67%	I-270 Spur Diverve to EB MD 190	Diverge	46	F	32	D	-31%
I-270 Spur	Freeway	31	D	4	A	-85%	I-270 Spur Diverve to Cabin John Pkwy	Diverge	27	C	81	F	206%
I-270 Spur Diverge to Democracy Blvd	Diverge	25	C	3	A	-90%	I-270 Spur	Freeway	28	D	43	E	54%
I-270 Spur	Freeway	23	C	5	A	-80%	I-270 Merge from MD 190	Merge	25	C	19	B	-26%
I-270 Spur Merge from EB Democracy Blvd	Merge	15	B	24	C	68%	I-270 Spur	Freeway	33	D	24	C	-28%
I-270 Spur	Freeway	23	C	11	A	-53%	I-270 Diverge to WB Clara Barton Pkwy	Diverge	22	C	31	D	38%
I-270 Spur Merge from WB Democracy Blvd	Merge	15	B	30	D	92%	I-270 Spur	Freeway	32	D	28	D	-13%
I-270 Spur	Freeway	23	C	22	C	-5%	I-270 Merge from Clara Barton Pkwy	Merge	28	D	36	E	27%
I-270 Spur Merge from Westlake Terrace	Merge	23	C	16	B	-33%							
I-270 Spur	Freeway	24	C	17	B	-29%							

Table A.7: AM Peak - Existing - I-270 Local Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Souhbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270 C-D	Freeway	33	D	23	C	-29%	I-270 C-D	Freeway	87	F	25	C	-71%
I-270 C-D Diverge to EB Montrose Rd	Diverge	21	C	20	C	-6%	I-270 C-D Weave from I-370 EB to I-270	Weave	88	F	28	C	-68%
I-270 C-D	Freeway	19	C	27	D	37%	I-270 C-D Diverge to Shady Grove Rd	Diverge	53	F	23	C	-56%
I-270 C-D Weave between Montrose Rd Loop Ramps	Weave	13	B	21	B	69%	I-270 C-D	Freeway	76	F	27	D	-65%
I-270 C-D	Freeway	18	B	33	D	85%	I-270 C-D Merge from WB Shady Grove Rd	Merge	62	F	15	B	-76%
I-270 C-D Merge from WB Montrose Rd	Merge	20	B	28	D	44%	I-270 C-D	Freeway	75	F	24	C	-67%
I-270 C-D	Freeway	28	D	23	C	-17%	I-270 C-D Merge from EB Shady Grove Rd	Merge	53	F	18	B	-66%
I-270 C-D Merge from I-270	Merge	28	D	19	B	-32%	I-270 C-D	Freeway	68	F	29	D	-58%
I-270 C-D	Freeway	29	D	13	B	-54%	I-270 C-D Merge from I-270	Merge	75	F	26	C	-65%
I-270 C-D Diverge to MD 189	Diverge	16	B	26	C	65%	I-270 C-D Diverge to I-270	Diverge	42	F	26	C	-38%
I-270 C-D	Freeway	22	C	16	B	-28%	I-270 C-D Diverge to I-270	Diverge	29	D	29	D	0%
I-270 C-D Merge from MD 189	Merge	15	B	19	B	26%	I-270 C-D	Freeway	20	C	32	D	57%
I-270 C-D	Freeway	29	D	21	C	-25%	I-270 C-D Diverge to MD 28	Diverge	13	B	35	E	167%
I-270 C-D Weave between I-270 (to MD 28 from MD 189)	Weave	28	C	15	B	-45%	I-270 C-D	Freeway	20	C	24	C	21%
I-270 C-D	Freeway	30	D	23	C	-24%	I-270 C-D Merge from WB MD 28	Merge	36	E	33	D	-9%
I-270 C-D Diverge to MD 28	Diverge	21	C	16	B	-25%	I-270 C-D	Freeway	64	F	7	A	-89%
I-270 C-D	Freeway	26	C	31	D	22%	I-270 C-D Merge from EB MD 28	Merge	134	F	38	E	-72%
I-270 C-D Weave between MD 28 Ramps	Weave	35	D	21	B	-39%	I-270 C-D	Freeway	109	F	19	C	-82%
I-270 C-D	Freeway	10	A	24	C	150%	I-270 C-D Merge from I-270	Merge	112	F	30	D	-73%
I-270 C-D Merge from MD 28 WB	Merge	7	A	31	D	363%	I-270 C-D	Freeway	79	F	38	E	-52%
I-270 C-D Merge from I-270 and Drop Lane	Merge	9	A	19	B	106%	I-270 C-D Diverge to MD 189	Diverge	48	F	26	C	-46%
I-270 C-D Diverge to I-270	Diverge	14	B	32	D	120%	I-270 C-D	Freeway	113	F	30	D	-73%
I-270 C-D	Freeway	23	C	14	B	-40%	I-270 C-D Merge from MD 189	Merge	110	F	26	C	-76%
I-270 C-D Diverge to Shady Grove Rd	Diverge	19	B	17	B	-11%	I-270 C-D Diverge to I-270	Diverge	68	F	20	B	-71%
I-270 C-D	Freeway	5	A	19	C	277%	I-270 C-D	Freeway	40	E	30	D	-27%
I-270 C- D Merge from I-270 and EB Shady Grove Rd	Merge	9	A	16	B	84%	I-270 C-D Diverge to WB Montrose Rd	Diverge	26	C	11	B	-56%
I-270 C-D	Freeway	9	A	20	C	133%	I-270 C-D	Freeway	53	F	24	C	-54%
I-270 C-D Merge from WB Shady Grove Rd	Merge	10	B	8	A	-25%	I-270 Weave between Montrose Rd Loops	Weave	61	F	35	D	-42%
I-270 C-D Diverge to I-270	Diverge	15	B	12	B	-17%	I-270 C-D	Freeway	67	F	29	D	-56%
I-270 C-D	Freeway	14	B	8	A	-43%	I-270 C-D Merge from EB Montrose Rd	Merge	54	F	36	E	-33%
I-270 C-D Diverge to I-370	Diverge	13	B	7	A	-51%	I-270 C-D	Freeway	59	F	30	D	-48%
I-270 C-D	Freeway	3	A	15	B	469%							
I-270 Merge from I-370 EB	Merge	6	A	14	B	121%							
I-270 C-D	Freeway	7	A	9	A	29%							
I-270 C-D Weave from I-370 to I-270	Weave	16	B	8	A	-48%							
I-270 C-D	Freeway	11	A	14	B	28%							
I-270 C-D Weave from I-270 to MD 117	Weave	16	B	8	A	-50%							
I-270 C-D Diverge to MD 124	Diverge	11	B	12	B	12%							
I-270 C-D	Freeway	2	A	13	B	690%							
I-270 C-D Merge from EB MD 124	Merge	5	A	12	B	145%							
I-270 C-D Merge From WB MD 124	Merge	8	A	11	B	42%							

Table A.8: AM Peak - Existing - I-270 Vehicle Throughput

I-270 Northbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Southbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between I-495 and MD 187	4495	4495	0%	North of I-70	2502	2502	0%
Between MD 187 on and off ramps	3999	3999	0%	Between I-70 on ramps	2857	2857	0%
Between Rockledge Blvd on and off ramps	3361	3361	0%	From I-70 interchange to MD-85	4925	4925	0%
Between Rockledge Dr and I-270 Spur	3094	3093	0%	Between MD-85 on and off ramps	2771	2771	0%
Between I-270 Spur and Montrose Rd	8311	8301	0%	Between MD-85 and MD-80	3221	3225	0%
Between Montrose Rd on and off ramps	4705	4703	0%	Between MD-80 on and off ramps	3185	2992	-6%
Between Montrose Rd and MD 189	4376	4373	0%	Between MD-80 and Md-109	3861	3803	-2%
Between MD 189 and MD 28	4381	4373	0%	Between MD-109 on and off ramps	3800	3792	0%
Between MD 28 on and off ramps	4677	4690	0%	Between MD-109 and MD-121	4257	4268	0%
Between MD 28 and Shady Grove Rd	3378	3388	0%	Between MD-121 on and off ramps	4043	4093	1%
Between Shady Grove Rd and I-370	2853	2869	1%	Between MD-121 and MD-27	4694	4966	6%
Between I-370 on and off ramps	3129	3144	0%	Between MD-27 on and off ramps	4342	4861	12%
Between I-370 and MD 117	4195	4206	0%	Between MD-27 and MD-118	4665	5304	14%
Between MD 117 and MD 124	3275	3279	0%	Between MD-118 on and off ramps	4480	5147	15%
Between MD-124 on and off ramps	3278	3280	0%	Between MD-118 and Middlebrook Rd	5032	5717	14%
Between MD 124 and Middlebrook Rd	4082	4084	0%	Between Middlebrook Rd on and off ramps	5031	5714	14%
Between Middlebrook Rd on and off ramps	3784	3783	0%	Between Middlebrook Rd and MD-124	6737	7478	11%
Between Middlebrook Rd and MD 118	3344	3342	0%	Between MD-124 on and off ramps	5818	6521	12%
Between MD-118 on and off ramps	3008	3007	0%	Between MD-124 and MD-117	6930	7725	11%
Between MD 118 and MD 27	2831	2828	0%	Between MD-117 and I-370	8479	9394	11%
Between MD-27 on and off ramps	2232	2228	0%	Between I-370 on and off ramps	3024	3280	8%
Between MD 27 and MD 121	2515	2517	0%	Between I-370 on ramp to Shady Grove Rd	4111	4691	14%
Between MD-121 on and off ramps	2211	2224	1%	Between Shady Grove Rd and MD 28	3568	4332	21%
Between MD 121 and MD 109	2420	2422	0%	Between MD 28 on and off ramps	4420	5261	19%
Between MD-109 on and off ramps	2263	2267	0%	Between MD 28 and MD 189	3950	4690	19%
Between MD 109 and MD 80	2363	2368	0%	Between MD 189 and Montrose Rd	3941	4717	20%
Between MD-80 on and off ramps	2126	2127	0%	Between Montrose Rd on and off ramps	4968	5910	19%
Between MD 80 and MD 85	2656	2658	0%	Between Montose Rd and I-270 Spur	8098	9274	15%
Between MD-85 on and off ramps	2016	2016	0%	Between I-270 Spur and Rockledge Blvd	3901	4422	13%
Between MD 85 and I-70	2858	2860	0%	Between Rockledge Blvd on and off ramps	2845	3213	13%
North of I-70	1832	1835	0%	Between MD 187 on and off ramps	2986	3380	13%
				Between MD 187 and I-495	3083	3400	10%
I-270 Spur Northbound				**I-270 Spur Southbound**			
Between I-495 and Democracy Blvd	5178	5179	0%	Between I-270 Split and HOV on ramp	4233	4939	17%
Between Democracy Blvd on and off ramps	4035	4033	0%	Between HOV on ramp and Democracy Blvd	4165	4941	19%
Between Democracy Blvd and I-270 Split	4304	4300	0%	Between Democracy Blvd on and off ramps	3636	4330	19%
				Between Democracy Blvd and I-495	4140	4866	18%

Table A.9: AM Peak - Existing - I-270 Local Vehicle Throughput

I-270 Local Northbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Local Southbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between Montrose Rd EB off ramp and and EB on ramp	2355	2355	0%	Between I-370 on ramp and I-270 off ramp	4068	4882	20%
Between Montrose Rd EB on ramp and WB off ramp	2567	2565	0%	Between I-270 off ramp and Shady Grove off ramp	2942	3495	19%
Between Montrose Rd WB off ramp and on ramp	2151	2149	0%	Between Shady Grove off ramp and Shady Grove WB on ramp	1759	2050	17%
Between Montrose Rd WB on ramp and I-270 on ramp	3067	3071	0%	Between Shady Grove WB and EB on ramps	2398	2651	11%
Between I-270 on ramp and MD 189 off ramp	3387	3389	0%	Between Shady Grove on ramp and I-270 on ramp	2797	3021	8%
Between MD 189 ramps	2705	2705	0%	Between I-270 on ramp and I-270 off ramp1	3423	3800	11%
Between MD 189 off ramp and I-270 on ramp	3252	3255	0%	Between I-270 off ramp1 and I-270 off ramp2	2902	3243	12%
Between I-270 on ramp and I-270 off ramp	3988	3992	0%	Between I-270 off ramp2 and MD 28 off ramp	2031	2299	13%
Between I-270 off ramp and MD 28 EB off ramp	2948	2959	0%	Between MD 28 off ramp and MD 28 WB on ramp	1466	1662	13%
Between MD 28 EB off ramp to MD 28 EB on ramp	2599	2605	0%	Between MD 28 WB on ramp and MD 28 EB on ramp	1781	1959	10%
Between MD 28 EB on ramp and MD 28 WB off ramp	2664	2693	1%	Between MD 28 EB on ramp and I-270 on ramp	2841	3372	19%
Between MD 28 WB off ramp and MD 28 WB on ramp	1160	1182	2%	Between I-270 on ramp and MD 189 off ramp	3310	3932	19%
Between MD 28 WB on ramp and I-270 on ramp	1631	1652	1%	Between MD 189 on and off ramps	2671	3185	19%
Between I-270 on ramp and I-270 off ramp	2926	2951	1%	Between MD 189 on ramp and I-270 off ramp	3800	4296	13%
Between I-270 off ramp and Shady Grove off ramp	2518	2535	1%	Between I-270 off ramp and Montrose Rd off ramp	2573	2871	12%
Between Shady Grove off ramp and I-270 on ramp	321	322	0%	Between Montrose Rd off ramp and Montrose Rd WB on ramp	2455	2724	11%
Between I-270 on ramp and Shady Grove WB on ramp	1562	1568	0%	Between Montrose Rd WB on ramp and EB off ramp	3375	3631	8%
Between Shady Grove WB on ramp and I-270 off ramp	1887	1893	0%	Between Montrose Rd EB off and on ramps	2652	2845	7%
Between I-270 off ramp and I-370 off ramp	1609	1615	0%	Between Montrose Rd EB off ramp and I-270	3384	3570	5%
Between I-370 off ramp and I-370 EB on ramp	332	333	0%				
Between I-370 EB and WB on ramps	826	827	0%				
Between I-370 WB on ramp and I-270 off ramp	2397	2399	0%				
Between I-270 off ramp and I-270 on ramp	1334	1334	0%				
Between I-270 on ramp and MD 117 off ramp	2251	2253	0%				
Between MD 117 off ramp and MD 124 off ramp	1034	1037	0%				
Between MD 124 off ramp and MD 124 EB on ramp	98	98	0%				
Between MD 124 EB and WB on ramps	487	489	0%				
Between MD 124 on ramp I-270	815	814	0%				

Table A.10: AM Peak - Existing - I-270 On Ramp Queue Length - Northbound

I-270 Northbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
Rockledge Dr on ramp	0	0	0%	0	0	0%
MD 189 C-D on ramp	0	0	0%	0	0	0%
MD 28 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp	0	0	0%	0	0	0%
I-370 C-D on ramp	0	0	0%	0	0	0%
MD 124 C-D on ramp	0	0	0%	0	0	0%
MD 118 on ramp	0	0	0%	0	0	0%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 121 on ramp	0	0	0%	0	0	0%
MD 109 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	0	0	0%	0	0	0%
MD 85 on ramp	0	0	0%	0	0	0%
I-270 Spur Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd EB on ramp	0	0	0%	0	0	0%
Democracy Blvd WB on ramp	0	0	0%	0	0	0%
I-495 Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Cabin John Pkwy on ramp	0	0	0%	0	0	0%
MD 190 on ramp	0	0	0%	0	0	0%
I-270 C-D Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Montrose Rd EB on ramp	0	0	0%	0	0	0%
Montrose Rd WB on ramp	0	1	0%	0	103	0%
I-270 on ramp	0	0	0%	0	0	0%
MD 189 on ramp	0	0	0%	0	7	0%
I-270 on ramp	0	0	0%	0	0	0%
MD 28 EB on ramp	0	0	-100%	17	0	-100%
MD 28 WB on ramp	0	0	0%	0	0	0%
Shady Grove Rd EB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	0	0%	0	0	0%
Shady Grove Rd WB on ramp	0	0	0%	0	0	0%
I-370 EB on ramp	0	0	0%	0	0	0%
I-370 WB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	0	0%	0	0	0%
MD 124 EB on ramp	0	0	0%	0	0	0%
MD 124 WB on ramp	0	0	0%	0	0	0%

Table A.11: AM Peak - Existing - I-270 Off Ramp Queue Length - Northbound

I-270 Northbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 187 off ramp NB	56	101	82%	347	503	45%
MD 187 off ramp SB	87	128	46%	439	596	36%
Rockledge Dr off ramp	5	4	-15%	316	263	-17%
Tower Oaks Blvd off ramp	14	15	4%	165	146	-12%
Montrose Rd off ramp EB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
MD 189 off ramp WB	11	12	7%	97	106	10%
MD 189 off ramp EB	1	3	150%	131	274	109%
MD 28 off ramp EB	48	49	3%	296	283	-4%
MD 28 off ramp WB	1	0	-100%	119	0	-100%
Shady Grove Rd off ramp - Redland Blvd	0	0	0%	0	0	0%
Shady Grove Rd off ramp WB	191	192	0%	620	681	10%
Shady Grove Rd off ramp EB	0	0	0%	0	0	0%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
MD 117 off ramp	218	269	23%	793	1039	31%
MD 124 off ramp	340	418	23%	957	1162	21%
Watkins Mill Rd off ramp*						
Middlebrook Rd EB off ramp	0	0	0%	0	0	0%
Middlebrook Rd WB off ramp	0	0	0%	0	0	0%
MD 118 WB off ramp - Seneca Meadows	0	0	-100%	19	0	-100%
MD 118 WB off ramp	0	0	0%	0	0	0%
MD 118 EB off ramp	0	0	0%	0	0	0%
MD 27 off ramp WB	5	6	3%	83	93	12%
MD 27 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp WB	0	0	-37%	37	22	-40%
MD 121 off ramp EB	0	0	0%	0	0	0%
MD 109 off ramp EB	3	3	9%	97	122	26%
MD 109 off ramp WB	0	0	0%	0	0	0%
MD 80 off ramp EB	5	5	-4%	110	96	-13%
MD 80 off ramp WB	2	0	-100%	34	0	-100%
MD 85 NB off ramp	0	0	0%	0	0	0%
MD 85 SB off ramp	0	0	-19%	66	54	-18%
I-270 Spur Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Clara Barton Pkwy off ramp EB	1	1	0%	157	157	0%
Clara Barton Pkwy off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp EB	0	0	0%	0	60	0%
MD 190 off ramp WB	0	0	0%	0	0	0%
Democracy Blvd off ramp WB	108	104	-3%	589	469	-20%
Democracy Blvd off ramp EB	16	16	-4%	149	138	-8%

* Ramp in Future Scenario

Table A.12: AM Peak - Existing - I-270 On Ramp Queue Length - Southbound

I-270 Southbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	575	6	-99%	2307	197	-91%
MD 109 on ramp	66	0	-100%	841	0	-100%
MD 121 WB on ramp	8	0	-100%	263	0	-100%
MD 121 EB on ramp*			0%			0%
MD 27 WB on ramp	145	0	-100%	1297	0	-100%
MD 27 EB on ramp	1	0	-100%	89	0	-100%
MD 118 WB on ramp	0	0	0%	0	0	0%
MD 118 EB on ramp	0	0	-100%	9	0	-100%
Middlebrook Rd on ramp	161	0	-100%	1641	0	-100%
MD 124 WB on ramp	254	0	-100%	2615	0	-100%
MD 117 on ramp	94	0	-100%	1640	0	-100%
I-370 C-D on ramp	805	0	-100%	1861	0	-100%
Shady Grove Rd C-D on ramp North	2	0	-100%	160	0	-100%
Shady Grove Rd C-D on ramp South	68	0	-100%	927	0	-100%
MD 189 C-D on ramp	1393	0	-100%	3991	0	-100%
Montrose Rd C-D on ramp	2	0	-100%	246	0	-100%
Rockledge Dr on ramp	0	0	0%	0	0	0%
MD 187 on ramp	0	0	0%	0	0	0%
I-270 Spur Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd on ramp	0		0%	0	0	0%
I-495 Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 Spur on ramp	260	164	-37%	1015	1689	66%
MD 190 on ramp	0	14	0%	0	302	0%
I-270 C-D Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 on ramp	2305	2	-100%	5053	230	-95%
I-370 on ramp	1241	0	-100%	2914	95	-97%
Shady Grove Rd WB on ramp	1	0	-100%	150	0	-100%
Shady Grove Rd EB on ramp	0	0	-100%	29	0	-100%
I-270 on ramp	0	0	-100%	39	0	-100%
MD 28 WB on ramp	6	0	-100%	121	0	-100%
MD 28 EB on ramp	3166	0	-100%	3877	0	-100%
I-270 on ramp	0	0	-100%	55	0	-100%
MD 189 on ramp	111	0	-100%	1104	0	-100%
Montrose Rd WB on ramp	8	0	-96%	440	68	-84%
Montrose Rd EB on ramp	0	0	-100%	95	0	-100%

* Ramp in Future Scenario

Table A.13: AM Peak - Existing - I-270 Off Ramp Queue Length - Southbound

I-270 Southbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 SB off ramp	0	0	0%	0	0	0%
MD 85 NB off ramp	0	0	0%	0	0	0%
MD 80 off ramp	0	0	-77%	69	55	-21%
MD 109 off ramp WB	0	0	582%	7	16	130%
MD 109 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp EB	1	2	38%	93	105	13%
MD 121 off ramp WB	0	0	0%	0	0	0%
MD 27 off ramp EB	53	56	5%	279	259	-7%
MD 27 off ramp WB	45	5	-89%	289	191	-34%
MD 118 off ramp EB	31	30	-2%	161	155	-4%
MD 118 off ramp WB	0	0	0%	0	0	0%
Watkins Mill Rd off ramp*						
MD 124 off ramp EB	75	94	25%	342	390	14%
MD 124 off ramp WB	18	20	11%	405	405	0%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Omega Drive	6	8	26%	194	240	24%
Shady Grove Rd off ramp	0	0	0%	0	0	0%
MD 28 off ramp	3	6	147%	132	155	18%
MD 189 off ramp EB	40	48	21%	296	318	7%
MD 189 off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp EB	0	0	0%	0	0	0%
Rockledge Dr off ramp	18	91	407%	261	621	138%
I-270 Spur Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd off ramp EB	51	58	14%	230	260	13%
Democracy Blvd off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp WB	995	2147	116%	2271	4507	98%
MD 190 off ramp EB	0	0	0%	0	0	0%
Clara Barton Pkwy WB off ramp	0	0	0%	0	5	0%

* Ramp in Future Scenario

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	18.8	B	NB Left	103	76	57	282	E	33.3	C
				NB Through	312	24	57	282	C		
				NB Right	581	6	6	284	A		
	SB	42.4	D	SB Left	110	57	123	552	E		
				SB Through	535	41	123	552	D		
				SB Right	52	24	123	552	C		
	EB	44.4	D	EB Left	81	70	42	165	E		
				EB Through	47	81	42	165	F		
				EB Right	102	7	42	165	A		
	WB	50.7	D	WB Left	204	72	75	302	E		
				WB Through	12	61	75	302	E		
				WB Right	100	6	75	302	A		
2- MD 85 at I-270 NB on and off ramp											
2	NB	42.6	D	NB Left	560	43	155	745	D	28.8	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	14.6	B	SB Left	0	0	0	0	A		
				SB Through	547	15	36	483	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	4.3	A	NB Left	0	0	0	0	A	10.2	B
				NB Through	812	4	12	316	A		
				NB Right	0	0	0	0	A		
	SB	41.3	D	SB Left	154	41	37	267	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	15.8	C	NB Left	10	57	34	262	E	19.8	B
				NB Through	585	15	34	262	B		
				NB U-Turn	0	0	0	0	A		
	SB	13.7	B	SB Left	57	68	23	146	E		
				SB Through	1657	14	55	477	B		
				SB Right	751	9	43	467	A		
	EB	49.1	D	EB Left	481	51	70	208	D		
				EB Through	19	62	70	208	E		
				EB Right	32	10	70	208	A		
	WB	43.1	D	WB Left	37	56	17	111	E		
				WB Through	15	59	17	111	E		
				WB Right	19	6	17	111	A		
5- MD 80 at I-270 NB on and ramp											
5	NB	-1.1	A	NB Left	3	0	0	0	A	16.1	B
				NB Through	2	0	0	0	A		
				NB Right	4	-2	0	0	A		
	SB	12.8	B	SB Left	183	15	12	115	B		
				SB Through	5	17	12	115	B		
				SB Right	52	4	1	16	A		
	EB	7.0	A	EB Left	38	8	6	165	A		
				EB Through	0	0	8	0	A		
				EB Right	7	4	13	196	A		
	WB	17.2	B	WB Left	31	13	1	48	B		
				WB Through	684	24	94	544	C		
				WB Right	504	8	6	182	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	4.1	A	NB Left	22	25	1	113	C	22.2	C
				NB Through	0	0	0	0	A		
				NB Right	262	2	1	113	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	23.0	C	EB Left	0	0	0	0	A		
				EB Through	241	22	26	226	C		
				EB Right	133	25	26	235	D		
	WB	47.1	E	WB Left	0	0	0	0	A		
				WB Through	194	47	126	641	E		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	2.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	8.3	A	SB Left	118	11	7	116	B		
				SB Through	0	0	0	0	A		
				SB Right	38	1	0	0	A		
	EB	3.2	A	EB Left	59	3	0	36	A		
				EB Through	0	0	0	0	A		
				EB Right	40	3	0	0	A		
	WB	0.4	A	WB Left	0	0	0	0	A		
				WB Through	462	0	0	54	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	2.5	A	NB Left	15	10	1	65	B	3.5	A
				NB Through	0	0	0	0	A		
				NB Right	41	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	3.4	A	EB Left	0	0	0	0	A		
				EB Through	59	0	0	34	A		
				EB Right	70	6	1	34	A		
	WB	3.6	A	WB Left	393	3	8	292	A		
				WB Through	109	5	8	269	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	8.4	A	NB Left	95	11	13	147	B	20.7	C
				NB Through	279	12	13	147	B		
				NB Right	198	2	17	173	A		
	SB	16.8	C	SB Left	47	11	31	312	B		
				SB Through	577	17	41	312	B		
				SB Right	6	13	46	333	B		
	EB	33.6	D	EB Left	7	37	86	427	D		
				EB Through	88	44	93	427	D		
				EB Right	547	32	117	459	C		
	WB	30.3	D	WB Left	96	35	19	123	D		
				WB Through	12	33	19	123	C		
				WB Right	21	7	13	142	A		
10- MD 121 at I-270 NB on and off ramp											
10	NB	1.7	A	NB Left	40	10	2	86	A	0.7	A
				NB Through	0	0	0	0	A		
				NB Right	253	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	318	0	0	0	A		
				EB Right	49	0	0	0	A		
	WB	0.6	A	WB Left	151	2	1	87	A		
				WB Through	1070	0	0	58	A		
				WB Right	0	0	0	0	A		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	1.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	7.7	A	SB Left	123	10	6	120	B		
				SB Through	0	0	0	0	A		
				SB Right	46	1	0	0	A		
	EB	0.4	A	EB Left	25	2	0	35	A		
				EB Through	0	0	0	0	A		
				EB Right	833	0	0	0	A		
	WB	0.1	A	WB Left	0	0	0	0	A		
				WB Through	277	0	0	0	A		
				WB Right	0	0	0	0	A		
12- MD 27 at Observation Dr											
12	NB	48.0	D	NB U-Turn	0	0	0	0	A	19.3	B
				NB Through	34	63	10	64	E		
				NB Right	12	7	10	64	A		
	SB	40.9	D	SB Left	75	52	23	142	D		
				SB Through	43	60	30	226	E		
				SB Right	157	30	52	263	C		
	EB	13.0	B	EB Left	149	30	29	290	C		
				EB Through	1202	11	31	291	B		
				EB Right	50	9	38	329	A		
	WB	20.1	C	WB Left	83	15	138	788	B		
				WB Through	2047	21	138	788	C		
				WB Right	94	10	138	788	A		
13- MD 27 at I-270 NB off ramp											
13	NB	30.7	C	NB Left	89	31	12	90	C	11.6	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	891	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	15.7	B	WB Left	0	0	0	0	A		
				WB Through	2110	16	194	1341	B		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	24.7	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	49.6	D	SB Left	376	50	64	293	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	9.0	A	EB Left	0	0	0	0	A		
				EB Through	657	9	12	192	A		
				EB Right	0	0	0	0	A		
	WB	25.5	C	WB Left	0	0	0	0	A		
				WB Through	1263	25	195	645	C		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	17.8	B	NB Left	22	18	31	405	B	38.3	D
				NB Through	819	18	57	405	B		
				NB Right	72	16	60	418	B		
	SB	46.4	D	SB Left	407	69	356	1190	E		
				SB Through	1333	40	356	1190	D		
				SB Right	40	27	320	1184	C		
	EB	44.6	D	EB Left	177	49	47	169	D		
				EB Through	74	49	43	164	D		
				EB Right	60	27	44	196	C		
	WB	56.0	E	WB Left	8	63	85	273	E		
				WB Through	21	302	85	273	F		
				WB Right	104	6	85	273	A		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	3.4	A	NB Left	123	10	1	70	A	5.5	A
				NB Through	727	3	4	119	A		
				NB Right	79	1	8	171	A		
	SB	3.7	A	SB Left	25	5	5	169	A		
				SB Through	808	4	8	169	A		
				SB Right	32	2	9	202	A		
	EB	16.9	B	EB Left	15	64	8	69	E		
				EB Through	6	59	8	69	E		
				EB Right	96	7	8	69	A		
	WB	44.2	D	WB Left	30	65	12	94	E		
				WB Through	5	68	8	94	E		
				WB Right	21	9	11	113	A		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	11.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	33.0	C	EB Left	222	33	44	277	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	6.0	A	WB Left	0	0	0	0	A		
				WB Through	155	1	0	4	A		
				WB Right	778	7	16	276	A		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	7.4	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	41.5	D	SB Left	193	41.5	34	164	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	3.1	A	EB Left	0	0.0	0	0	A		
				EB Through	615	3.1	4	135	A		
				EB Right	0	0.0	0	0	A		
	WB	3.6	A	WB Left	0	0.0	0	0	A		
				WB Through	1036	3.6	7	209	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	45.2	D	NB Left	7	70	8	75	E	18.1	B
				NB Through	12	80	8	75	F		
				NB Right	14	3	0	22	A		
	SB	60.7	E	SB Left	241	58	98	368	E		
				SB Through	41	66	98	368	E		
				SB Right	81	67	98	368	E		
	EB	10.4	B	EB Left	102	13	28	310	B		
				EB Through	932	10	28	310	B		
				EB Right	27	9	28	310	A		
	WB	11.5	B	WB Left	73	17	31	246	B		
				WB Through	899	14	31	246	B		
				WB Right	277	4	31	246	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	16.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	18.7	B	SB Left	22	35	4	44	D		
				SB Through	0	0	0	0	A		
				SB Right	25	4	4	44	A		
	EB	14.2	B	EB Left	240	21	31	226	C		
				EB Through	865	12	31	226	B		
				EB Right	0	0	0	0	A		
	WB	17.7	B	WB Left	0	0	0	0	A		
				WB Through	1072	19	69	381	B		
				WB Right	215	13	92	431	B		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21	NB			NB Left	0	0	0	0	A	16.0	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	11.2	B	EB Left	0	0	0	0	A		
				EB Through	805	11	26	186	B		
				EB Right	0	0	0	0	A		
	WB	21.3	C	WB Left	743	21	64	867	C		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22	NB	63.1	E	NB Left	147	52	145	449	D	25.3	C
				NB Through	6	52	145	449	D		
				NB Right	342	68	145	449	E		
	SB	21.9	C	SB Left	3	37	1	29	D		
				SB Through	0	0	1	29	A		
				SB Right	3	7	2	67	A		
	EB	18.2	B	EB Left	28	12	124	845	B		
				EB Through	1483	19	124	845	B		
				EB Right	76	10	124	845	A		
	WB	16.1	B	WB Left	78	20	28	213	C		
				WB Through	682	16	28	213	B		
				WB Right	35	4	28	213	A		
23- MD 124 at MD 355											
23	NB	50.5	D	NB Left	229	69	72	198	E	83.6	F
				NB Through	306	42	70	196	D		
				NB Right	37	2	0	0	A		
	SB	33.5	C	SB Left	49	86	121	406	F		
				SB Through	966	50	121	406	D		
				SB Right	619	3	34	375	A		
	EB	99.1	F	EB Left	615	255	1024	1207	F		
				EB Through	528	22	1024	1207	C		
				EB Right	582	5	921	1184	A		
	WB	122.0	F	WB Left	0	0	0	0	A		
				WB Through	1884	123	727	1112	F		
				WB Right	42	68	0	0	E		
24- MD 124 at I-270 SB on and off											
24	NB	65.0	F	NB Left	15	66	15	78	E	22.2	C
				NB Through	29	64	15	78	E		
				NB U-Turn	0	0	0	0	A		
	SB	27.6	C	SB Left	306	67	81	347	E		
				SB Through	4	87	81	347	F		
				SB Right	572	6	13	335	A		
	EB	15.7	B	EB Left	0	0	0	0	A		
				EB Through	904	16	41	321	B		
				EB Right	67	12	50	345	B		
	WB	22.0	C	WB Left	33	27	116	1390	C		
				WB Through	1193	22	116	1390	C		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25	NB	42.7	D	NB Left	16	65	95	577	E	43.0	D
				NB Through	421	58	95	577	E		
				NB Right	407	26	61	641	C		
	SB	37.8	D	SB Left	181	47	126	605	D		
				SB Through	839	40	126	605	D		
				SB Right	95	2	0	0	A		
	EB	48.4	D	EB Left	80	108	175	722	F		
				EB Through	1383	45	174	723	D		
				EB Right	66	44	187	750	D		
	WB	40.7	D	WB Left	314	73	108	332	E		
				WB Through	480	27	108	332	C		
				WB Right	95	0	0	0	A		
26- MD 117 at Bureau Dr											
26	NB	52.3	D	NB Left	18	70	16	93	E	42.3	D
				NB Through	17	79	16	93	E		
				NB Right	25	21	16	93	C		
	SB	63.4	E	SB Left	191	70	80	297	E		
				SB Through	43	68	80	297	E		
				SB Right	28	13	80	297	B		
	EB	47.0	D	EB Left	28	36	314	962	D		
				EB Through	1928	47	322	962	D		
				EB Right	20	59	315	951	E		
	WB	31.8	C	WB Left	298	93	195	602	F		
				WB Through	852	19	195	603	B		
				WB Right	316	8	169	651	A		
27- MD 117 at I-270 SB off ramp											
27	NB			NB Left	0	0	0	0	A	8.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.8	A	EB Left	0	0	0	0	A		
				EB Through	799	2	1	180	A		
				EB Right	0	0	0	0	A		
	WB	24.0	C	WB Left	310	24	45	344	C		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28	NB			NB Left	0	0	0	0	A	30.5	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	49.1	D	SB Left	307	54	230	811	D		
				SB Through	0	0	0	0	A		
				SB Right	915	48	236	813	D		
	EB	19.4	B	EB Left	10	111	80	888	F		
				EB Through	782	18	80	888	B		
				EB Right	0	0	0	0	A		
	WB	14.2	B	WB Left	0	0	0	0	A		
				WB Through	860	14	51	343	B		
				WB Right	9	5	55	373	A		
29- MD 117 at Perry Pkwy											
29	NB	42.5	D	NB Left	35	67	14	97	E	13.6	B
				NB Through	6	61	14	96	E		
				NB Right	31	11	23	117	B		
	SB	33.8	C	SB Left	91	72	37	167	E		
				SB Through	13	72	37	167	E		
				SB Right	124	2	37	167	A		
	EB	10.3	B	EB Left	119	69	42	237	E		
				EB Through	957	3	42	237	A		
				EB Right	9	1	29	221	A		
	WB	9.9	A	WB Left	5	87	20	261	F		
				WB Through	709	10	20	261	A		
				WB Right	104	5	20	261	A		
30- Shady Grove Rd at I-270 NB off ramp											
30	NB	9.5	A	NB Left	0	0	0	0	A	24.6	C
				NB Through	917	9	21	216	A		
				NB Right	0	0	0	0	A		
	SB	10.1	B	SB Left	0	0	0	0	A		
				SB Through	1284	10	31	344	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	56.8	E	WB Left	1008	57	201	631	E		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
31	NB	14.6	B	NB Left	0	0	0	0	A	21.0	C
				NB Through	920	15	41	379	B		
				NB Right	0	0	0	0	A		
	SB	11.4	B	SB Left	0	0	0	0	A		
				SB Through	1692	11	46	658	B		
				SB Right	0	0	0	0	A		
	EB	44.2	D	EB Left	313	37	42	360	D		
				EB Through	0	0	0	0	A		
				EB Right	642	48	102	463	D		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
32	NB			NB U-Turn	0	0	0	0	A	32.6	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	35.9	D	SB Left	456	44	72	304	D		
				SB Through	0	0	0	0	A		
				SB Right	108	3	0	59	A		
	EB	57.4	E	EB Left	0	0	0	0	A		
				EB Through	1050	87	1521	2131	F		
				EB Right	663	11	1050	2134	B		
	WB	9.1	A	WB Left	0	0	0	0	A		
				WB Through	1879	9	32	405	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
33	NB	34.9	C	NB Left	0	0	54	306	A	17.4	B
				NB Through	213	51	62	315	D		
				NB Right	139	11	62	315	B		
	SB	21.1	C	SB Left	25	60	19	169	E		
				SB Through	0	0	0	0	A		
				SB Right	260	17	19	169	B		
	EB	15.0	B	EB Left	224	28	46	333	C		
				EB Through	829	11	46	333	B		
				EB Right	0	0	0	0	A		
	WB	12.3	B	WB Left	22	11	41	286	B		
				WB Through	887	12	29	249	B		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
34	NB	40.7	D	NB Left	62	45	16	111	D	10.0	B
				NB Through	6	42	13	110	D		
				NB Right	8	8	15	121	A		
	SB	5.2	A	SB Left	66	46	20	162	D		
				SB Through	7	40	20	162	D		
				SB Right	601	0	0	0	A		
	EB	10.2	B	EB Left	325	16	14	215	B		
				EB Through	920	8	18	229	A		
				EB Right	13	6	26	265	A		
	WB	12.1	B	WB Left	3	21	16	184	C		
				WB Through	315	12	16	184	B		
				WB Right	10	9	27	218	A		
35- MD 189 at I-270 Ramps											
35	NB	50.5	D	NB Left	133	51	25	119	D	41.6	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	48.3	D	SB Left	184	48	54	316	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	23.2	C	EB Left	384	20	81	458	B		
				EB Through	529	26	81	458	C		
				EB Right	0	0	0	0	A		
	WB	59.1	E	WB Left	533	50	137	497	D		
				WB Through	284	76	137	497	E		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
36	NB	43.1	D	NB Left	129	52	52	178	D	58.1	E
				NB Through	100	80	52	178	E		
				NB Right	151	12	52	178	B		
	SB	91.5	F	SB Left	385	105	294	792	F		
				SB Through	516	81	218	720	F		
				SB Right	0	0	0	0	A		
	EB	48.8	D	EB Left	132	75	214	884	E		
				EB Through	958	48	214	884	D		
				EB Right	95	23	214	884	C		
	WB	42.6	D	WB Left	423	62	108	314	E		
				WB Through	390	27	108	314	C		
				WB Right	58	5	108	314	A		
37- Montrose Rd at Tower Oaks Blvd											
37	NB			NB Left	0	0	0	0	A	26.1	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	106.3	F	SB Left	126	40	201	957	D		
				SB Through	0	0	0	0	A		
				SB Right	521	122	323	955	F		
	EB	7.9	A	EB Left	28	16	25	421	B		
				EB Through	1424	8	25	421	A		
				EB Right	0	0	0	0	A		
	WB	9.2	A	WB Left	0	0	0	0	A		
				WB Through	1443	9	26	286	A		
				WB Right	62	4	26	286	A		
38- Tower Oaks Blvd at I-270 off rmap											
38	NB	15.7	B	NB Left	475	16	25	187	B	14.8	B
				NB Through	12	17.0	19	179	B		
				NB Right	26	4.9	25	187	A		
	SB	0.1	A	SB Left	2	-0.2	0	16	A		
				SB Through	0	0.0	0	16	A		
				SB Right	2	0.5	0	0	A		
	EB	14.6	B	EB Left	7	11.4	39	282	B		
				EB Through	621	15.1	39	282	B		
				EB Right	91	11.5	32	272	B		
	WB	11.9	B	WB Left	0	0.0	4	71	A		
				WB Through	84	12.6	4	71	B		
				WB Right	7	4.2	0	0	A		
39- Montrose Rd at Tower Oaks Blvd											
39	NB	9.6	A	NB Left	26	45	21	127	D	61.8	E
				NB Through	188	30	21	127	C		
				NB Right	507	0	0	0	A		
	SB	38.9	D	SB Left	297	70	128	520	E		
				SB Through	605	26	127	519	C		
				SB Right	64	18	130	533	B		
	EB	144.4	F	EB Left	56	123	558	723	F		
				EB Through	816	146	559	724	F		
				EB Right	45	147	582	747	F		
	WB	39.8	D	WB Left	362	48	77	299	D		
				WB Through	231	46	77	299	D		
				WB Right	134	7	91	329	A		
40- Rockledge Blvd at I-270 NB on and off ramp											
40	NB			NB Left	0	0	0	0	A	16.0	B
				NB Through	85	32	30	146	C		
				NB Right	195	34	30	146	C		
	SB	2.3	A	SB Left	0	0	6	75	A		
				SB Through	986	2	6	75	A		
				SB Right	0	0	0	0	A		
	EB	24.3	C	EB Left	5	35	109	424	C		
				EB Through	501	50	109	424	D		
				EB Right	550	1	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	2.6	A	NB Left	89	3	1	25	A	20.5	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	21.6	C	WB Left	986	23	98	664	C		
				WB Through	452	19	98	664	B		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	290.3	F	NB Left	184	172	1149	1512	F	195.3	F
				NB Through	1181	240	1149	1512	F		
				NB Right	143	859	1149	1512	F		
	SB	172.4	F	SB Left	60	147	2547	2696	F		
				SB Through	1511	171	2547	2696	F		
				SB Right	177	192	2547	2696	F		
	EB	65.2	E	EB Left	185	47	206	895	D		
				EB Through	548	73	207	896	E		
				EB Right	135	58	228	920	E		
	WB	203.3	F	WB Left	702	243	1957	2147	F		
				WB Through	354	165	1957	2147	F		
				WB Right	135	100	1957	2147	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	67.1	E	NB Left	153	90	240	435	F	44.4	D
				NB Through	1250	64	240	435	E		
				NB Right	0	0	0	0	A		
	SB	24.4	C	SB Left	0	0	0	0	A		
				SB Through	1718	24	91	590	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	64.9	E	WB Left	120	64	63	355	E		
				WB Through	10	75	63	355	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	131.6	F	NB Left	0	0	0	0	A	62.8	E
				NB Through	1241	132	392	892	F		
				NB Right	0	0	0	0	A		
	SB	7.5	A	SB Left	193	56	63	268	E		
				SB Through	1641	2	63	268	A		
				SB Right	0	0	0	0	A		
	EB	91.6	F	EB Left	190	98	179	700	F		
				EB Through	0	0	179	700	A		
				EB Right	370	88	218	693	F		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	19.7	B	NB Left	192	61	84	380	E	22.2	C
				NB Through	1193	13	84	381	B		
				NB Right	6	16	104	414	B		
	SB	21.0	C	SB Left	12	25	104	666	C		
				SB Through	1837	23	104	666	C		
				SB Right	160	1	74	661	A		
	EB	38.3	D	EB Left	160	64	45	180	E		
				EB Through	22	54	45	180	D		
				EB Right	197	16	45	180	B		
	WB	4.8	A	WB Left	1	14	0	19	B		
				WB Through	8	6	0	19	A		
				WB Right	4	-1	0	0	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	31.2	C	NB Left	212	31	26	165	C	14.0	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	13.5	B	EB Left	0	0	0	0	A		
				EB Through	1585	13	52	439	B		
				EB Right	0	0	0	0	A		
	WB	10.1	B	WB Left	0	0	0	0	A		
				WB Through	736	10	21	176	B		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	6.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.0	A	EB Left	0	0	0	0	A		
				EB Through	1691	5	20	274	A		
				EB Right	0	0	0	0	A		
	WB	8.6	A	WB Left	210	37	30	188	D		
				WB Through	733	1	19	167	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	12.4	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	33.1	C	SB Left	334	49	58	237	D		
				SB Through	0	0	0	0	A		
				SB Right	173	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	2.5	A	WB Left	0	0	0	0	A		
				WB Through	732	3	4	112	A		
				WB Right	323	2	0	103	A		
50- MD 190 at Burdette Rd											
50	NB	76.6	E	NB Left	19	69	12	111	E	11.8	B
				NB Through	3	74	12	111	E		
				NB Right	8	95	12	111	F		
	SB	33.2	C	SB Left	41	84	27	151	F		
				SB Through	13	84	27	151	F		
				SB Right	113	9	27	151	A		
	EB	9.6	A	EB Left	47	98	53	454	F		
				EB Through	1709	7	52	453	A		
				EB Right	15	5	42	477	A		
	WB	10.7	B	WB Left	0	87	45	661	F		
				WB Through	1437	11	46	662	B		
				WB Right	18	3	41	702	A		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51	NB			NB Left	0	0	0	0	A	37.1	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	81.7	F	EB Left	493	82	233	519	F		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	14.6	B	WB Left	0	0	0	0	A		
				WB Through	975	15	62	601	B		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52	NB	78.7	E	NB Left	251	79	996	2228	E	14.3	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.9	A	EB Left	0	0	0	0	A		
				EB Through	864	3	6	140	A		
				EB Right	0	0	0	0	A		
	WB	4.8	A	WB Left	0	0	0	0	A		
				WB Through	675	5	6	147	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53	NB	66.4	E	NB Left	17	67	16	123	E	43.0	D
				NB Through	44	66	19	123	E		
				NB Right	0	0	0	0	A		
	SB	67.6	E	SB Left	581	67	199	696	E		
				SB Through	145	68	199	696	E		
				SB Right	13	73	198	696	E		
	EB	29.4	C	EB Left	18	25	93	480	C		
				EB Through	781	29	93	480	C		
				EB Right	32	30	93	480	C		
	WB	34.1	C	WB Left	121	113	109	329	F		
				WB Through	642	27	112	331	C		
				WB Right	159	1	2	57	A		
54- MD 124 at I-270 NB off ramp											
54	NB	84.3	F	NB Left	0	0	0	0	A	95.4	F
				NB Through	0	0	0	0	A		
				NB Right	920	84	345	963	F		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	107.9	F	EB Left	0	0	0	0	A		
				EB Through	813	108	473	1086	F		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55	NB	37.9	D	NB Left	0	0	0	0	A	16.9	B
				NB Through	0	0	0	0	A		
				NB Right	926	38	117	601	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	4.6	A	EB Left	0	0	0	0	A		
				EB Through	1586	5	18	88	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.15: AM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	18.8	B	NB Left	102	75	60	368	E	33.2	C
				NB Through	312	24	60	368	C		
				NB Right	580	6	4	229	A		
	SB	42.1	D	SB Left	110	59	120	520	E		
				SB Through	535	41	120	520	D		
				SB Right	52	20	120	520	B		
	EB	43.7	D	EB Left	81	69	42	155	E		
				EB Through	48	78	42	155	E		
				EB Right	102	7	42	155	A		
	WB	51.1	D	WB Left	206	72	74	301	E		
				WB Through	12	69	74	301	E		
				WB Right	100	6	74	301	A		
2- MD 85 at I-270 NB on and off ramp											
2	NB	39.8	D	NB Left	556	40	142	723	D	27.2	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	14.4	B	SB Left	0	0	0	0	A		
				SB Through	547	14	37	476	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	4.4	A	NB Left	0	0	0	0	A	10.2	B
				NB Through	814	4	11	293	A		
				NB Right	0	0	0	0	A		
	SB	40.9	D	SB Left	156	41	37	267	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	15.7	C	NB Left	10	57	34	268	E	19.3	B
				NB Through	585	15	34	268	B		
				NB U-Turn	0	0	0	0	A		
	SB	13.0	B	SB Left	57	66	22	136	E		
				SB Through	1656	13	52	438	B		
				SB Right	752	8	41	428	A		
	EB	48.8	D	EB Left	484	51	70	230	D		
				EB Through	19	62	70	230	E		
				EB Right	32	9	70	230	A		
	WB	42.9	D	WB Left	37	56	16	111	E		
				WB Through	15	59	16	111	E		
				WB Right	19	6	16	111	A		
5- MD 80 at I-270 NB on and ramp											
5	NB	-0.9	A	NB Left	4	0	0	4	A	6.8	A
				NB Through	2	0	0	4	A		
				NB Right	4	-2	0	4	A		
	SB	12.1	B	SB Left	183	15	11	101	B		
				SB Through	5	17	11	101	B		
				SB Right	52	2	0	0	A		
	EB	8.4	A	EB Left	38	9	7	140	A		
				EB Through	0	0	8	0	A		
				EB Right	7	4	14	170	A		
	WB	5.7	A	WB Left	31	8	0	59	A		
				WB Through	683	9	26	307	A		
				WB Right	503	1	0	0	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	2.1	A	NB Left	21	3	0	90	A	5.8	A
				NB Through	0	0	0	0	A		
				NB Right	250	2	0	90	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	8.0	A	EB Left	0	0	0	0	A		
				EB Through	242	8	6	118	A		
				EB Right	133	7	6	126	A		
	WB	7.0	A	WB Left	0	0	0	0	A		
				WB Through	194	7	2	150	A		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	2.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	8.1	A	SB Left	119	10	7	139	B		
				SB Through	0	0	0	0	A		
				SB Right	38	1	0	60	A		
	EB	3.3	A	EB Left	59	3	0	35	A		
				EB Through	0	0	0	0	A		
				EB Right	40	3	0	0	A		
	WB	0.3	A	WB Left	0	0	0	0	A		
				WB Through	462	0	0	6	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	2.4	A	NB Left	14	11	1	73	B	2.0	A
				NB Through	0	0	0	0	A		
				NB Right	42	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.7	A	EB Left	0	0	0	0	A		
				EB Through	59	0	0	30	A		
				EB Right	70	5	0	30	A		
	WB	1.7	A	WB Left	393	1	0	102	A		
				WB Through	109	3	0	79	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	8.2	A	NB Left	95	11	13	126	B	23.1	C
				NB Through	279	12	13	126	B		
				NB Right	198	2	17	152	A		
	SB	15.0	C	SB Left	47	11	27	310	B		
				SB Through	578	15	37	310	B		
				SB Right	6	14	40	331	B		
	EB	42.5	E	EB Left	7	42	117	460	D		
				EB Through	88	51	123	460	D		
				EB Right	546	41	147	492	D		
	WB	32.7	D	WB Left	96	38	20	132	D		
				WB Through	12	34	21	132	C		
				WB Right	21	6	16	151	A		
10- MD 121 at I-270 NB on and off ramp											
10	NB	1.6	A	NB Left	39	10	2	78	A	0.7	A
				NB Through	0	0	0	0	A		
				NB Right	253	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	319	0	0	0	A		
				EB Right	49	0	0	0	A		
	WB	0.7	A	WB Left	151	2	1	69	A		
				WB Through	1070	0	0	39	A		
				WB Right	0	0	0	0	A		

Table A.15: AM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	1.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	8.2	A	SB Left	124	11	7	131	B		
				SB Through	0	0	0	0	A		
				SB Right	46	1	0	0	A		
	EB	0.4	A	EB Left	25	2	0	32	A		
				EB Through	0	0	0	0	A		
				EB Right	836	0	0	0	A		
	WB	0.1	A	WB Left	0	0	0	0	A		
				WB Through	276	0	0	0	A		
				WB Right	0	0	0	0	A		
12- MD 27 at Observation Dr											
12	NB	48.0	D	NB U-Turn	0	0	0	0	A	20.3	C
				NB Through	34	63	10	64	E		
				NB Right	12	7	10	64	A		
	SB	40.9	D	SB Left	75	52	23	142	D		
				SB Through	43	60	30	226	E		
				SB Right	157	30	52	263	C		
	EB	13.2	B	EB Left	155	31	31	284	C		
				EB Through	1238	11	32	285	B		
				EB Right	50	9	40	323	A		
	WB	21.7	C	WB Left	83	16	148	798	B		
				WB Through	2047	22	148	798	C		
				WB Right	94	10	148	798	B		
13- MD 27 at I-270 NB off ramp											
13	NB	30.6	C	NB Left	89	31	13	101	C	7.9	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	935	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	10.4	B	WB Left	0	0	0	0	A		
				WB Through	2105	10	164	1222	B		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	17.2	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	46.4	D	SB Left	420	46	67	273	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	10.0	A	EB Left	0	0	0	0	A		
				EB Through	656	10	14	193	A		
				EB Right	0	0	0	0	A		
	WB	11.2	B	WB Left	0	0	0	0	A		
				WB Through	1255	11	46	546	B		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	18.1	B	NB Left	22	19	32	406	B	38.7	D
				NB Through	819	18	58	409	B		
				NB Right	72	17	61	421	B		
	SB	46.7	D	SB Left	422	67	328	1448	E		
				SB Through	1375	41	328	1448	D		
				SB Right	42	23	293	1441	C		
	EB	44.4	D	EB Left	177	49	47	169	D		
				EB Through	73	50	43	164	D		
				EB Right	60	26	43	196	C		
	WB	56.0	E	WB Left	8	63	85	273	E		
				WB Through	21	302	85	273	F		
				WB Right	104	6	85	273	A		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	3.3	A	NB Left	123	10	1	72	A	5.3	A
				NB Through	749	3	4	131	A		
				NB Right	82	1	8	184	A		
	SB	3.6	A	SB Left	25	5	4	159	A		
				SB Through	808	4	8	159	A		
				SB Right	32	2	9	187	A		
	EB	16.6	B	EB Left	15	62	8	69	E		
				EB Through	6	59	8	69	E		
				EB Right	96	7	8	69	A		
	WB	43.1	D	WB Left	30	63	12	94	E		
				WB Through	5	68	8	93	E		
				WB Right	21	9	11	113	A		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	10.8	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	31.9	C	EB Left	222	32	42	278	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.7	A	WB Left	0	0	0	0	A		
				WB Through	155	1	0	4	A		
				WB Right	778	7	15	270	A		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	8.0	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	35.4	D	SB Left	217	35.4	33	159	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	4.0	A	EB Left	0	0.0	0	0	A		
				EB Through	615	4.0	5	158	A		
				EB Right	0	0.0	0	0	A		
	WB	4.6	A	WB Left	0	0.0	0	0	A		
				WB Through	1036	4.6	10	193	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	45.1	D	NB Left	7	70	8	75	E	18.0	B
				NB Through	12	80	8	75	F		
				NB Right	14	2	0	22	A		
	SB	60.7	E	SB Left	241	58	98	368	E		
				SB Through	41	66	98	368	E		
				SB Right	81	67	98	368	E		
	EB	10.4	B	EB Left	102	13	28	310	B		
				EB Through	932	10	28	310	B		
				EB Right	27	9	28	310	A		
	WB	11.6	B	WB Left	73	19	32	301	B		
				WB Through	925	14	32	301	B		
				WB Right	280	2	32	301	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	16.3	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	18.8	B	SB Left	22	35	4	43	D		
				SB Through	0	0	0	0	A		
				SB Right	25	5	4	43	A		
	EB	14.7	B	EB Left	240	22	33	247	C		
				EB Through	865	13	33	247	B		
				EB Right	0	0	0	0	A		
	WB	17.7	B	WB Left	0	0	0	0	A		
				WB Through	1070	19	68	393	B		
				WB Right	214	13	92	443	B		

Table A.15: AM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21	NB			NB Left	0	0	0	0	A	16.0	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	11.2	B	EB Left	0	0	0	0	A		
				EB Through	804	11	26	186	B		
				EB Right	0	0	0	0	A		
	WB	21.1	C	WB Left	743	21	65	871	C		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22	NB	63.0	E	NB Left	147	52	145	449	D	25.0	C
				NB Through	6	52	145	449	D		
				NB Right	342	68	145	449	E		
	SB	21.7	C	SB Left	3	37	1	29	D		
				SB Through	0	0	1	29	A		
				SB Right	3	6	2	67	A		
	EB	17.7	B	EB Left	28	11	119	838	B		
				EB Through	1489	18	119	838	B		
				EB Right	76	10	119	838	A		
	WB	15.9	B	WB Left	78	19	27	207	B		
				WB Through	681	16	27	207	B		
				WB Right	35	4	27	207	A		
23- MD 124 at MD 355											
23	NB	51.0	D	NB Left	230	70	73	203	E	84.8	F
				NB Through	306	43	70	201	D		
				NB Right	37	2	0	0	A		
	SB	33.3	C	SB Left	49	86	121	412	F		
				SB Through	965	50	121	412	D		
				SB Right	619	3	28	349	A		
	EB	103.3	F	EB Left	603	268	1075	1216	F		
				EB Through	530	24	1075	1216	C		
				EB Right	584	5	1041	1198	A		
	WB	121.8	F	WB Left	0	0	0	0	A		
				WB Through	1892	123	725	1113	F		
				WB Right	43	74	0	0	E		
24- MD 124 at I-270 SB on and off											
24	NB	65.0	F	NB Left	15	66	15	78	E	22.0	C
				NB Through	29	64	15	78	E		
				NB U-Turn	0	0	0	0	A		
	SB	28.3	C	SB Left	334	72	100	396	E		
				SB Through	4	86	100	396	F		
				SB Right	637	5	14	335	A		
	EB	16.7	B	EB Left	0	0	0	0	A		
				EB Through	900	17	43	334	B		
				EB Right	67	13	53	357	B		
	WB	19.8	B	WB Left	33	25	82	710	C		
				WB Through	1209	20	82	710	B		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25	NB	60.1	E	NB Left	16	74	159	692	E	46.9	D
				NB Through	421	71	159	692	E		
				NB Right	408	48	142	733	D		
	SB	37.9	D	SB Left	182	50	125	586	D		
				SB Through	841	39	125	586	D		
				SB Right	95	3	0	0	A		
	EB	47.5	D	EB Left	80	106	168	645	F		
				EB Through	1387	44	168	647	D		
				EB Right	66	42	179	674	D		
	WB	44.6	D	WB Left	317	77	114	370	E		
				WB Through	477	32	114	370	C		
				WB Right	95	0	0	0	A		
26- MD 117 at Bureau Dr											
26	NB	51.2	D	NB Left	18	66	15	101	E	48.0	D
				NB Through	17	77	15	101	E		
				NB Right	25	23	15	101	C		
	SB	61.5	E	SB Left	193	68	74	281	E		
				SB Through	43	65	74	281	E		
				SB Right	28	14	74	281	B		
	EB	56.1	E	EB Left	28	39	390	952	D		
				EB Through	1932	56	395	952	E		
				EB Right	19	66	387	942	E		
	WB	34.6	C	WB Left	302	97	214	791	F		
				WB Through	849	21	215	792	C		
				WB Right	315	10	193	840	B		
27- MD 117 at I-270 SB off ramp											
27	NB			NB Left	0	0	0	0	A	8.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.9	A	EB Left	0	0	0	0	A		
				EB Through	797	2	1	208	A		
				EB Right	0	0	0	0	A		
	WB	24.9	C	WB Left	311	25	52	481	C		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28	NB			NB Left	0	0	0	0	A	32.8	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	54.5	D	SB Left	304	57	282	1056	E		
				SB Through	0	0	0	0	A		
				SB Right	913	54	287	1058	D		
	EB	19.6	B	EB Left	10	116	81	936	F		
				EB Through	783	18	81	936	B		
				EB Right	0	0	0	0	A		
	WB	14.4	B	WB Left	0	0	0	0	A		
				WB Through	859	15	51	338	B		
				WB Right	9	5	55	368	A		
29- MD 117 at Perry Pkwy											
29	NB	43.2	D	NB Left	35	69	14	98	E	13.6	B
				NB Through	6	61	14	97	E		
				NB Right	31	11	24	118	B		
	SB	32.7	C	SB Left	90	71	36	161	E		
				SB Through	13	65	36	161	E		
				SB Right	124	2	36	161	A		
	EB	10.6	B	EB Left	119	71	44	251	E		
				EB Through	954	3	44	251	A		
				EB Right	9	2	31	235	A		
	WB	9.6	A	WB Left	5	92	19	248	F		
				WB Through	709	10	19	248	A		
				WB Right	104	5	19	248	A		
30- Shady Grove Rd at I-270 NB off ramp											
30	NB	8.2	A	NB Left	0	0	0	0	A	24.1	C
				NB Through	970	8	20	207	A		
				NB Right	0	0	0	0	A		
	SB	10.1	B	SB Left	0	0	0	0	A		
				SB Through	1284	10	31	344	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	56.9	E	WB Left	1018	57	202	693	E		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.15: AM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB	18.3	B	NB Through	920	18	51	355	B		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	15.0	B	SB Through	1701	15	63	646	B		
				SB Right	0	0	0	0	A		
31				EB Left	366	35	46	286	C	23.6	C
	EB	40.7	D	EB Through	0	0	0	0	A		
				EB Right	764	44	113	509	D		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
				NB U-Turn	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	522	43	83	328	D		
	SB	35.4	D	SB Through	0	0	0	0	A		
				SB Right	121	3	1	73	A		
32				EB Left	0	0	0	0	A	10.1	B
	EB	3.5	A	EB Through	1421	1	0	0	A		
				EB Right	892	8	21	252	A		
				WB Left	0	0	0	0	A		
	WB	9.6	A	WB Through	1883	10	35	479	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
				NB Left	0	0	52	294	A		
	NB	36.0	D	NB Through	213	51	63	303	D		
				NB Right	139	13	63	303	B		
				SB Left	25	56	19	172	E		
	SB	21.0	C	SB Through	0	0	0	0	A		
				SB Right	259	18	19	172	B		
33				EB Left	283	34	69	377	C	17.9	B
	EB	16.7	B	EB Through	1040	12	69	377	B		
				EB Right	0	0	0	0	A		
				WB Left	22	11	39	289	B		
	WB	11.8	B	WB Through	888	12	27	252	B		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
				NB Left	62	45	16	111	D		
	NB	40.7	D	NB Through	6	39	13	110	D		
				NB Right	8	8	15	121	A		
				SB Left	66	46	24	162	D		
	SB	6.2	A	SB Through	7	41	24	162	D		
				SB Right	601	1	3	50	A		
34				EB Left	333	17	17	206	B	11.2	B
	EB	11.4	B	EB Through	944	9	20	235	A		
				EB Right	14	7	28	272	A		
				WB Left	3	26	19	191	C		
	WB	14.0	B	WB Through	316	14	19	191	B		
				WB Right	10	8	30	225	A		
35- MD 189 at I-270 Ramps											
				NB Left	134	50	25	128	D		
	NB	49.6	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	211	48	63	338	D		
	SB	48.2	D	SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
35				EB Left	385	22	89	467	C	44.5	D
	EB	24.9	C	EB Through	529	27	89	467	C		
				EB Right	0	0	0	0	A		
				WB Left	536	55	158	571	D		
	WB	64.5	E	WB Through	283	83	158	571	F		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
				NB Left	130	51	51	176	D		
	NB	42.4	D	NB Through	101	78	51	176	E		
				NB Right	151	12	51	176	B		
				SB Left	387	113	319	747	F		
	SB	98.7	F	SB Through	520	88	255	734	F		
				SB Right	0	0	0	0	A		
36				EB Left	131	72	198	733	E	58.6	E
	EB	46.3	D	EB Through	964	45	198	733	D		
				EB Right	95	20	198	733	B		
				WB Left	458	62	117	413	E		
	WB	42.2	D	WB Through	424	26	117	413	C		
				WB Right	65	6	117	413	A		
37- Montrose Rd at Tower Oaks Blvd											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	126	47	529	1050	D		
	SB	149.7	F	SB Through	0	0	0	0	A		
				SB Right	528	174	580	1097	F		
37				EB Left	27	16	25	319	B	33.5	C
	EB	7.5	A	EB Through	1481	7	25	319	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	9.2	A	WB Through	1443	9	26	312	A		
				WB Right	62	4	26	312	A		
38- Tower Oaks Blvd at I-270 off rmap											
				NB Left	474	17	25	167	B		
	NB	16.0	B	NB Through	12	14.3	19	159	B		
				NB Right	26	6.0	25	167	A		
				SB Left	2	2.7	0	17	A		
	SB	1.6	A	SB Through	0	0.0	0	17	A		
				SB Right	2	0.5	0	0	A		
38				EB Left	7	12.2	47	296	B	17.1	B
	EB	18.8	B	EB Through	622	19.4	47	296	B		
				EB Right	92	15.1	41	286	B		
				WB Left	0	0.0	4	81	A		
	WB	10.9	B	WB Through	83	11.3	4	81	B		
				WB Right	6	4.4	0	22	A		
39- Montrose Rd at Tower Oaks Blvd											
				NB Left	26	43	21	129	D		
	NB	9.5	A	NB Through	188	30	21	129	C		
				NB Right	507	0	0	0	A		
				SB Left	297	69	124	478	E		
	SB	38.0	D	SB Through	605	25	123	477	C		
				SB Right	64	16	128	492	B		
39				EB Left	56	123	560	729	F	61.9	E
	EB	146.5	F	EB Through	801	148	561	729	F		
				EB Right	45	148	585	753	F		
				WB Left	369	50	81	291	D		
	WB	40.8	D	WB Through	236	45	81	291	D		
				WB Right	135	7	95	322	A		
40- Rockledge Blvd at I-270 NB on and off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	85	33	30	136	C		
				NB Right	194	34	30	136	C		
				SB Left	0	0	6	76	A		
	SB	2.4	A	SB Through	982	2	6	76	A		
				SB Right	0	0	0	0	A		
40				EB Left	6	49	205	784	D	22.3	C
	EB	35.7	D	EB Through	576	69	205	784	E		
				EB Right	637	6	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.15: AM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	2.3	A	NB Left	90	2	1	25	A	21.0	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	22.2	C	WB Left	984	23	97	592	C		
				WB Through	447	21	97	592	C		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	301.5	F	NB Left	182	171	1144	1576	F	196.6	F
				NB Through	1118	253	1144	1576	F		
				NB Right	142	851	1144	1576	F		
	SB	172.0	F	SB Left	60	149	2545	2702	F		
				SB Through	1512	171	2545	2702	F		
				SB Right	177	190	2545	2702	F		
	EB	63.3	E	EB Left	185	47	195	881	D		
				EB Through	547	71	196	882	E		
				EB Right	135	56	216	906	E		
	WB	202.9	F	WB Left	707	241	1967	2137	F		
				WB Through	347	165	1967	2137	F		
				WB Right	134	101	1967	2137	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	63.8	E	NB Left	144	88	219	389	F	43.7	D
				NB Through	1205	61	219	389	E		
				NB Right	0	0	0	0	A		
	SB	25.6	C	SB Left	0	0	0	0	A		
				SB Through	1730	26	95	646	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	75.9	E	WB Left	119	76	108	510	E		
				WB Through	10	76	108	510	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	128.7	F	NB Left	0	0	0	0	A	76.1	E
				NB Through	1172	129	377	892	F		
				NB Right	0	0	0	0	A		
	SB	7.0	A	SB Left	193	52	60	274	D		
				SB Through	1654	2	60	274	A		
				SB Right	0	0	0	0	A		
	EB	183.7	F	EB Left	209	102	806	1375	F		
				EB Through	0	0	806	1375	A		
				EB Right	404	226	825	1363	F		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	25.4	C	NB Left	189	64	113	503	E	25.0	C
				NB Through	1176	19	114	504	B		
				NB Right	6	10	133	537	B		
	SB	22.1	C	SB Left	13	32	112	710	C		
				SB Through	1873	24	112	710	C		
				SB Right	163	1	76	696	A		
	EB	39.6	D	EB Left	158	67	46	182	E		
				EB Through	22	55	46	182	D		
				EB Right	197	16	46	182	B		
	WB	4.8	A	WB Left	1	15	0	19	B		
				WB Through	8	6	0	19	A		
				WB Right	4	-1	0	0	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	30.1	C	NB Left	211	30	25	154	C	13.9	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	13.5	B	EB Left	0	0	0	0	A		
				EB Through	1648	14	55	462	B		
				EB Right	0	0	0	0	A		
	WB	10.0	B	WB Left	0	0	0	0	A		
				WB Through	736	10	21	170	B		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	6.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.4	A	EB Left	0	0	0	0	A		
				EB Through	1754	5	22	265	A		
				EB Right	0	0	0	0	A		
	WB	8.7	A	WB Left	211	37	30	188	D		
				WB Through	733	1	19	167	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	13.5	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	31.5	C	SB Left	398	47	65	267	D		
				SB Through	0	0	0	0	A		
				SB Right	209	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	3.1	A	WB Left	0	0	0	0	A		
				WB Through	732	4	5	136	A		
				WB Right	323	2	1	139	A		
50- MD 190 at Burdette Rd											
50	NB	76.6	E	NB Left	19	69	12	111	E	11.8	B
				NB Through	3	74	12	111	E		
				NB Right	8	95	12	111	F		
	SB	33.5	C	SB Left	41	84	28	151	F		
				SB Through	13	84	28	151	F		
				SB Right	113	9	28	151	A		
	EB	9.6	A	EB Left	51	94	55	508	F		
				EB Through	1776	7	54	507	A		
				EB Right	15	3	44	531	A		
	WB	10.8	B	WB Left	0	87	46	652	F		
				WB Through	1436	11	47	652	B		
				WB Right	18	3	41	692	A		

Table A.14: AM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51				NB Left	0	0	0	0	A	37.6	D
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	492	83	237	529	F		
	EB	83.0	F	EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	14.7	B	WB Through	976	15	63	645	B		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52				NB Left	270	86	2150	4507	F	16.1	B
	NB	85.8	F	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	3.0	A	EB Through	864	3	6	135	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	4.9	A	WB Through	675	5	7	164	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53				NB Left	17	67	16	123	E	43.6	D
	NB	66.4	E	NB Through	44	66	19	123	E		
				NB Right	0	0	0	0	A		
				SB Left	581	67	198	697	E		
	SB	67.4	E	SB Through	145	68	199	698	E		
				SB Right	13	73	198	698	E		
				EB Left	18	25	93	480	C		
	EB	29.4	C	EB Through	781	29	93	480	C		
				EB Right	32	30	93	480	C		
				WB Left	121	125	122	348	F		
	WB	36.0	D	WB Through	656	28	125	351	C		
				WB Right	158	1	0	5	A		
54- MD 124 at I-270 NB off ramp											
54				NB Left	0	0	0	0	A	113.8	F
	NB	99.8	F	NB Through	0	0	0	0	A		
				NB Right	904	100	423	1167	F		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	129.2	F	EB Through	822	129	635	1122	F		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55				NB Left	0	0	0	0	A	16.5	B
	NB	37.4	D	NB Through	0	0	0	0	A		
				NB Right	929	37	114	482	D		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	4.8	A	EB Through	1648	5	19	87	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table A.16: AM Peak - Existing - I-270 Vehicle Network Performance

	Existing	Alternative	% Change
Total Delay	21,906,753	10,684,836	-51%
Average Delay per Vehicle	227	112	-51%
Total Travel Time	51,252,838	41,381,431	-19%
Vehicles (Arrived)	81,275	83,772	3%
Latent Demand	4,969	4,230	-15%
Latent Delay	13,122,672	11,962,294	-9%
Total Distance	467,210	487,185	4%
Average Speed	33	42	29%

PM Peak

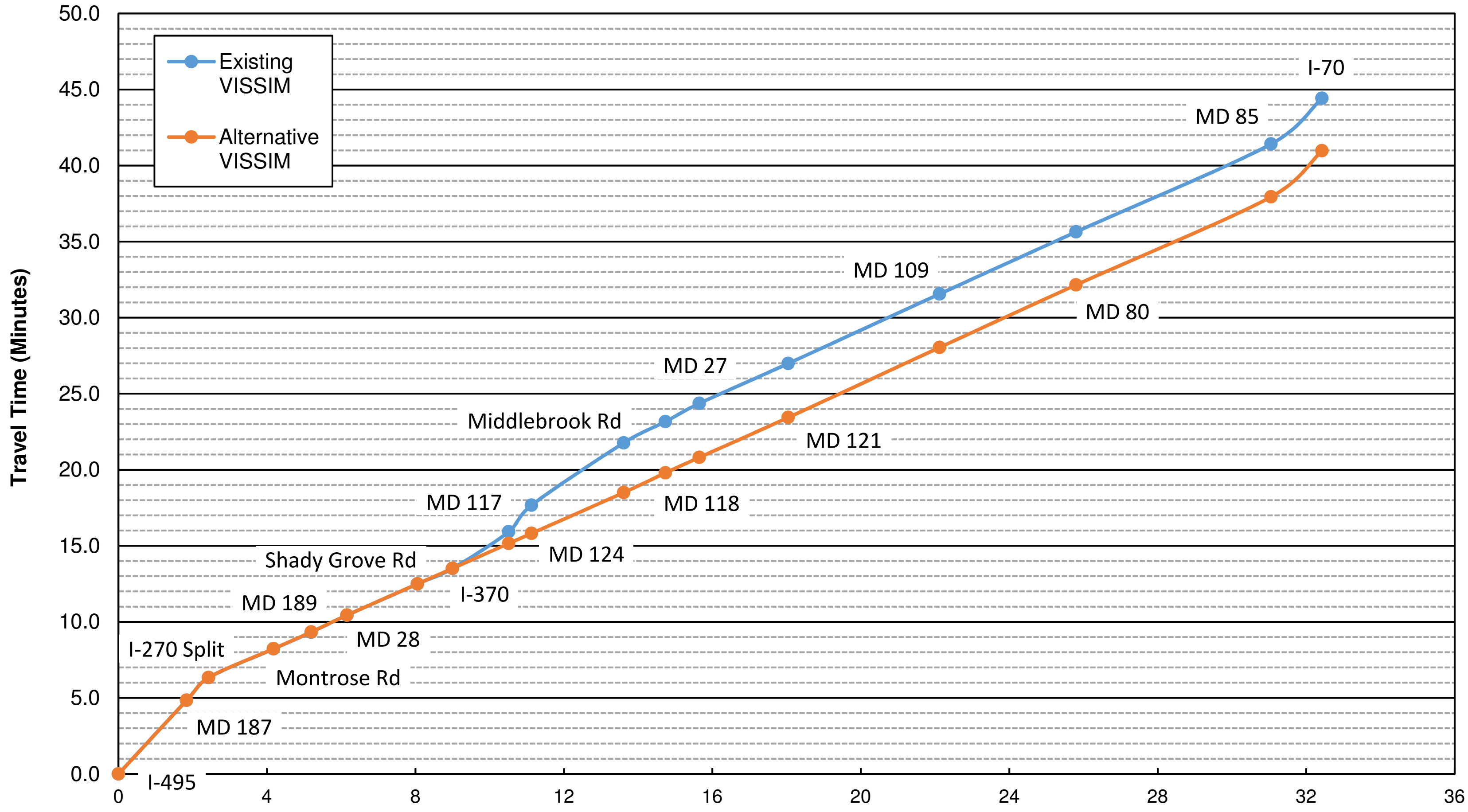
Table B.1: PM Peak - Existing - I-270 Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From I-495 interchange					From I-70				
to MD 187	1.8	290.1	290.5	0%	to MD 85	1.7	92.4	92.4	0%
to I-270 Split	0.6	89.3	89.5	0%	to MD 80	5.4	301.4	301.2	0%
to Montrose Rd	1.8	113.6	113.8	0%	to MD 109	3.7	207.9	208.0	0%
to MD 189	1.0	66.0	66.2	0%	to MD 121	3.6	201.4	201.5	0%
to MD 28	1.0	67.1	66.5	-1%	to MD 27	2.5	133.7	133.8	0%
to Shady Grove Rd	1.9	123.3	123.3	0%	to MD 118	1.1	57.6	57.6	0%
to I-370	0.9	61.3	60.9	-1%	to Middlebrook Rd	1.1	60.4	60.6	0%
to MD 117	1.5	145.0	98.6	-32%	to MD 124	2.2	120.9	119.6	-1%
to MD 124	0.6	104.3	39.5	-62%	to MD 117	0.9	66.4	48.6	-27%
to Middlebrook Rd	2.5	246.0	161.5	-34%	to I-370	1.0	55.8	53.6	-4%
to MD 118	1.1	83.6	77.5	-7%	to Shady Grove Rd	1.5	79.7	79.8	0%
to MD 27	0.9	72.2	61.1	-15%	to MD 28	1.9	109.5	109.4	0%
to MD 121	2.4	157.6	157.5	0%	to MD 189	1.0	60.1	60.1	0%
to MD 109	4.1	274.2	276.3	1%	to Montrose Rd	1.0	62.9	62.9	0%
to MD 80	3.7	244.9	246.7	1%	to I-270 Split	1.9	111.5	111.2	0%
to MD 85	5.3	346.9	347.4	0%	to MD 187	0.4	22.8	22.8	0%
to I-70	1.4	180.2	181.5	1%	to I-495 interchange	1.9	154.8	154.8	0%
I-270 Total (miles/minutes)	**32.4**	**44.4**	**41.0**	**-8%**	**I-270 Total (miles/minutes)**	**32.6**	**31.7**	**31.3**	**-1%**
I-270 Spur Northbound					**I-270 Spur Southbound**				
From Cabin John Pkwy					From I-70				
to MD 190	0.5	105.6	108.4	3%	to I-270 Split	30.3	1,721.6	1,700.2	-1%
to I-495	1.1	259.8	263.3	1%	to Democracy Blvd	0.7	135.0	39.7	-71%
to Democracy Blvd	1.4	222.8	224.6	1%	to I-495	1.3	466.2	115.9	-75%
to I-270 Split	0.9	76.3	76.2	0%	to MD 190	1.3	196.3	203.5	4%
to I-70	30.0	2,286.1	2,078.2	-9%	to Cabin John Pkwy	0.6	158.2	159.0	1%
I-270 Spur Total (miles/minutes)	**34.0**	**49.2**	**45.8**	**-7%**	**I-270 Spur Total (miles/minutes)**	**34.2**	**44.6**	**37.0**	**-17%**

Table B.2: PM Peak - Existing - I-270 Local Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	Existing VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From C-D start					From C-D start				
to Montrose Rd	0.8	59.3	54.8	-8%	to Shady Grove	1.3	81.2	81.4	0%
to MD 189	1.3	159.8	89.9	-44%	to MD 28	1.8	119.8	119.2	-1%
to MD 28	1.0	87.2	73.7	-15%	to MD 189	1.1	77.1	75.5	-2%
to Shady Grove	2.0	388.8	264.6	-32%	to Montrose	1.2	86.4	84.0	-3%
to I-370	1.0	92.6	87.3	-6%	to I-270 mainline	0.9	59.4	59.5	0%
to MD 117	1.2	88.2	100.5	14%					
to MD 124	0.8	232.8	58.9	-75%					
to I-270 mainline	0.4	91.1	26.7	-71%					
I-270 Local Total (miles/minutes)	**8.5**	**20.0**	**12.6**	**-37%**	**I-270 Local Total (miles/minutes)**	**6.3**	**7.1**	**7.0**	**-1%**

Figure B.1: PM Peak - Existing
I-270 Travel Time Graph - Northbound



Miles Along Corridor / *Direction of Traffic Flow* ↑

Figure B.2: PM Peak - Existing
I-270 Travel Time Graph - Southbound

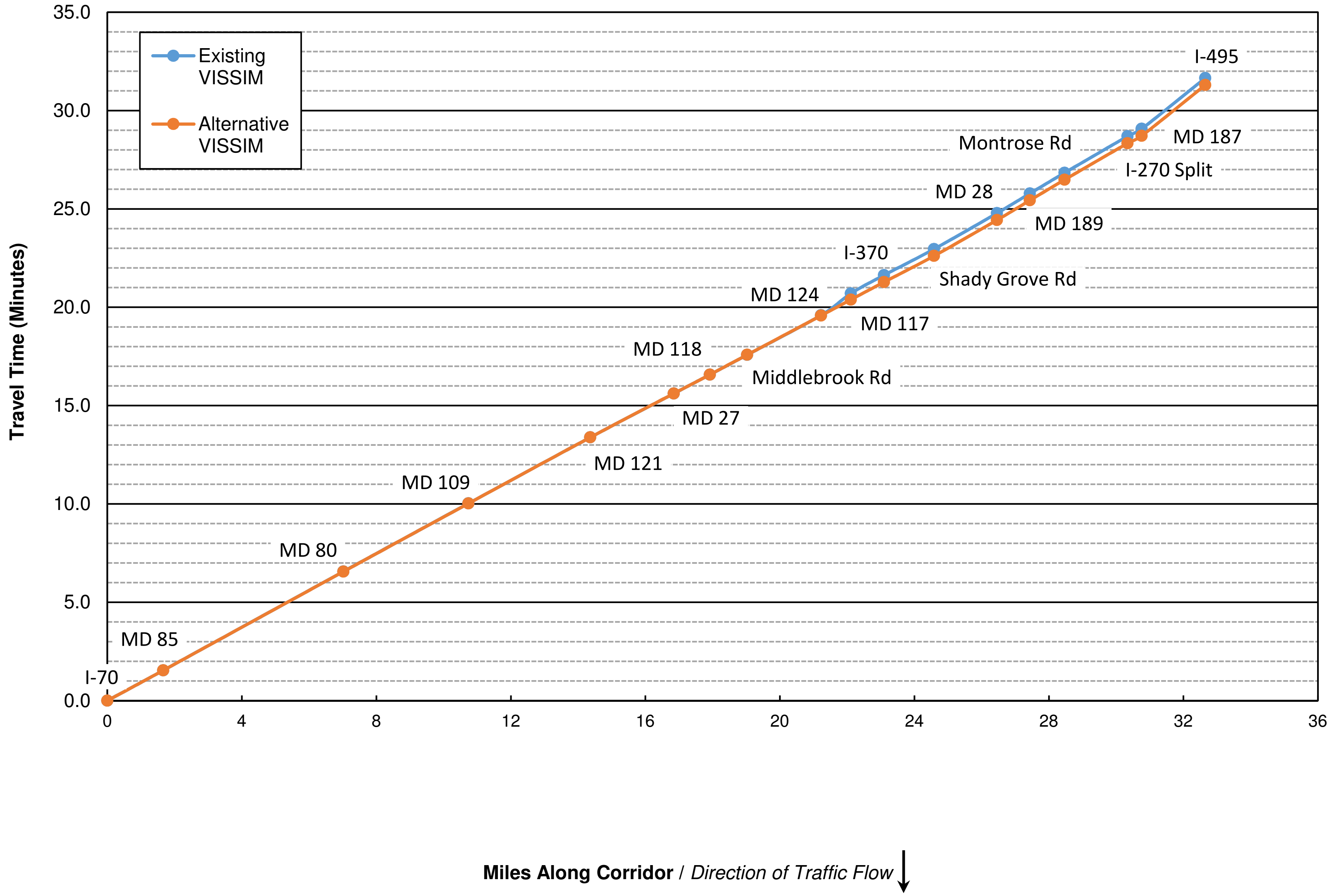


Figure B.3: PM Peak - Existing
I-270 Spur Travel Time Graph - Northbound

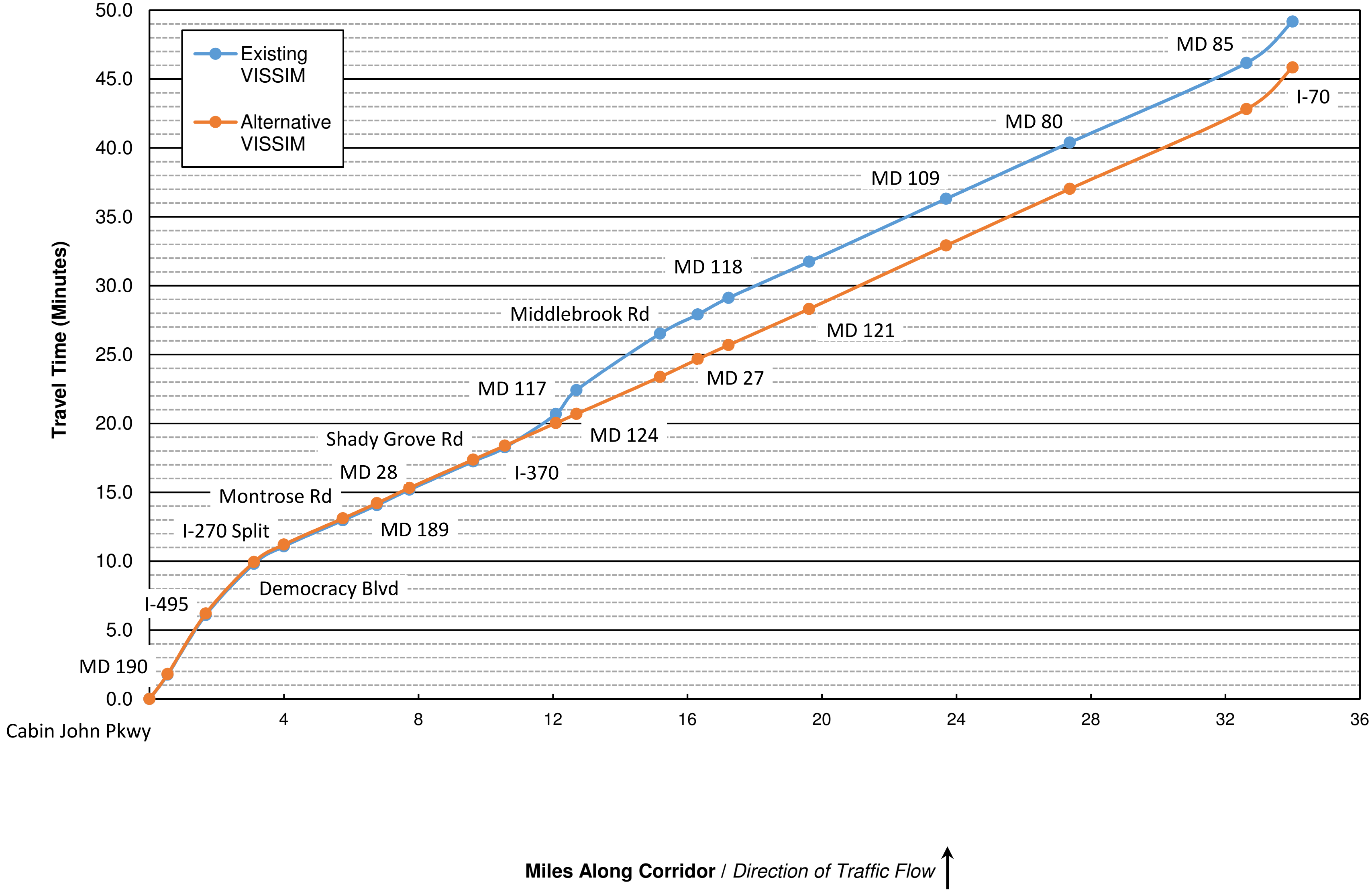


Figure B4: PM Peak - Existing
I-270 Spur Travel Time Graph - Southbound

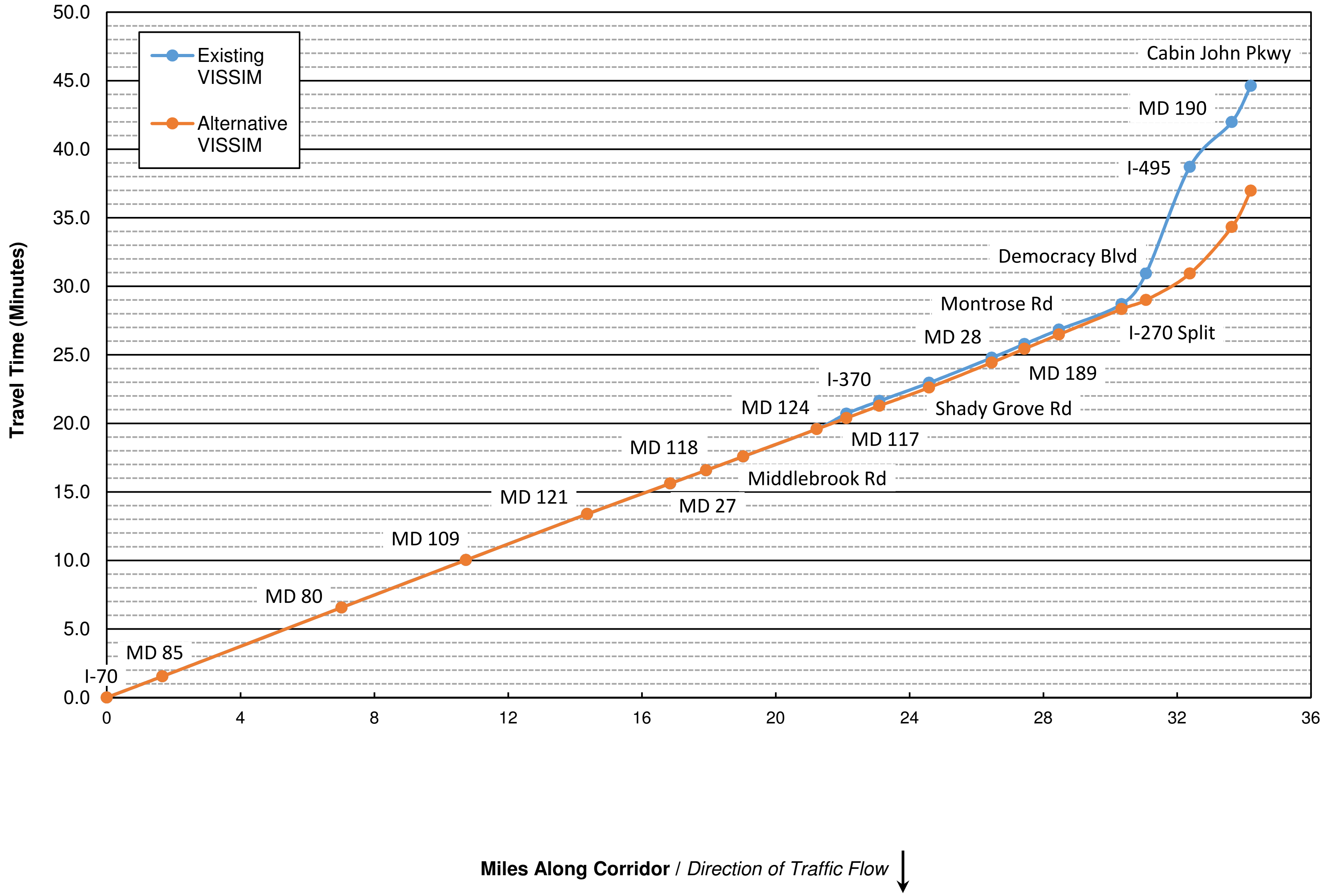
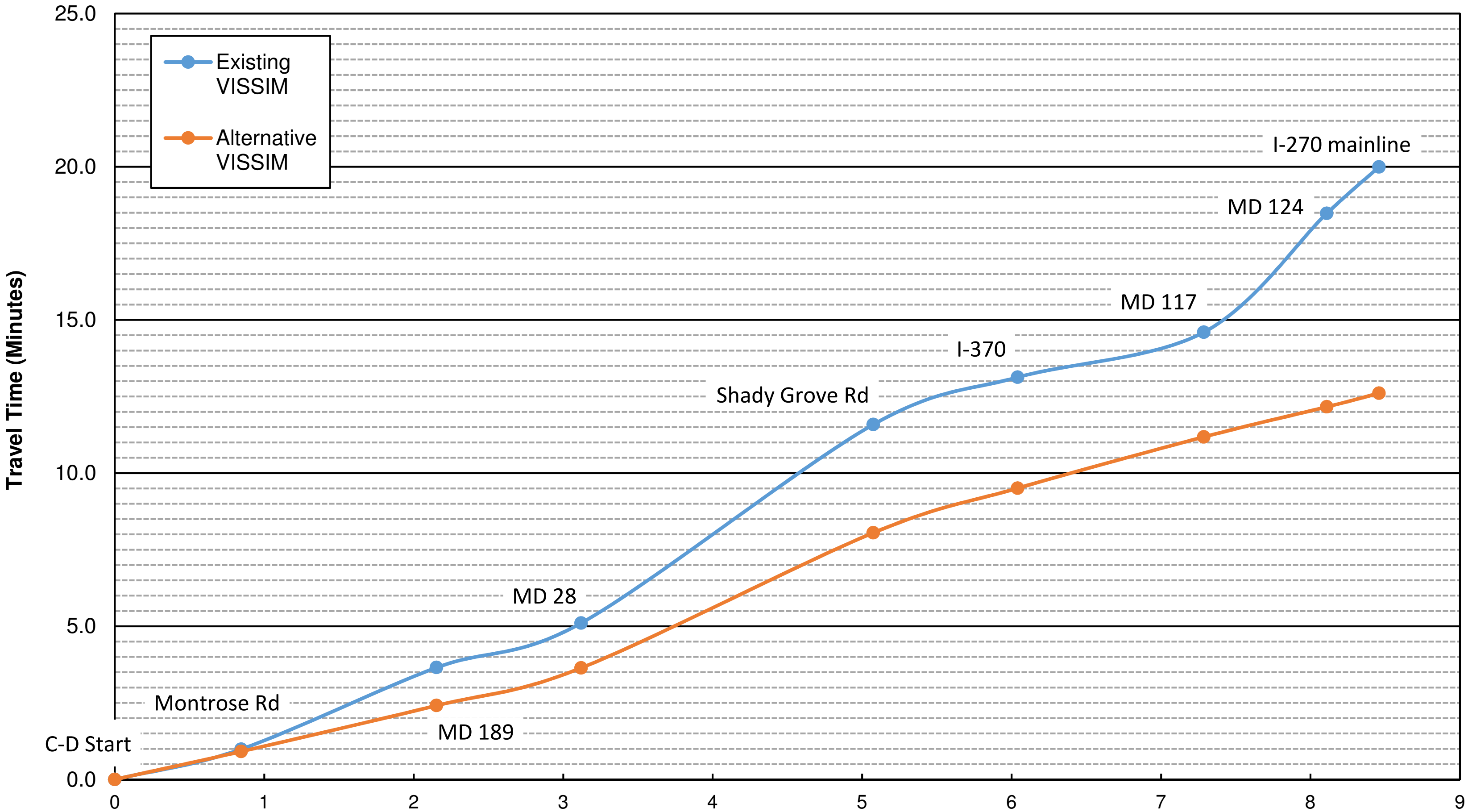
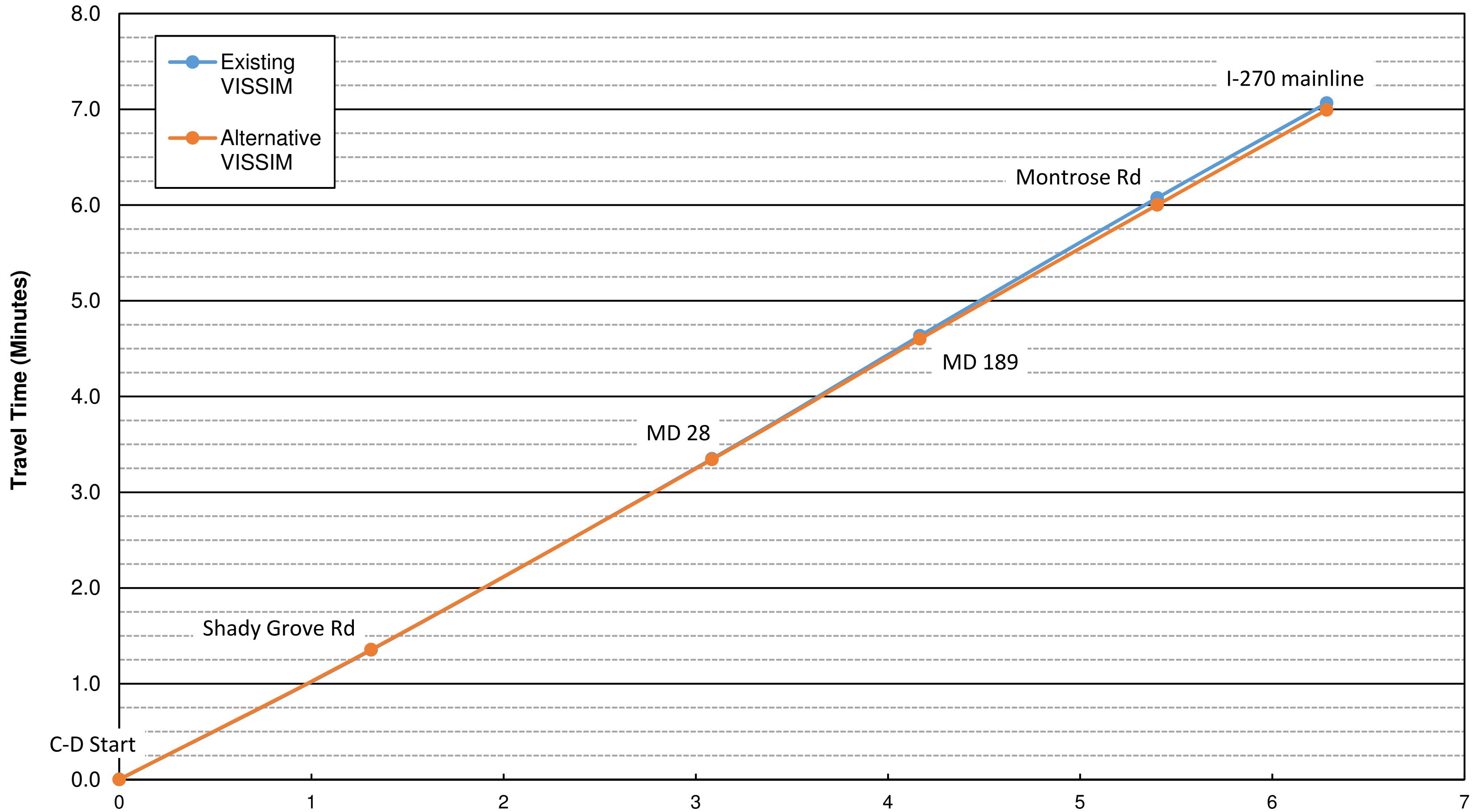


Figure B.5: PM Peak - Existing
I-270 Local Travel Time Graph - Northbound



Miles Along Corridor / *Direction of Traffic Flow* ↑

Figure B.6: PM Peak - Existing
I-270 Local Travel Time Graph - Southbound



Miles Along Corridor / *Direction of Traffic Flow* ↓

Table B.3: PM Peak - Existing - I-270 Vehicle Speed

I-270 Northbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From I-495 interchange				From I-70			
to MD 187	22.8	22.7	0%	to MD 85	64.8	64.8	0%
to I-270 Split	23.8	23.8	0%	to MD 80	64.0	64.0	0%
to Montrose Rd	55.6	55.5	0%	to MD 109	64.4	64.4	0%
to MD 189	55.3	55.1	0%	to MD 121	64.7	64.7	0%
to MD 28	51.8	52.2	1%	to MD 27	66.9	66.9	0%
to Shady Grove Rd	55.4	55.4	0%	to MD 118	67.0	67.0	0%
to I-370	55.5	55.8	1%	to Middlebrook Rd	66.2	66.0	0%
to MD 117	37.6	55.3	47%	to MD 124	65.4	66.1	1%
to MD 124	21.1	55.9	164%	to MD 117	48.1	65.7	37%
to Middlebrook Rd	36.4	55.5	52%	to I-370	63.6	66.1	4%
to MD 118	48.3	52.1	8%	to Shady Grove Rd	67.2	67.1	0%
to MD 27	45.7	53.9	18%	to MD 28	61.6	61.6	0%
to MD 121	54.7	54.7	0%	to MD 189	58.6	58.6	0%
to MD 109	53.5	53.1	-1%	to Montrose Rd	59.1	59.1	0%
to MD 80	54.1	53.7	-1%	to I-270 Split	60.4	60.6	0%
to MD 85	54.5	54.5	0%	to MD 187	66.4	66.3	0%
to I-70	27.4	27.2	-1%	to I-495 interchange	44.0	44.0	0%
I-270 Spur Northbound				**I-270 Spur Southbound**			
From Cabin John Pkwy				From I-70			
to MD 190	18.4	17.9	-3%	to I-270 Split	63.4	64.2	1%
to I-495	15.7	15.5	-1%	to Democracy Blvd	19.5	66.2	240%
to Democracy Blvd	23.2	23.0	-1%	to I-495	10.1	40.7	302%
to I-270 Split	42.1	42.1	0%	to MD 190	23.0	22.2	-4%
to I-70	47.2	52.0	10%	to Cabin John Pkwy	13.0	12.9	-1%

Table B.4: PM Peak - Existing - I-270 Local Vehicle Speed

I-270 Northbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	Existing VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From C-D start				From C-D start			
to Montrose Rd	51.3	55.5	8%	to Shady Grove	58.1	58.0	0%
to MD 189	29.4	52.3	78%	to MD 28	53.3	53.6	1%
to MD 28	40.0	47.3	18%	to MD 189	50.5	51.6	2%
to Shady Grove	18.1	26.6	47%	to Montrose	51.4	52.9	3%
to I-370	37.5	39.8	6%	to I-270 mainline	53.5	53.4	0%
to MD 117	50.9	44.6	-12%				
to MD 124	12.7	50.3	295%				
to I-270 mainline	13.8	47.2	241%				

Figure B.7: HCM 2010 Density Level of Service Criteria (pc/mi/ln)

HCM 2010 Freeway LOS	
< 11	A
> 11 - 18	B
> 18 - 26	C
> 26 - 35	D
> 35 - 45	E
> 45	F
HCM 2010 Freeway Merge and Diverge Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 Freeway Weaving Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 C-D Weaving Segment LOS	
< 12	A
> 12 - 24	B
> 24 - 32	C
> 32 - 36	D
> 36 - 40	E
> 40	F

Table B.5: PM Peak - Existing - I-270 Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Southbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270	Freeway	47	F	5	A	-90%	I-270	Freeway	16	B	16	B	0%
I-270 Diverge to MD 187	Diverge	69	F	59	F	-15%	I-270 Merge from WB I-70	Merge	13	B	13	B	0%
I-270	Freeway	73	F	47	F	-36%	I-270	Freeway	19	C	19	C	0%
I-270 Diverge to Rockledge Rd	Diverge	69	F	59	F	-15%	I-270 Merge from EB I-70	Merge	14	B	14	B	0%
I-270	Freeway	82	F	72	F	-13%	I-270	Freeway	18	C	18	C	0%
I-270 Weave from MD 187 to I-270 HOV	Weave	56	F	50	F	-12%	I-270 Diverge to SB MD 85	Diverge	19	B	31	D	61%
I-270 Lane Drop	Merge	65	F	18	B	-72%	I-270	Freeway	20	C	20	C	0%
I-270	Freeway	51	F	68	F	33%	I-270 Diverge to NB MD 85	Diverge	12	B	12	B	0%
I-270 Merge from I-270 Spur	Merge	37	E	49	F	30%	I-270	Freeway	16	B	16	B	0%
I-270 Weave from I-270 HOV to I-270 C-D	Weave	33	D	43	F	30%	I-270 Merge from MD 85	Merge	14	B	14	B	0%
I-270	Freeway	32	D	26	C	-20%	I-270	Freeway	21	C	21	C	-1%
I-270 Diverge to C-D (MD 189)	Diverge	37	E	24	C	-36%	I-270 Diverge to MD 80	Diverge	13	B	12	B	-13%
I-270	Freeway	32	D	18	C	-43%	I-270	Freeway	17	B	17	B	0%
I-270 Diverge to C-D (MD 28)	Diverge	38	E	35	E	-8%	I-270 Merge from MD 80	Merge	11	B	11	B	0%
I-270	Freeway	30	D	49	F	66%	I-270	Freeway	20	C	21	C	7%
I-270 Merge from C-D (MD 189)	Merge	41	F	24	C	-41%	I-270 Diverge to MD 109	Diverge	10	B	10	A	-1%
I-270 Diverge to C-D (Shady Grove Rd)	Diverge	42	F	24	C	-44%	I-270	Freeway	19	C	19	C	0%
I-270	Freeway	30	D	16	B	-44%	I-270 Merge from MD 109	Merge	11	B	11	B	-2%
I-270 Weave from C-D (MD 28) to C-D (Shady Grove Rd)	Weave	32	D	25	C	-22%	I-270	Freeway	20	C	20	C	0%
I-270	Freeway	26	D	21	C	-20%	I-270 Diverge to SB Weigh Station	Diverge	10	B	10	A	-1%
I-270 Merge from C-D (Shady Grove Rd)	Merge	21	C	68	F	222%	I-270	Freeway	20	C	20	C	0%
I-270	Freeway	33	D	26	D	-20%	I-270 Merge from SB Weigh Station	Merge	10	B	10	A	-1%
I-270 Merge from C-D (I-370)	Merge	32	D	26	C	-20%	I-270	Freeway	19	C	18	C	-4%
I-270 Diverge to C-D (MD 117)	Diverge	53	F	18	B	-65%	I-270 Diverge to MD 121	Diverge	7	A	7	A	0%
I-270	Freeway	74	F	29	D	-61%	I-270	Freeway	12	B	12	B	0%
I-270 Merge from C-D (MD 124)	Merge	101	F	14	B	-86%	I-270 Merge from MD 121	Merge	9	A	2	A	-78%
I-270	Freeway	36	E	25	C	-30%	I-270	Freeway	14	B	14	B	0%
I-270 Diverge to EB Middlebrook Rd	Diverge	28	D	31	D	12%	I-270 Diverge to MD 27	Diverge	10	A	9	A	0%
I-270	Freeway	34	D	29	D	-15%	I-270	Freeway	12	B	12	B	0%
I-270 Diverge to WB Middlebrook Rd	Diverge	30	D	30	D	0%	I-270 Merge from WB MD 27	Merge	11	B	11	B	-1%
I-270	Freeway	27	D	31	D	15%	I-270	Freeway	15	B	15	B	0%
I-270 Diverge to EB MD 118	Diverge	24	C	24	C	4%	I-270 Weave from EB MD 27 to MD 118	Weave	12	B	12	B	0%
I-270 Diverge to WB MD 118	Diverge	42	F	35	E	-17%	I-270	Freeway	14	B	14	B	0%
I-270	Freeway	33	D	22	C	-33%	I-270 Merge from WB MD 118	Merge	12	B	12	B	1%
I-270 Weave from MD 118 to MD 27	Weave	46	F	14	B	-70%	I-270	Freeway	17	B	17	B	0%
I-270	Freeway	26	D	28	D	9%	I-270 Merge from EB MD 118	Merge	15	B	15	B	0%
I-270 Merge from EB MD 27	Merge	46	F	14	B	-70%	I-270	Freeway	20	C	20	C	0%
I-270	Freeway	26	C	32	D	24%	I-270 Merge from Middlebrook Rd	Merge	21	C	21	C	0%
I-270 Merge from WB MD 27	Merge	20	C	19	B	-4%	I-270	Freeway	21	C	21	C	0%
I-270	Freeway	27	D	27	D	-2%	I-270 Diverge to MD 124	Diverge	18	B	17	B	-8%
I-270 Diverge to MD 121	Diverge	21	C	27	C	32%	I-270	Freeway	22	C	15	B	-33%

Table B.5: PM Peak - Existing - I-270 Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270	Freeway	22	C	28	D	26%	I-270 Merge from WB MD 124	Merge	44	F	20	C	-54%
I-270 Merge from EB MD 121	Merge	16	B	21	C	29%	I-270	Freeway	21	C	16	B	-21%
I-270 Lane Drop	Merge	27	C	24	C	-8%	I-270 Merge from MD 117	Merge	25	C	27	C	9%
I-270	Freeway	40	E	32	D	-19%	I-270	Freeway	21	C	17	B	-21%
I-270 Diverge to NB Weigh Station	Diverge	17	B	12	B	-31%	I-270 Diverge to I-370	Diverge	19	B	16	B	-12%
I-270	Freeway	35	D	23	C	-34%	I-270	Freeway	16	B	17	B	4%
I-270 Merge from NB Weight Station	Merge	17	B	27	C	57%	I-270 Diverge to I-270 C-D	Diverge	13	B	17	B	27%
I-270	Freeway	36	E	39	E	9%	I-270	Freeway	13	B	13	B	1%
I-270 Diverge to MD 109	Diverge	20	B	18	B	-7%	I-270 Merge from I-270 (I-370)	Merge	18	B	8	A	-52%
I-270	Freeway	33	D	37	E	14%	I-270 Diverge to I-270 C-D (Shady Grove Rd)	Diverge	22	C	18	B	-18%
I-270 Merge from MD 109	Merge	17	B	34	D	101%	I-270	Freeway	17	B	17	B	-4%
I-270	Freeway	34	D	34	D	-1%	I-270 Merge from I-270 C-D (Shady Grove Rd Northern)	Merge	16	B	17	B	6%
I-270 Diverge to MD 80	Diverge	24	C	43	F	79%	I-270	Freeway	22	C	20	C	-5%
I-270	Freeway	29	D	19	C	-33%	I-270 Merge from I-270 C-D (Shady Grove Rd Southern)	Merge	17	B	12	B	-28%
I-270 Merge from MD 80	Merge	16	B	36	E	120%	I-270 Diverge to I-270 C-D (MD 189)	Diverge	23	C	12	B	-47%
I-270	Freeway	33	D	22	C	-33%	I-270	Freeway	20	C	19	C	-5%
I-270 Diverge to Scenic View	Diverge	17	B	38	E	124%	I-270 Merge from I-270 C-D (MD 189)	Merge	18	B	17	B	-9%
I-270	Freeway	33	D	10	A	-69%	I-270	Freeway	24	C	44	E	84%
I-270 Merge from Scenic View	Merge	17	B	89	F	438%	I-270 Merge from I-270 C-D	Merge	20	C	12	B	-40%
I-270	Freeway	33	D	10	A	-70%	I-270 Diverge to I-270 HOV Lane	Diverge	17	B	17	B	2%
I-270 Diverge to NB MD 85	Diverge	19	B	27	C	38%	I-270 Diverge to I-270 Spur	Diverge	33	D	4	A	-89%
I-270	Freeway	32	D	31	D	-2%	I-270	Freeway	13	B	21	C	63%
I-270 Diverge to SB MD 85	Diverge	18	B	14	B	-22%	I-270 Diverge to Rockledge Dr / MD 187	Diverge	9	A	1	A	-86%
I-270	Freeway	28	D	21	C	-25%	I-270	Freeway	13	B	29	D	122%
I-270 Weave from MD 85 to I-70	Weave	21	C	7	A	-67%	I-270 Merge from Rockledge Dr	Merge	11	B	73	F	539%
I-270	Freeway	59	F	19	C	-69%	I-270	Freeway	16	B	13	B	-16%
							I-270 Merge from Rockledge Dr / MD 187	Merge	14	B	12	B	-15%
							I-270	Freeway	35	D	16	B	-54%

Table B.6: PM Peak - Existing - I-270 Spur Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Spur Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270 Spur	Freeway	45	F	85	F	87%	I-270 Spur	Freeway	53	F	11	A	-80%
I-270 Spur Merge from Clara Barton Parkway	Merge	51	F	85	F	67%	I-270 Spur Weave from I-270 HOV to Democracy Blvd	Weave	76	F	67	F	-11%
I-270 Spur	Freeway	66	F	63	F	-4%	I-270 Spur	Freeway	95	F	13	B	-86%
I-270 Diverge to MD 190	Diverge	43	F	83	F	95%	I-270 Merge from Democracy Blvd	Merge	134	F	14	B	-89%
I-270 Spur	Freeway	78	F	88	F	13%	I-270 Spur Lane Drop	Merge	131	F	13	B	-90%
I-270 Spur Merge from Cabin John Parkway	Merge	95	F	74	F	-22%	I-270 Spur	Freeway	123	F	27	D	-78%
I-270 Spur Merge from MD 190	Merge	94	F	52	F	-45%	I-270 Spur Merge from I-495	Merge	124	F	14	B	-88%
I-270 Spur	Freeway	83	F	96	F	16%	I-270 Spur	Freeway	48	F	34	D	-29%
I-270 Spur Diverge to I-495	Merge	65	F	12	B	-81%	I-270 Spur Diverve to EB MD 190	Diverge	49	F	79	F	63%
I-270 Spur	Freeway	45	E	47	F	4%	I-270 Spur Diverve to Cabin John Pkwy	Diverge	66	F	44	F	-34%
I-270 Spur Diverge to Democracy Blvd	Diverge	49	F	6	A	-87%	I-270 Spur	Freeway	93	F	132	F	42%
I-270 Spur	Freeway	58	F	6	A	-89%	I-270 Merge from MD 190	Merge	111	F	97	F	-13%
I-270 Spur Merge from EB Democracy Blvd	Merge	98	F	48	F	-51%	I-270 Spur	Freeway	94	F	74	F	-21%
I-270 Spur	Freeway	58	F	58	F	0%	I-270 Diverge to WB Clara Barton Pkwy	Diverge	60	F	69	F	14%
I-270 Spur Merge from WB Democracy Blvd	Merge	65	F	15	B	-77%	I-270 Spur	Freeway	83	F	57	F	-31%
I-270 Spur	Freeway	39	E	19	C	-51%	I-270 Merge from Clara Barton Pkwy	Merge	72	F	49	F	-32%
I-270 Spur Merge from Westlake Terrace	Merge	31	D	23	C	-27%							
I-270 Spur	Freeway	35	D	33	D	-5%							

Table B.7: PM Peak - Existing - I-270 Local Vehicle Density

		Existing		Alternative					Existing		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Souhbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270 C-D	Freeway	29	D	29	D	1%	I-270 C-D	Freeway	8	A	12	B	52%
I-270 C-D Diverge to EB Montrose Rd	Diverge	20	B	28	D	41%	I-270 C-D Weave from I-370 EB to I-270	Weave	15	B	15	B	4%
I-270 C-D	Freeway	17	B	29	D	68%	I-270 C-D Diverge to Shady Grove Rd	Diverge	10	A	21	C	124%
I-270 C-D Weave between Montrose Rd Loop Ramps	Weave	12	A	22	B	80%	I-270 C-D	Freeway	7	A	16	B	125%
I-270 C-D	Freeway	20	C	34	D	70%	I-270 C-D Merge from WB Shady Grove Rd	Merge	9	A	16	B	72%
I-270 C-D Merge from WB Montrose Rd	Merge	52	F	9	A	-83%	I-270 C-D	Freeway	15	B	13	B	-11%
I-270 C-D	Freeway	51	F	16	B	-68%	I-270 C-D Merge from EB Shady Grove Rd	Merge	11	B	13	B	22%
I-270 C-D Merge from I-270	Merge	66	F	29	D	-57%	I-270 C-D	Freeway	21	C	19	C	-8%
I-270 C-D	Freeway	51	F	3	A	-93%	I-270 C-D Merge from I-270	Merge	25	C	18	B	-26%
I-270 C-D Diverge to MD 189	Diverge	31	D	33	D	6%	I-270 C-D Diverge to I-270	Diverge	26	C	16	B	-38%
I-270 C-D	Freeway	67	F	34	D	-49%	I-270 C-D Diverge to I-270	Diverge	18	B	21	C	23%
I-270 C-D Merge from MD 189	Merge	94	F	28	D	-70%	I-270 C-D	Freeway	16	B	21	C	32%
I-270 C-D	Freeway	49	F	12	B	-75%	I-270 C-D Diverge to MD 28	Diverge	12	B	11	B	-6%
I-270 C-D Weave between I-270 (to MD 28 from MD 189)	Weave	57	F	27	C	-52%	I-270 C-D	Freeway	11	A	11	B	5%
I-270 C-D	Freeway	48	F	46	F	-5%	I-270 C-D Merge from WB MD 28	Merge	13	B	21	C	65%
I-270 C-D Diverge to MD 28	Diverge	20	B	33	D	64%	I-270 C-D	Freeway	13	B	6	A	-52%
I-270 C-D	Freeway	31	D	41	E	32%	I-270 C-D Merge from EB MD 28	Merge	25	C	25	C	2%
I-270 C-D Weave between MD 28 Ramps	Weave	28	C	43	F	51%	I-270 C-D	Freeway	29	D	19	C	-36%
I-270 C-D	Freeway	18	C	22	C	21%	I-270 C-D Merge from I-270	Merge	35	E	23	C	-35%
I-270 C-D Merge from MD 28 WB	Merge	13	B	34	D	151%	I-270 C-D	Freeway	40	E	21	C	-49%
I-270 C-D Merge from I-270 and Drop Lane	Merge	18	B	29	D	62%	I-270 C-D Diverge to MD 189	Diverge	24	C	22	C	-10%
I-270 C-D Diverge to I-270	Diverge	25	C	14	B	-46%	I-270 C-D	Freeway	25	C	17	B	-32%
I-270 C-D	Freeway	39	E	31	D	-19%	I-270 C-D Merge from MD 189	Merge	23	C	19	B	-16%
I-270 C-D Diverge to Shady Grove Rd	Diverge	14	B	25	C	83%	I-270 C-D Diverge to I-270	Diverge	32	D	18	B	-43%
I-270 C-D	Freeway	111	F	18	C	-84%	I-270 C-D	Freeway	22	C	20	C	-10%
I-270 C- D Merge from I-270 and EB Shady Grove Rd	Merge	116	F	54	F	-54%	I-270 C-D Diverge to WB Montrose Rd	Diverge	16	B	18	B	10%
I-270 C-D	Freeway	112	F	28	D	-75%	I-270 C-D	Freeway	20	C	26	D	29%
I-270 C-D Merge from WB Shady Grove Rd	Merge	108	F	89	F	-17%	I-270 Weave between Montrose Rd Loops	Weave	35	D	14	B	-59%
I-270 C-D Diverge to I-270	Diverge	90	F	102	F	13%	I-270 C-D	Freeway	15	B	30	D	98%
I-270 C-D	Freeway	60	F	80	F	34%	I-270 C-D Merge from EB Montrose Rd	Merge	9	A	31	D	245%
I-270 C-D Diverge to I-370	Diverge	28	C	46	F	68%	I-270 C-D	Freeway	18	B	12	B	-33%
I-270 C-D	Freeway	10	A	29	D	193%							
I-270 Merge from I-370 EB	Merge	11	B	13	B	20%							
I-270 C-D	Freeway	19	C	30	D	60%							
I-270 C-D Weave from I-370 to I-270	Weave	27	C	22	B	-19%							
I-270 C-D	Freeway	22	C	19	C	-15%							
I-270 C-D Weave from I-270 to MD 117	Weave	33	D	31	C	-8%							
I-270 C-D Diverge to MD 124	Diverge	39	E	31	D	-22%							
I-270 C-D	Freeway	55	F	27	D	-51%							
I-270 C-D Merge from EB MD 124	Merge	96	F	47	F	-51%							
I-270 C-D Merge From WB MD 124	Merge	81	F	37	E	-54%							

Table B.8: PM Peak - Existing - I-270 Vehicle Throughput

I-270 Northbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Southbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between I-495 and MD 187	4350	4330	0%	North of I-70	1975	1975	0%
Between MD 187 on and off ramps	3888	3868	-1%	Between I-70 on ramps	2287	2287	0%
Between Rockledge Blvd on and off ramps	3666	3645	-1%	From I-70 interchange to MD-85	3429	3429	0%
Between Rockledge Dr and I-270 Spur	3880	3872	0%	Between MD-85 on and off ramps	2006	2006	0%
Between I-270 Spur and Montrose Rd	8718	8707	0%	Between MD-85 and MD-80	2633	2632	0%
Between Montrose Rd on and off ramps	5750	5738	0%	Between MD-80 on and off ramps	2093	2095	0%
Between Montrose Rd and MD 189	5477	5467	0%	Between MD-80 and Md-109	2457	2460	0%
Between MD 189 and MD 28	5905	5891	0%	Between MD-109 on and off ramps	2395	2398	0%
Between MD 28 on and off ramps	6240	6246	0%	Between MD-109 and MD-121	2521	2517	0%
Between MD 28 and Shady Grove Rd	5494	5508	0%	Between MD-121 on and off ramps	2351	2349	0%
Between Shady Grove Rd and I-370	4789	4809	0%	Between MD-121 and MD-27	2723	2727	0%
Between I-370 on and off ramps	4814	4876	1%	Between MD-27 on and off ramps	2890	2892	0%
Between I-370 and MD 117	6142	6313	3%	Between MD-27 and MD-118	3164	3163	0%
Between MD 117 and MD 124	4713	5050	7%	Between MD-118 on and off ramps	3197	3199	0%
Between MD-124 on and off ramps	4706	5144	9%	Between MD-118 and Middlebrook Rd	3798	3803	0%
Between MD 124 and Middlebrook Rd	6115	6712	10%	Between Middlebrook Rd on and off ramps	3796	3800	0%
Between Middlebrook Rd on and off ramps	5713	6263	10%	Between Middlebrook Rd and MD-124	4826	4826	0%
Between Middlebrook Rd and MD 118	4798	5265	10%	Between MD-124 on and off ramps	3765	3763	0%
Between MD-118 on and off ramps	4409	4847	10%	Between MD-124 and MD-117	4938	5065	3%
Between MD 118 and MD 27	4456	4828	8%	Between MD-117 and I-370	6461	6579	2%
Between MD-27 on and off ramps	2842	3088	9%	Between I-370 on and off ramps	3327	3392	2%
Between MD 27 and MD 121	3330	3581	8%	Between I-370 on ramp to Shady Grove Rd	4663	4729	1%
Between MD-121 on and off ramps	2574	2776	8%	Between Shady Grove Rd and MD 28	4984	5038	1%
Between MD 121 and MD 109	3787	3984	5%	Between MD 28 on and off ramps	5158	5217	1%
Between MD-109 on and off ramps	3547	3736	5%	Between MD 28 and MD 189	4536	4590	1%
Between MD 109 and MD 80	3657	3835	5%	Between MD 189 and Montrose Rd	4527	4579	1%
Between MD-80 on and off ramps	3096	3278	6%	Between Montrose Rd on and off ramps	5414	5483	1%
Between MD 80 and MD 85	3596	3759	5%	Between Montose Rd and I-270 Spur	7201	7320	2%
Between MD-85 on and off ramps	3046	3162	4%	Between I-270 Spur and Rockledge Blvd	3293	3323	1%
Between MD 85 and I-70	4867	4984	2%	Between Rockledge Blvd on and off ramps	2549	2578	1%
North of I-70	2562	2653	4%	Between MD 187 on and off ramps	3017	3047	1%
				Between MD 187 and I-495	3372	3393	1%
I-270 Spur Northbound				**I-270 Spur Southbound**			
Between I-495 and Democracy Blvd	4608	4597	0%	Between I-270 Split and HOV on ramp	3113	3402	9%
Between Democracy Blvd on and off ramps	4128	4119	0%	Between HOV on ramp and Democracy Blvd	2461	3161	28%
Between Democracy Blvd and I-270 Split	4849	4845	0%	Between Democracy Blvd on and off ramps	1970	2686	36%
				Between Democracy Blvd and I-495	2297	3308	44%

Table B.9: PM Peak - Existing - I-270 Local Vehicle Throughput

I-270 Local Northbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Local Southbound	Existing VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between Montrose Rd EB off ramp and and EB on ramp	1881	1880	0%	Between I-370 on ramp and I-270 off ramp	2740	2756	1%
Between Montrose Rd EB on ramp and WB off ramp	2172	2164	0%	Between I-270 off ramp and Shady Grove off ramp	1420	1435	1%
Between Montrose Rd WB off ramp and on ramp	1921	1910	-1%	Between Shady Grove off ramp and Shady Grove WB on ramp	764	773	1%
Between Montrose Rd WB on ramp and I-270 on ramp	3366	3383	1%	Between Shady Grove WB and EB on ramps	1543	1550	0%
Between I-270 on ramp and MD 189 off ramp	3611	3665	1%	Between Shady Grove on ramp and I-270 on ramp	2168	2174	0%
Between MD 189 ramps	2908	2965	2%	Between I-270 on ramp and I-270 off ramp1	2660	2675	1%
Between MD 189 off ramp and I-270 on ramp	3782	3853	2%	Between I-270 off ramp1 and I-270 off ramp2	1854	1866	1%
Between I-270 on ramp and I-270 off ramp	4472	4539	1%	Between I-270 off ramp2 and MD 28 off ramp	1681	1693	1%
Between I-270 off ramp and MD 28 EB off ramp	3481	3538	2%	Between MD 28 off ramp and MD 28 WB on ramp	1149	1155	1%
Between MD 28 EB off ramp to MD 28 EB on ramp	3133	3182	2%	Between MD 28 WB on ramp and MD 28 EB on ramp	1401	1409	1%
Between MD 28 EB on ramp and MD 28 WB off ramp	3262	3314	2%	Between MD 28 EB on ramp and I-270 on ramp	2908	2912	0%
Between MD 28 WB off ramp and MD 28 WB on ramp	2023	2048	1%	Between I-270 on ramp and MD 189 off ramp	3530	3552	1%
Between MD 28 WB on ramp and I-270 on ramp	2725	2746	1%	Between MD 189 on and off ramps	2601	2614	0%
Between I-270 on ramp and I-270 off ramp	3565	3587	1%	Between MD 189 on ramp and I-270 off ramp	3166	3172	0%
Between I-270 off ramp and Shady Grove off ramp	2136	2189	2%	Between I-270 off ramp and Montrose Rd off ramp	2280	2283	0%
Between Shady Grove off ramp and I-270 on ramp	673	753	12%	Between Montrose Rd off ramp and Montrose Rd WB on ramp	2039	2047	0%
Between I-270 on ramp and Shady Grove WB on ramp	3348	3469	4%	Between Montrose Rd WB on ramp and EB off ramp	2605	2613	0%
Between Shady Grove WB on ramp and I-270 off ramp	4148	4264	3%	Between Montrose Rd EB off and on ramps	1525	1528	0%
Between I-270 off ramp and I-370 off ramp	3663	3760	3%	Between Montrose Rd EB off ramp and I-270	1846	1848	0%
Between I-370 off ramp and I-370 EB on ramp	1138	1169	3%				
Between I-370 EB and WB on ramps	2096	2126	1%				
Between I-370 WB on ramp and I-270 off ramp	3687	3711	1%				
Between I-270 off ramp and I-270 on ramp	2254	2271	1%				
Between I-270 on ramp and MD 117 off ramp	3661	3732	2%				
Between MD 117 off ramp and MD 124 off ramp	2448	2509	2%				
Between MD 124 off ramp and MD 124 EB on ramp	479	504	5%				
Between MD 124 EB and WB on ramps	943	1022	8%				
Between MD 124 on ramp I-270	1427	1564	10%				

Table B.10: PM Peak - Existing - I-270 On Ramp Queue Length - Northbound

I-270 Northbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
Rockledge Dr on ramp	1	1	54%	181	159	-12%
MD 189 C-D on ramp	0	0	-100%	33	0	-100%
MD 28 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp	0	0	0%	0	0	0%
I-370 C-D on ramp	2	1	-57%	233	97	-58%
MD 124 C-D on ramp	2459	0	-100%	3978	0	-100%
MD 118 on ramp	0	0	-100%	37	0	-100%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 121 on ramp	0	0	0%	0	0	0%
MD 109 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	0	0	0%	0	0	0%
MD 85 on ramp	0	0	0%	0	0	0%
I-270 Spur Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd EB on ramp	0	0	0%	0	5	0%
Democracy Blvd WB on ramp	0	0	0%	0	0	0%
I-495 Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Cabin John Pkwy on ramp	16	26	61%	661	849	28%
MD 190 on ramp	0	0	0%	0	38	0%
I-270 C-D Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Montrose Rd EB on ramp	0	0	0%	0	0	0%
Montrose Rd WB on ramp	265	0	-100%	1386	0	-100%
I-270 on ramp	0	0	0%	0	0	0%
MD 189 on ramp	15	3	-77%	555	239	-57%
I-270 on ramp	0	0	86%	23	77	241%
MD 28 EB on ramp	0	0	0%	0	0	0%
MD 28 WB on ramp	0	0	0%	0	0	0%
Shady Grove Rd EB on ramp	78	67	-14%	836	686	-18%
I-270 on ramp	178	21	-88%	1103	465	-58%
Shady Grove Rd WB on ramp	12	2	-81%	340	156	-54%
I-370 EB on ramp	0	0	0%	0	0	0%
I-370 WB on ramp	0	0	0%	0	0	0%
I-270 on ramp	12	151	1127%	658	997	52%
MD 124 EB on ramp	257	0	-100%	1230	0	-100%
MD 124 WB on ramp	1	0	-100%	63	0	-100%

Table B.11: PM Peak - Existing - I-270 Off Ramp Queue Length - Northbound

I-270 Northbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 187 off ramp NB	42	39	-5%	278	272	-2%
MD 187 off ramp SB	0	0	0%	0	0	0%
Rockledge Dr off ramp	1	1	-23%	73	63	-14%
Tower Oaks Blvd off ramp	32	33	1%	235	213	-10%
Montrose Rd off ramp EB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
MD 189 off ramp WB	29	31	6%	168	167	-1%
MD 189 off ramp EB	1	1	-25%	122	139	14%
MD 28 off ramp EB	37	40	7%	231	229	-1%
MD 28 off ramp WB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Redland Blvd	0	0	0%	0	0	0%
Shady Grove Rd off ramp WB	49	49	0%	248	234	-6%
Shady Grove Rd off ramp EB	0	0	0%	0	0	0%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
MD 117 off ramp	205	578	183%	859	2529	194%
MD 124 off ramp	799	283	-65%	2471	1380	-44%
Watkins Mill Rd off ramp*			0%			0%
Middlebrook Rd EB off ramp	0	0	0%	0	0	0%
Middlebrook Rd WB off ramp	0	0	0%	0	0	0%
MD 118 WB off ramp - Seneca Meadows	0	0	-100%	20	0	-100%
MD 118 WB off ramp	0	0	0%	0	6	0%
MD 118 EB off ramp	0	0	0%	0	0	0%
MD 27 off ramp WB	56	61	10%	290	261	-10%
MD 27 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp WB	0	0	0%	0	16	0%
MD 121 off ramp EB	0	0	0%	0	0	0%
MD 109 off ramp EB	9	11	17%	158	181	14%
MD 109 off ramp WB	0	0	0%	0	0	0%
MD 80 off ramp EB	15	17	19%	140	139	0%
MD 80 off ramp WB	0	0	-80%	11	7	-40%
MD 85 NB off ramp	0	0	0%	0	0	0%
MD 85 SB off ramp	0	0	-6%	72	49	-31%
I-270 Spur Northbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Clara Barton Pkwy off ramp EB	0	0	0%	0	0	0%
Clara Barton Pkwy off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp EB	0	0	0%	0	0	0%
MD 190 off ramp WB	2	2	-9%	287	251	-13%
Democracy Blvd off ramp WB	42	43	4%	188	192	2%
Democracy Blvd off ramp EB	18	17	-5%	143	132	-8%

* Ramp in Future Scenario

Table B.12: PM Peak - Existing - I-270 On Ramp Queue Length - Southbound

I-270 Southbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	0	0	0%	0	0	0%
MD 109 on ramp	0	0	0%	0	0	0%
MD 121 WB on ramp	0	0	0%	0	0	0%
MD 121 EB on ramp*			0%			0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 118 WB on ramp	0	0	0%	0	0	0%
MD 118 EB on ramp	0	0	0%	0	0	0%
Middlebrook Rd on ramp	0	0	0%	0	0	0%
MD 124 WB on ramp	5	0	-100%	332	0	-100%
MD 117 on ramp	0	0	0%	0	0	0%
I-370 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp North	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp South	0	0	0%	0	0	0%
MD 189 C-D on ramp	0	0	0%	0	0	0%
Montrose Rd C-D on ramp	0	0	0%	0	0	0%
Rockledge Dr on ramp	0	0	0%	0	0	0%
MD 187 on ramp	0	0	0%	0	0	0%
I-270 Spur Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd on ramp	335	0	-100%	1366	0	-100%
I-495 Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 Spur on ramp	4212	472	-89%	5058	2814	-44%
MD 190 on ramp	1	2	119%	107	287	168%
I-270 C-D Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 on ramp	0	0	0%	0	0	0%
I-370 on ramp	0	0	0%	0	0	0%
Shady Grove Rd WB on ramp	0	0	0%	0	0	0%
Shady Grove Rd EB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	0	0%	0	0	0%
MD 28 WB on ramp	0	0	-100%	14	0	-100%
MD 28 EB on ramp	2	1	-51%	219	148	-32%
I-270 on ramp	0	0	0%	0	0	0%
MD 189 on ramp	0	0	0%	0	0	0%
Montrose Rd WB on ramp	1	0	-63%	107	44	-59%
Montrose Rd EB on ramp	0	0	0%	0	0	0%

* Ramp in Future Scenario

Table B.13: PM Peak - Existing - I-270 Off Ramp Queue Length - Southbound

I-270 Southbound	Existing VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	Existing VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 SB off ramp	0	0	0%	0	0	0%
MD 85 NB off ramp	0	0	-13%	114	79	-31%
MD 80 off ramp	1	0	-42%	154	128	-17%
MD 109 off ramp WB	0	0	-2%	58	56	-3%
MD 109 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp EB	2	2	-22%	98	90	-8%
MD 121 off ramp WB	0	0	0%	0	0	0%
MD 27 off ramp EB	23	23	1%	149	150	1%
MD 27 off ramp WB	0	0	0%	0	0	0%
MD 118 off ramp EB	19	18	-2%	110	125	13%
MD 118 off ramp WB	0	0	0%	0	0	0%
Watkins Mill Rd off ramp*			0%			0%
MD 124 off ramp EB	310	175	-44%	1658	966	-42%
MD 124 off ramp WB	147	10	-93%	1129	384	-66%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Omega Drive	1	0	-23%	42	58	40%
Shady Grove Rd off ramp	0	0	0%	0	0	0%
MD 28 off ramp	3	3	0%	127	119	-7%
MD 189 off ramp EB	123	126	2%	849	614	-28%
MD 189 off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp EB	0	0	0%	0	20	0%
Rockledge Dr off ramp	51	78	51%	295	386	31%
I-270 Spur Southbound	**Existing VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**Existing VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd off ramp EB	24	28	18%	157	147	-6%
Democracy Blvd off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp WB	85	91	7%	826	979	18%
MD 190 off ramp EB	0	0	0%	0	0	0%
Clara Barton Pkwy WB off ramp	0	0	0%	0	0	0%

* Ramp in Future Scenario

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	28.2	C	NB Left	115	79	116	611	E	53.2	D
				NB Through	503	33	116	611	C		
				NB Right	824	18	55	634	B		
	SB	82.9	F	SB Left	142	77	401	1055	E		
				SB Through	875	84	401	1055	F		
				SB Right	67	87	401	1055	F		
	EB	33.5	C	EB Left	43	83	26	115	F		
				EB Through	20	91	26	115	F		
				EB Right	144	11	26	115	B		
	WB	63.9	E	WB Left	508	77	221	686	E		
				WB Through	27	67	221	686	E		
				WB Right	192	29	221	686	C		
2- MD 85 at I-270 NB on and off ramp											
2	NB	36.0	D	NB Left	977	36	187	908	D	32.7	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	27.9	C	SB Left	0	0	0	0	A		
				SB Through	671	28	100	634	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	6.0	A	NB Left	0	0	0	0	A	9.4	A
				NB Through	1699	6	41	829	A		
				NB Right	0	0	0	0	A		
	SB	43.8	D	SB Left	170	44	46	320	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	33.3	D	NB Left	60	70	154	653	E	33.5	C
				NB Through	1255	32	154	654	C		
				NB U-Turn	0	0	0	0	A		
	SB	22.0	C	SB Left	91	80	45	208	E		
				SB Through	810	25	59	445	C		
				SB Right	796	12	45	436	B		
	EB	54.8	D	EB Left	802	57	133	610	E		
				EB Through	31	44	133	610	D		
				EB Right	22	0	133	610	A		
	WB	43.4	D	WB Left	36	75	39	162	E		
				WB Through	61	65	39	162	E		
				WB Right	81	13	39	162	B		
5- MD 80 at I-270 NB on and ramp											
5	NB	-1.8	A	NB Left	1	0	0	0	A	8.6	A
				NB Through	2	0	0	0	A		
				NB Right	8	-3	0	0	A		
	SB	12.2	B	SB Left	385	15	21	145	B		
				SB Through	17	17	21	145	B		
				SB Right	122	2	0	0	A		
	EB	8.9	A	EB Left	70	9	13	171	A		
				EB Through	0	0	8	0	A		
				EB Right	6	5	24	202	A		
	WB	6.9	A	WB Left	16	10	0	40	B		
				WB Through	510	12	28	281	B		
				WB Right	482	1	0	0	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	2.3	A	NB Left	47	3	1	190	A	4.2	A
				NB Through	0	0	0	0	A		
				NB Right	491	2	1	190	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.0	A	EB Left	0	0	0	0	A		
				EB Through	271	5	2	61	A		
				EB Right	53	3	1	69	A		
	WB	6.6	A	WB Left	0	0	0	0	A		
				WB Through	316	7	1	89	A		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	5.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	10.2	B	SB Left	224	11	14	175	B		
				SB Through	0	0	0	0	A		
				SB Right	17	2	0	67	A		
	EB	2.2	A	EB Left	56	1	0	37	A		
				EB Through	0	0	0	0	A		
				EB Right	59	3	0	0	A		
	WB	0.3	A	WB Left	0	0	0	0	A		
				WB Through	160	0	0	0	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	4.0	A	NB Left	44	7	2	115	A	1.6	A
				NB Through	0	0	0	0	A		
				NB Right	29	0	0	43	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.8	A	EB Left	0	0	0	0	A		
				EB Through	114	0	0	0	A		
				EB Right	24	4	0	0	A		
	WB	1.2	A	WB Left	98	1	0	42	A		
				WB Through	78	1	0	19	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	10.6	B	NB Left	471	13	31	242	B	17.0	B
				NB Through	638	10	31	242	A		
				NB Right	54	2	36	268	A		
	SB	17.8	C	SB Left	20	13	5	143	B		
				SB Through	169	19	14	163	B		
				SB Right	8	4	13	184	A		
	EB	16.6	C	EB Left	2	50	3	93	D		
				EB Through	19	51	11	170	D		
				EB Right	142	12	21	202	B		
	WB	34.8	D	WB Left	214	46	57	220	D		
				WB Through	56	41	57	219	D		
				WB Right	140	16	71	244	B		
10- MD 121 at I-270 NB on and off ramp											
10	NB	0.8	A	NB Left	25	9	1	67	A	0.6	A
				NB Through	0	0	0	0	A		
				NB Right	718	1	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	447	0	0	0	A		
				EB Right	58	0	0	0	A		
	WB	0.8	A	WB Left	100	3	1	73	A		
				WB Through	423	0	0	48	A		
				WB Right	0	0	0	0	A		

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	2.2	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	7.7	A	SB Left	136	10	8	125	A		
				SB Through	0	0	0	0	A		
				SB Right	36	0	0	0	A		
	EB	0.3	A	EB Left	29	1	0	23	A		
				EB Through	0	0	0	0	A		
				EB Right	349	0	0	0	A		
	WB	0.1	A	WB Left	0	0	0	0	A		
				WB Through	99	0	0	0	A		
				WB Right	0	0	0	0	A		
12- MD 27 at Observation Dr											
12	NB	40.1	D	NB U-Turn	0	0	0	0	A	22.2	C
				NB Through	73	57	19	86	E		
				NB Right	47	13	19	86	B		
	SB	39.7	D	SB Left	114	46	31	182	D		
				SB Through	41	62	35	244	E		
				SB Right	173	30	57	281	C		
	EB	16.8	B	EB Left	208	27	68	502	C		
				EB Through	2223	16	70	503	B		
				EB Right	106	15	82	541	B		
	WB	25.8	C	WB Left	31	22	123	627	C		
				WB Through	1503	26	123	627	C		
				WB Right	54	9	123	627	A		
13- MD 27 at I-270 NB off ramp											
13	NB	44.8	D	NB Left	390	45	63	297	D	8.1	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	1284	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.5	A	WB Left	0	0	0	0	A		
				WB Through	1582	6	41	680	A		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	5.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	52.2	D	SB Left	171	52	35	162	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.3	A	EB Left	0	0	0	0	A		
				EB Through	1351	2	4	149	A		
				EB Right	0	0	0	0	A		
	WB	2.7	A	WB Left	0	0	0	0	A		
				WB Through	1433	3	7	257	A		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	22.6	C	NB Left	58	20	55	379	C	29.8	C
				NB Through	965	23	68	379	C		
				NB Right	43	20	72	391	B		
	SB	33.9	C	SB Left	140	57	185	770	E		
				SB Through	1310	35	185	770	D		
				SB Right	196	9	164	764	A		
	EB	43.0	D	EB Left	103	54	28	120	D		
				EB Through	37	46	25	115	D		
				EB Right	47	17	17	141	B		
	WB	27.6	C	WB Left	83	49	70	297	D		
				WB Through	102	43	70	297	D		
				WB Right	552	22	70	297	C		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	4.0	A	NB Left	90	12	1	82	B	8.2	A
				NB Through	1174	3	7	154	A		
				NB Right	0	0	15	207	A		
	SB	6.5	A	SB Left	11	6	14	270	A		
				SB Through	1091	7	18	270	A		
				SB Right	9	3	21	302	A		
	EB	13.1	B	EB Left	18	55	12	130	E		
				EB Through	1	76	12	130	E		
				EB Right	275	10	12	130	B		
	WB	53.5	D	WB Left	93	64	37	199	E		
				WB Through	6	61	33	198	E		
				WB Right	25	13	42	218	B		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	16.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	33.9	C	EB Left	435	34	90	501	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	10.8	B	WB Left	0	0	0	0	A		
				WB Through	246	2	1	116	A		
				WB Right	1216	13	46	480	B		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	6.1	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	37.1	D	SB Left	129	37.1	22	114	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	4.8	A	EB Left	0	0.0	0	0	A		
				EB Through	1182	4.8	10	322	A		
				EB Right	0	0.0	0	0	A		
	WB	4.5	A	WB Left	0	0.0	0	0	A		
				WB Through	1465	4.5	8	237	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	24.0	C	NB Left	42	69	33	176	E	27.5	C
				NB Through	43	70	33	176	E		
				NB Right	196	4	3	77	A		
	SB	90.2	F	SB Left	381	90	221	577	F		
				SB Through	12	82	221	577	F		
				SB Right	97	91	221	577	F		
	EB	17.8	B	EB Left	98	22	60	395	C		
				EB Through	1215	17	60	395	B		
				EB Right	17	15	60	395	B		
	WB	17.6	B	WB Left	12	17	66	441	B		
				WB Through	1324	21	66	441	C		
				WB Right	351	5	66	441	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	8.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	18.0	B	SB Left	96	35	18	131	D		
				SB Through	0	0	0	0	A		
				SB Right	179	9	18	131	A		
	EB	6.4	A	EB Left	15	9	17	155	A		
				EB Through	1180	6	17	155	A		
				EB Right	0	0	0	0	A		
	WB	8.4	A	WB Left	0	0	0	0	A		
				WB Through	1238	8	24	251	A		
				WB Right	12	6	39	300	A		

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
21				SB Right	0	0	0	0	A	4.4	A
				EB Left	0	0	0	0	A		
	EB	2.8	A	EB Through	686	3	4	96	A		
				EB Right	0	0	0	0	A		
				WB Left	429	7	4	194	A		
	WB	7.1	A	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
				NB Left	156	45	75	316	D		
	NB	48.4	D	NB Through	0	0	75	316	A		
				NB Right	219	51	75	316	D		
				SB Left	30	44	7	66	D		
	SB	30.6	C	SB Through	2	37	7	66	D		
22				SB Right	19	9	18	104	A	12.5	B
				EB Left	3	10	23	262	B		
	EB	7.3	A	EB Through	1035	7	23	262	A		
				EB Right	160	7	23	262	A		
				WB Left	242	20	33	332	C		
	WB	8.3	A	WB Through	1650	7	33	332	A		
				WB Right	4	2	33	332	A		
23- MD 124 at MD 355											
				NB Left	507	63	186	529	E		
	NB	51.6	D	NB Through	942	46	183	527	D		
				NB Right	6	12	0	0	B		
				SB Left	141	71	99	395	E		
	SB	30.7	C	SB Through	554	53	99	395	D		
23				SB Right	736	6	20	339	A	63.0	E
				EB Left	468	93	363	1176	F		
	EB	42.4	D	EB Through	2720	41	363	1176	D		
				EB Right	575	7	160	1150	A		
				WB Left	0	0	0	0	A		
	WB	153.9	F	WB Through	1481	156	718	950	F		
				WB Right	65	101	0	0	F		
24- MD 124 at I-270 SB on and off											
				NB Left	55	65	23	98	E		
	NB	64.4	F	NB Through	23	64	23	98	E		
				NB U-Turn	0	0	0	0	A		
				SB Left	572	94	316	1663	F		
	SB	57.0	E	SB Through	10	80	316	1663	F		
24				SB Right	452	9	141	1059	A	40.8	D
				EB Left	0	0	0	0	A		
	EB	43.4	D	EB Through	1738	44	307	1098	D		
				EB Right	31	34	323	1121	C		
				WB Left	4	66	77	588	E		
	WB	18.7	B	WB Through	1046	19	77	588	B		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
				NB Left	45	63	116	666	E		
	NB	36.4	D	NB Through	545	54	116	666	D		
				NB Right	447	13	4	216	B		
				SB Left	119	44	98	447	D		
	SB	32.8	C	SB Through	762	37	98	447	D		
25				SB Right	144	2	0	0	A	40.6	D
				EB Left	120	82	142	477	F		
	EB	46.1	D	EB Through	1092	42	142	478	D		
				EB Right	43	39	149	506	D		
				WB Left	402	70	280	1027	E		
	WB	43.5	D	WB Through	1338	39	280	1027	D		
				WB Right	129	2	0	0	A		
26- MD 117 at Bureau Dr											
				NB Left	78	79	65	281	E		
	NB	45.7	D	NB Through	27	75	65	281	E		
				NB Right	260	33	65	281	C		
				SB Left	274	83	109	351	F		
	SB	71.9	E	SB Through	17	82	109	351	F		
26				SB Right	65	21	109	351	C	38.8	D
				EB Left	41	80	156	829	F		
	EB	31.4	C	EB Through	1593	30	157	829	C		
				EB Right	3	13	151	818	B		
				WB Left	19	43	337	1058	D		
	WB	37.7	D	WB Through	1703	40	337	1059	D		
				WB Right	292	26	368	1107	C		
27- MD 117 at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
27				SB Right	0	0	0	0	A	13.3	B
				EB Left	0	0	0	0	A		
	EB	4.6	A	EB Through	896	5	10	466	A		
				EB Right	0	0	0	0	A		
				WB Left	294	40	140	1068	E		
	WB	39.8	E	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	256	46	214	871	D		
	SB	52.1	D	SB Through	0	0	0	0	A		
28				SB Right	951	54	214	870	D	30.5	C
				EB Left	3	125	152	980	F		
	EB	27.6	C	EB Through	897	27	152	980	C		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	13.3	B	WB Through	1359	13	87	383	B		
				WB Right	0	0	87	383	A		
29- MD 117 at Perry Pkwy											
				NB Left	18	69	13	110	E		
	NB	42.6	D	NB Through	21	50	13	109	D		
				NB Right	23	15	21	129	B		
				SB Left	194	85	89	332	F		
	SB	57.1	E	SB Through	14	84	89	332	F		
29				SB Right	112	6	89	332	A	37.0	D
				EB Left	240	69	84	355	E		
	EB	20.8	C	EB Through	864	8	84	355	A		
				EB Right	32	6	69	339	A		
				WB Left	36	105	245	752	F		
	WB	44.4	D	WB Through	1228	46	245	752	D		
				WB Right	300	33	245	752	C		
30- Shady Grove Rd at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	7.1	A	NB Through	1025	7	16	209	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	9.5	A	SB Through	1280	9	41	481	A		
30				SB Right	0	0	0	0	A	13.8	B
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	317	53	58	260	D		
	WB	52.9	D	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
				31- Shady Grove Rd at I-270 SB off ramp							
31	NB	6.8	A	NB Left	0	0	0	0	A	15.9	B
				NB Through	1463	7	28	378	A		
				NB Right	0	0	0	0	A		
	SB	5.5	A	SB Left	0	0	0	0	A		
				SB Through	817	5	8	156	A		
				SB Right	0	0	0	0	A		
	EB	57.5	E	EB Left	229	55	44	200	D		
				EB Through	0	0	0	0	A		
				EB Right	295	60	63	241	E		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
				32- MD 28 at I-270 SB off ramp							
32	NB			NB U-Turn	0	0	0	0	A	8.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	36.5	D	SB Left	440	44	74	300	D		
				SB Through	0	0	0	0	A		
				SB Right	98	3	1	70	A		
	EB	2.7	A	EB Left	0	0	0	0	A		
				EB Through	1505	1	0	0	A		
				EB Right	830	6	14	245	A		
	WB	6.1	A	WB Left	0	0	0	0	A		
				WB Through	1693	6	18	227	A		
				WB Right	0	0	0	0	A		
				33- MD 28 at I-270 on and off ramps							
33	NB	34.9	C	NB Left	0	0	43	241	A	21.5	C
				NB Through	208	47	51	250	D		
				NB Right	134	16	51	250	B		
	SB	33.6	C	SB Left	11	101	175	288	F		
				SB Through	0	0	0	0	A		
				SB Right	164	29	175	288	C		
	EB	12.7	B	EB Left	254	38	53	287	D		
				EB Through	885	5	53	287	A		
				EB Right	0	0	0	0	A		
	WB	24.1	C	WB Left	36	20	96	383	B		
				WB Through	1241	24	77	346	C		
				WB Right	0	0	0	0	A		
				34- MD 189 at Great Falls Rd							
34	NB	38.6	D	NB Left	45	44	12	86	D	13.4	B
				NB Through	11	50	8	84	D		
				NB Right	12	10	8	94	A		
	SB	3.3	A	SB Left	14	51	7	73	D		
				SB Through	11	51	7	73	D		
				SB Right	401	0	0	0	A		
	EB	12.0	B	EB Left	425	24	38	464	C		
				EB Through	669	5	5	161	A		
				EB Right	58	4	9	198	A		
	WB	18.4	B	WB Left	11	18	48	405	B		
				WB Through	827	18	48	405	B		
				WB Right	14	17	63	439	B		
				35- MD 189 at I-270 Ramps							
35	NB	46.1	D	NB Left	250	46	44	190	D	41.7	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	55.4	E	SB Left	350	55	139	869	E		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	27.5	C	EB Left	480	31	89	371	C		
				EB Through	367	23	89	371	C		
				EB Right	0	0	0	0	A		
	WB	48.9	D	WB Left	440	54	106	299	D		
				WB Through	417	43	106	299	D		
				WB Right	0	0	0	0	A		
				36- MD 189 at Wooton Pkwy							
36	NB	45.1	D	NB Left	187	57	113	410	E	43.8	D
				NB Through	536	52	113	410	D		
				NB Right	174	10	113	410	B		
	SB	62.3	E	SB Left	247	79	151	606	E		
				SB Through	729	57	154	631	E		
				SB Right	0	0	0	0	A		
	EB	34.6	C	EB Left	118	71	101	438	E		
				EB Through	543	34	101	438	C		
				EB Right	160	10	101	438	B		
	WB	34.5	C	WB Left	160	71	123	603	E		
				WB Through	781	35	123	603	C		
				WB Right	317	15	123	603	B		
				37- Montrose Rd at Tower Oaks Blvd							
37	NB	0.4	A	NB Left	0	0	0	0	A	16.2	B
				NB Through	0	0	0	0	A		
				NB Right	490	0	0	0	A		
	SB	71.2	E	SB Left	68	48	37	256	D		
				SB Through	0	0	0	0	A		
				SB Right	270	77	97	348	E		
	EB	6.1	A	EB Left	0	0	0	0	A		
				EB Through	1685	6	30	360	A		
				EB Right	0	0	0	0	A		
	WB	18.3	B	WB Left	69	35	30	360	C		
				WB Through	2563	18	105	727	B		
				WB Right	244	12	105	727	B		
				38- Tower Oaks Blvd at I-270 off rmap							
38	NB	22.9	C	NB Left	650	23	46	257	C	17.4	B
				NB Through	0	0.0	39	249	A		
				NB Right	21	6.3	46	257	A		
	SB	15.4	B	SB Left	8	24.8	1	43	C		
				SB Through	0	0.0	1	43	A		
				SB Right	7	4.7	0	30	A		
	EB	11.1	B	EB Left	1	11.0	14	153	B		
				EB Through	310	11.6	14	153	B		
				EB Right	33	6.4	9	144	A		
	WB	12.7	B	WB Left	121	15.9	14	122	B		
				WB Through	192	10.8	14	122	B		
				WB Right	1	3.7	2	78	A		
				39- Montrose Rd at Tower Oaks Blvd							
39	NB	17.3	B	NB Left	76	34	62	288	C	55.3	E
				NB Through	606	30	62	288	C		
				NB Right	572	1	0	0	A		
	SB	30.3	C	SB Left	193	62	61	206	E		
				SB Through	394	20	59	205	C		
				SB Right	105	11	54	250	B		
	EB	216.7	F	EB Left	81	178	517	714	F		
				EB Through	458	222	518	715	F		
				EB Right	32	240	542	739	F		
	WB	35.5	D	WB Left	565	44	110	402	D		
				WB Through	473	41	111	402	D		
				WB Right	330	13	130	433	B		
				40- Rockledge Blvd at I-270 NB on and off ramp							
40	NB	124.2	F	NB Left	0	0	0	0	A	98.5	F
				NB Through	335	113	520	837	F		
				NB Right	854	129	520	837	F		
	SB	86.6	F	SB Left	0	0	86	220	A		
				SB Through	346	87	86	220	F		
				SB Right	0	0	0	0	A		
	EB	62.2	E	EB Left	5	127	169	458	F		
				EB Through	428	103	169	458	F		
				EB Right	297	2	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41				NB Left	341	30	76	261	C	49.5	D
	NB	30.2	C	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	345	59	193	786	E		
	WB	54.7	D	WB Through	894	53	193	786	D		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42				NB Left	198	21	316	1253	C	120.3	F
	NB	43.7	D	NB Through	2133	43	316	1253	D		
				NB Right	188	73	316	1253	E		
				SB Left	185	168	2553	2702	F		
	SB	201.4	F	SB Through	1122	201	2553	2702	F		
				SB Right	270	226	2553	2702	F		
				EB Left	238	52	94	407	D		
	EB	51.7	D	EB Through	409	54	95	408	D		
				EB Right	103	43	113	432	D		
				WB Left	459	211	1918	2138	F		
	WB	215.4	F	WB Through	614	233	1918	2138	F		
				WB Right	151	158	1918	2138	F		
43- MD 187 at I-270 NB on and off ramps											
43				NB Left	552	34	103	399	C	18.5	B
	NB	14.8	B	NB Through	2291	10	103	399	B		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	22.7	C	SB Through	1247	23	57	248	C		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	65	60	50	290	E		
	WB	61.4	E	WB Through	65	63	50	290	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44				NB Left	0	0	0	0	A	33.3	C
	NB	32.2	D	NB Through	2211	32	103	485	C		
				NB Right	0	0	0	0	A		
				SB Left	150	59	74	305	E		
	SB	20.4	C	SB Through	1163	15	74	305	B		
				SB Right	0	0	0	0	A		
				EB Left	636	57	137	558	E		
	EB	57.1	E	EB Through	0	0	137	558	A		
				EB Right	185	57	77	519	E		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45				NB Left	383	34	90	614	C	23.8	C
	NB	16.8	B	NB Through	2000	14	91	614	B		
				NB Right	14	12	111	647	B		
				SB Left	20	47	82	400	D		
	SB	26.7	C	SB Through	1160	30	82	400	C		
				SB Right	172	1	54	356	A		
				EB Left	396	59	98	362	E		
	EB	40.2	D	EB Through	37	63	98	362	E		
				EB Right	375	18	98	362	B		
				WB Left	5	32	3	77	C		
	WB	11.6	B	WB Through	12	25	3	77	C		
				WB Right	32	4	1	67	A		
47-Democracy Blvd at I-270 NB off ramp											
47				NB Left	152	46	29	159	D	3.0	A
	NB	45.7	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	1.2	A	EB Through	1114	1	3	51	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	0.9	A	WB Through	2129	1	2	62	A		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48				NB Left	0	0	0	0	A	6.3	A
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	5.0	A	EB Through	1326	5	17	250	A		
				EB Right	0	0	0	0	A		
				WB Left	531	24	39	287	C		
	WB	7.0	A	WB Through	1748	2	30	266	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49				NB Left	0	0	0	0	A	7.4	A
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	159	53	31	164	D		
	SB	38.9	D	SB Through	0	0	0	0	A		
				SB Right	60	2	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	3.8	A	WB Through	1748	4	16	274	A		
				WB Right	168	3	12	305	A		
50- MD 190 at Burdette Rd											
50				NB Left	26	74	15	100	E	31.1	C
	NB	72.8	E	NB Through	4	84	15	100	F		
				NB Right	5	56	15	100	E		
				SB Left	34	78	19	122	E		
	SB	32.1	C	SB Through	7	56	19	122	E		
				SB Right	118	18	19	122	B		
				EB Left	122	85	82	513	F		
	EB	17.6	B	EB Through	1151	11	82	513	B		
				EB Right	28	4	68	540	A		
				WB Left	11	113	334	1111	F		
	WB	38.3	D	WB Through	2146	38	334	1111	D		
				WB Right	52	28	334	1111	C		

Table B.14: PM Peak - Existing - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
51				EB Left	233	70	101	369	E	16.9	B
	EB	70.2	E	EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	8.4	A	WB Through	1464	8	42	713	A		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
				NB Left	222	74	89	830	E		
	NB	73.8	E	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
52				EB Left	0	0	0	0	A	12.4	B
	EB	2.9	A	EB Through	840	3	6	143	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	9.1	A	WB Through	1705	9	26	545	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
				NB Left	21	1	0	0	A		
	NB	0.3	A	NB Through	243	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	306	56	103	375	E		
	SB	55.7	E	SB Through	180	56	103	375	E		
				SB Right	17	56	103	375	E		
53				EB Left	22	33	66	355	C	24.7	C
	EB	27.1	C	EB Through	664	27	66	355	C		
				EB Right	34	25	66	355	C		
				WB Left	262	75	125	534	E		
	WB	19.0	B	WB Through	935	15	125	534	B		
				WB Right	715	4	125	534	A		
54- MD 124 at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	59.5	E	NB Through	0	0	0	0	A		
				NB Right	1911	59	802	2475	E		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
54				EB Left	0	0	0	0	A	64.0	E
	EB	68.6	E	EB Through	1874	69	579	1267	E		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	47.0	D	NB Through	0	0	0	0	A		
				NB Right	314	47	51	199	D		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
55				EB Left	0	0	0	0	A	11.5	B
	EB	1.5	A	EB Through	1113	2	4	65	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
				NB Left	115	74	113	589	E		
	NB	27.8	C	NB Through	502	32	113	589	C		
				NB Right	831	19	61	612	B		
				SB Left	143	78	395	1043	E		
	SB	81.7	F	SB Through	879	82	395	1043	F		
1				SB Right	66	87	395	1043	F	52.3	D
				EB Left	43	83	26	114	F		
	EB	33.3	C	EB Through	20	91	26	114	F		
				EB Right	144	10	26	114	B		
				WB Left	509	76	218	713	E		
	WB	62.7	E	WB Through	28	63	218	713	E		
				WB Right	193	29	218	713	C		
2- MD 85 at I-270 NB on and off ramp											
				NB Left	971	36	189	911	D		
	NB	35.7	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	25.7	C	SB Through	677	26	87	618	C		
2				SB Right	0	0	0	0	A	31.6	C
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
				NB Left	0	0	0	0	A		
	NB	6.1	A	NB Through	1695	6	43	723	A		
				NB Right	0	0	0	0	A		
				SB Left	173	44	47	323	D		
	SB	43.9	D	SB Through	0	0	0	0	A		
3				SB Right	0	0	0	0	A	9.6	A
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
				NB Left	60	70	152	634	E		
	NB	33.0	D	NB Through	1255	31	152	635	C		
				NB U-Turn	0	0	0	0	A		
				SB Left	92	80	44	194	E		
	SB	22.5	C	SB Through	817	25	60	422	C		
4				SB Right	803	13	48	413	B	33.6	C
				EB Left	800	57	135	594	E		
	EB	54.8	D	EB Through	31	44	135	594	D		
				EB Right	22	0	135	594	A		
				WB Left	36	75	39	162	E		
	WB	43.5	D	WB Through	61	65	39	162	E		
				WB Right	81	13	39	162	B		
5- MD 80 at I-270 NB on and ramp											
				NB Left	2	0	0	5	A		
	NB	-1.6	A	NB Through	2	0	0	5	A		
				NB Right	6	-3	0	5	A		
				SB Left	407	16	24	145	B		
	SB	12.9	B	SB Through	18	16	24	145	B		
5				SB Right	128	3	0	0	A	9.2	A
				EB Left	70	11	15	178	B		
	EB	10.3	B	EB Through	0	0	8	0	A		
				EB Right	6	4	25	209	A		
				WB Left	16	10	0	40	B		
	WB	7.2	A	WB Through	510	13	29	266	B		
				WB Right	482	1	0	0	A		
6- MD 80 at I-270 SB on and off ramp											
				NB Left	47	2	1	163	A		
	NB	2.1	A	NB Through	0	0	0	0	A		
				NB Right	491	2	1	163	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
6				SB Right	0	0	0	0	A	4.2	A
				EB Left	0	0	0	0	A		
	EB	5.1	A	EB Through	272	5	2	75	A		
				EB Right	54	3	1	84	A		
				WB Left	0	0	0	0	A		
	WB	6.8	A	WB Through	324	7	1	120	A		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	237	11	16	198	B		
	SB	10.8	B	SB Through	0	0	0	0	A		
7				SB Right	18	2	0	17	A	5.7	A
				EB Left	56	1	0	37	A		
	EB	2.2	A	EB Through	0	0	0	0	A		
				EB Right	59	3	0	0	A		
				WB Left	0	0	0	0	A		
	WB	0.3	A	WB Through	160	0	0	0	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
				NB Left	44	7	2	94	A		
	NB	4.2	A	NB Through	0	0	0	0	A		
				NB Right	29	0	0	18	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
8				SB Right	0	0	0	0	A	1.6	A
				EB Left	0	0	0	0	A		
	EB	0.8	A	EB Through	114	0	0	0	A		
				EB Right	24	4	0	0	A		
				WB Left	98	1	0	41	A		
	WB	1.2	A	WB Through	79	1	0	18	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
				NB Left	493	13	37	282	B		
	NB	11.8	B	NB Through	669	12	37	282	B		
				NB Right	57	2	43	308	A		
				SB Left	20	13	6	127	B		
	SB	19.1	C	SB Through	168	20	16	165	C		
9				SB Right	8	5	15	186	A	17.9	B
				EB Left	2	70	3	88	E		
	EB	14.8	B	EB Through	19	49	9	140	D		
				EB Right	142	9	18	172	A		
				WB Left	213	47	57	207	D		
	WB	36.7	E	WB Through	57	46	58	207	D		
				WB Right	140	17	72	231	B		
10- MD 121 at I-270 NB on and off ramp											
				NB Left	27	8	1	75	A		
	NB	0.7	A	NB Through	0	0	0	0	A		
				NB Right	774	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
10				SB Right	0	0	0	0	A	0.6	A
				EB Left	0	0	0	0	A		
	EB	0.1	A	EB Through	448	0	0	0	A		
				EB Right	58	0	0	0	A		
				WB Left	100	3	1	89	A		
	WB	0.9	A	WB Through	424	0	0	61	A		
				WB Right	0	0	0	0	A		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	137	9	7	116	A		
	SB	7.4	A	SB Through	0	0	0	0	A		
11				SB Right	36	0	0	0	A	2.1	A
				EB Left	29	1	0	13	A		
	EB	0.3	A	EB Through	0	0	0	0	A		
				EB Right	349	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	0.1	A	WB Through	101	0	0	0	A		
				WB Right	0	0	0	0	A		
12- MD 27 at Observation Dr											
				NB U-Turn	0	0	0	0	A		
	NB	40.9	D	NB Through	73	57	19	88	E		
				NB Right	47	15	19	88	B		
				SB Left	114	46	31	182	D		
	SB	40.0	D	SB Through	41	62	36	244	E		
12				SB Right	173	31	58	281	C	22.4	C
				EB Left	218	28	77	559	C		
	EB	17.9	B	EB Through	2318	17	79	560	B		
				EB Right	112	17	92	599	B		
				WB Left	31	23	118	602	C		
	WB	24.8	C	WB Through	1503	25	118	602	C		
				WB Right	54	7	118	602	A		
13- MD 27 at I-270 NB off ramp											
				NB Left	420	46	69	269	D		
	NB	45.9	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
13				SB Right	0	0	0	0	A	8.6	A
				EB Left	0	0	0	0	A		
	EB	0.1	A	EB Through	1283	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	5.7	A	WB Through	1583	6	41	594	A		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	170	52	36	163	D		
	SB	52.1	D	SB Through	0	0	0	0	A		
14				SB Right	0	0	0	0	A	5.3	A
				EB Left	0	0	0	0	A		
	EB	2.3	A	EB Through	1351	2	4	127	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	2.7	A	WB Through	1468	3	7	257	A		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
				NB Left	58	20	55	379	B		
	NB	22.8	C	NB Through	966	23	68	379	C		
				NB Right	43	20	73	391	B		
				SB Left	143	58	189	731	E		
	SB	34.0	C	SB Through	1339	35	189	731	D		
15				SB Right	201	9	167	725	A	29.9	C
				EB Left	103	54	28	120	D		
	EB	42.8	D	EB Through	37	46	25	115	D		
				EB Right	47	17	17	141	B		
				WB Left	83	49	70	297	D		
	WB	27.7	C	WB Through	102	43	70	297	D		
				WB Right	552	22	70	297	C		
16- MD 118 at Seneca Meadows Pkwy											
				NB Left	94	12	1	76	B		
	NB	4.0	A	NB Through	1205	3	7	172	A		
				NB Right	0	0	14	225	A		
				SB Left	11	6	13	284	A		
	SB	6.2	A	SB Through	1091	6	16	284	A		
16				SB Right	9	3	20	317	A	8.0	A
				EB Left	18	55	12	134	E		
	EB	13.1	B	EB Through	1	76	12	134	E		
				EB Right	275	10	12	134	B		
				WB Left	93	64	37	199	E		
	WB	53.5	D	WB Through	6	61	33	198	E		
				WB Right	25	13	42	218	B		
17- MD 118 at I-270 NB on ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
17				SB Right	0	0	0	0	A	15.9	B
				EB Left	434	33	87	456	C		
	EB	32.9	C	EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	10.9	B	WB Through	246	2	0	45	A		
				WB Right	1216	13	47	431	B		
18- MD 118 at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
				SB Left	130	36.2	22	128	D		
	SB	36.2	D	SB Through	0	0.0	0	0	A		
18				SB Right	0	0.0	0	0	A	6.1	A
				EB Left	0	0.0	0	0	A		
	EB	4.7	A	EB Through	1182	4.7	10	309	A		
				EB Right	0	0.0	0	0	A		
				WB Left	0	0.0	0	0	A		
	WB	4.6	A	WB Through	1528	4.6	9	201	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
				NB Left	41	70	34	176	E		
	NB	24.1	C	NB Through	43	70	34	176	E		
				NB Right	196	4	3	86	A		
				SB Left	382	89	218	574	F		
	SB	90.0	F	SB Through	12	94	218	574	F		
19				SB Right	97	94	218	574	F	27.5	C
				EB Left	98	22	60	421	C		
	EB	17.7	B	EB Through	1215	17	60	421	B		
				EB Right	16	14	60	421	B		
				WB Left	13	19	71	430	B		
	WB	18.0	B	WB Through	1373	21	71	430	C		
				WB Right	361	5	71	430	A		
20- Middlebrook Rd at Observation Dr											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	96	35	18	131	D		
	SB	18.1	B	SB Through	0	0	0	0	A		
20				SB Right	179	9	18	131	A	8.6	A
				EB Left	15	11	17	162	B		
	EB	6.6	A	EB Through	1225	7	17	162	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	8.6	A	WB Through	1238	9	25	243	A		
				WB Right	12	8	39	292	A		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21	NB			NB Left	0	0	0	0	A	4.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.9	A	EB Left	0	0	0	0	A		
				EB Through	686	3	4	101	A		
				EB Right	0	0	0	0	A		
	WB	7.1	A	WB Left	429	7	4	190	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22	NB	48.4	D	NB Left	156	45	75	316	D	12.7	B
				NB Through	0	0	75	316	A		
				NB Right	219	51	75	316	D		
	SB	30.7	C	SB Left	30	44	7	66	D		
				SB Through	2	37	7	66	D		
				SB Right	19	9	18	104	A		
	EB	7.4	A	EB Left	3	9	23	250	A		
				EB Through	1035	7	23	250	A		
				EB Right	160	7	23	250	A		
	WB	8.6	A	WB Left	254	21	34	329	C		
				WB Through	1731	7	34	329	A		
				WB Right	4	2	34	329	A		
23- MD 124 at MD 355											
23	NB	50.9	D	NB Left	502	60	172	521	E	61.3	E
				NB Through	943	46	170	518	D		
				NB Right	6	15	0	0	B		
	SB	30.8	C	SB Left	138	72	97	380	E		
				SB Through	555	52	97	380	D		
				SB Right	734	7	25	360	A		
	EB	43.9	D	EB Left	484	91	376	1188	F		
				EB Through	2788	43	376	1188	D		
				EB Right	585	8	182	1152	A		
	WB	131.2	F	WB Left	0	0	0	0	A		
				WB Through	1718	134	715	945	F		
				WB Right	75	71	5	185	E		
24- MD 124 at I-270 SB on and off											
24	NB	66.6	F	NB Left	55	66	24	109	E	34.7	C
				NB Through	23	68	24	109	E		
				NB U-Turn	0	0	0	0	A		
	SB	46.4	D	SB Left	566	78	180	971	E		
				SB Through	10	74	180	971	E		
				SB Right	452	6	8	314	A		
	EB	34.1	C	EB Left	0	0	0	0	A		
				EB Through	1768	34	238	1080	C		
				EB Right	31	27	251	1103	C		
	WB	23.1	C	WB Left	5	78	108	761	E		
				WB Through	1154	23	108	761	C		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25	NB	45.6	D	NB Left	45	74	154	692	E	41.2	D
				NB Through	540	67	154	692	E		
				NB Right	446	16	4	320	B		
	SB	37.8	D	SB Left	117	51	116	489	D		
				SB Through	756	43	116	489	D		
				SB Right	144	2	0	0	A		
	EB	49.2	D	EB Left	124	75	153	482	E		
				EB Through	1085	47	153	484	D		
				EB Right	42	43	168	511	D		
	WB	35.2	D	WB Left	409	53	234	1025	D		
				WB Through	1337	33	234	1025	C		
				WB Right	130	1	0	0	A		
26- MD 117 at Bureau Dr											
26	NB	42.2	D	NB Left	78	72	61	257	E	38.2	D
				NB Through	28	69	61	257	E		
				NB Right	261	30	61	257	C		
	SB	74.8	E	SB Left	273	85	109	353	F		
				SB Through	18	92	109	353	F		
				SB Right	65	26	109	353	C		
	EB	31.8	C	EB Left	42	75	154	770	E		
				EB Through	1585	31	156	770	C		
				EB Right	3	29	149	760	C		
	WB	36.2	D	WB Left	19	34	324	1070	C		
				WB Through	1721	38	325	1070	D		
				WB Right	293	26	356	1119	C		
27- MD 117 at I-270 SB off ramp											
27	NB			NB Left	0	0	0	0	A	14.0	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.3	A	EB Left	0	0	0	0	A		
				EB Through	898	5	17	546	A		
				EB Right	0	0	0	0	A		
	WB	40.4	E	WB Left	294	40	125	1029	E		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28	NB			NB Left	0	0	0	0	A	34.2	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	64.0	E	SB Left	259	59	548	2545	E		
				SB Through	0	0	0	0	A		
				SB Right	968	65	548	2544	E		
	EB	26.2	C	EB Left	4	112	140	977	F		
				EB Through	896	26	140	977	C		
				EB Right	0	0	0	0	A		
	WB	12.6	B	WB Left	0	0	0	0	A		
				WB Through	1364	13	84	386	B		
				WB Right	0	0	84	386	A		
29- MD 117 at Perry Pkwy											
29	NB	45.8	D	NB Left	18	73	14	94	E	39.3	D
				NB Through	23	56	13	94	E		
				NB Right	24	16	22	114	B		
	SB	57.8	E	SB Left	195	85	91	333	F		
				SB Through	15	83	91	333	F		
				SB Right	113	7	91	333	A		
	EB	20.9	C	EB Left	241	70	87	371	E		
				EB Through	863	8	87	371	A		
				EB Right	31	7	72	355	A		
	WB	48.5	D	WB Left	37	107	274	749	F		
				WB Through	1235	50	274	749	D		
				WB Right	300	37	274	749	D		
30- Shady Grove Rd at I-270 NB off ramp											
30	NB	7.0	A	NB Left	0	0	0	0	A	13.8	B
				NB Through	1026	7	16	203	A		
				NB Right	0	0	0	0	A		
	SB	9.4	A	SB Left	0	0	0	0	A		
				SB Through	1280	9	41	481	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	52.3	D	WB Left	326	52	59	246	D		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
31	NB	6.8	A	NB Left	0	0	0	0	A	16.0	B
				NB Through	1463	7	27	385	A		
				NB Right	0	0	0	0	A		
	SB	5.6	A	SB Left	0	0	0	0	A		
				SB Through	825	6	8	159	A		
				SB Right	0	0	0	0	A		
	EB	58.2	E	EB Left	230	57	47	193	E		
				EB Through	0	0	0	0	A		
				EB Right	296	59	66	243	E		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
32	NB			NB U-Turn	0	0	0	0	A	8.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	37.8	D	SB Left	443	46	76	291	D		
				SB Through	0	0	0	0	A		
				SB Right	99	3	0	36	A		
	EB	2.7	A	EB Left	0	0	0	0	A		
				EB Through	1506	1	0	0	A		
				EB Right	829	6	14	220	A		
	WB	6.8	A	WB Left	0	0	0	0	A		
				WB Through	1725	7	20	249	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
33	NB	35.6	D	NB Left	0	0	46	240	A	21.9	C
				NB Through	216	47	54	249	D		
				NB Right	136	18	54	249	B		
	SB	33.9	C	SB Left	11	87	161	285	F		
				SB Through	0	0	0	0	A		
				SB Right	174	31	161	285	C		
	EB	13.3	B	EB Left	256	40	56	313	D		
				EB Through	888	6	56	313	A		
				EB Right	0	0	0	0	A		
	WB	24.2	C	WB Left	36	19	98	383	B		
				WB Through	1239	24	78	346	C		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
34	NB	38.1	D	NB Left	45	43	11	86	D	13.8	B
				NB Through	11	48	8	84	D		
				NB Right	12	10	8	95	A		
	SB	3.3	A	SB Left	14	51	7	73	D		
				SB Through	11	53	7	73	D		
				SB Right	401	0	0	0	A		
	EB	12.0	B	EB Left	430	23	39	462	C		
				EB Through	673	5	6	166	A		
				EB Right	58	5	10	202	A		
	WB	19.5	B	WB Left	11	19	51	377	B		
				WB Through	828	19	50	376	B		
				WB Right	14	18	66	410	B		
35- MD 189 at I-270 Ramps											
35	NB	45.8	D	NB Left	255	46	46	188	D	42.3	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	58.7	E	SB Left	350	59	142	634	E		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	27.7	C	EB Left	477	31	91	360	C		
				EB Through	368	24	91	360	C		
				EB Right	0	0	0	0	A		
	WB	49.0	D	WB Left	440	54	105	264	D		
				WB Through	418	44	105	264	D		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
36	NB	45.3	D	NB Left	186	59	114	406	E	44.3	D
				NB Through	536	52	114	406	D		
				NB Right	174	10	114	406	A		
	SB	63.9	E	SB Left	248	83	161	653	F		
				SB Through	730	57	160	640	E		
				SB Right	0	0	0	0	A		
	EB	34.7	C	EB Left	118	72	101	428	E		
				EB Through	541	34	101	428	C		
				EB Right	160	11	101	428	B		
	WB	34.7	C	WB Left	160	70	123	611	E		
				WB Through	788	35	123	611	C		
				WB Right	319	16	123	611	B		
37- Montrose Rd at Tower Oaks Blvd											
37	NB	0.4	A	NB Left	0	0	0	0	A	13.5	B
				NB Through	0	0	0	0	A		
				NB Right	491	0	0	0	A		
	SB	49.9	D	SB Left	68	51	18	176	D		
				SB Through	0	0	0	0	A		
				SB Right	273	50	62	216	D		
	EB	6.1	A	EB Left	0	0	0	0	A		
				EB Through	1687	6	31	394	A		
				EB Right	0	0	0	0	A		
	WB	15.8	B	WB Left	69	35	31	394	D		
				WB Through	2569	16	85	550	B		
				WB Right	245	10	85	550	B		
38- Tower Oaks Blvd at I-270 off rmap											
38	NB	23.2	C	NB Left	650	24	46	234	C	17.4	B
				NB Through	0	0.0	40	226	A		
				NB Right	21	6.4	46	234	A		
	SB	17.0	B	SB Left	8	27.9	1	43	C		
				SB Through	0	0.0	1	43	A		
				SB Right	7	4.4	0	30	A		
	EB	11.0	B	EB Left	1	16.7	14	156	B		
				EB Through	310	11.5	14	156	B		
				EB Right	33	6.1	9	147	A		
	WB	12.3	B	WB Left	122	15.3	14	116	B		
				WB Through	192	10.4	14	116	B		
				WB Right	1	15.1	2	72	B		
39- Montrose Rd at Tower Oaks Blvd											
39	NB	17.3	B	NB Left	76	33	62	277	C	56.5	E
				NB Through	606	30	62	277	C		
				NB Right	572	1	0	0	A		
	SB	29.4	C	SB Left	192	60	59	202	E		
				SB Through	394	20	57	201	B		
				SB Right	105	11	54	232	B		
	EB	229.6	F	EB Left	79	189	541	714	F		
				EB Through	447	235	541	714	F		
				EB Right	30	249	565	738	F		
	WB	35.8	D	WB Left	567	45	111	400	D		
				WB Through	473	41	111	400	D		
				WB Right	330	13	131	430	B		
40- Rockledge Blvd at I-270 NB on and off ramp											
40	NB	123.4	F	NB Left	0	0	0	0	A	100.7	F
				NB Through	338	109	525	829	F		
				NB Right	866	129	525	829	F		
	SB	87.6	F	SB Left	0	0	87	213	A		
				SB Through	341	88	87	213	F		
				SB Right	0	0	0	0	A		
	EB	69.7	E	EB Left	5	136	197	548	F		
				EB Through	435	115	197	548	F		
				EB Right	301	4	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	29.1	C	NB Left	343	29	68	262	C	45.3	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	49.8	D	WB Left	338	55	177	699	E		
				WB Through	882	48	177	699	D		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	51.5	D	NB Left	199	26	369	1220	C	125.5	F
				NB Through	2136	52	369	1220	D		
				NB Right	187	73	369	1220	E		
	SB	209.1	F	SB Left	181	186	2550	2697	F		
				SB Through	1101	208	2550	2697	F		
				SB Right	267	231	2550	2697	F		
	EB	51.7	D	EB Left	238	52	94	407	D		
				EB Through	409	54	95	408	D		
				EB Right	103	43	113	432	D		
	WB	217.9	F	WB Left	459	213	1932	2131	F		
				WB Through	607	236	1932	2131	F		
				WB Right	150	157	1932	2131	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	15.4	B	NB Left	552	32	105	388	C	19.0	B
				NB Through	2285	11	105	388	B		
				NB Right	0	0	0	0	A		
	SB	23.2	C	SB Left	0	0	0	0	A		
				SB Through	1229	23	56	215	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	60.5	E	WB Left	64	60	49	283	E		
				WB Through	64	61	49	283	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	32.8	D	NB Left	0	0	0	0	A	34.4	C
				NB Through	2209	33	105	462	C		
				NB Right	0	0	0	0	A		
	SB	20.1	C	SB Left	148	56	72	302	E		
				SB Through	1147	16	72	302	B		
				SB Right	0	0	0	0	A		
	EB	61.6	E	EB Left	630	63	155	755	E		
				EB Through	0	0	155	755	A		
				EB Right	183	57	71	493	E		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	16.2	B	NB Left	383	35	87	622	C	23.3	C
				NB Through	1994	13	88	622	B		
				NB Right	14	11	108	655	B		
	SB	26.3	C	SB Left	21	45	81	349	D		
				SB Through	1146	30	81	349	C		
				SB Right	169	1	48	340	A		
	EB	40.1	D	EB Left	396	59	98	371	E		
				EB Through	37	64	98	371	E		
				EB Right	375	18	98	371	B		
	WB	11.7	B	WB Left	5	32	3	77	C		
				WB Through	12	25	3	77	C		
				WB Right	32	4	1	67	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	45.8	D	NB Left	151	46	29	147	D	3.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.2	A	EB Left	0	0	0	0	A		
				EB Through	1138	1	3	48	A		
				EB Right	0	0	0	0	A		
	WB	0.9	A	WB Left	0	0	0	0	A		
				WB Through	2129	1	2	62	A		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	6.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.1	A	EB Left	0	0	0	0	A		
				EB Through	1357	5	18	238	A		
				EB Right	0	0	0	0	A		
	WB	6.9	A	WB Left	534	23	38	282	C		
				WB Through	1747	2	30	261	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	7.9	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	38.0	D	SB Left	182	52	36	154	D		
				SB Through	0	0	0	0	A		
				SB Right	71	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	3.9	A	WB Left	0	0	0	0	A		
				WB Through	1747	4	19	266	A		
				WB Right	175	1	0	0	A		
50- MD 190 at Burdette Rd											
50	NB	72.5	E	NB Left	27	74	15	100	E	29.6	C
				NB Through	4	84	15	100	F		
				NB Right	5	56	15	100	E		
	SB	31.2	C	SB Left	33	76	19	129	E		
				SB Through	7	57	19	129	E		
				SB Right	117	17	19	129	B		
	EB	18.3	B	EB Left	121	93	86	492	F		
				EB Through	1145	11	86	492	B		
				EB Right	27	4	73	519	A		
	WB	35.4	D	WB Left	11	118	312	1107	F		
				WB Through	2151	35	312	1107	D		
				WB Right	51	24	312	1107	C		

Table B.15: PM Peak - Existing - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
51				SB Right	0	0	0	0	A	17.3	B
				EB Left	234	71	103	363	E		
	EB	70.9	E	EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	8.7	A	WB Through	1467	9	46	743	A		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
				NB Left	226	73	96	982	E		
	NB	73.0	E	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
52				SB Right	0	0	0	0	A	12.6	B
				EB Left	0	0	0	0	A		
	EB	2.9	A	EB Through	840	3	6	144	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	9.3	A	WB Through	1703	9	30	794	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
				NB Left	21	1	0	0	A		
	NB	0.3	A	NB Through	243	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	306	56	104	375	E		
	SB	55.9	E	SB Through	180	56	104	375	E		
53				SB Right	17	56	104	375	E	24.7	C
				EB Left	22	33	66	358	C		
	EB	27.4	C	EB Through	664	27	66	358	C		
				EB Right	34	25	66	358	C		
				WB Left	265	75	124	493	E		
	WB	18.9	B	WB Through	935	15	124	493	B		
				WB Right	717	4	124	493	A		
54- MD 124 at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	41.1	D	NB Through	0	0	0	0	A		
				NB Right	1989	41	285	1383	D		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
54				SB Right	0	0	0	0	A	48.9	D
				EB Left	0	0	0	0	A		
	EB	57.3	E	EB Through	1870	57	426	1238	E		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	48.0	D	NB Through	0	0	0	0	A		
				NB Right	315	48	52	202	D		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
55				SB Right	0	0	0	0	A	11.6	B
				EB Left	0	0	0	0	A		
	EB	1.5	A	EB Through	1138	2	4	66	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table B.16: PM Peak - Existing - I-270 Vehicle Network Performance

	Existing	Alternative	% Change
Total Delay	21,792,153	18,829,642	-14%
Average Delay per Vehicle	206	179	-13%
Total Travel Time	53,628,278	51,138,063	-5%
Vehicles (Arrived)	88,401	89,474	1%
Latent Demand	1,544	2,007	30%
Latent Delay	2,650,217	2,593,214	-2%
Total Distance	484,473	491,752	2%
Average Speed	33	35	6%

2040 Conditions

AM Peak

Table C.1: AM Peak - No Build - I-270 Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From I-495 interchange					From I-70				
to MD 187	1.8	115.1	110.3	-4%	to MD 85	1.7	260.9	198.2	-24%
to I-270 Split	0.6	47.5	39.7	-16%	to MD 80	5.4	1,374.0	1,332.1	-3%
to Montrose Rd	1.8	139.0	100.7	-28%	to MD 109	3.7	583.2	692.5	19%
to MD 189	1.0	77.0	57.8	-25%	to MD 121	3.6	284.4	287.1	1%
to MD 28	1.0	61.0	55.6	-9%	to MD 27	2.5	266.9	174.0	-35%
to Shady Grove Rd	1.9	108.7	109.9	1%	to MD 118	1.1	254.6	74.0	-71%
to I-370	0.9	53.0	53.1	0%	to Middlebrook Rd	1.1	206.2	78.2	-62%
to MD 117	1.5	85.5	85.9	0%	to MD 124	2.2	528.0	159.2	-70%
to MD 124	0.6	34.5	34.5	0%	to MD 117	0.9	180.6	67.5	-63%
to Middlebrook Rd	2.5	140.8	141.4	0%	to I-370	1.0	94.3	76.6	-19%
to MD 118	1.1	64.7	66.6	3%	to Shady Grove Rd	1.5	124.1	109.8	-12%
to MD 27	0.9	52.0	52.5	1%	to MD 28	1.9	141.9	139.7	-2%
to MD 121	2.4	135.6	136.9	1%	to MD 189	1.0	157.8	72.3	-54%
to MD 109	4.1	235.2	236.6	1%	to Montrose Rd	1.0	251.0	76.0	-70%
to MD 80	3.7	214.0	215.2	1%	to I-270 Split	1.9	243.1	146.9	-40%
to MD 85	5.3	310.9	311.0	0%	to MD 187	0.4	30.7	44.7	46%
to I-70	1.4	80.1	80.3	0%	to I-495 interchange	1.9	134.0	145.3	8%
I-270 Total (miles/minutes)	**32.4**	**32.6**	**31.5**	**-3%**	**I-270 Total (miles/minutes)**	**32.7**	**85.3**	**64.6**	**-24%**
I-270 Spur Northbound					**I-270 Spur Southbound**				
From Cabin John Pkwy					From I-70				
to MD 190	0.5	32.4	32.4	0%	to I-270 Split	30.3	4,951.1	3,684.1	-26%
to I-495	1.1	68.6	66.9	-3%	to Democracy Blvd	0.7	91.3	73.0	-20%
to Democracy Blvd	1.4	102.7	92.6	-10%	to I-495	1.3	191.0	146.9	-23%
to I-270 Split	0.9	77.7	51.2	-34%	to MD 190	1.3	101.6	146.3	44%
to I-70	30.0	1,792.1	1,737.9	-3%	to Cabin John Pkwy	0.6	35.1	35.8	2%
I-270 Spur Total (miles/minutes)	**34.0**	**34.6**	**33.0**	**-4%**	**I-270 Spur Total (miles/minutes)**	**34.2**	**89.5**	**68.1**	**-24%**

Table C.2: AM Peak - No Build - I-270 Local Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From C-D start					From C-D start				
to Montrose Rd	0.8	256.2	53.3	-79%	to Shady Grove	1.3	490.1	126.6	-74%
to MD 189	1.3	471.8	81.1	-83%	to MD 28	1.8	491.5	125.5	-74%
to MD 28	1.0	250.0	63.8	-74%	to MD 189	1.1	481.0	94.4	-80%
to Shady Grove	2.0	117.6	122.2	4%	to Montrose	1.2	344.5	91.5	-73%
to I-370	1.0	56.5	57.0	1%	to I-270 mainline	0.9	197.1	76.1	-61%
to MD 117	1.2	74.0	73.9	0%					
to MD 124	0.8	49.5	49.6	0%					
to I-270 mainline	0.8	49.7	48.6	-2%					
I-270 Local Total (miles/minutes)	**8.9**	**22.1**	**9.2**	**-59%**	**I-270 Local Total (miles/minutes)**	**6.3**	**33.4**	**8.6**	**-74%**

Figure C.1: AM Peak - No Build
I-270 Travel Time Graph - Northbound

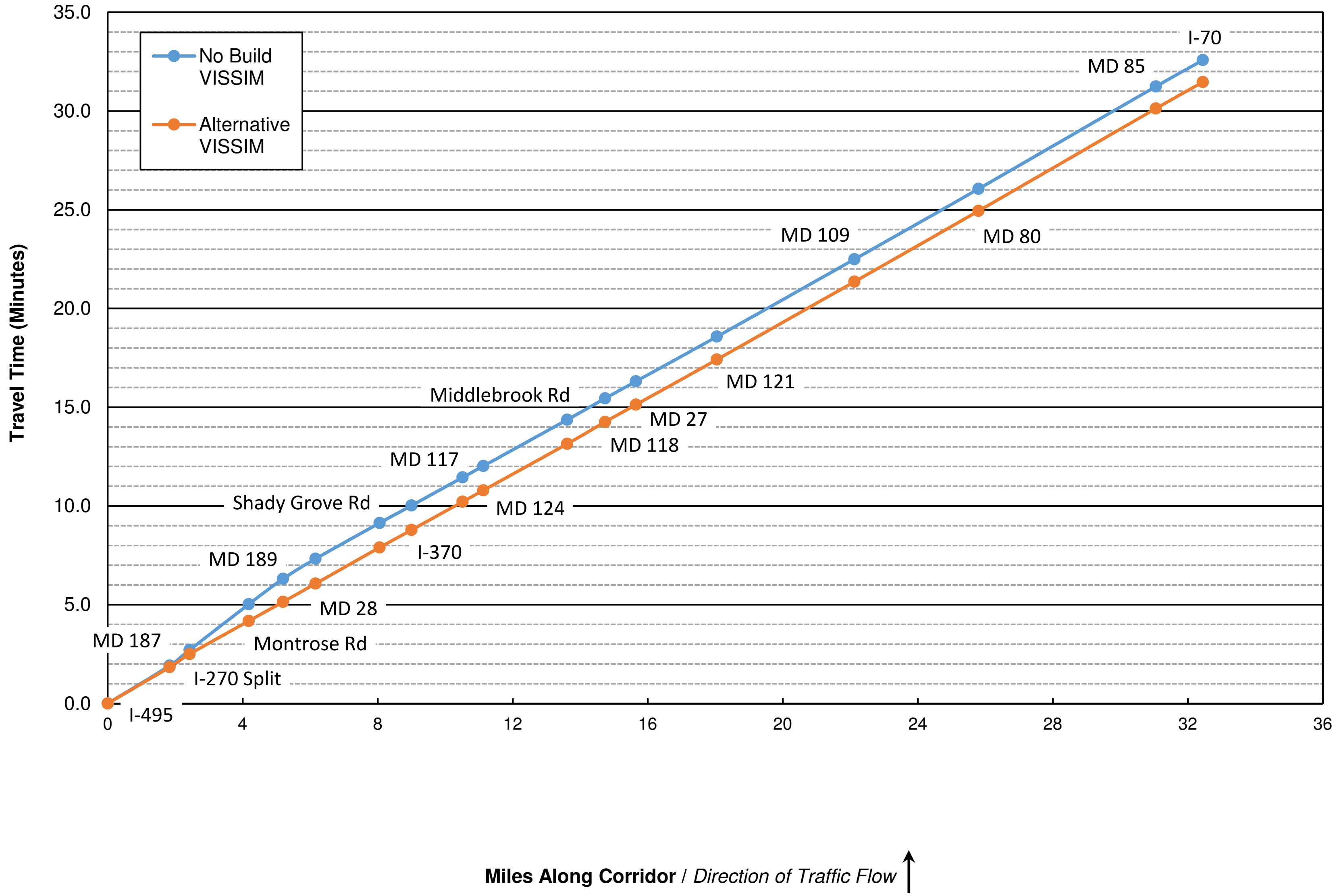


Figure C.2: AM Peak - No Build
I-270 Travel Time Graph - Southbound

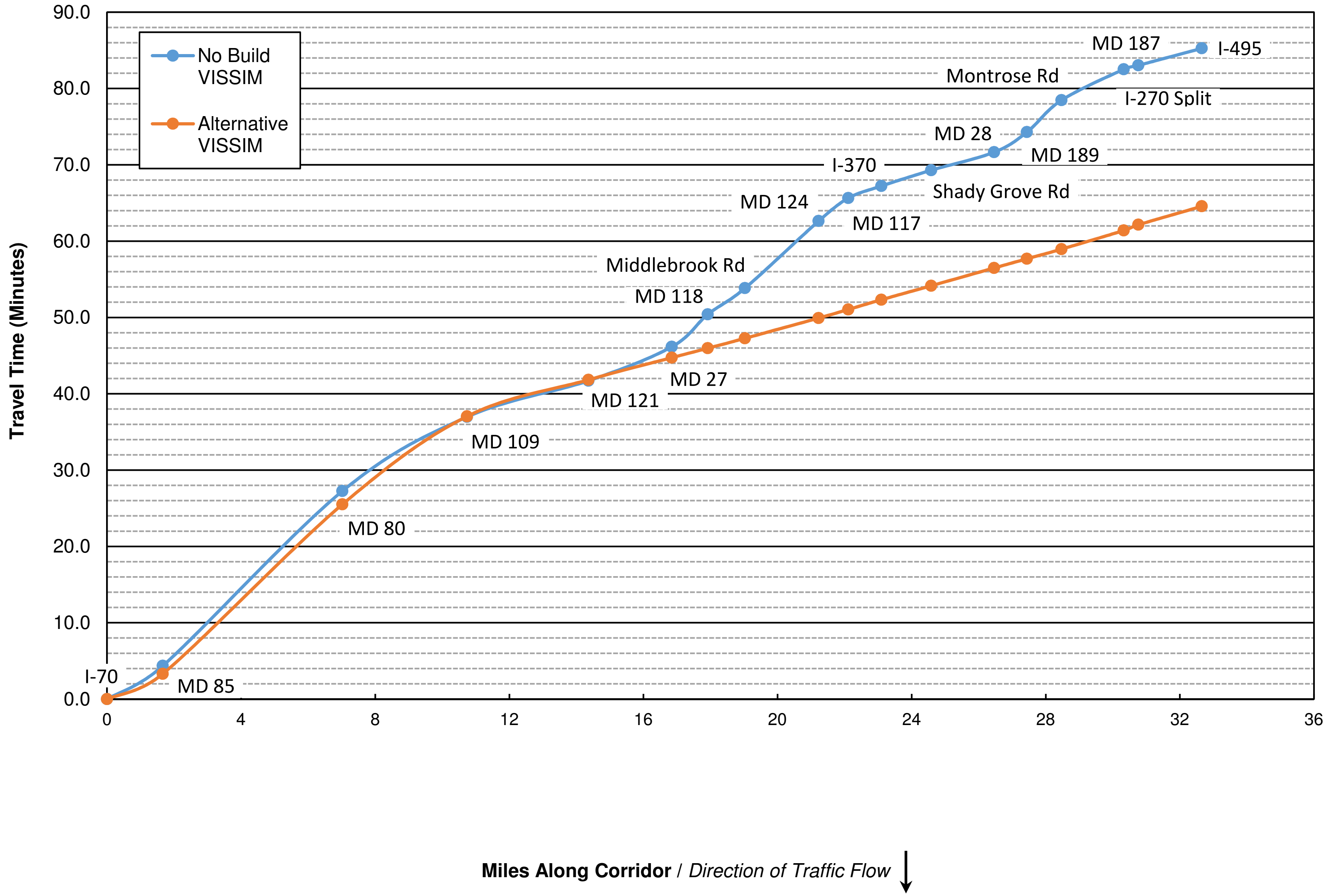
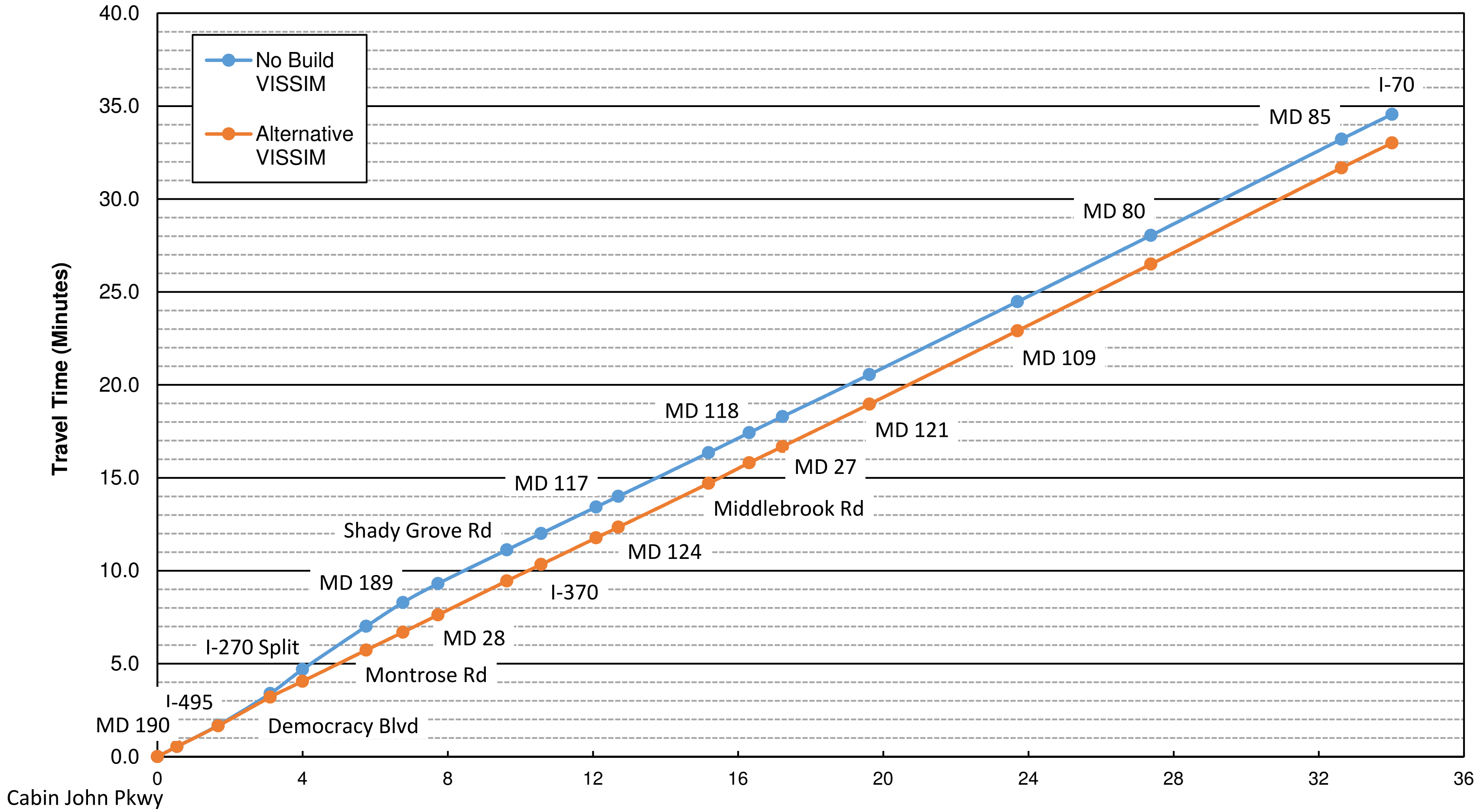
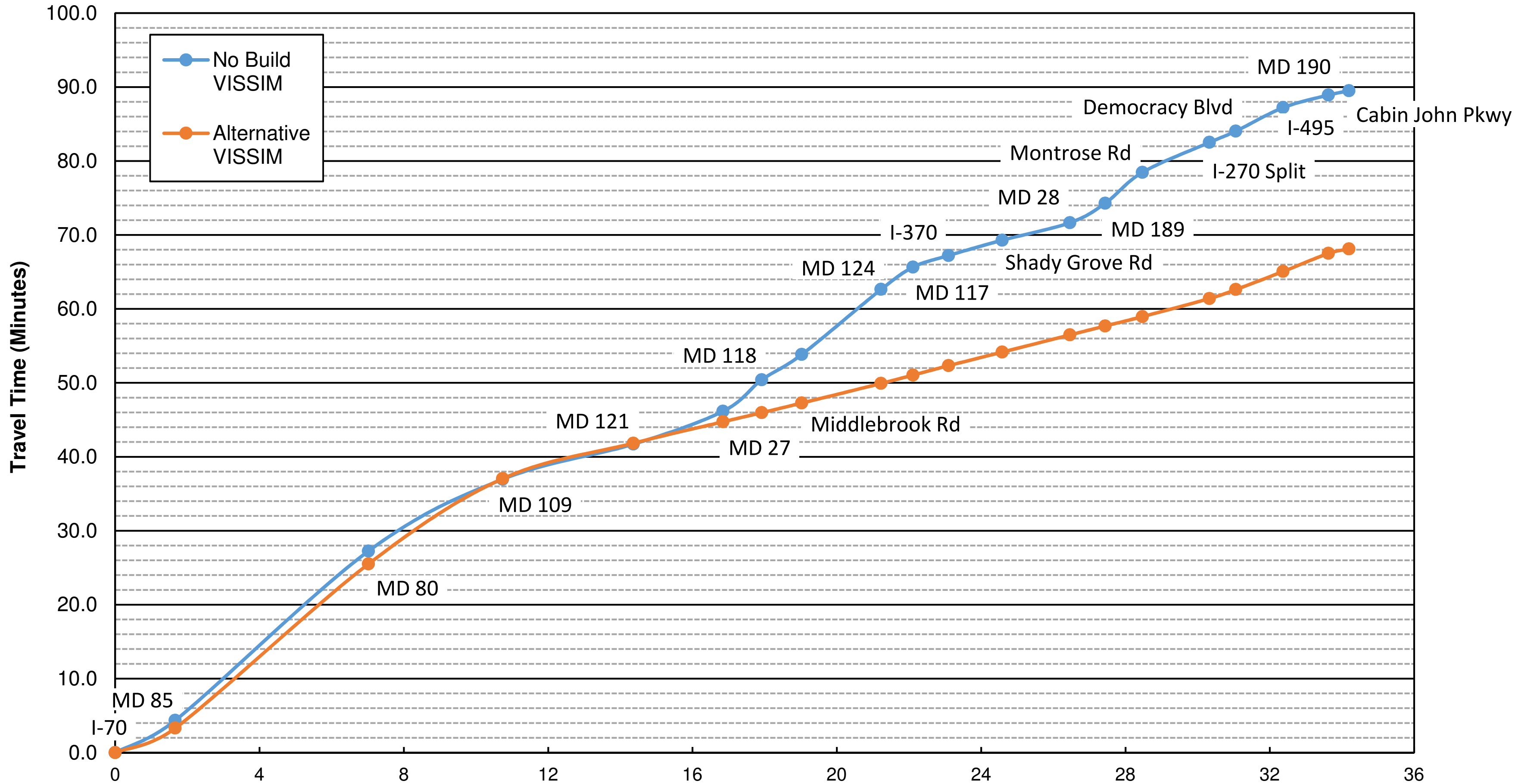


Figure C.3: AM Peak - No Build
I-270 Spur Travel Time Graph - Northbound



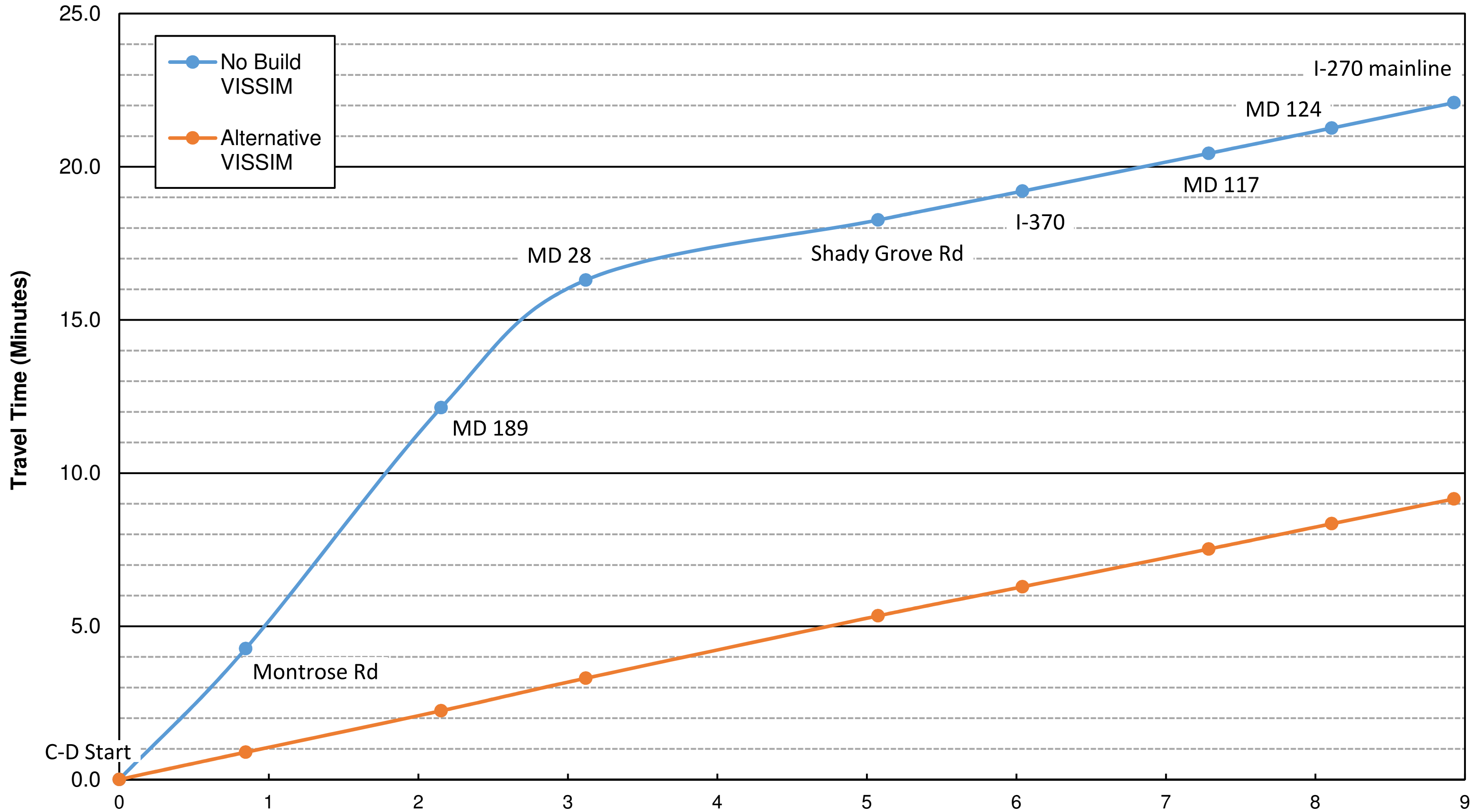
Miles Along Corridor / *Direction of Traffic Flow* ↑

Figure C.4: AM Peak - No Build
I-270 Spur Travel Time Graph - Southbound



Miles Along Corridor / *Direction of Traffic Flow* ↓

Figure C.5: AM Peak - No Build
I-270 Local Travel Time Graph - Northbound



Miles Along Corridor / *Direction of Traffic Flow* ↑

Figure C.6: AM Peak - No Build
I-270 Local Travel Time Graph - Southbound

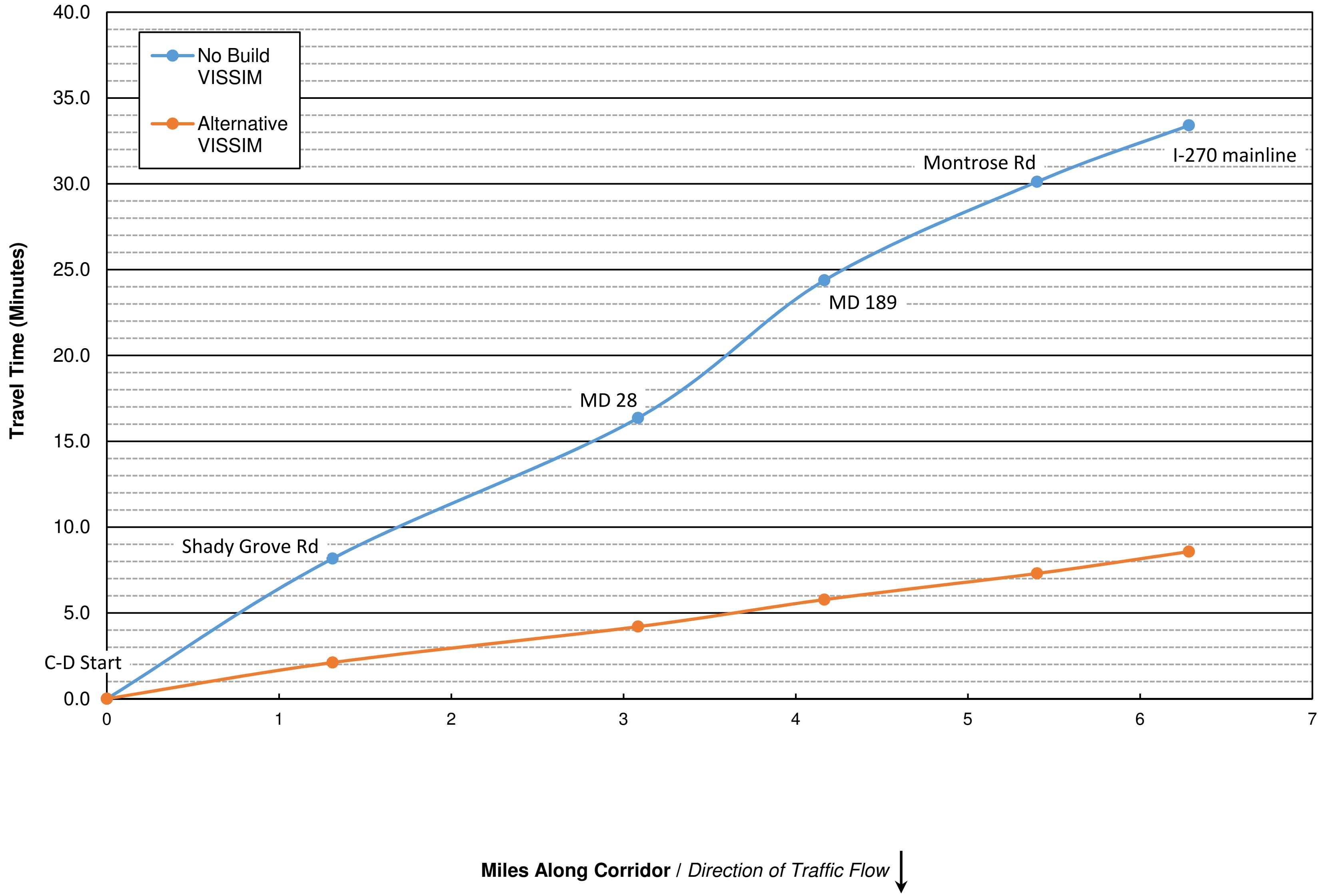


Table C.3: AM Peak - No Build - I-270 Vehicle Speed

I-270 Northbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From I-495 interchange				From I-70			
to MD 187	57.4	59.9	4%	to MD 85	22.9	30.2	32%
to I-270 Split	44.8	53.6	20%	to MD 80	14.0	14.5	3%
to Montrose Rd	45.4	62.7	38%	to MD 109	23.0	19.3	-16%
to MD 189	47.4	63.1	33%	to MD 121	45.8	45.4	-1%
to MD 28	56.9	62.5	10%	to MD 27	33.5	51.4	53%
to Shady Grove Rd	62.9	62.2	-1%	to MD 118	15.2	52.2	244%
to I-370	64.1	64.0	0%	to Middlebrook Rd	19.4	51.1	164%
to MD 117	63.8	63.5	0%	to MD 124	15.0	49.7	232%
to MD 124	64.0	63.9	0%	to MD 117	17.7	47.2	168%
to Middlebrook Rd	63.6	63.3	0%	to I-370	37.6	46.3	23%
to MD 118	62.3	60.6	-3%	to Shady Grove Rd	43.1	48.7	13%
to MD 27	63.4	62.8	-1%	to MD 28	47.6	48.3	2%
to MD 121	63.6	63.0	-1%	to MD 189	22.3	48.7	118%
to MD 109	62.4	62.0	-1%	to Montrose Rd	14.8	48.9	230%
to MD 80	61.9	61.5	-1%	to I-270 Split	27.5	45.6	66%
to MD 85	60.8	60.8	0%	to MD 187	51.0	35.0	-31%
to I-70	62.5	62.3	0%	to I-495 interchange	50.8	46.8	-8%
I-270 Total (miles/minutes)	**59.8**	**61.9**	**4%**	**I-270 Total (miles/minutes)**	**23.0**	**30.3**	**32%**
I-270 Spur Northbound				**I-270 Spur Southbound**			
From Cabin John Pkwy				From I-70			
to MD 190	59.9	59.9	0%	to I-270 Split	22.1	29.6	34%
to I-495	59.5	61.0	3%	to Democracy Blvd	28.8	36.0	25%
to Democracy Blvd	50.3	55.7	11%	to I-495	24.7	32.1	30%
to I-270 Split	41.3	62.7	52%	to MD 190	44.4	30.9	-31%
to I-70	60.3	62.2	3%	to Cabin John Pkwy	58.5	57.3	-2%
I-270 Spur Total (miles/minutes)	**59.1**	**61.8**	**5%**	**I-270 Spur Total (miles/minutes)**	**22.9**	**30.1**	**31%**

Table C.4: AM Peak - No Build - I-270 Local Vehicle Speed

I-270 Northbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From C-D start				From C-D start			
to Montrose Rd	11.9	57.1	381%	to Shady Grove	9.6	37.3	287%
to MD 189	10.0	58.0	482%	to MD 28	13.0	50.9	292%
to MD 28	13.9	54.6	292%	to MD 189	8.1	41.2	409%
to Shady Grove	59.8	57.6	-4%	to Montrose	12.9	48.6	276%
to I-370	61.5	61.0	-1%	to I-270 mainline	16.1	41.7	159%
to MD 117	60.6	60.7	0%				
to MD 124	59.8	59.7	0%				
to I-270 mainline	59.3	60.6	2%				
I-270 Local Total (miles/minutes)	**24.2**	**58.5**	**141%**	**I-270 Local Total (miles/minutes)**	**11.3**	**44.0**	**290%**

Figure C.7: HCM 2010 Density Level of Service Criteria (pc/mi/ln)

HCM 2010 Freeway LOS	
< 11	A
> 11 - 18	B
> 18 - 26	C
> 26 - 35	D
> 35 - 45	E
> 45	F
HCM 2010 Freeway Merge and Diverge Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 Freeway Weaving Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 C-D Weaving Segment LOS	
< 12	A
> 12 - 24	B
> 24 - 32	C
> 32 - 36	D
> 36 - 40	E
> 40	F

Table C.5: AM Peak - No Build - I-270 Vehicle Density

I-270 Northbound	Type	No Build Density (pc/mi/ln)	No Build LOS	Alternative Density (pc/mi/ln)	Alternative LOS	% Change	I-270 Southbound	Type	No Build Density (pc/mi/ln)	No Build LOS	Alternative Density (pc/mi/ln)	Alternative LOS	% Change
I-270	Freeway	40	E	15	B	-62%	I-270	Freeway	45	F	33	D	-28%
I-270 Diverge to MD 187	Diverge	35	D	27	C	-21%	I-270 Merge from WB I-70	Merge	62	F	40	F	-34%
I-270	Freeway	45	F	37	E	-17%	I-270	Freeway	67	F	50	F	-26%
I-270 Diverge to Rockledge Rd	Diverge	35	D	27	C	-21%	I-270 Merge from EB I-70	Merge	57	F	43	F	-26%
I-270	Freeway	48	F	21	C	-56%	I-270	Freeway	67	F	57	F	-15%
I-270 Weave from MD 187 to I-270 HOV	Weave	30	D	18	B	-39%	I-270 Diverge to SB MD 85	Diverge	70	F	18	B	-75%
I-270 Lane Drop	Merge	47	F	22	C	-52%	I-270	Freeway	92	F	83	F	-10%
I-270	Freeway	64	F	2	A	-97%	I-270 Diverge to NB MD 85	Diverge	56	F	52	F	-7%
I-270 Merge from I-270 Spur	Merge	63	F	30	D	-53%	I-270	Freeway	119	F	107	F	-10%
I-270 Weave from I-270 HOV to I-270 C-D	Weave	68	F	27	C	-61%	I-270 Merge from MD 85	Merge	104	F	85	F	-18%
I-270	Freeway	38	E	25	C	-33%	I-270	Freeway	112	F	115	F	3%
I-270 Diverge to C-D (MD 189)	Diverge	31	D	25	C	-18%	I-270 Diverge to MD 80	Diverge	61	F	40	E	-35%
I-270	Freeway	23	C	21	C	-10%	I-270	Freeway	108	F	116	F	7%
I-270 Diverge to C-D (MD 28)	Diverge	50	F	22	C	-56%	I-270 Merge from MD 80	Merge	111	F	106	F	-4%
I-270	Freeway	14	B	22	C	55%	I-270	Freeway	75	F	66	F	-12%
I-270 Merge from C-D (MD 189)	Merge	14	B	18	B	34%	I-270 Diverge to MD 109	Diverge	41	F	46	F	14%
I-270 Diverge to C-D (Shady Grove Rd)	Diverge	18	B	31	D	68%	I-270	Freeway	80	F	92	F	14%
I-270	Freeway	12	B	14	B	17%	I-270 Merge from MD 109	Merge	87	F	82	F	-5%
I-270 Weave from C-D (MD 28) to C-D (Shady Grove Rd)	Weave	10	B	15	B	44%	I-270	Freeway	44	E	45	E	1%
I-270	Freeway	10	A	19	C	83%	I-270 Diverge to SB Weigh Station	Diverge	19	B	19	B	3%
I-270 Merge from C-D (Shady Grove Rd)	Merge	9	A	12	B	42%	I-270	Freeway	38	E	40	E	5%
I-270	Freeway	12	B	15	B	31%	I-270 Merge from SB Weigh Station	Merge	20	B	20	C	0%
I-270 Merge from C-D (I-370)	Merge	10	B	15	B	47%	I-270	Freeway	41	E	38	E	-7%
I-270 Diverge to C-D (MD 117)	Diverge	16	B	10	A	-41%	I-270 Diverge to MD 121	Diverge	20	B	16	B	-19%
I-270	Freeway	12	B	16	B	27%	I-270	Freeway	28	D	23	C	-19%
I-270 Merge from C-D (MD 124)	Merge	14	B	23	C	65%	I-270 Merge from WB MD 121	Merge	33	D	36	E	8%
I-270	Freeway	16	B	16	B	-3%	I-270	Freeway	43	E	30	D	-30%
I-270 Diverge to EB Middlebrook Rd	Diverge	10	B	10	A	-7%	I-270 Merge from EB MD 121	Merge	37	E	9	A	-76%
I-270	Freeway	15	B	14	B	-9%	I-270	Freeway	55	F	16	B	-70%
I-270 Diverge to WB Middlebrook Rd	Diverge	10	A	16	B	64%	I-270 Diverge to MD 27	Diverge	57	F	24	C	-58%
I-270	Freeway	13	B	16	B	19%	I-270	Freeway	81	F	25	C	-69%
I-270 Diverge to EB MD 118	Diverge	11	B	12	B	6%	I-270 Merge from WB MD 27	Merge	90	F	22	C	-75%
I-270 Diverge to WB MD 118	Diverge	15	B	14	B	-8%	I-270	Freeway	82	F	32	D	-61%
I-270	Freeway	13	B	15	B	13%	I-270 Weave from EB MD 27 to MD 118	Weave	81	F	25	C	-69%
I-270 Weave from MD 118 to MD 27	Weave	13	B	14	B	8%	I-270	Freeway	91	F	31	D	-65%
I-270	Freeway	12	B	15	B	18%	I-270 Merge from WB MD 118	Merge	73	F	23	C	-68%
I-270 Merge from EB MD 27	Merge	13	B	14	B	8%	I-270	Freeway	85	F	34	D	-60%
I-270	Freeway	14	B	11	B	-16%	I-270 Merge from EB MD 118	Merge	73	F	28	D	-61%
I-270 Merge from WB MD 27	Merge	11	B	14	B	27%	I-270	Freeway	70	F	39	E	-44%
I-270	Freeway	14	B	12	B	-15%	I-270 Merge from Middlebrook Rd	Merge	113	F	43	F	-62%
I-270 Diverge to MD 121	Diverge	11	B	11	B	-2%	I-270	Freeway	86	F	20	C	-77%

Table C.5: AM Peak - No Build - I-270 Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270	Freeway	11	A	11	B	7%	I-270 Diverge to Watkins Mill Rd	Diverge	81	F	20	C	-75%
I-270 Merge from EB MD 121	Merge	10	A	26	C	166%	I-270	Freeway	124	F	56	F	-55%
I-270 Lane Drop	Merge	13	B	16	B	23%	I-270 Diverge to MD 124	Diverge	89	F	13	B	-86%
I-270	Freeway	19	C	14	B	-28%	I-270	Freeway	133	F	26	D	-80%
I-270 Diverge to NB Weigh Station	Diverge	10	B	17	B	64%	I-270 Merge from Watkins Mill	Merge	158	F	40	F	-74%
I-270	Freeway	21	C	14	B	-31%	I-270	Freeway	99	F	33	D	-66%
I-270 Merge from NB Weight Station	Merge	10	B	10	B	-2%	I-270 Merge from WB MD 124	Merge	132	F	29	D	-78%
I-270	Freeway	21	C	12	B	-43%	I-270	Freeway	53	F	34	D	-36%
I-270 Diverge to MD 109	Diverge	11	B	17	B	48%	I-270 Merge from MD 117	Merge	49	F	39	E	-19%
I-270	Freeway	19	C	11	B	-42%	I-270	Freeway	48	F	25	C	-48%
I-270 Merge from MD 109	Merge	11	B	11	B	4%	I-270 Diverge to I-370	Diverge	41	F	32	D	-23%
I-270	Freeway	21	C	16	B	-23%	I-270	Freeway	49	F	38	E	-23%
I-270 Diverge to MD 80	Diverge	12	B	22	C	84%	I-270 Diverge to I-270 C-D	Diverge	96	F	38	E	-61%
I-270	Freeway	19	C	22	C	19%	I-270	Freeway	20	C	24	C	22%
I-270 Merge from MD 80	Merge	14	B	21	C	51%	I-270 Merge from I-270 (I-370)	Merge	20	C	20	B	-4%
I-270	Freeway	24	C	11	B	-53%	I-270 Diverge to I-270 C-D (Shady Grove Rd)	Diverge	27	C	31	D	16%
I-270 Diverge to Scenic View	Diverge	12	B	140	F	1020%	I-270	Freeway	21	C	28	D	35%
I-270	Freeway	24	C	1	A	-96%	I-270 Merge from I-270 C-D (Shady Grove Rd Northern)	Merge	18	B	41	F	134%
I-270 Merge from Scenic View	Merge	12	B	28	C	129%	I-270	Freeway	26	C	29	D	13%
I-270	Freeway	25	C	6	A	-77%	I-270 Merge from I-270 C-D (Shady Grove Rd Southern)	Merge	32	D	24	C	-24%
I-270 Diverge to NB MD 85	Diverge	14	B	18	B	31%	I-270 Diverge to I-270 C-D (MD 189)	Diverge	46	F	20	C	-56%
I-270	Freeway	23	C	52	F	121%	I-270	Freeway	82	F	33	D	-59%
I-270 Diverge to SB MD 85	Diverge	17	B	22	C	26%	I-270 Merge from I-270 C-D (MD 189)	Merge	106	F	31	D	-70%
I-270	Freeway	19	C	16	B	-19%	I-270	Freeway	77	F	25	C	-67%
I-270 Weave from MD 85 to I-70	Weave	13	B	19	B	45%	I-270 Merge from I-270 C-D	Merge	39	E	31	D	-22%
I-270	Freeway	17	B	5	A	-71%	I-270 Diverge to I-270 HOV Lane	Diverge	19	B	49	F	164%
							I-270 Diverge to I-270 Spur	Diverge	40	E	5	A	-88%
							I-270	Freeway	23	C	40	E	75%
							I-270 Diverge to Rockledge Dr / MD 187	Diverge	17	B	29	D	70%
							I-270	Freeway	23	C	20	C	-15%
							I-270 Merge from Rockledge Dr	Merge	19	B	42	F	118%
							I-270	Freeway	24	C	74	F	205%
							I-270 Merge from Rockledge Dr / MD 187	Merge	22	C	8	A	-62%
							I-270	Freeway	26	C	30	D	18%

Table C.6: AM Peak - No Build - I-270 Spur Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Spur Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270 Spur	Freeway	57	F	51	F	-11%	I-270 Spur	Freeway	49	F	26	C	-47%
I-270 Spur Merge from Clara Barton Parkway	Merge	25	C	61	F	141%	I-270 Spur Weave from I-270 HOV to Democracy Blvd	Weave	60	F	24	C	-61%
I-270 Spur	Freeway	39	E	31	D	-20%	I-270 Spur	Freeway	54	F	13	B	-76%
I-270 Diverge to MD 190	Diverge	28	D	53	F	87%	I-270 Merge from Democracy Blvd	Merge	30	D	31	D	4%
I-270 Spur	Freeway	34	D	15	B	-56%	I-270 Spur Lane Drop	Merge	54	F	9	A	-83%
I-270 Spur Merge from Cabin John Parkway	Merge	25	C	22	C	-14%	I-270 Spur	Freeway	75	F	14	B	-82%
I-270 Spur Merge from MD 190	Merge	26	C	13	B	-48%	I-270 Spur Merge from I-495	Merge	37	E	10	B	-72%
I-270 Spur	Freeway	35	D	99	F	187%	I-270 Spur	Freeway	45	F	15	B	-66%
I-270 Spur Diverge to I-495	Merge	38	E	9	A	-77%	I-270 Spur Diverve to EB MD 190	Diverge	56	F	84	F	52%
I-270 Spur	Freeway	40	E	3	A	-92%	I-270 Spur Diverve to Cabin John Pkwy	Diverge	27	C	30	D	9%
I-270 Spur Diverge to Democracy Blvd	Diverge	33	D	7	A	-79%	I-270 Spur	Freeway	29	D	23	C	-21%
I-270 Spur	Freeway	36	E	53	F	45%	I-270 Merge from MD 190	Merge	26	C	24	C	-8%
I-270 Spur Merge from EB Democracy Blvd	Merge	30	D	10	B	-66%	I-270 Spur	Freeway	34	D	37	E	8%
I-270 Spur	Freeway	39	E	27	D	-30%	I-270 Diverge to WB Clara Barton Pkwy	Diverge	23	C	33	D	48%
I-270 Spur Merge from WB Democracy Blvd	Merge	30	D	47	F	56%	I-270 Spur	Freeway	33	D	33	D	-2%
I-270 Spur	Freeway	43	E	19	C	-57%	I-270 Merge from Clara Barton Pkwy	Merge	30	D	22	C	-27%
I-270 Spur Merge from Westlake Terrace	Merge	45	F	36	E	-22%							
I-270 Spur	Freeway	50	F	113	F	124%							

Table C.7: AM Peak - No Build - I-270 Local Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Souhbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270 C-D	Freeway	84	F	22	C	-73%	I-270 C-D	Freeway	107	F	24	C	-77%
I-270 C-D Diverge to EB Montrose Rd	Diverge	48	F	31	D	-35%	I-270 C-D Weave from I-370 EB to I-270	Weave	128	F	40	F	-68%
I-270 C-D	Freeway	80	F	28	D	-65%	I-270 C-D Diverge to Shady Grove Rd	Diverge	115	F	29	D	-75%
I-270 C-D Weave between Montrose Rd Loop Ramps	Weave	69	F	23	B	-68%	I-270 C-D	Freeway	137	F	27	D	-80%
I-270 C-D	Freeway	84	F	25	C	-71%	I-270 C-D Merge from WB Shady Grove Rd	Merge	106	F	16	B	-85%
I-270 C-D Merge from WB Montrose Rd	Merge	89	F	22	C	-76%	I-270 C-D	Freeway	113	F	26	C	-77%
I-270 C-D	Freeway	98	F	9	A	-90%	I-270 C-D Merge from EB Shady Grove Rd	Merge	77	F	19	B	-76%
I-270 C-D Merge from I-270	Merge	96	F	23	C	-76%	I-270 C-D	Freeway	93	F	30	D	-68%
I-270 C-D	Freeway	104	F	15	B	-85%	I-270 C-D Merge from I-270	Merge	98	F	26	C	-73%
I-270 C-D Diverge to MD 189	Diverge	58	F	18	B	-68%	I-270 C-D Diverge to I-270	Diverge	56	F	28	D	-50%
I-270 C-D	Freeway	111	F	28	D	-75%	I-270 C-D Diverge to I-270	Diverge	64	F	33	D	-48%
I-270 C-D Merge from MD 189	Merge	101	F	18	B	-82%	I-270 C-D	Freeway	75	F	47	F	-38%
I-270 C-D	Freeway	114	F	25	C	-78%	I-270 C-D Diverge to MD 28	Diverge	62	F	39	E	-36%
I-270 C-D Weave between I-270 (to MD 28 from MD 189)	Weave	108	F	12	B	-89%	I-270 C-D	Freeway	128	F	23	C	-82%
I-270 C-D	Freeway	106	F	32	D	-69%	I-270 C-D Merge from WB MD 28	Merge	160	F	40	E	-75%
I-270 C-D Diverge to MD 28	Diverge	64	F	26	C	-60%	I-270 C-D	Freeway	132	F	8	A	-94%
I-270 C-D	Freeway	87	F	13	B	-85%	I-270 C-D Merge from EB MD 28	Merge	152	F	43	F	-72%
I-270 C-D Weave between MD 28 Ramps	Weave	109	F	19	B	-82%	I-270 C-D	Freeway	123	F	24	C	-80%
I-270 C-D	Freeway	7	A	19	C	185%	I-270 C-D Merge from I-270	Merge	124	F	33	D	-73%
I-270 C-D Merge from MD 28 WB	Merge	6	A	28	C	333%	I-270 C-D	Freeway	95	F	48	F	-50%
I-270 C-D Merge from I-270 and Drop Lane	Merge	7	A	34	D	367%	I-270 C-D Diverge to MD 189	Diverge	60	F	33	D	-45%
I-270 C-D Diverge to I-270	Diverge	12	B	8	A	-35%	I-270 C-D	Freeway	117	F	32	D	-73%
I-270 C-D	Freeway	19	C	15	B	-23%	I-270 C-D Merge from MD 189	Merge	120	F	32	D	-73%
I-270 C-D Diverge to Shady Grove Rd	Diverge	15	B	16	B	3%	I-270 C-D Diverge to I-270	Diverge	84	F	22	C	-74%
I-270 C-D	Freeway	5	A	12	B	128%	I-270 C-D	Freeway	92	F	33	D	-64%
I-270 C- D Merge from I-270 and EB Shady Grove Rd	Merge	8	A	11	B	41%	I-270 C-D Diverge to WB Montrose Rd	Diverge	55	F	30	D	-45%
I-270 C-D	Freeway	8	A	9	A	9%	I-270 C-D	Freeway	98	F	30	D	-70%
I-270 C-D Merge from WB Shady Grove Rd	Merge	10	A	13	B	32%	I-270 Weave between Montrose Rd Loops	Weave	94	F	35	D	-63%
I-270 C-D Diverge to I-270	Diverge	14	B	14	B	-3%	I-270 C-D	Freeway	76	F	34	D	-55%
I-270 C-D	Freeway	13	B	5	A	-63%	I-270 C-D Merge from EB Montrose Rd	Merge	56	F	46	F	-18%
I-270 C-D Diverge to I-370	Diverge	13	B	17	B	32%	I-270 C-D	Freeway	54	F	38	E	-30%
I-270 C-D	Freeway	2	A	4	A	61%							
I-270 Merge from I-370 EB	Merge	7	A	12	B	66%							
I-270 C-D	Freeway	8	A	12	B	63%							
I-270 C-D Weave from I-370 to I-270	Weave	19	B	15	B	-21%							
I-270 C-D	Freeway	14	B	8	A	-45%							
I-270 C-D Weave from I-270 to MD 117	Weave	19	B	18	B	-3%							
I-270 C-D Diverge to MD 124	Diverge	13	B	10	B	-19%							
I-270 C-D	Freeway	13	B	16	B	17%							
I-270 C-D Merge from EB MD 124	Merge	12	B	16	B	33%							
I-270 C-D Merge From WB MD 124	Merge	12	B	27	C	119%							
I-270 C-D	Freeway	10	A	19	C	92%							
I-270 C-D Merge fromWatkins Mill	Merge	10	A	9	A	-6%							

Table C.8: AM Peak - No Build - I-270 Vehicle Throughput

I-270 Northbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Southbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between I-495 and MD 187	4485	4861	8%	North of I-70	2514	2591	3%
Between MD 187 on and off ramps	3881	4320	11%	Between I-70 on ramps	2842	2948	4%
Between Rockledge Blvd on and off ramps	3138	3624	15%	From I-70 interchange to MD-85	4882	5070	4%
Between Rockledge Dr and I-270 Spur	2720	3301	21%	Between MD-85 on and off ramps	2530	2590	2%
Between I-270 Spur and Montrose Rd	7422	8829	19%	Between MD-85 and MD-80	3043	2973	-2%
Between Montrose Rd on and off ramps	4321	5083	18%	Between MD-80 on and off ramps	2724	2712	0%
Between Montrose Rd and MD 189	4064	4743	17%	Between MD-80 and Md-109	3532	3548	0%
Between MD 189 and MD 28	4018	4738	18%	Between MD-109 on and off ramps	3430	3471	1%
Between MD 28 on and off ramps	4122	5138	25%	Between MD-109 and MD-121	4100	4126	1%
Between MD 28 and Shady Grove Rd	2980	3805	28%	Between MD-121 on and off ramps	3551	3600	1%
Between Shady Grove Rd and I-370	2552	3290	29%	Between MD-121 and MD-27	4802	5165	8%
Between I-370 on and off ramps	2849	3590	26%	Between MD-27 on and off ramps	4223	4747	12%
Between I-370 and MD 117	3979	4728	19%	Between MD-27 and MD-118	4688	5313	13%
Between MD 117 and MD 124	3010	3497	16%	Between MD-118 on and off ramps	4542	5139	13%
Between MD-124 on and off ramps	3023	3492	16%	Between MD-118 and Middlebrook Rd	5199	5814	12%
Between Watkins Mill Rd and Middlebrook Rd	3974	4677	18%	Between Middlebrook Rd on and off ramps	5197	5821	12%
Between Middlebrook Rd on and off ramps	3705	4337	17%	Between Middlebrook Rd and MD-124	6832	7699	13%
Between Middlebrook Rd and MD 118	3293	3838	17%	Between MD-124 on and off ramps	5415	6433	19%
Between MD-118 on and off ramps	2981	3463	16%	Between MD-124 and MD-117	6469	7636	18%
Between MD 118 and MD 27	2827	3200	13%	Between MD-117 and I-370	8146	9378	15%
Between MD-27 on and off ramps	2280	2583	13%	Between I-370 on and off ramps	2997	3388	13%
Between MD 27 and MD 121	2687	2977	11%	Between I-370 on ramp to Shady Grove Rd	3871	4959	28%
Between MD-121 on and off ramps	1970	2176	10%	Between Shady Grove Rd and MD 28	3552	4514	27%
Between MD 121 and MD 109	2497	2707	8%	Between MD 28 on and off ramps	4372	5515	26%
Between MD-109 on and off ramps	2327	2499	7%	Between MD 28 and MD 189	3946	4898	24%
Between MD 109 and MD 80	2487	2645	6%	Between MD 189 and Montrose Rd	4070	4899	20%
Between MD-80 on and off ramps	2222	2352	6%	Between Montrose Rd on and off ramps	5046	6136	22%
Between MD 80 and MD 85	2916	3032	4%	Between Montose Rd and I-270 Spur	8064	9751	21%
Between MD-85 on and off ramps	2213	2303	4%	Between I-270 Spur and Rockledge Blvd	3823	4519	18%
Between MD 85 and I-70	3227	3311	3%	Between Rockledge Blvd on and off ramps	2733	3238	18%
North of I-70	2081	2137	3%	Between MD 187 on and off ramps	2887	3426	19%
				Between MD 187 and I-495	2902	3295	14%
I-270 Spur Northbound				**I-270 Spur Southbound**			
Between I-495 and Democracy Blvd	5264	5470	4%	Between I-270 Split and HOV on ramp	4251	5257	24%
Between Democracy Blvd on and off ramps	4077	4273	5%	Between HOV on ramp and Democracy Blvd	4186	5261	26%
Between Democracy Blvd and I-270 Split	4219	4557	8%	Between Democracy Blvd on and off ramps	3670	4621	26%
				Between Democracy Blvd and I-495	4194	5168	23%

Table C.9: AM Peak - No Build - I-270 Local Vehicle Throughput

I-270 Local Northbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Local Southbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between Montrose Rd EB off ramp and and EB on ramp	1707	2369	39%	Between I-370 on ramp and I-270 off ramp	3627	5314	47%
Between Montrose Rd EB on ramp and WB off ramp	1884	2615	39%	Between I-270 off ramp and Shady Grove off ramp	2767	3768	36%
Between Montrose Rd WB off ramp and on ramp	1556	2197	41%	Between Shady Grove off ramp and Shady Grove WB on ramp	1593	2148	35%
Between Montrose Rd WB on ramp and I-270 on ramp	2215	3294	49%	Between Shady Grove WB and EB on ramps	2225	2774	25%
Between I-270 on ramp and MD 189 off ramp	2316	3634	57%	Between Shady Grove on ramp and I-270 on ramp	2594	3160	22%
Between MD 189 ramps	1739	2929	68%	Between I-270 on ramp and I-270 off ramp1	3272	4041	24%
Between MD 189 off ramp and I-270 on ramp	2036	3523	73%	Between I-270 off ramp1 and I-270 off ramp2	2767	3429	24%
Between I-270 on ramp and I-270 off ramp	2547	4300	69%	Between I-270 off ramp2 and MD 28 off ramp	1961	2424	24%
Between I-270 off ramp and MD 28 EB off ramp	1823	3109	71%	Between MD 28 off ramp and MD 28 WB on ramp	1428	1769	24%
Between MD 28 EB off ramp to MD 28 EB on ramp	1585	2749	73%	Between MD 28 WB on ramp and MD 28 EB on ramp	1700	2088	23%
Between MD 28 EB on ramp and MD 28 WB off ramp	1616	2835	75%	Between MD 28 EB on ramp and I-270 on ramp	2375	3582	51%
Between MD 28 WB off ramp and MD 28 WB on ramp	751	1292	72%	Between I-270 on ramp and MD 189 off ramp	2871	4201	46%
Between MD 28 WB on ramp and I-270 on ramp	1263	1813	44%	Between MD 189 on and off ramps	2353	3436	46%
Between I-270 on ramp and I-270 off ramp	2439	3147	29%	Between MD 189 on ramp and I-270 off ramp	3387	4628	37%
Between I-270 off ramp and Shady Grove off ramp	2131	2690	26%	Between I-270 off ramp and Montrose Rd off ramp	2357	3125	33%
Between Shady Grove off ramp and I-270 on ramp	322	406	26%	Between Montrose Rd off ramp and Montrose Rd WB on ramp	2251	2966	32%
Between I-270 on ramp and Shady Grove WB on ramp	1448	1726	19%	Between Montrose Rd WB on ramp and EB off ramp	2992	3982	33%
Between Shady Grove WB on ramp and I-270 off ramp	1788	2063	15%	Between Montrose Rd EB off and on ramps	2336	3096	33%
Between I-270 off ramp and I-370 off ramp	1515	1770	17%	Between Montrose Rd EB off ramp and I-270	3139	3881	24%
Between I-370 off ramp and I-370 EB on ramp	286	334	17%				
Between I-370 EB and WB on ramps	919	967	5%				
Between I-370 WB on ramp and I-270 off ramp	2785	2834	2%				
Between I-270 off ramp and I-270 on ramp	1670	1698	2%				
Between I-270 on ramp and MD 117 off ramp	2654	2931	10%				
Between MD 117 off ramp and MD 124 off ramp	1509	1657	10%				
Between MD 124 off ramp and MD 124 EB on ramp	789	863	9%				
Between MD 124 EB and WB on ramps	1183	1255	6%				
Between MD 124 on ramp I-270	573	593	3%				

Table C.10: AM Peak - No Build - I-270 On Ramp Queue Length - Northbound

I-270 Northbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
Rockledge Dr on ramp	67	0	-100%	421	0	-100%
MD 189 C-D on ramp	0	0	0%	0	0	0%
MD 28 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp	0	0	0%	0	0	0%
I-370 C-D on ramp	0	0	0%	0	0	0%
MD 124 C-D on ramp	0	0	0%	0	0	0%
MD 118 on ramp	0	0	0%	0	0	0%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 121 on ramp	0	0	0%	0	0	0%
MD 109 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	0	0	0%	0	0	0%
MD 85 on ramp	0	0	0%	0	0	0%
I-270 Spur Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd EB on ramp	4	0	-100%	57	0	-100%
Democracy Blvd WB on ramp	0	0	-100%	5	0	-100%
I-495 Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Cabin John Pkwy on ramp	0	0	0%	0	0	0%
MD 190 on ramp	0	0	0%	0	0	0%
I-270 C-D Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Montrose Rd EB on ramp	436	0	-100%	1548	0	-100%
Montrose Rd WB on ramp	1047	0	-100%	2581	16	-99%
I-270 on ramp	409	0	-100%	1171	0	-100%
MD 189 on ramp	1304	0	-100%	2877	35	-99%
I-270 on ramp	1354	0	-100%	3378	0	-100%
MD 28 EB on ramp	3	0	-100%	55	3	-94%
MD 28 WB on ramp	0	0	0%	0	0	0%
Shady Grove Rd EB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	0	0%	0	0	0%
Shady Grove Rd WB on ramp	0	0	0%	0	0	0%
I-370 EB on ramp	0	0	0%	0	0	0%
I-370 WB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	5	4697%	29	233	714%
MD 124 EB on ramp	0	0	0%	0	0	0%
MD 124 WB on ramp	0	0	0%	0	0	0%
Watkins Mill Rd on ramp	0	0	-100%	24	0	-100%

Table C.11: AM Peak - No Build - I-270 Off Ramp Queue Length - Northbound

I-270 Northbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 187 off ramp NB	28	32	12%	242	236	-2%
MD 187 off ramp SB	0	0	0%	0	0	0%
Rockledge Dr off ramp	6	8	51%	359	373	4%
Tower Oaks Blvd off ramp	19	25	34%	179	175	-2%
Montrose Rd off ramp EB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	18	0%
MD 189 off ramp WB	8	11	34%	99	103	4%
MD 189 off ramp EB	60	4	-94%	1148	277	-76%
MD 28 off ramp EB	28	58	108%	227	346	52%
MD 28 off ramp WB	2636	0	-100%	5046	0	-100%
Shady Grove Rd off ramp - Redland Blvd	0	0	0%	0	0	0%
Shady Grove Rd off ramp WB	151	214	42%	605	758	25%
Shady Grove Rd off ramp EB	0	0	0%	0	0	0%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
MD 117 off ramp	311	363	17%	1011	1547	53%
MD 124 off ramp	95	106	12%	453	498	10%
Watkins Mill Rd off ramp	78	115	46%	366	496	36%
Middlebrook Rd EB off ramp	0	0	0%	0	0	0%
Middlebrook Rd WB off ramp	0	0	0%	0	0	0%
MD 118 WB off ramp - Seneca Meadows	0	0	0%	0	4	0%
MD 118 WB off ramp	0	0	0%	0	0	0%
MD 118 EB off ramp	0	0	0%	0	0	0%
MD 27 off ramp WB	7	8	22%	81	91	13%
MD 27 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp WB	62	70	14%	250	272	9%
MD 121 off ramp EB	0	0	0%	0	0	0%
MD 109 off ramp EB	29	12	-57%	228	162	-29%
MD 109 off ramp WB	8	0	-100%	84	0	-100%
MD 80 off ramp EB	7	8	8%	102	108	5%
MD 80 off ramp WB	0	0	-100%	26	0	-100%
MD 85 NB off ramp	0	0	0%	0	0	0%
MD 85 SB off ramp	1	0	-30%	126	74	-41%
I-270 Spur Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Clara Barton Pkwy off ramp EB	1	1	0%	214	214	0%
Clara Barton Pkwy off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp EB	0	1	4847%	10	118	1060%
MD 190 off ramp WB	0	0	0%	0	0	0%
Democracy Blvd off ramp WB	104	112	8%	563	545	-3%
Democracy Blvd off ramp EB	15	17	11%	143	132	-8%

Table C.12: AM Peak - No Build - I-270 On Ramp Queue Length - Southbound

I-270 Southbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 on ramp	41	7	-84%	528	261	-51%
MD 80 on ramp	1039	221	-79%	2688	1692	-37%
MD 109 on ramp	995	414	-58%	1914	1452	-24%
MD 121 WB on ramp	135	0	-100%	972	0	-100%
MD 121 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	552	0	-100%	2591	0	-100%
MD 27 EB on ramp	3	0	-100%	173	0	-100%
MD 118 WB on ramp	0	0	0%	0	0	0%
MD 118 EB on ramp	0	0	-100%	44	0	-100%
Middlebrook Rd on ramp	2842	0	-100%	4433	0	-100%
Watkins Mill Rd on ramp	3066	0	-100%	3136	0	-100%
MD 124 WB on ramp	2789	0	-100%	4158	0	-100%
MD 117 on ramp	293	0	-100%	1898	0	-100%
I-370 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp North	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp South	2	0	-100%	127	0	-100%
MD 189 C-D on ramp	1787	0	-100%	3610	30	-99%
Montrose Rd C-D on ramp	2	45	1791%	227	841	271%
Rockledge Dr on ramp	0	0	0%	0	0	0%
MD 187 on ramp	0	0	0%	0	0	0%
I-270 Spur Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd on ramp	0	0	0%	0	0	0%
I-495 Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 Spur on ramp	147	1199	716%	1557	2579	66%
MD 190 on ramp	0	0	0%	0	0	0%
I-270 C-D Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 on ramp	2947	95	-97%	4900	1776	-64%
I-370 on ramp	2511	10	-100%	2932	532	-82%
Shady Grove Rd WB on ramp	28	0	-100%	597	0	-100%
Shady Grove Rd EB on ramp	0	0	-100%	37	0	-100%
I-270 on ramp	0	0	-100%	42	0	-100%
MD 28 WB on ramp	1406	0	-100%	2299	0	-100%
MD 28 EB on ramp	3724	101	-97%	3882	664	-83%
I-270 on ramp	1	0	-100%	74	0	-100%
MD 189 on ramp	3725	0	-100%	4200	0	-100%
Montrose Rd WB on ramp	68	2	-98%	926	247	-73%
Montrose Rd EB on ramp	0	0	-93%	69	11	-84%

Table C.13: AM Peak - No Build - I-270 Off Ramp Queue Length - Southbound

I-270 Southbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 SB off ramp	297	16	-95%	1410	687	-51%
MD 85 NB off ramp	0	0	85%	43	79	84%
MD 80 off ramp	1	0	-67%	99	98	0%
MD 109 off ramp WB	0	0	-99%	25	7	-72%
MD 109 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp EB	219	261	19%	946	990	5%
MD 121 off ramp WB	10	18	82%	519	527	2%
MD 27 off ramp EB	50	59	18%	262	289	11%
MD 27 off ramp WB	881	229	-74%	3309	1048	-68%
MD 118 off ramp EB	31	33	6%	160	156	-2%
MD 118 off ramp WB	0	0	0%	0	0	0%
Watkins Mill Rd off ramp	2034	138	-93%	5055	953	-81%
MD 124 off ramp EB	70	75	6%	368	337	-9%
MD 124 off ramp WB	19	14	-27%	419	364	-13%
I-370 off ramp WB	0	0	0%	0	0	0%
I-370 off ramp EB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Omega Drive	4	9	93%	172	232	35%
Shady Grove Rd off ramp	0	0	0%	0	0	0%
MD 28 off ramp	4	7	68%	154	181	18%
MD 189 off ramp EB	35	51	46%	238	311	31%
MD 189 off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp EB	382	1	-100%	1566	115	-93%
Rockledge Dr off ramp	27	1442	5214%	343	3142	815%
I-270 Spur Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd off ramp EB	50	60	21%	219	232	6%
Democracy Blvd off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp WB	1389	2302	66%	3571	4439	24%
MD 190 off ramp EB	0	0	0%	0	41	0%
Clara Barton Pkwy WB off ramp	0	0	176%	5	11	108%

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	23.0	C	NB Left	119	77	82	496	E	38.6	D
				NB Through	365	28	82	496	C		
				NB Right	664	11	22	438	B		
	SB	50.1	D	SB Left	137	63	174	771	E		
				SB Through	599	50	174	771	D		
				SB Right	68	26	174	771	C		
	EB	50.9	D	EB Left	105	78	56	182	E		
				EB Through	62	81	56	182	F		
				EB Right	113	9	56	182	A		
	WB	52.7	D	WB Left	230	77	90	355	E		
				WB Through	15	67	90	355	E		
				WB Right	126	7	90	355	A		
2- MD 85 at I-270 NB on and off ramp											
2	NB	52.1	D	NB Left	683	52	265	1136	D	36.3	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	18.8	B	SB Left	0	0	0	0	A		
				SB Through	611	19	56	562	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	5.3	A	NB Left	0	0	0	0	A	10.2	B
				NB Through	1071	5	19	413	A		
				NB Right	0	0	0	0	A		
	SB	40.9	D	SB Left	172	41	43	440	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	19.4	C	NB Left	13	71	54	382	E	25.0	C
				NB Through	762	19	54	382	B		
				NB U-Turn	0	0	0	0	A		
	SB	18.8	B	SB Left	64	69	25	156	E		
				SB Through	1783	18	80	627	B		
				SB Right	808	16	68	617	B		
	EB	52.7	D	EB Left	621	54	91	276	D		
				EB Through	28	68	91	276	E		
				EB Right	42	17	91	276	B		
	WB	44.1	D	WB Left	52	53	21	137	D		
				WB Through	18	56	21	137	E		
				WB Right	19	9	21	137	A		
5- MD 80 at I-270 NB on and ramp											
5	NB	-1.0	A	NB Left	3	1	0	4	A	21.2	C
				NB Through	1	1	0	4	A		
				NB Right	5	-3	0	4	A		
	SB	13.0	B	SB Left	204	16	14	108	B		
				SB Through	6	20	14	108	B		
				SB Right	59	2	0	0	A		
	EB	11.3	B	EB Left	54	12	11	183	B		
				EB Through	0	0	8	0	A		
				EB Right	5	5	19	213	A		
	WB	23.1	C	WB Left	35	24	1	56	C		
				WB Through	879	31	182	786	C		
				WB Right	639	12	11	442	B		
6- MD 80 at I-270 SB on and off ramp											
6	NB	6.2	A	NB Left	24	37	2	134	E	31.6	D
				NB Through	0	0	0	0	A		
				NB Right	258	3	2	134	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	36.7	E	EB Left	0	0	0	0	A		
				EB Through	360	36	67	436	E		
				EB Right	161	38	68	446	E		
	WB	47.8	E	WB Left	0	0	0	0	A		
				WB Through	278	48	157	758	E		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	29.9	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	33.1	D	SB Left	143	37	37	244	E		
				SB Through	0	0	0	0	A		
				SB Right	47	20	17	177	C		
	EB	15.7	C	EB Left	88	11	5	149	B		
				EB Through	0	0	0	0	A		
				EB Right	63	22	0	0	C		
	WB	32.2	D	WB Left	0	0	0	0	A		
				WB Through	671	32	399	555	D		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	9.3	A	NB Left	17	36	4	78	E	33.7	D
				NB Through	0	0	0	0	A		
				NB Right	48	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	50.0	E	EB Left	0	0	0	0	A		
				EB Through	92	34	58	270	D		
				EB Right	102	64	60	268	F		
	WB	31.6	D	WB Left	570	29	158	594	D		
				WB Through	156	39	152	571	E		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	17.8	C	NB Left	154	27	43	285	C	51.2	D
				NB Through	434	22	43	285	C		
				NB Right	327	8	52	311	A		
	SB	32.3	D	SB Left	55	22	113	555	C		
				SB Through	792	33	123	555	C		
				SB Right	8	26	131	576	C		
	EB	120.4	F	EB Left	8	97	421	525	F		
				EB Through	99	125	422	525	F		
				EB Right	646	120	452	557	F		
	WB	21.8	C	WB Left	137	25	18	147	C		
				WB Through	17	22	18	147	C		
				WB Right	28	6	16	171	A		
10- MD 121 at I-270 NB on and off ramp											
10	NB	28.3	D	NB Left	324	59	67	255	F	19.0	B
				NB Through	0	0	0	0	A		
				NB Right	402	3	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	11.5	B	EB Left	0	0	0	0	A		
				EB Through	513	18	32	325	C		
				EB Right	285	1	0	0	A		
	WB	18.6	C	WB Left	233	63	145	805	F		
				WB Through	1337	11	145	805	B		
				WB Right	0	0	0	0	A		

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	18.3	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	62.8	E	SB Left	218	94	225	953	F		
				SB Through	0	0	0	0	A		
				SB Right	304	40	8	439	E		
	EB	5.2	A	EB Left	0	0	0	0	A		
				EB Through	578	5	12	206	A		
				EB Right	0	0	0	0	A		
	WB	8.8	A	WB Left	0	0	0	0	A		
				WB Through	642	18	61	438	C		
				WB Right	1010	3	30	185	A		
12- MD 27 at Observation Dr											
12	NB	48.1	D	NB U-Turn	0	0	0	0	A	37.1	D
				NB Through	48	58	14	72	E		
				NB Right	12	7	14	72	A		
	SB	44.0	D	SB Left	91	52	29	192	D		
				SB Through	54	52	39	261	D		
				SB Right	178	38	64	298	D		
	EB	16.9	B	EB Left	151	40	40	324	D		
				EB Through	1217	14	42	325	B		
				EB Right	48	10	49	363	B		
	WB	48.1	D	WB Left	100	32	333	847	C		
				WB Through	2130	50	333	847	D		
				WB Right	109	30	333	847	C		
13- MD 27 at I-270 NB off ramp											
13	NB	35.6	D	NB Left	106	36	15	88	D	52.4	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	973	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	76.7	E	WB Left	0	0	0	0	A		
				WB Through	2166	77	1092	2164	E		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	70.6	E
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	49.4	D	SB Left	384	49	61	275	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.6	A	EB Left	0	0	0	0	A		
				EB Through	840	3	2	62	A		
				EB Right	0	0	0	0	A		
	WB	118.3	F	WB Left	0	0	0	0	A		
				WB Through	1365	118	1106	1497	F		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	64.8	E	NB Left	30	38	296	736	D	92.0	F
				NB Through	1051	65	316	736	E		
				NB Right	92	70	327	748	E		
	SB	119.1	F	SB Left	514	118	1842	3792	F		
				SB Through	1620	121	1842	3792	F		
				SB Right	51	81	1836	3787	F		
	EB	44.2	D	EB Left	224	50	59	199	D		
				EB Through	97	43	55	194	D		
				EB Right	75	29	60	228	C		
	WB	46.8	D	WB Left	11	56	32	103	E		
				WB Through	32	224	32	103	F		
				WB Right	142	6	32	103	A		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	3.6	A	NB Left	109	11	1	72	B	6.1	A
				NB Through	725	3	4	134	A		
				NB Right	60	1	9	187	A		
	SB	4.0	A	SB Left	31	4	7	238	A		
				SB Through	948	4	10	238	A		
				SB Right	41	2	12	271	A		
	EB	18.4	B	EB Left	20	65	10	77	E		
				EB Through	6	82	10	77	F		
				EB Right	115	7	10	77	A		
	WB	44.2	D	WB Left	35	71	16	102	E		
				WB Through	6	55	11	101	D		
				WB Right	27	7	14	111	A		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	10.2	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	29.6	C	EB Left	274	30	31	194	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.4	A	WB Left	0	0	0	0	A		
				WB Through	188	1	0	0	A		
				WB Right	911	6	15	309	A		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	7.5	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	38.1	D	SB Left	215	38.1	34	163	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	3.7	A	EB Left	0	0.0	0	0	A		
				EB Through	631	3.7	5	194	A		
				EB Right	0	0.0	0	0	A		
	WB	4.1	A	WB Left	0	0.0	0	0	A		
				WB Through	1214	4.1	9	173	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	46.2	D	NB Left	9	78	9	75	E	20.6	C
				NB Through	13	80	9	75	F		
				NB Right	17	3	0	24	A		
	SB	60.5	E	SB Left	267	55	112	418	E		
				SB Through	53	72	112	418	E		
				SB Right	96	68	112	418	E		
	EB	12.4	B	EB Left	132	16	37	329	B		
				EB Through	1019	12	37	329	B		
				EB Right	34	12	37	329	B		
	WB	15.1	B	WB Left	83	23	47	310	C		
				WB Through	1046	17	47	310	B		
				WB Right	324	6	47	310	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	16.4	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	20.4	C	SB Left	26	36	5	63	D		
				SB Through	0	0	0	0	A		
				SB Right	27	5	5	63	A		
	EB	14.1	B	EB Left	231	21	29	249	C		
				EB Through	825	12	29	249	B		
				EB Right	0	0	0	0	A		
	WB	18.0	B	WB Left	0	0	0	0	A		
				WB Through	1141	19	72	392	B		
				WB Right	275	15	97	441	B		

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21	NB			NB Left	0	0	0	0	A	19.5	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	13.7	B	EB Left	0	0	0	0	A		
				EB Through	763	14	31	203	B		
				EB Right	0	0	0	0	A		
	WB	25.4	C	WB Left	761	25	104	893	C		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22	NB	179.6	F	NB Left	145	136	348	485	F	70.4	E
				NB Through	6	133	348	485	F		
				NB Right	268	204	348	485	F		
	SB	17.6	B	SB Left	3	39	1	29	D		
				SB Through	0	0	1	29	A		
				SB Right	5	5	2	67	A		
	EB	69.3	E	EB Left	31	21	645	1297	C		
				EB Through	1448	71	645	1297	E		
				EB Right	80	62	645	1297	E		
	WB	18.4	B	WB Left	80	23	33	237	C		
				WB Through	719	19	33	237	B		
				WB Right	41	4	33	237	A		
23- MD 124 at MD 355											
23	NB	52.9	D	NB Left	228	73	86	264	E	96.2	F
				NB Through	390	48	84	262	D		
				NB Right	54	3	0	0	A		
	SB	104.2	F	SB Left	64	166	490	804	F		
				SB Through	1188	124	490	804	F		
				SB Right	559	54	284	780	D		
	EB	54.5	D	EB Left	610	130	444	1095	F		
				EB Through	494	17	444	1095	B		
				EB Right	555	5	236	1008	A		
	WB	143.6	F	WB Left	0	0	0	0	A		
				WB Through	1717	146	760	1115	F		
				WB Right	52	73	0	0	E		
24- MD 124 at I-270 SB on and off											
24	NB	65.3	F	NB Left	16	62	18	95	E	29.3	C
				NB Through	37	67	18	95	E		
				NB U-Turn	0	0	0	0	A		
	SB	26.0	C	SB Left	285	65	77	373	E		
				SB Through	11	65	77	373	E		
				SB Right	588	6	14	350	A		
	EB	17.0	B	EB Left	0	0	0	0	A		
				EB Through	1037	17	50	409	B		
				EB Right	67	14	60	433	B		
	WB	41.6	D	WB Left	43	47	1679	2437	D		
				WB Through	1136	41	1679	2437	D		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25	NB	49.7	D	NB Left	20	108	157	726	F	48.5	D
				NB Through	541	64	157	726	E		
				NB Right	433	30	76	717	C		
	SB	47.0	D	SB Left	181	69	221	826	E		
				SB Through	1072	48	221	826	D		
				SB Right	131	9	0	0	A		
	EB	54.0	D	EB Left	102	119	217	782	F		
				EB Through	1470	50	217	783	D		
				EB Right	82	47	229	811	D		
	WB	39.4	D	WB Left	319	70	103	304	E		
				WB Through	478	27	103	304	C		
				WB Right	99	0	0	0	A		
26- MD 117 at Bureau Dr											
26	NB	50.3	D	NB Left	25	64	19	125	E	41.1	D
				NB Through	24	65	19	125	E		
				NB Right	26	23	19	125	C		
	SB	174.5	F	SB Left	197	177	223	397	F		
				SB Through	55	190	223	397	F		
				SB Right	32	130	223	397	F		
	EB	36.8	D	EB Left	33	26	272	958	C		
				EB Through	2020	37	278	958	D		
				EB Right	29	43	271	948	D		
	WB	20.8	C	WB Left	299	67	134	543	E		
				WB Through	840	10	134	544	A		
				WB Right	314	6	100	582	A		
27- MD 117 at I-270 SB off ramp											
27	NB			NB Left	0	0	0	0	A	9.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.0	A	EB Left	0	0	0	0	A		
				EB Through	835	2	1	180	A		
				EB Right	0	0	0	0	A		
	WB	28.1	D	WB Left	328	28	59	453	D		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28	NB			NB Left	0	0	0	0	A	34.5	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	60.5	E	SB Left	287	63	325	1037	E		
				SB Through	0	0	0	0	A		
				SB Right	871	60	329	1039	E		
	EB	19.2	B	EB Left	14	123	74	848	F		
				EB Through	821	17	74	848	B		
				EB Right	0	0	0	0	A		
	WB	15.6	B	WB Left	0	0	0	0	A		
				WB Through	909	16	60	360	B		
				WB Right	9	8	66	390	A		
29- MD 117 at Perry Pkwy											
29	NB	44.5	D	NB Left	36	76	17	120	E	15.9	B
				NB Through	7	58	17	119	E		
				NB Right	38	12	27	140	B		
	SB	48.7	D	SB Left	112	96	60	247	F		
				SB Through	14	102	60	247	F		
				SB Right	133	3	60	247	A		
	EB	10.6	B	EB Left	119	70	44	269	E		
				EB Through	975	3	44	269	A		
				EB Right	10	1	31	254	A		
	WB	10.4	B	WB Left	8	89	21	297	F		
				WB Through	747	10	21	297	B		
				WB Right	136	6	21	297	A		
30- Shady Grove Rd at I-270 NB off ramp											
30	NB	9.8	A	NB Left	0	0	0	0	A	22.3	C
				NB Through	959	10	22	267	A		
				NB Right	0	0	0	0	A		
	SB	10.4	B	SB Left	0	0	0	0	A		
				SB Through	1349	10	34	334	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	55.7	E	WB Left	846	56	160	616	E		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB	12.7	B	NB Through	1004	13	37	399	B		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	9.3	A	SB Through	1565	9	32	563	A		
				SB Right	0	0	0	0	A		
31				EB Left	286	41	42	360	D	19.9	B
	EB	47.4	D	EB Through	0	0	0	0	A		
				EB Right	576	51	98	441	D		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
				NB U-Turn	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	426	44	68	327	D		
	SB	35.7	D	SB Through	0	0	0	0	A		
				SB Right	103	3	0	36	A		
32				EB Left	0	0	0	0	A	67.9	E
	EB	131.7	F	EB Through	683	200	1979	2136	F		
				EB Right	409	18	1925	2144	B		
				WB Left	0	0	0	0	A		
	WB	25.4	C	WB Through	1235	25	23	384	C		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
				NB Left	0	0	32	238	A		
	NB	36.5	D	NB Through	128	53	38	247	D		
				NB Right	80	10	38	247	A		
				SB Left	26	102	128	357	F		
	SB	84.5	F	SB Through	0	0	0	0	A		
				SB Right	273	83	128	357	F		
33				EB Left	177	45	57	407	D	36.3	D
	EB	21.4	C	EB Through	599	15	57	407	B		
				EB Right	0	0	0	0	A		
				WB Left	26	37	101	391	D		
	WB	33.3	C	WB Through	944	33	83	354	C		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
				NB Left	63	42	17	117	D		
	NB	37.3	D	NB Through	8	40	14	117	D		
				NB Right	10	8	16	128	A		
				SB Left	63	45	19	229	D		
	SB	17.3	B	SB Through	6	45	19	229	D		
				SB Right	478	13	54	147	B		
34				EB Left	227	55	111	1165	E	23.3	C
	EB	24.6	C	EB Through	680	15	17	199	B		
				EB Right	10	10	26	236	A		
				WB Left	4	26	64	389	C		
	WB	26.4	C	WB Through	311	27	63	388	C		
				WB Right	11	13	77	422	B		
35- MD 189 at I-270 Ramps											
				NB Left	88	61	18	121	E		
	NB	60.5	E	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	150	56	48	258	E		
	SB	55.9	E	SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
35				EB Left	284	138	627	1494	F	79.7	E
	EB	106.2	F	EB Through	436	85	627	1494	F		
				EB Right	0	0	0	0	A		
				WB Left	457	53	107	429	D		
	WB	60.0	E	WB Through	244	73	107	429	E		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
				NB Left	161	48	85	311	D		
	NB	71.9	E	NB Through	125	95	85	311	F		
				NB Right	155	78	85	311	E		
				SB Left	325	210	509	805	F		
	SB	142.8	F	SB Through	593	106	482	792	F		
				SB Right	0	0	0	0	A		
36				EB Left	137	157	650	1047	F	117.9	F
	EB	162.3	F	EB Through	803	170	650	1047	F		
				EB Right	101	106	650	1047	F		
				WB Left	346	69	104	353	E		
	WB	49.3	D	WB Through	318	34	104	353	C		
				WB Right	47	6	104	353	A		
37- Montrose Rd at Tower Oaks Blvd											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	123	49	1098	1406	D		
	SB	235.8	F	SB Through	0	0	0	0	A		
				SB Right	435	289	1123	1402	F		
37				EB Left	28	65	136	923	E	104.5	F
	EB	25.5	C	EB Through	1513	25	136	923	C		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	141.4	F	WB Through	1255	145	491	850	F		
				WB Right	58	60	491	850	E		
38- Tower Oaks Blvd at I-270 off rmap											
				NB Left	385	22	30	200	C		
	NB	24.1	C	NB Through	8	22.5	25	192	C		
				NB Right	22	64.1	30	200	E		
				SB Left	0	800.1	0	20	F		
	SB	0.6	A	SB Through	0	0.0	0	20	A		
				SB Right	4	0.6	0	0	A		
38				EB Left	6	113.7	347	465	F	78.2	E
	EB	122.8	F	EB Through	558	122.3	347	465	F		
				EB Right	82	126.7	338	456	F		
				WB Left	0	0.0	3	80	A		
	WB	9.5	A	WB Through	81	9.9	3	80	A		
				WB Right	6	5.0	0	25	A		
39- Montrose Rd at Tower Oaks Blvd											
				NB Left	37	71	49	285	E		
	NB	17.9	B	NB Through	240	42	49	285	D		
				NB Right	555	4	12	151	A		
				SB Left	334	54	163	619	D		
	SB	41.1	D	SB Through	778	37	163	618	D		
				SB Right	78	29	124	658	C		
39				EB Left	76	74	416	718	E	50.9	D
	EB	90.2	F	EB Through	971	92	418	718	F		
				EB Right	62	89	439	742	F		
				WB Left	300	52	68	290	D		
	WB	43.4	D	WB Through	188	50	68	290	D		
				WB Right	109	7	77	321	A		
40- Rockledge Blvd at I-270 NB on and off ramp											
				NB Left	0	0	0	0	A		
	NB	34.1	C	NB Through	92	32	33	165	C		
				NB Right	216	35	33	165	C		
				SB Left	0	0	4	61	A		
	SB	2.0	A	SB Through	923	2	4	61	A		
				SB Right	0	0	0	0	A		
40				EB Left	7	48	126	506	D	18.0	B
	EB	26.9	C	EB Through	529	54	126	506	D		
				EB Right	563	1	0	0	A		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	2.6	A	NB Left	97	3	5	72	A	20.4	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	21.7	C	WB Left	923	23	92	655	C		
				WB Through	403	20	92	655	B		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	58.8	E	NB Left	230	25	265	793	C	153.0	F
				NB Through	1468	55	265	793	D		
				NB Right	213	124	265	793	F		
	SB	224.9	F	SB Left	60	164	2605	2704	F		
				SB Through	1204	225	2605	2704	F		
				SB Right	162	247	2605	2704	F		
	EB	186.0	F	EB Left	223	128	1864	1988	F		
				EB Through	624	205	1865	1989	F		
				EB Right	129	194	1889	2013	F		
	WB	188.4	F	WB Left	721	229	1921	2147	F		
				WB Through	393	152	1921	2147	F		
				WB Right	159	92	1921	2147	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	11.2	B	NB Left	163	76	57	257	E	19.1	B
				NB Through	1541	4	57	257	A		
				NB Right	0	0	0	0	A		
	SB	25.4	C	SB Left	0	0	0	0	A		
				SB Through	1529	25	81	553	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	49.5	D	WB Left	114	50	35	250	D		
				WB Through	10	47	35	250	D		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	23.9	C	NB Left	0	0	0	0	A	25.9	C
				NB Through	1478	24	68	404	C		
				NB Right	0	0	0	0	A		
	SB	7.7	A	SB Left	178	49	58	295	D		
				SB Through	1465	3	58	295	A		
				SB Right	0	0	0	0	A		
	EB	80.8	F	EB Left	228	58	187	740	E		
				EB Through	0	0	187	740	A		
				EB Right	371	95	232	784	F		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	14.9	B	NB Left	255	57	68	257	E	20.8	C
				NB Through	1383	7	69	258	A		
				NB Right	10	6	93	291	A		
	SB	21.9	C	SB Left	13	25	98	632	C		
				SB Through	1668	24	98	632	C		
				SB Right	144	1	63	619	A		
	EB	37.9	D	EB Left	190	59	56	222	E		
				EB Through	26	54	56	222	D		
				EB Right	251	20	56	222	C		
	WB	7.2	A	WB Left	1	7	1	29	A		
				WB Through	9	11	1	29	B		
				WB Right	5	0	0	7	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	29.7	C	NB Left	217	30	24	159	C	13.4	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	12.7	B	EB Left	0	0	0	0	A		
				EB Through	1654	13	50	446	B		
				EB Right	0	0	0	0	A		
	WB	10.4	B	WB Left	0	0	0	0	A		
				WB Through	778	10	23	187	B		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	6.6	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.4	A	EB Left	0	0	0	0	A		
				EB Through	1768	5	23	270	A		
				EB Right	0	0	0	0	A		
	WB	8.7	A	WB Left	223	37	31	173	D		
				WB Through	771	1	21	152	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	12.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	32.9	C	SB Left	329	49	57	226	D		
				SB Through	0	0	0	0	A		
				SB Right	171	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	2.6	A	WB Left	0	0	0	0	A		
				WB Through	770	3	4	133	A		
				WB Right	334	2	1	163	A		
50- MD 190 at Burdette Rd											
50	NB	73.2	E	NB Left	20	80	15	118	E	13.2	B
				NB Through	4	59	15	118	E		
				NB Right	11	67	15	118	E		
	SB	34.4	C	SB Left	50	79	31	151	E		
				SB Through	17	64	31	151	E		
				SB Right	120	12	31	151	B		
	EB	10.5	B	EB Left	53	93	61	561	F		
				EB Through	1814	8	60	561	A		
				EB Right	15	6	51	584	A		
	WB	12.5	B	WB Left	1	106	61	828	F		
				WB Through	1494	13	62	828	B		
				WB Right	21	2	55	834	A		

Table C.14: AM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51	NB			NB Left	0	0	0	0	A	53.3	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	123.2	F	EB Left	531	123	347	715	F		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	15.9	B	WB Left	0	0	0	0	A		
				WB Through	994	16	76	747	B		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52	NB	79.3	E	NB Left	258	79	1392	3574	E	14.2	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.9	A	EB Left	0	0	0	0	A		
				EB Through	982	3	6	151	A		
				EB Right	0	0	0	0	A		
	WB	5.7	A	WB Left	0	0	0	0	A		
				WB Through	667	6	8	160	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53	NB	68.2	E	NB Left	21	67	23	149	E	45.0	D
				NB Through	59	69	25	148	E		
				NB Right	0	0	0	0	A		
	SB	56.9	E	SB Left	624	56	184	777	E		
				SB Through	183	59	185	778	E		
				SB Right	18	54	184	777	D		
	EB	37.5	D	EB Left	24	30	135	584	C		
				EB Through	846	38	135	584	D		
				EB Right	42	42	135	584	D		
	WB	39.7	D	WB Left	119	127	125	418	F		
				WB Through	639	33	128	421	C		
				WB Right	157	1	4	127	A		
54- MD 124 at I-270 NB off ramp											
54	NB	40.6	D	NB Left	0	0	0	0	A	26.5	C
				NB Through	0	0	0	0	A		
				NB Right	723	41	100	459	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	15.6	B	EB Left	0	0	0	0	A		
				EB Through	933	16	37	359	B		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55	NB	37.1	D	NB Left	0	0	0	0	A	16.2	B
				NB Through	0	0	0	0	A		
				NB Right	928	37	113	575	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	4.5	A	EB Left	0	0	0	0	A		
				EB Through	1657	5	18	95	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
56- Watkins Mill Rd at I-270 SB off ramp/Parkview Ave											
56	NB	747.0	F	NB Left	46	222	668	726	F	174.0	F
				NB Through	0	0	0	0	A		
				NB Right	86	1028	668	726	F		
	SB	83.5	F	SB Left	552	113	2037	5048	F		
				SB Through	131	109	2037	5048	F		
				SB Right	447	39	2037	5048	D		
	EB	463.4	F	EB Left	0	0	0	0	A		
				EB Through	494	463	1163	1232	F		
				EB Right	2	599	1163	1232	F		
	WB	41.8	D	WB Left	116	87	120	459	F		
				WB Through	769	35	117	457	D		
				WB Right	0	0	0	0	A		
57- Watkins Mill Rd at I-270 NB on ramp											
57	NB	35.2	D	NB Left	386	51	92	383	D	70.0	E
				NB Through	0	0	0	0	A		
				NB Right	478	23	92	383	C		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	19.1	B	EB Left	190	61	49	301	E		
				EB Through	749	8	49	301	A		
				EB Right	0	0	0	0	A		
	WB	139.2	F	WB Left	0	0	0	0	A		
				WB Through	954	150	640	849	F		
				WB Right	174	78	640	849	E		
58- Watkins Mill Rd at I-270 SB on ramp											
58	NB			NB Left	0	0	0	0	A	60.7	E
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	73.4	E	EB Left	0	0	0	0	A		
				EB Through	938	30	483	620	C		
				EB Right	182	299	483	620	F		
	WB	50.0	D	WB Left	456	142	273	516	F		
				WB Through	883	2	273	516	A		
				WB Right	0	0	0	0	A		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	21.8	C	NB Left	119	76	76	484	E	36.7	D
				NB Through	373	26	76	484	C		
				NB Right	676	10	28	455	B		
	SB	47.7	D	SB Left	137	65	154	712	E		
				SB Through	596	46	154	712	D		
				SB Right	68	26	154	712	C		
	EB	48.4	D	EB Left	107	75	54	196	E		
				EB Through	62	75	54	196	E		
				EB Right	113	9	54	196	A		
	WB	50.3	D	WB Left	234	72	88	345	E		
				WB Through	16	68	88	345	E		
				WB Right	126	7	88	345	A		
2- MD 85 at I-270 NB on and off ramp											
2	NB	53.7	D	NB Left	687	54	286	1303	D	37.8	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	19.8	B	SB Left	0	0	0	0	A		
				SB Through	608	20	57	655	B		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	5.4	A	NB Left	0	0	0	0	A	10.8	B
				NB Through	1068	5	19	447	A		
				NB Right	0	0	0	0	A		
	SB	43.6	D	SB Left	175	44	46	284	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	19.2	C	NB Left	13	51	54	397	D	25.5	C
				NB Through	762	19	54	397	B		
				NB U-Turn	0	0	0	0	A		
	SB	19.8	B	SB Left	66	73	27	165	E		
				SB Through	1840	19	87	696	B		
				SB Right	831	18	73	686	B		
	EB	52.6	D	EB Left	619	54	92	290	D		
				EB Through	28	72	92	290	E		
				EB Right	43	16	92	290	B		
	WB	43.9	D	WB Left	52	53	21	134	D		
				WB Through	18	55	21	134	D		
				WB Right	19	9	21	134	A		
5- MD 80 at I-270 NB on and ramp											
5	NB	-1.0	A	NB Left	4	0	0	0	A	10.6	B
				NB Through	2	0	0	0	A		
				NB Right	4	-3	0	0	A		
	SB	12.8	B	SB Left	218	16	14	113	B		
				SB Through	6	16	14	113	B		
				SB Right	63	2	0	0	A		
	EB	10.7	B	EB Left	55	11	10	151	B		
				EB Through	0	0	8	0	A		
				EB Right	5	5	18	182	A		
	WB	10.2	B	WB Left	35	10	1	55	B		
				WB Through	879	16	81	601	B		
				WB Right	637	3	0	102	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	3.5	A	NB Left	22	9	1	136	A	13.3	B
				NB Through	0	0	0	0	A		
				NB Right	258	3	1	136	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	15.4	C	EB Left	0	0	0	0	A		
				EB Through	359	15	22	259	C		
				EB Right	160	16	22	268	C		
	WB	19.2	C	WB Left	0	0	0	0	A		
				WB Through	278	19	28	451	C		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	13.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	16.2	C	SB Left	153	20	21	178	C		
				SB Through	0	0	0	0	A		
				SB Right	50	4	1	106	A		
	EB	9.2	A	EB Left	85	7	1	102	A		
				EB Through	0	0	0	0	A		
				EB Right	62	12	0	0	B		
	WB	13.0	B	WB Left	0	0	0	0	A		
				WB Through	659	13	128	447	B		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	4.1	A	NB Left	16	17	2	94	C	14.2	B
				NB Through	0	0	0	0	A		
				NB Right	48	0	0	39	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	15.0	C	EB Left	0	0	0	0	A		
				EB Through	89	8	15	135	A		
				EB Right	98	21	16	147	C		
	WB	14.9	B	WB Left	559	14	69	354	B		
				WB Through	156	19	66	331	C		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	18.2	C	NB Left	161	27	45	275	C	51.2	D
				NB Through	456	23	45	275	C		
				NB Right	342	7	55	301	A		
	SB	31.6	D	SB Left	57	20	107	506	B		
				SB Through	803	32	116	506	C		
				SB Right	8	37	127	526	D		
	EB	122.1	F	EB Left	9	97	421	520	F		
				EB Through	100	127	421	520	F		
				EB Right	656	122	452	552	F		
	WB	20.5	C	WB Left	138	23	17	128	C		
				WB Through	16	21	18	128	C		
				WB Right	28	5	15	149	A		
10- MD 121 at I-270 NB on and off ramp											
10	NB	28.5	D	NB Left	356	60	76	277	F	19.3	B
				NB Through	0	0	0	0	A		
				NB Right	451	4	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	12.1	B	EB Left	0	0	0	0	A		
				EB Through	508	18	34	308	C		
				EB Right	285	1	0	0	A		
	WB	18.3	C	WB Left	235	65	134	779	F		
				WB Through	1361	10	134	779	B		
				WB Right	0	0	0	0	A		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	18.4	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	68.9	E	SB Left	212	100	267	997	F		
				SB Through	0	0	0	0	A		
				SB Right	302	47	15	443	E		
	EB	5.2	A	EB Left	0	0	0	0	A		
				EB Through	578	5	12	221	A		
				EB Right	0	0	0	0	A		
	WB	7.7	A	WB Left	0	0	0	0	A		
				WB Through	677	19	41	335	C		
				WB Right	1037	1	0	0	A		
12- MD 27 at Observation Dr											
12	NB	48.5	D	NB U-Turn	0	0	0	0	A	34.7	C
				NB Through	48	59	14	71	E		
				NB Right	12	7	14	71	A		
	SB	45.6	D	SB Left	91	52	30	192	D		
				SB Through	54	52	42	281	D		
				SB Right	178	40	67	318	D		
	EB	16.7	B	EB Left	162	39	42	301	D		
				EB Through	1294	14	43	302	B		
				EB Right	51	11	51	340	B		
	WB	44.3	D	WB Left	101	31	313	840	C		
				WB Through	2149	46	313	840	D		
				WB Right	109	25	313	840	C		
13- MD 27 at I-270 NB off ramp											
13	NB	36.3	D	NB Left	118	36	16	99	D	44.8	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	1001	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	65.8	E	WB Left	0	0	0	0	A		
				WB Through	2177	66	973	2057	E		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	72.7	E
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	48.0	D	SB Left	419	48	70	303	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.5	A	EB Left	0	0	0	0	A		
				EB Through	830	3	2	53	A		
				EB Right	0	0	0	0	A		
	WB	122.1	F	WB Left	0	0	0	0	A		
				WB Through	1389	122	1127	1633	F		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	71.4	E	NB Left	30	42	327	744	D	94.5	F
				NB Through	1034	72	348	744	E		
				NB Right	91	79	358	757	E		
	SB	118.9	F	SB Left	532	115	1483	2046	F		
				SB Through	1685	121	1483	2046	F		
				SB Right	54	81	1477	2040	F		
	EB	44.0	D	EB Left	224	50	58	199	D		
				EB Through	97	43	55	194	D		
				EB Right	76	28	60	228	C		
	WB	47.7	D	WB Left	11	56	33	103	E		
				WB Through	32	229	33	103	F		
				WB Right	142	6	33	103	A		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	3.5	A	NB Left	125	11	1	76	B	6.0	A
				NB Through	782	2	4	146	A		
				NB Right	66	1	8	199	A		
	SB	4.1	A	SB Left	31	4	7	206	A		
				SB Through	948	4	10	206	A		
				SB Right	41	3	12	238	A		
	EB	18.4	B	EB Left	20	65	10	77	E		
				EB Through	6	82	10	77	F		
				EB Right	115	7	10	77	A		
	WB	44.7	D	WB Left	35	72	16	102	E		
				WB Through	6	55	11	101	D		
				WB Right	27	8	14	111	A		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	10.0	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	28.3	C	EB Left	274	28	29	195	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.5	A	WB Left	0	0	0	0	A		
				WB Through	188	1	0	0	A		
				WB Right	911	6	16	292	A		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	8.7	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	35.2	D	SB Left	241	35.2	36	159	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	4.9	A	EB Left	0	0.0	0	0	A		
				EB Through	631	4.9	7	196	A		
				EB Right	0	0.0	0	0	A		
	WB	5.7	A	WB Left	0	0.0	0	0	A		
				WB Through	1316	5.7	15	260	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	46.2	D	NB Left	9	78	9	75	E	20.2	C
				NB Through	13	81	9	75	F		
				NB Right	17	3	0	23	A		
	SB	60.5	E	SB Left	267	55	112	418	E		
				SB Through	53	72	112	418	E		
				SB Right	96	68	112	418	E		
	EB	12.3	B	EB Left	133	16	37	329	B		
				EB Through	1019	12	37	329	B		
				EB Right	34	12	37	329	B		
	WB	14.9	B	WB Left	88	24	50	350	C		
				WB Through	1144	18	50	350	B		
				WB Right	351	4	50	350	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	17.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	20.5	C	SB Left	26	36	6	63	D		
				SB Through	0	0	0	0	A		
				SB Right	27	5	6	63	A		
	EB	15.3	B	EB Left	266	25	37	272	C		
				EB Through	950	13	37	272	B		
				EB Right	0	0	0	0	A		
	WB	18.6	B	WB Left	0	0	0	0	A		
				WB Through	1142	19	75	414	B		
				WB Right	275	15	101	464	B		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
21				SB Right	0	0	0	0	A	17.3	B
				EB Left	0	0	0	0	A		
	EB	11.9	B	EB Through	871	12	29	189	B		
				EB Right	0	0	0	0	A		
				WB Left	761	23	94	931	C		
	WB	23.5	C	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
				NB Left	188	53	159	439	D		
	NB	63.9	E	NB Through	8	51	159	439	D		
				NB Right	363	70	159	439	E		
				SB Left	3	40	1	29	D		
	SB	18.1	B	SB Through	0	0	1	29	A		
22				SB Right	5	5	2	67	A	27.5	C
				EB Left	34	12	160	915	B		
	EB	20.9	C	EB Through	1611	22	160	915	C		
				EB Right	92	12	160	915	B		
				WB Left	87	22	34	235	C		
	WB	17.8	B	WB Through	781	18	34	235	B		
				WB Right	47	4	34	235	A		
23- MD 124 at MD 355											
				NB Left	228	69	86	260	E		
	NB	51.8	D	NB Through	390	49	84	258	D		
				NB Right	54	3	0	0	A		
				SB Left	67	144	352	801	F		
	SB	73.2	E	SB Through	1243	97	352	801	F		
23				SB Right	597	16	161	783	B	82.8	F
				EB Left	634	165	652	1169	F		
	EB	67.3	E	EB Through	528	18	652	1169	B		
				EB Right	585	5	472	1151	A		
				WB Left	0	0	0	0	A		
	WB	116.3	F	WB Through	1920	118	717	1123	F		
				WB Right	59	67	0	0	E		
24- MD 124 at I-270 SB on and off											
				NB Left	16	62	18	95	E		
	NB	65.3	F	NB Through	37	67	18	95	E		
				NB U-Turn	0	0	0	0	A		
				SB Left	318	62	82	342	E		
	SB	24.1	C	SB Through	12	64	82	342	E		
24				SB Right	659	5	9	295	A	20.9	C
				EB Left	0	0	0	0	A		
	EB	17.3	B	EB Through	1036	17	52	455	B		
				EB Right	67	14	62	479	B		
				WB Left	48	26	85	760	C		
	WB	19.8	B	WB Through	1253	20	85	760	B		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
				NB Left	20	118	140	701	F		
	NB	45.9	D	NB Through	546	60	140	701	E		
				NB Right	432	25	54	671	C		
				SB Left	181	69	218	820	E		
	SB	46.3	D	SB Through	1074	47	218	820	D		
25				SB Right	130	9	0	0	A	47.0	D
				EB Left	102	116	207	792	F		
	EB	52.1	D	EB Through	1472	48	207	793	D		
				EB Right	82	44	219	820	D		
				WB Left	333	71	110	364	E		
	WB	40.3	D	WB Through	505	28	110	364	C		
				WB Right	105	0	0	0	A		
26- MD 117 at Bureau Dr											
				NB Left	25	72	21	118	E		
	NB	54.5	D	NB Through	24	71	21	118	E		
				NB Right	26	23	21	118	C		
				SB Left	197	203	257	405	F		
	SB	201.5	F	SB Through	53	213	257	405	F		
26				SB Right	31	170	257	405	F	42.1	D
				EB Left	33	27	240	953	C		
	EB	35.0	C	EB Through	2008	35	246	953	D		
				EB Right	29	41	239	942	D		
				WB Left	316	69	147	489	E		
	WB	21.8	C	WB Through	885	11	148	490	B		
				WB Right	331	7	111	537	A		
27- MD 117 at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
27				SB Right	0	0	0	0	A	9.3	A
				EB Left	0	0	0	0	A		
	EB	1.8	A	EB Through	831	2	1	101	A		
				EB Right	0	0	0	0	A		
				WB Left	328	28	62	516	D		
	WB	28.3	D	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	321	64	383	1652	E		
	SB	68.7	E	SB Through	0	0	0	0	A		
28				SB Right	957	70	388	1654	E	40.2	D
				EB Left	13	124	88	678	F		
	EB	21.8	C	EB Through	817	20	88	678	C		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	17.2	B	WB Through	909	17	68	364	B		
				WB Right	9	6	76	394	A		
29- MD 117 at Perry Pkwy											
				NB Left	36	78	18	120	E		
	NB	45.1	D	NB Through	7	60	17	119	E		
				NB Right	38	11	28	140	B		
				SB Left	113	98	61	237	F		
	SB	49.3	D	SB Through	14	97	61	237	F		
29				SB Right	133	3	61	237	A	16.4	B
				EB Left	123	70	45	278	E		
	EB	10.7	B	EB Through	1001	3	45	278	A		
				EB Right	10	2	32	262	A		
				WB Left	8	87	22	278	F		
	WB	11.5	B	WB Through	747	12	22	278	B		
				WB Right	136	6	22	278	A		
30- Shady Grove Rd at I-270 NB off ramp											
				NB Left	0	0	0	0	A		
	NB	8.5	A	NB Through	1059	8	22	240	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	10.5	B	SB Through	1349	11	34	334	B		
30				SB Right	0	0	0	0	A	24.9	C
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	1048	60	224	769	E		
	WB	59.9	E	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
				NB Left	0	0	0	0	A		
	NB	18.9	B	NB Through	1004	19	55	396	B		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	16.5	B	SB Through	1768	16	73	713	B		
31				SB Right	0	0	0	0	A	24.7	C
				EB Left	387	35	47	420	C		
	EB	42.0	D	EB Through	0	0	0	0	A		
				EB Right	794	45	118	501	D		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
				NB U-Turn	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	520	44	86	354	D		
	SB	35.9	D	SB Through	0	0	0	0	A		
32				SB Right	127	3	1	61	A	10.4	B
				EB Left	0	0	0	0	A		
	EB	4.7	A	EB Through	1507	3	14	293	A		
				EB Right	970	8	23	308	A		
				WB Left	0	0	0	0	A		
	WB	9.1	A	WB Through	2006	9	45	514	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
				NB Left	0	0	65	357	A		
	NB	39.5	D	NB Through	220	55	73	366	D		
				NB Right	143	16	73	366	B		
				SB Left	30	59	30	219	E		
	SB	25.4	C	SB Through	0	0	0	0	A		
33				SB Right	317	22	30	219	C	29.0	C
				EB Left	324	81	191	803	F		
	EB	37.9	D	EB Through	1063	25	191	803	C		
				EB Right	0	0	0	0	A		
				WB Left	26	15	50	318	B		
	WB	13.9	B	WB Through	966	14	36	281	B		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
				NB Left	65	42	15	107	D		
	NB	38.0	D	NB Through	8	42	12	107	D		
				NB Right	10	7	14	117	A		
				SB Left	83	44	25	224	D		
	SB	6.2	A	SB Through	8	48	25	224	D		
34				SB Right	619	1	0	0	A	11.2	B
				EB Left	343	17	17	254	B		
	EB	11.6	B	EB Through	1003	10	22	232	A		
				EB Right	13	7	31	268	A		
				WB Left	5	21	20	186	C		
	WB	13.9	B	WB Through	328	14	20	186	B		
				WB Right	11	9	32	220	A		
35- MD 189 at I-270 Ramps											
				NB Left	140	46	24	125	D		
	NB	46.0	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	214	49	66	331	D		
	SB	49.2	D	SB Through	0	0	0	0	A		
35				SB Right	0	0	0	0	A	40.7	D
				EB Left	426	21	95	418	C		
	EB	23.8	C	EB Through	579	26	95	418	C		
				EB Right	0	0	0	0	A		
				WB Left	555	51	134	416	D		
	WB	57.9	E	WB Through	290	71	134	416	E		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
				NB Left	160	54	58	234	D		
	NB	39.1	D	NB Through	125	54	58	234	D		
				NB Right	160	12	58	234	B		
				SB Left	487	87	358	803	F		
	SB	79.5	E	SB Through	840	75	326	789	E		
36				SB Right	0	0	0	0	A	67.5	E
				EB Left	169	87	357	949	F		
	EB	73.8	E	EB Through	992	75	357	949	E		
				EB Right	127	46	357	949	D		
				WB Left	468	77	149	464	E		
	WB	55.9	E	WB Through	430	41	149	464	D		
				WB Right	69	7	149	464	A		
37- Montrose Rd at Tower Oaks Blvd											
				NB Left	0	0	0	0	A		
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	162	45	1087	1387	D		
	SB	199.1	F	SB Through	0	0	0	0	A		
37				SB Right	599	241	1083	1382	F	88.2	F
				EB Left	34	50	358	1252	D		
	EB	40.9	D	EB Through	1763	41	358	1252	D		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	88.4	F	WB Through	1723	91	470	853	F		
				WB Right	83	33	470	853	C		
38- Tower Oaks Blvd at I-270 off rmap											
				NB Left	536	22	38	196	C		
	NB	21.9	C	NB Through	10	25.1	31	188	C		
				NB Right	29	22.0	38	196	C		
				SB Left	0	42.3	0	25	D		
	SB	0.8	A	SB Through	0	0.0	0	25	A		
38				SB Right	4	0.8	0	0	A	57.3	E
				EB Left	9	63.3	298	475	E		
	EB	88.4	F	EB Through	732	89.4	298	475	F		
				EB Right	109	83.7	290	466	F		
				WB Left	0	0.0	3	71	A		
	WB	8.0	A	WB Through	110	8.4	3	72	A		
				WB Right	8	3.1	0	5	A		
39- Montrose Rd at Tower Oaks Blvd											
				NB Left	37	75	41	179	E		
	NB	16.6	B	NB Through	240	45	41	179	D		
				NB Right	560	0	0	0	A		
				SB Left	334	56	183	627	E		
	SB	45.4	D	SB Through	774	42	182	626	D		
39				SB Right	77	33	130	655	C	51.2	D
				EB Left	76	77	422	726	E		
	EB	90.6	F	EB Through	982	92	424	727	F		
				EB Right	64	90	445	751	F		
				WB Left	408	50	89	307	D		
	WB	41.1	D	WB Through	254	47	88	307	D		
				WB Right	148	7	102	337	A		
40- Rockledge Blvd at I-270 NB on and off ramp											
				NB Left	0	0	0	0	A		
	NB	36.3	D	NB Through	92	35	34	168	C		
				NB Right	215	37	34	168	D		
				SB Left	0	0	5	63	A		
	SB	2.2	A	SB Through	984	2	5	63	A		
40				SB Right	0	0	0	0	A	69.8	E
				EB Left	10	233	1571	3239	F		
	EB	129.6	F	EB Through	611	224	1571	3239	F		
				EB Right	663	41	0	0	D		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41				NB Left	102	4	2	49	A	21.7	C
	NB	4.1	A	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	982	24	105	693	C		
	WB	23.0	C	WB Through	430	22	105	693	C		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42				NB Left	232	25	284	751	C	151.7	F
	NB	60.3	E	NB Through	1504	56	284	751	E		
				NB Right	221	128	284	751	F		
				SB Left	60	157	2597	2709	F		
	SB	218.8	F	SB Through	1240	219	2597	2709	F		
				SB Right	162	243	2597	2709	F		
				EB Left	224	134	1869	1985	F		
	EB	186.6	F	EB Through	631	203	1870	1986	F		
				EB Right	131	196	1894	2010	F		
				WB Left	728	225	1925	2149	F		
	WB	187.8	F	WB Through	398	156	1925	2149	F		
				WB Right	158	96	1925	2149	F		
43- MD 187 at I-270 NB on and off ramps											
43				NB Left	161	76	56	243	E	18.7	B
	NB	10.3	B	NB Through	1562	4	56	243	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	25.3	C	SB Through	1559	25	84	519	C		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	125	50	38	244	D		
	WB	49.6	D	WB Through	10	43	38	244	D		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44				NB Left	0	0	0	0	A	42.9	D
	NB	23.3	C	NB Through	1485	23	67	427	C		
				NB Right	0	0	0	0	A		
				SB Left	181	43	54	273	D		
	SB	6.8	A	SB Through	1501	2	54	273	A		
				SB Right	0	0	0	0	A		
				EB Left	246	63	1034	1458	E		
	EB	181.1	F	EB Through	0	0	1034	1458	A		
				EB Right	402	253	1034	1447	F		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45				NB Left	255	57	68	232	E	20.9	C
	NB	14.9	B	NB Through	1384	7	69	232	A		
				NB Right	10	6	92	266	A		
				SB Left	12	35	103	664	D		
	SB	22.0	C	SB Through	1735	24	103	664	C		
				SB Right	153	1	66	656	A		
				EB Left	190	60	55	230	E		
	EB	38.0	D	EB Through	26	54	55	230	D		
				EB Right	252	20	55	230	B		
				WB Left	1	7	1	29	A		
	WB	7.3	A	WB Through	9	11	1	29	B		
				WB Right	5	0	0	7	A		
47-Democracy Blvd at I-270 NB off ramp											
47				NB Left	228	31	27	148	C	14.2	B
	NB	31.2	C	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	13.6	B	EB Through	1740	14	58	474	B		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	10.6	B	WB Through	778	11	23	190	B		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48				NB Left	0	0	0	0	A	6.7	A
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	5.6	A	EB Through	1850	6	26	282	A		
				EB Right	0	0	0	0	A		
				WB Left	223	36	31	172	D		
	WB	8.6	A	WB Through	781	1	20	151	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49				NB Left	0	0	0	0	A	13.8	B
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	418	48	67	239	D		
	SB	32.2	C	SB Through	0	0	0	0	A		
				SB Right	217	2	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	3.4	A	WB Through	781	4	6	136	A		
				WB Right	335	3	1	155	A		
50- MD 190 at Burdette Rd											
50				NB Left	20	80	15	118	E	13.4	B
	NB	73.3	E	NB Through	4	59	15	118	E		
				NB Right	11	67	15	118	E		
				SB Left	50	79	31	150	E		
	SB	34.7	C	SB Through	17	64	31	150	E		
				SB Right	120	12	31	150	B		
				EB Left	54	91	63	637	F		
	EB	10.8	B	EB Through	1830	8	62	637	A		
				EB Right	15	5	54	660	A		
				WB Left	1	106	62	846	F		
	WB	12.7	B	WB Through	1495	13	63	847	B		
				WB Right	21	2	56	874	A		

Table C.15: AM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51	NB			NB Left	0	0	0	0	A	57.3	E
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	134.2	F	EB Left	530	134	381	778	F		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	16.2	B	WB Left	0	0	0	0	A		
				WB Through	994	16	77	754	B		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52	NB	84.2	F	NB Left	260	84	2303	4441	F	15.5	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	4.1	A	EB Left	0	0	0	0	A		
				EB Through	982	4	10	257	A		
				EB Right	0	0	0	0	A		
	WB	5.5	A	WB Left	0	0	0	0	A		
				WB Through	667	6	8	171	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53	NB	68.2	E	NB Left	21	67	23	149	E	44.0	D
				NB Through	59	69	25	148	E		
				NB Right	0	0	0	0	A		
	SB	57.0	E	SB Left	624	56	185	777	E		
				SB Through	183	59	185	778	E		
				SB Right	18	56	184	777	E		
	EB	37.4	D	EB Left	24	29	135	584	C		
				EB Through	846	37	135	584	D		
				EB Right	42	42	135	584	D		
	WB	36.6	D	WB Left	121	109	113	358	F		
				WB Through	639	32	115	361	C		
				WB Right	160	1	1	74	A		
54- MD 124 at I-270 NB off ramp											
54	NB	40.7	D	NB Left	0	0	0	0	A	31.6	C
				NB Through	0	0	0	0	A		
				NB Right	788	41	111	503	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	24.1	C	EB Left	0	0	0	0	A		
				EB Through	958	24	71	467	C		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55	NB	38.0	D	NB Left	0	0	0	0	A	16.5	B
				NB Through	0	0	0	0	A		
				NB Right	965	38	121	557	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	4.6	A	EB Left	0	0	0	0	A		
				EB Through	1740	5	20	96	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
56- Watkins Mill Rd at I-270 SB off ramp/Parkview Ave											
56	NB	44.8	D	NB Left	90	68	43	193	E	46.4	D
				NB Through	0	0	0	0	A		
				NB Right	165	32	43	193	C		
	SB	42.1	D	SB Left	620	52	143	958	D		
				SB Through	150	48	143	958	D		
				SB Right	509	28	143	958	C		
	EB	57.7	E	EB Left	0	0	0	0	A		
				EB Through	1087	58	247	832	E		
				EB Right	6	50	247	832	D		
	WB	40.1	D	WB Left	133	82	130	474	F		
				WB Through	889	34	127	473	C		
				WB Right	0	0	0	0	A		
57- Watkins Mill Rd at I-270 NB on ramp											
57	NB	38.3	D	NB Left	419	43	128	513	D	59.6	E
				NB Through	0	0	0	0	A		
				NB Right	517	35	128	513	C		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	30.1	C	EB Left	385	80	130	423	E		
				EB Through	1047	12	130	423	B		
				EB Right	0	0	0	0	A		
	WB	104.3	F	WB Left	0	0	0	0	A		
				WB Through	1176	111	590	855	F		
				WB Right	213	68	590	855	E		
58- Watkins Mill Rd at I-270 SB on ramp											
58	NB			NB Left	0	0	0	0	A	15.1	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	17.5	B	EB Left	0	0	0	0	A		
				EB Through	1435	17	128	595	B		
				EB Right	438	18	128	595	B		
	WB	12.3	B	WB Left	568	31	82	484	C		
				WB Through	1027	2	82	484	A		
				WB Right	0	0	0	0	A		

Table C.16: AM Peak - No Build - I-270 Vehicle Network Performance

	No Build	Alternative	% Change
Total Delay	35,032,576	19,795,166	-43%
Average Delay per Vehicle	326	178	-45%
Total Travel Time	64,317,886	52,384,471	-19%
Vehicles (Arrived)	87,894	96,342	10%
Latent Demand	44,530	37,177	-17%
Latent Delay	120,600,723	105,510,186	-13%
Total Distance	463,125	513,145	11%
Average Speed	26	35	36%

PM Peak

Table D.1: PM Peak - No Build - I-270 Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From I-495 interchange					From I-70				
to MD 187	1.8	432.3	430.4	0%	to MD 85	1.7	94.6	94.6	0%
to I-270 Split	0.6	90.3	90.3	0%	to MD 80	5.4	307.1	307.3	0%
to Montrose Rd	1.8	115.8	113.7	-2%	to MD 109	3.7	210.7	210.9	0%
to MD 189	1.0	76.0	66.0	-13%	to MD 121	3.6	204.4	204.3	0%
to MD 28	1.0	92.5	66.7	-28%	to MD 27	2.5	146.4	146.6	0%
to Shady Grove Rd	1.9	211.0	122.9	-42%	to MD 118	1.1	65.1	65.6	1%
to I-370	0.9	185.6	62.7	-66%	to Middlebrook Rd	1.1	71.2	70.9	0%
to MD 117	1.5	158.7	101.4	-36%	to MD 124	2.2	137.5	135.4	-2%
to MD 124	0.6	38.8	39.3	1%	to MD 117	0.9	117.3	53.2	-55%
to Middlebrook Rd	2.5	214.3	209.0	-2%	to I-370	1.0	72.5	62.7	-14%
to MD 118	1.1	80.3	146.6	83%	to Shady Grove Rd	1.5	83.4	82.8	-1%
to MD 27	0.9	69.9	79.2	13%	to MD 28	1.9	114.1	113.6	0%
to MD 121	2.4	161.1	197.2	22%	to MD 189	1.0	62.7	62.7	0%
to MD 109	4.1	337.8	351.8	4%	to Montrose Rd	1.0	64.8	64.9	0%
to MD 80	3.7	247.0	250.1	1%	to I-270 Split	1.9	114.7	113.7	-1%
to MD 85	5.3	348.1	350.3	1%	to MD 187	0.4	23.0	22.9	0%
to I-70	1.4	182.3	183.8	1%	to I-495 interchange	1.9	155.6	156.1	0%
I-270 Total (miles/minutes)	**32.4**	**50.7**	**47.7**	**-6%**	**I-270 Total (miles/minutes)**	**32.6**	**34.1**	**32.8**	**-4%**
I-270 Spur Northbound					**I-270 Spur Southbound**				
From Cabin John Pkwy					From I-70				
to MD 190	0.5	125.4	128.4	2%	to I-270 Split	30.3	1,866.3	1,789.3	-4%
to I-495	1.1	271.9	275.1	1%	to Democracy Blvd	0.7	183.2	39.7	-78%
to Democracy Blvd	1.4	226.8	231.1	2%	to I-495	1.3	509.9	125.2	-75%
to I-270 Split	0.9	76.4	76.1	0%	to MD 190	1.3	199.4	202.9	2%
to I-70	30.0	2,519.1	2,340.6	-7%	to Cabin John Pkwy	0.6	164.4	164.2	0%
I-270 Spur Total (miles/minutes)	**34.0**	**53.7**	**50.9**	**-5%**	**I-270 Spur Total (miles/minutes)**	**34.2**	**48.7**	**38.7**	**-21%**

Table D.2: PM Peak - No Build - I-270 Local Vehicle Travel Time

I-270 Northbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change	I-270 Southbound	Segment Length (miles)	No Build VISSIM Travel Time (seconds)	Alternative VISSIM Travel Time (seconds)	% Change
From C-D start					From C-D start				
to Montrose Rd	0.8	68.8	55.5	-19%	to Shady Grove	1.3	87.5	87.5	0%
to MD 189	1.3	212.1	91.3	-57%	to MD 28	1.8	120.3	119.9	0%
to MD 28	1.0	96.2	72.8	-24%	to MD 189	1.1	80.2	78.8	-2%
to Shady Grove	2.0	420.6	336.8	-20%	to Montrose	1.2	88.8	85.1	-4%
to I-370	1.0	346.7	91.8	-74%	to I-270 mainline	0.9	59.7	60.2	1%
to MD 117	1.2	819.0	109.3	-87%					
to MD 124	0.8	1,033.2	134.8	-87%					
to I-270 mainline	0.8	555.0	106.0	-81%					
I-270 Local Total (miles/minutes)	**8.9**	**59.2**	**16.6**	**-72%**	**I-270 Local Total (miles/minutes)**	**6.3**	**7.3**	**7.2**	**-1%**

Figure D.1: PM Peak - No Build
I-270 Travel Time Graph - Northbound

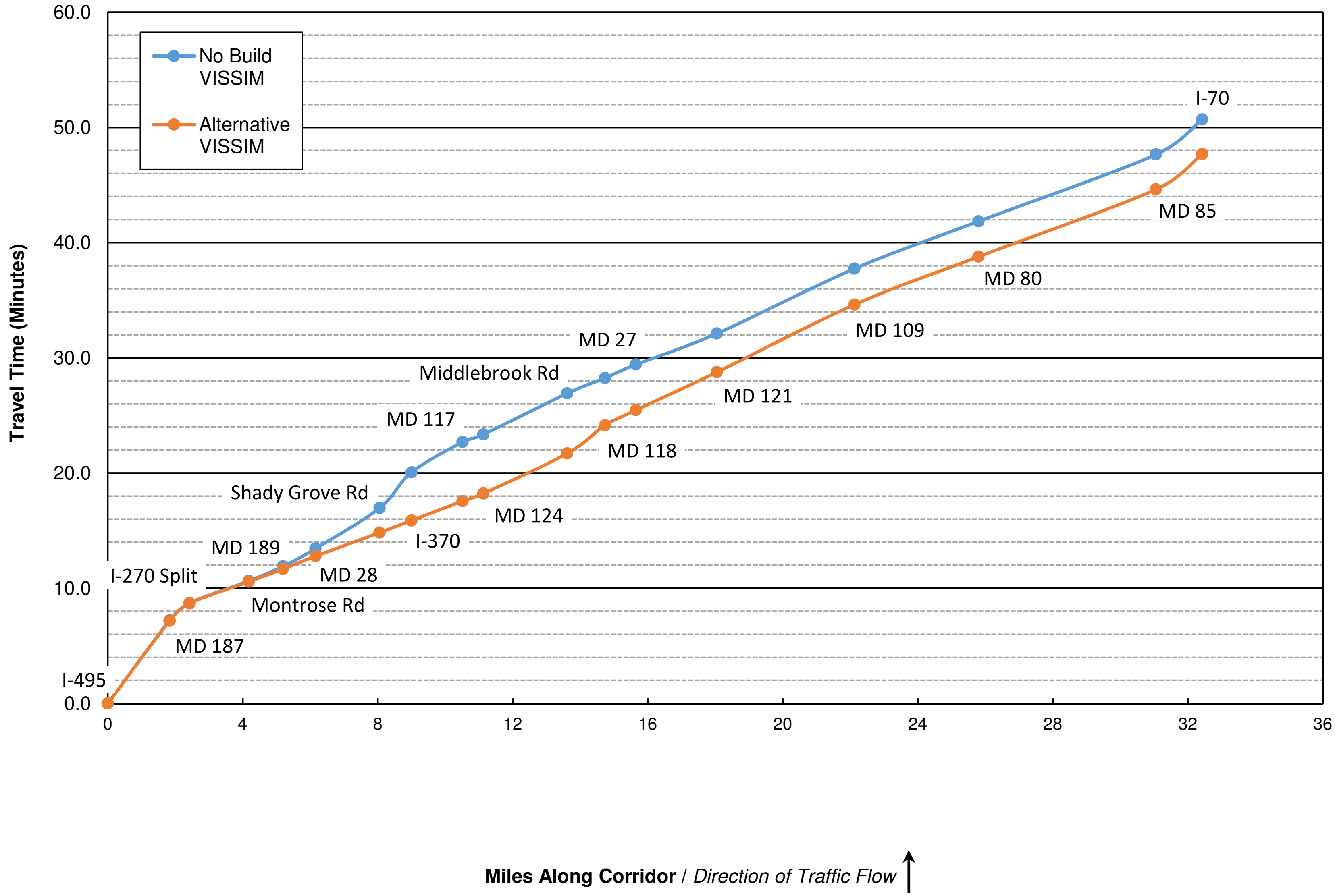
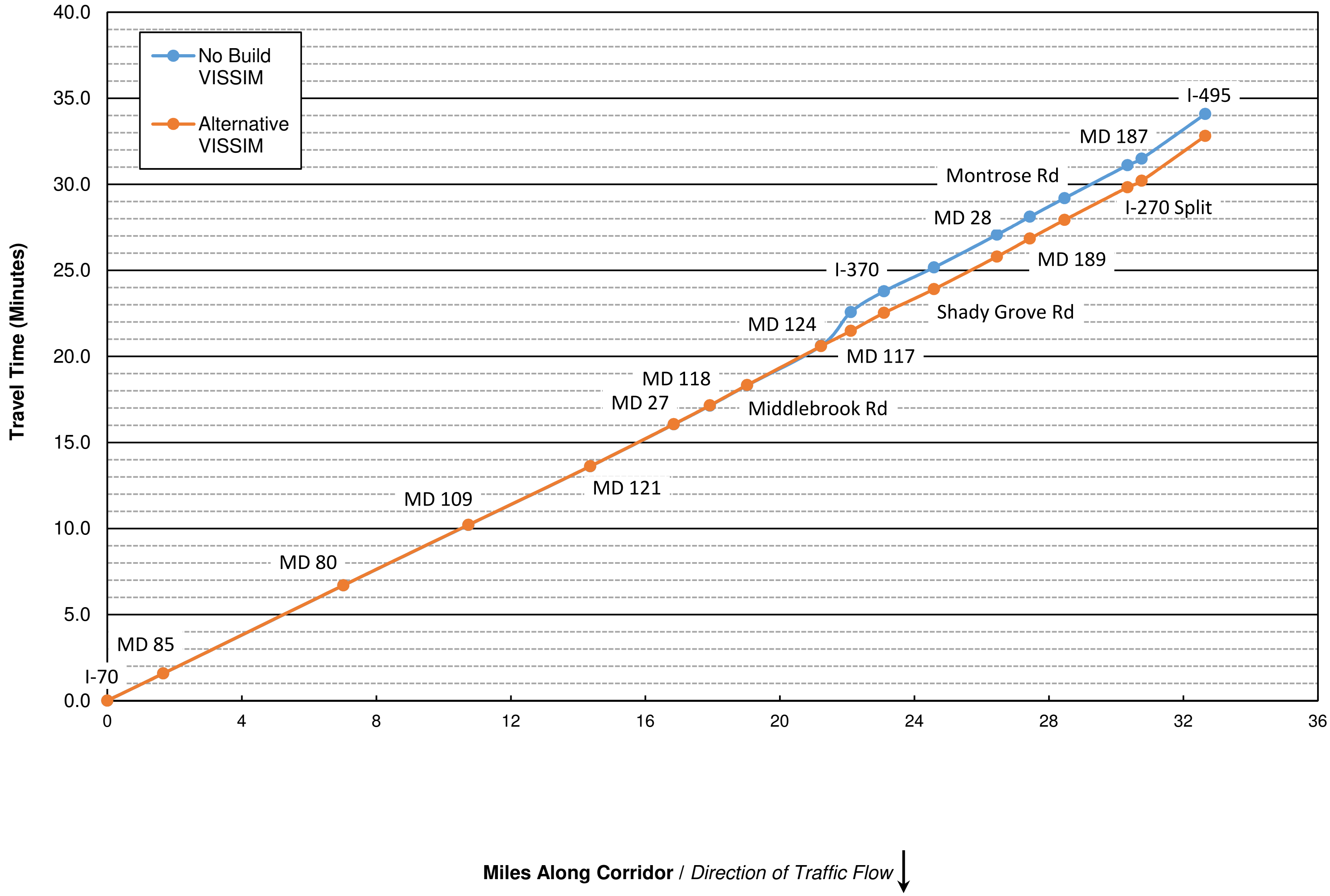


Figure D.2: PM Peak - No Build
I-270 Travel Time Graph - Southbound



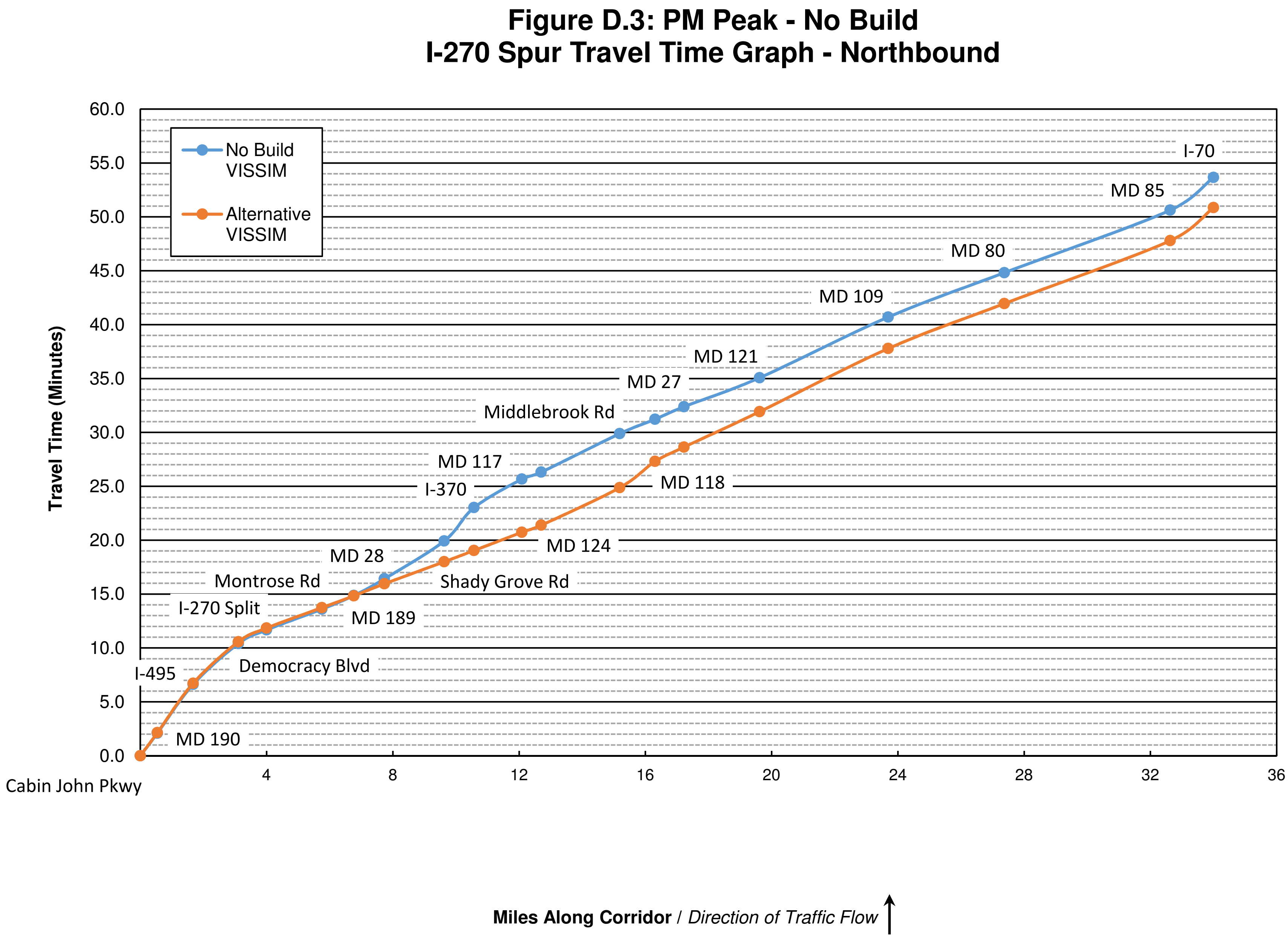
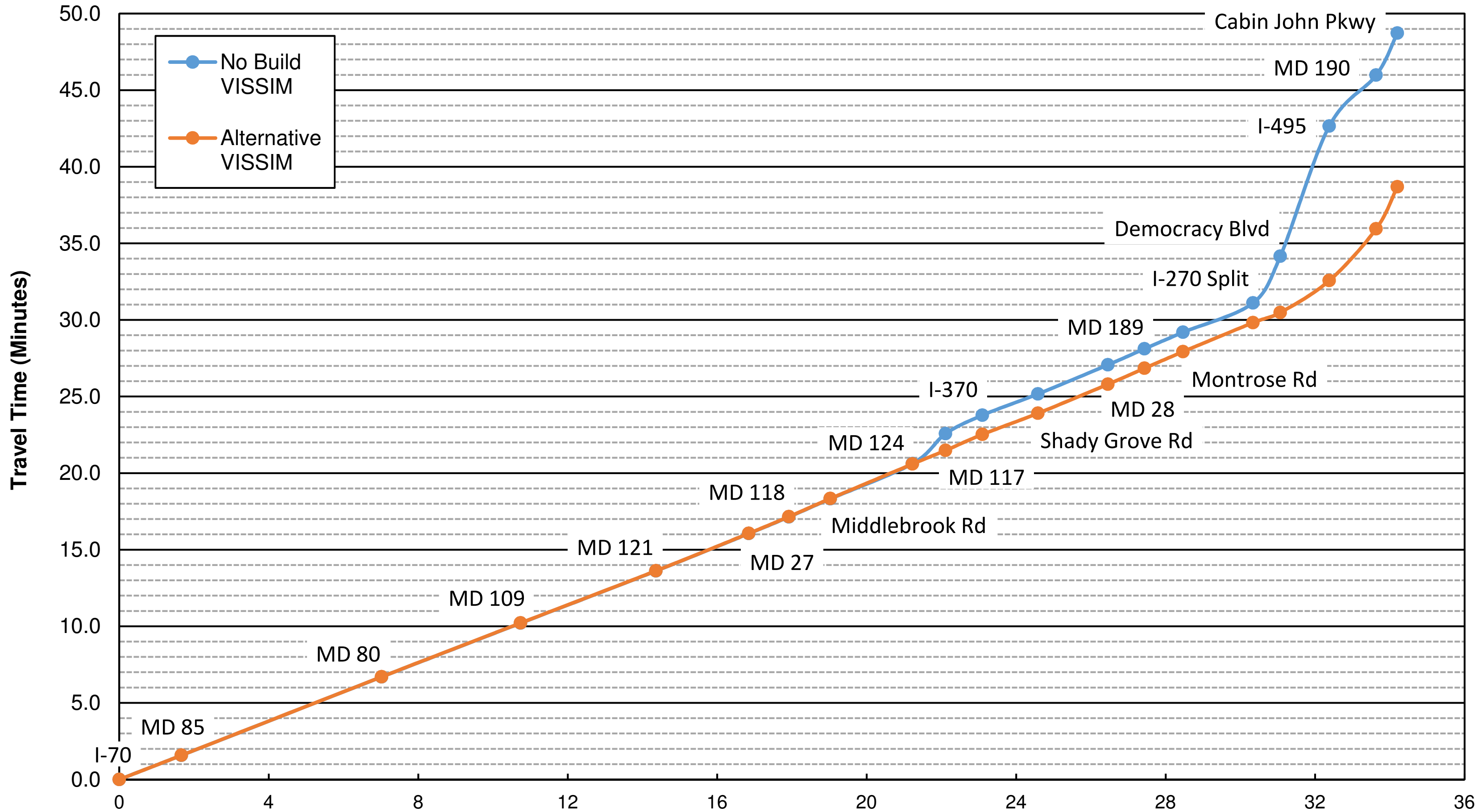


Figure D.3: PM Peak - No Build
I-270 Spur Travel Time Graph - Northbound
Travel Time (Minutes)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
No Build VISSIM
Alternative VISSIM
I-70
MD 85
MD 80
MD 109
MD 121
MD 27
Middlebrook Rd
MD 117
I-370
MD 118
MD 124
MD 28
Shady Grove Rd
Montrose Rd
I-270 Split
MD 189
Democracy Blvd
I-495
MD 190
Cabin John Pkwy
4
8
12
16
20
24
28
32
36
Miles Along Corridor / Direction of Traffic Flow

Figure D.4: PM Peak - No Build
I-270 Spur Travel Time Graph - Southbound



Miles Along Corridor / *Direction of Traffic Flow* ↓

Figure D.5: PM Peak - No Build
I-270 Local Travel Time Graph - Northbound

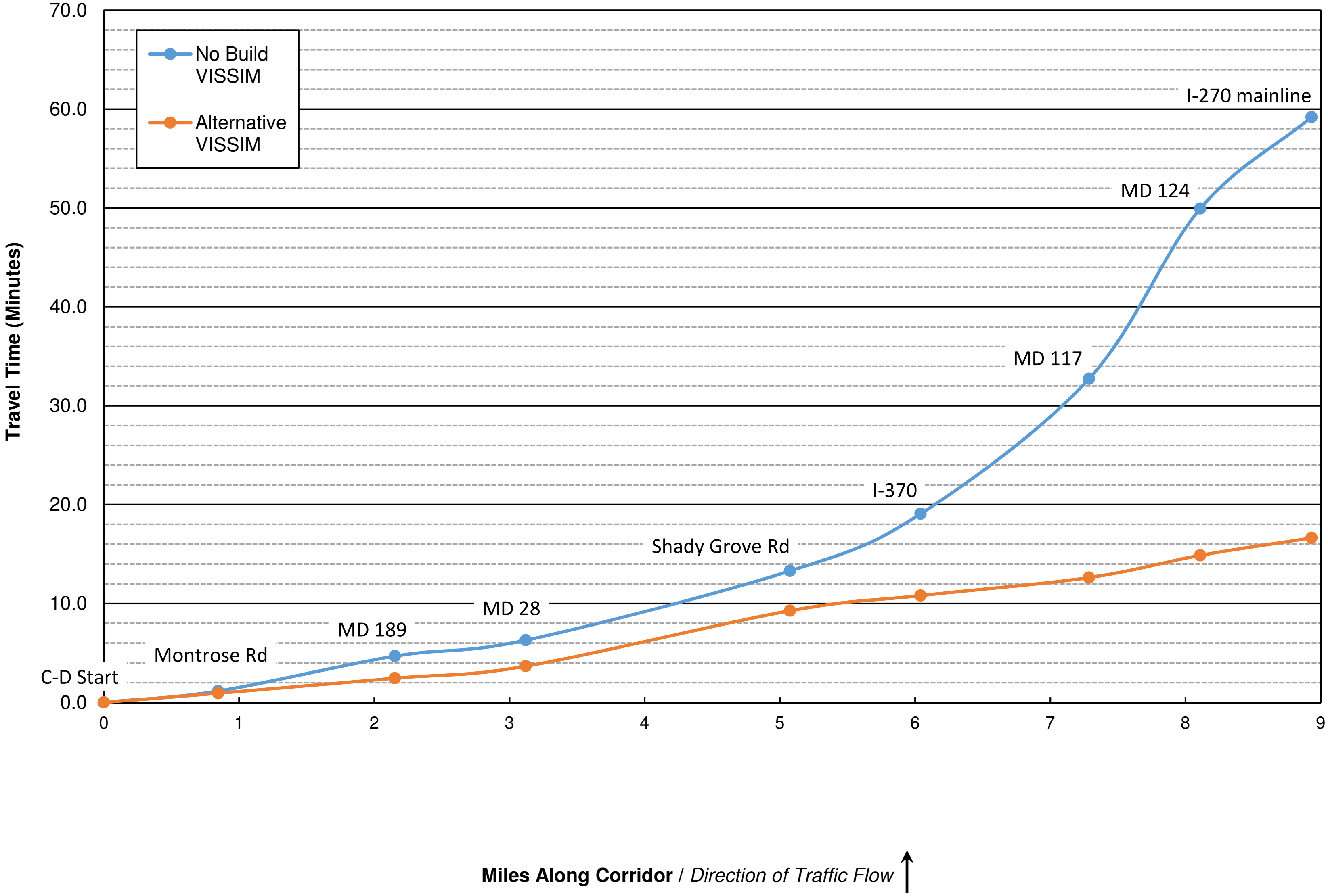


Figure D.6: PM Peak - No Build
I-270 Local Travel Time Graph - Southbound

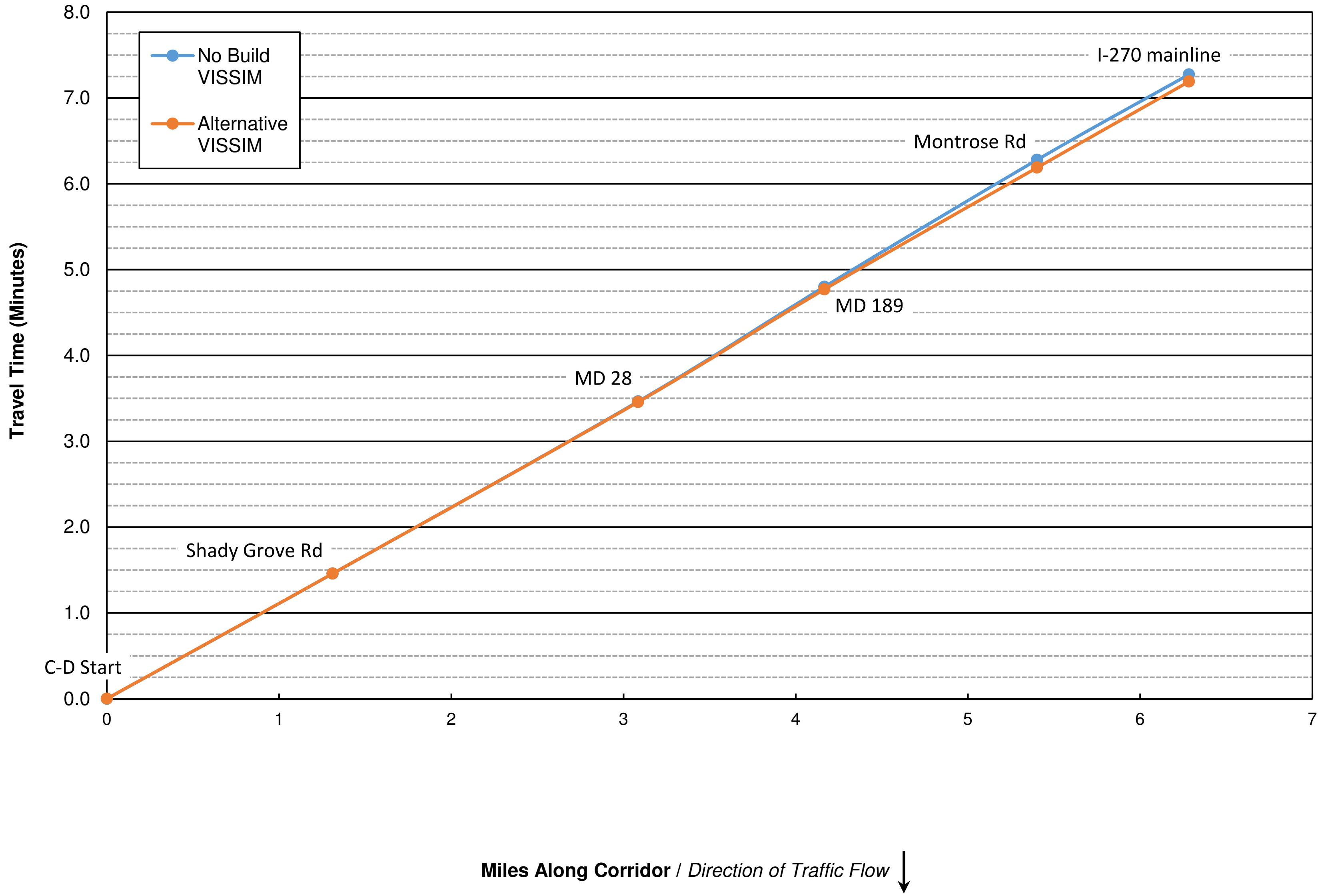


Table D.3: PM Peak - No Build - I-270 Vehicle Speed

I-270 Northbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From I-495 interchange				From I-70			
to MD 187	15.3	15.3	0%	to MD 85	63.3	63.3	0%
to I-270 Split	23.6	23.6	0%	to MD 80	62.8	62.7	0%
to Montrose Rd	54.5	55.5	2%	to MD 109	63.6	63.5	0%
to MD 189	48.0	55.3	15%	to MD 121	63.8	63.8	0%
to MD 28	37.5	52.0	39%	to MD 27	61.1	61.0	0%
to Shady Grove Rd	32.4	55.6	72%	to MD 118	59.3	58.9	-1%
to I-370	18.3	54.2	196%	to Middlebrook Rd	56.2	56.4	0%
to MD 117	34.4	53.8	56%	to MD 124	57.5	58.4	2%
to MD 124	56.9	56.2	-1%	to MD 117	27.2	60.0	121%
to Middlebrook Rd	41.8	42.8	3%	to I-370	48.9	56.6	16%
to MD 118	50.2	27.5	-45%	to Shady Grove Rd	64.2	64.6	1%
to MD 27	47.2	41.6	-12%	to MD 28	59.1	59.4	0%
to MD 121	53.5	43.7	-18%	to MD 189	56.2	56.1	0%
to MD 109	43.5	41.7	-4%	to Montrose Rd	57.4	57.3	0%
to MD 80	53.6	52.9	-1%	to I-270 Split	58.7	59.3	1%
to MD 85	54.3	54.0	-1%	to MD 187	65.7	66.0	0%
to I-70	27.1	26.9	-1%	to I-495 interchange	43.7	43.6	0%
I-270 Total (miles/minutes)	**38.4**	**40.8**	**6%**	**I-270 Total (miles/minutes)**	**57.5**	**59.7**	**4%**
I-270 Spur Northbound				**I-270 Spur Southbound**			
From Cabin John Pkwy				From I-70			
to MD 190	15.5	15.1	-2%	to I-270 Split	58.5	61.0	4%
to I-495	15.0	14.8	-1%	to Democracy Blvd	14.4	66.2	361%
to Democracy Blvd	22.8	22.3	-2%	to I-495	9.3	37.7	307%
to I-270 Split	42.0	42.2	0%	to MD 190	22.6	22.3	-2%
to I-70	42.9	46.1	8%	to Cabin John Pkwy	12.5	12.5	0%
I-270 Spur Total (miles/minutes)	**38.0**	**40.1**	**6%**	**I-270 Spur Total (miles/minutes)**	**42.1**	**53.0**	**26%**

Table D.4: PM Peak - No Build - I-270 Local Vehicle Speed

I-270 Northbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change	I-270 Southbound	No Build VISSIM Speed (MPH)	Alternative VISSIM Speed (MPH)	% Change
From C-D start				From C-D start			
to Montrose Rd	44.2	54.9	24%	to Shady Grove	53.9	53.9	0%
to MD 189	22.2	51.5	132%	to MD 28	53.1	53.2	0%
to MD 28	36.2	47.9	32%	to MD 189	48.6	49.4	2%
to Shady Grove	16.7	20.9	25%	to Montrose	50.1	52.2	4%
to I-370	10.0	37.8	277%	to I-270 mainline	53.2	52.8	-1%
to MD 117	5.5	41.0	649%				
to MD 124	2.9	22.0	667%				
to I-270 mainline	5.3	28.0	424%				
I-270 Local Total (miles/minutes)	**9.1**	**32.2**	**256%**	**I-270 Local Total (miles/minutes)**	**51.8**	**52.4**	**1%**

Figure D.7: HCM 2010 Density Level of Service Criteria (pc/mi/ln)

HCM 2010 Freeway LOS	
< 11	A
> 11 - 18	B
> 18 - 26	C
> 26 - 35	D
> 35 - 45	E
> 45	F
HCM 2010 Freeway Merge and Diverge Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 Freeway Weaving Segment LOS	
< 10	A
> 10 - 20	B
> 20 - 28	C
> 28 - 35	D
> 35 - 40	E
> 40	F
HCM 2010 C-D Weaving Segment LOS	
< 12	A
> 12 - 24	B
> 24 - 32	C
> 32 - 36	D
> 36 - 40	E
> 40	F

Table D.5: PM Peak - No Build - I-270 Vehicle Density

I-270 Northbound	Type	No Build Density (pc/mi/ln)	No Build LOS	Alternative Density (pc/mi/ln)	Alternative LOS	% Change	I-270 Southbound	Type	No Build Density (pc/mi/ln)	No Build LOS	Alternative Density (pc/mi/ln)	Alternative LOS	% Change
I-270	Freeway	91	F	39	E	-57%	I-270	Freeway	19	C	19	C	0%
I-270 Diverge to MD 187	Diverge	77	F	64	F	-17%	I-270 Merge from WB I-70	Merge	17	B	17	B	0%
I-270	Freeway	84	F	77	F	-9%	I-270	Freeway	24	C	24	C	0%
I-270 Diverge to Rockledge Rd	Diverge	77	F	64	F	-17%	I-270 Merge from EB I-70	Merge	16	B	16	B	0%
I-270	Freeway	85	F	78	F	-9%	I-270	Freeway	22	C	22	C	0%
I-270 Weave from MD 187 to I-270 HOV	Weave	57	F	85	F	50%	I-270 Diverge to SB MD 85	Diverge	23	C	8	A	-64%
I-270 Lane Drop	Merge	65	F	86	F	33%	I-270	Freeway	24	C	25	C	4%
I-270	Freeway	51	F	65	F	27%	I-270 Diverge to NB MD 85	Diverge	15	B	17	B	19%
I-270 Merge from I-270 Spur	Merge	37	E	59	F	58%	I-270	Freeway	19	C	19	C	1%
I-270 Weave from I-270 HOV to I-270 C-D	Weave	34	D	38	E	14%	I-270 Merge from MD 85	Merge	20	C	20	B	-3%
I-270	Freeway	34	D	30	D	-10%	I-270	Freeway	25	C	25	C	-3%
I-270 Diverge to C-D (MD 189)	Diverge	46	F	21	C	-53%	I-270 Diverge to MD 80	Diverge	17	B	152	F	819%
I-270	Freeway	46	F	11	B	-76%	I-270	Freeway	20	C	20	C	0%
I-270 Diverge to C-D (MD 28)	Diverge	62	F	28	D	-54%	I-270 Merge from MD 80	Merge	14	B	14	B	-1%
I-270	Freeway	55	F	37	E	-33%	I-270	Freeway	23	C	22	C	-7%
I-270 Merge from C-D (MD 189)	Merge	72	F	28	C	-62%	I-270 Diverge to MD 109	Diverge	12	B	12	B	1%
I-270 Diverge to C-D (Shady Grove Rd)	Diverge	77	F	41	F	-47%	I-270	Freeway	22	C	22	C	0%
I-270	Freeway	65	F	20	C	-69%	I-270 Merge from MD 109	Merge	13	B	14	B	2%
I-270 Weave from C-D (MD 28) to C-D (Shady Grove Rd)	Weave	90	F	27	C	-70%	I-270	Freeway	24	C	24	C	0%
I-270	Freeway	90	F	68	F	-24%	I-270 Diverge to SB Weigh Station	Diverge	12	B	12	B	1%
I-270 Merge from C-D (Shady Grove Rd)	Merge	124	F	35	E	-71%	I-270	Freeway	24	C	24	C	0%
I-270	Freeway	88	F	32	D	-64%	I-270 Merge from SB Weigh Station	Merge	12	B	12	B	0%
I-270 Merge from C-D (I-370)	Merge	155	F	21	C	-87%	I-270	Freeway	23	C	21	C	-6%
I-270 Diverge to C-D (MD 117)	Diverge	159	F	39	E	-76%	I-270 Diverge to MD 121	Diverge	9	A	9	A	0%
I-270	Freeway	21	C	30	D	40%	I-270	Freeway	12	B	12	B	0%
I-270 Merge from C-D (MD 124)	Merge	47	F	59	F	24%	I-270 Merge from WB MD 121	Merge	10	B	11	B	6%
I-270	Freeway	27	D	28	D	5%	I-270	Freeway	15	B	15	B	0%
I-270 Diverge to EB Middlebrook Rd	Diverge	20	B	34	D	71%	I-270 Merge from EB MD 121	Merge	13	B	13	B	-3%
I-270	Freeway	25	C	38	E	53%	I-270	Freeway	20	C	53	F	164%
I-270 Diverge to WB Middlebrook Rd	Diverge	20	C	50	F	147%	I-270 Diverge to MD 27	Diverge	13	B	13	B	0%
I-270	Freeway	22	C	39	E	81%	I-270	Freeway	16	B	17	B	0%
I-270 Diverge to EB MD 118	Diverge	17	B	85	F	390%	I-270 Merge from WB MD 27	Merge	14	B	14	B	1%
I-270 Diverge to WB MD 118	Diverge	31	D	58	F	91%	I-270	Freeway	20	C	20	C	1%
I-270	Freeway	27	D	62	F	131%	I-270 Weave from EB MD 27 to MD 118	Weave	15	B	15	B	1%
I-270 Weave from MD 118 to MD 27	Weave	36	E	84	F	133%	I-270	Freeway	19	C	19	C	0%
I-270	Freeway	25	C	50	F	103%	I-270 Merge from WB MD 118	Merge	15	B	15	B	-2%
I-270 Merge from EB MD 27	Merge	36	E	84	F	133%	I-270	Freeway	22	C	22	C	-1%
I-270	Freeway	26	C	39	E	54%	I-270 Merge from EB MD 118	Merge	18	B	18	B	0%
I-270 Merge from WB MD 27	Merge	22	C	22	C	3%	I-270	Freeway	28	D	28	D	-1%
I-270	Freeway	28	D	41	E	48%	I-270 Merge from Middlebrook Rd	Merge	30	D	30	D	0%
I-270 Diverge to MD 121	Diverge	22	C	10	A	-54%	I-270 Diverge to Watkins Mill Rd	Diverge	24	C	90	F	278%

Table D.5: PM Peak - No Build - I-270 Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Southbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270	Freeway	22	C	42	E	87%	I-270	Freeway	19	C	79	F	308%
I-270 Merge from EB MD 121	Merge	35	E	27	C	-24%	I-270 Diverge to MD 124	Diverge	17	B	46	F	175%
I-270 Lane Drop	Merge	78	F	37	E	-53%	I-270	Freeway	14	B	14	B	0%
I-270	Freeway	37	E	58	F	54%	I-270 Merge from Watkins Mill	Merge	17	B	46	F	175%
I-270 Diverge to NB Weigh Station	Diverge	18	B	34	D	89%	I-270	Freeway	58	F	19	C	-68%
I-270	Freeway	36	E	88	F	143%	I-270 Merge from WB MD 124	Merge	96	F	22	C	-76%
I-270 Merge from NB Weight Station	Merge	18	B	64	F	257%	I-270	Freeway	0	A	0	A	#DIV/0!
I-270	Freeway	38	E	21	C	-45%	I-270 Merge from MD 117	Merge	39	E	32	D	-19%
I-270 Diverge to MD 109	Diverge	22	C	21	C	-4%	I-270	Freeway	28	D	22	C	-19%
I-270	Freeway	34	D	35	D	3%	I-270 Diverge to I-370	Diverge	22	C	26	C	20%
I-270 Merge from MD 109	Merge	19	B	42	F	128%	I-270	Freeway	18	B	18	C	2%
I-270	Freeway	36	E	35	D	-4%	I-270 Diverge to I-270 C-D	Diverge	14	B	35	E	154%
I-270 Diverge to MD 80	Diverge	27	C	28	C	3%	I-270	Freeway	14	B	14	B	1%
I-270	Freeway	30	D	20	C	-32%	I-270 Merge from I-270 (I-370)	Merge	21	C	10	A	-53%
I-270 Merge from MD 80	Merge	18	B	39	E	116%	I-270 Diverge to I-270 C-D (Shady Grove Rd)	Diverge	23	C	20	B	-16%
I-270	Freeway	36	E	50	F	39%	I-270	Freeway	19	C	18	C	-3%
I-270 Diverge to Scenic View	Diverge	19	B	142	F	659%	I-270 Merge from I-270 C-D (Shady Grove Rd Northern)	Merge	18	B	18	B	-2%
I-270	Freeway	36	E	19	C	-46%	I-270	Freeway	23	C	22	C	-4%
I-270 Merge from Scenic View	Merge	18	B	92	F	401%	I-270 Merge from I-270 C-D (Shady Grove Rd Southern)	Merge	18	B	13	B	-27%
I-270	Freeway	36	E	8	A	-79%	I-270 Diverge to I-270 C-D (MD 189)	Diverge	25	C	13	B	-47%
I-270 Diverge to NB MD 85	Diverge	20	C	29	D	47%	I-270	Freeway	21	C	32	D	51%
I-270	Freeway	34	D	38	E	11%	I-270 Merge from I-270 C-D (MD 189)	Merge	20	C	18	B	-12%
I-270 Diverge to SB MD 85	Diverge	20	C	21	C	3%	I-270	Freeway	26	C	37	E	45%
I-270	Freeway	30	D	36	E	21%	I-270 Merge from I-270 C-D	Merge	25	C	13	B	-50%
I-270 Weave from MD 85 to I-70	Weave	22	C	14	B	-35%	I-270 Diverge to I-270 HOV Lane	Diverge	17	B	22	C	25%
I-270	Freeway	64	F	27	D	-58%	I-270 Diverge to I-270 Spur	Diverge	47	F	5	A	-90%
							I-270	Freeway	13	B	22	C	70%
							I-270 Diverge to Rockledge Dr / MD 187	Diverge	9	A	13	B	43%
							I-270	Freeway	13	B	110	F	741%
							I-270 Merge from Rockledge Dr	Merge	11	B	13	B	19%
							I-270	Freeway	16	B	10	A	-35%
							I-270 Merge from Rockledge Dr / MD 187	Merge	14	B	16	B	15%
							I-270	Freeway	35	E	10	A	-71%

Table D.6: PM Peak - No Build - I-270 Spur Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Spur Northbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change	I-270 Southbound	Type	Density (pc/mi/ln)	LOS	Density (pc/mi/ln)	LOS	% Change
I-270 Spur	Freeway	62	F	117	F	87%	I-270 Spur	Freeway	72	F	11	B	-84%
I-270 Spur Merge from Clara Barton Parkway	Merge	64	F	109	F	71%	I-270 Spur Weave from I-270 HOV to Democracy Blvd	Weave	94	F	67	F	-28%
I-270 Spur	Freeway	78	F	70	F	-9%	I-270 Spur	Freeway	108	F	13	B	-88%
I-270 Diverge to MD 190	Diverge	49	F	79	F	61%	I-270 Merge from Democracy Blvd	Merge	152	F	14	B	-91%
I-270 Spur	Freeway	89	F	81	F	-8%	I-270 Spur Lane Drop	Merge	144	F	14	B	-90%
I-270 Spur Merge from Cabin John Parkway	Merge	105	F	123	F	17%	I-270 Spur	Freeway	125	F	92	F	-26%
I-270 Spur Merge from MD 190	Merge	97	F	65	F	-33%	I-270 Spur Merge from I-495	Merge	124	F	83	F	-33%
I-270 Spur	Freeway	84	F	93	F	11%	I-270 Spur	Freeway	49	F	13	B	-73%
I-270 Spur Diverge to I-495	Merge	66	F	17	B	-75%	I-270 Spur Diverve to EB MD 190	Diverge	50	F	68	F	36%
I-270 Spur	Freeway	45	F	20	C	-56%	I-270 Spur Diverve to Cabin John Pkwy	Diverge	67	F	90	F	34%
I-270 Spur Diverge to Democracy Blvd	Diverge	50	F	9	A	-82%	I-270 Spur	Freeway	95	F	52	F	-46%
I-270 Spur	Freeway	58	F	50	F	-14%	I-270 Merge from MD 190	Merge	120	F	17	B	-86%
I-270 Spur Merge from EB Democracy Blvd	Merge	97	F	33	D	-66%	I-270 Spur	Freeway	93	F	49	F	-47%
I-270 Spur	Freeway	58	F	98	F	70%	I-270 Diverge to WB Clara Barton Pkwy	Diverge	60	F	66	F	8%
I-270 Spur Merge from WB Democracy Blvd	Merge	65	F	16	B	-76%	I-270 Spur	Freeway	83	F	79	F	-6%
I-270 Spur	Freeway	39	E	28	D	-28%	I-270 Merge from Clara Barton Pkwy	Merge	77	F	71	F	-8%
I-270 Spur Merge from Westlake Terrace	Merge	31	D	19	B	-39%							
I-270 Spur	Freeway	34	D	29	D	-15%							

Table D.7: PM Peak - No Build - I-270 Local Vehicle Density

		No Build		Alternative					No Build		Alternative		
I-270 Northbound	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**	**I-270 Souhbound**	**Type**	**Density (pc/mi/ln)**	**LOS**	**Density (pc/mi/ln)**	**LOS**	**% Change**
I-270 C-D	Freeway	29	D	31	D	7%	I-270 C-D	Freeway	8	A	14	B	67%
I-270 C-D Diverge to EB Montrose Rd	Diverge	21	C	33	D	55%	I-270 C-D Weave from I-370 EB to I-270	Weave	21	B	19	B	-10%
I-270 C-D	Freeway	16	B	19	C	17%	I-270 C-D Diverge to Shady Grove Rd	Diverge	11	B	29	D	175%
I-270 C-D Weave between Montrose Rd Loop Ramps	Weave	13	B	34	D	160%	I-270 C-D	Freeway	8	A	19	C	148%
I-270 C-D	Freeway	28	D	20	C	-29%	I-270 C-D Merge from WB Shady Grove Rd	Merge	8	A	17	B	104%
I-270 C-D Merge from WB Montrose Rd	Merge	83	F	16	B	-81%	I-270 C-D	Freeway	14	B	14	B	1%
I-270 C-D	Freeway	67	F	24	C	-65%	I-270 C-D Merge from EB Shady Grove Rd	Merge	10	A	14	B	44%
I-270 C-D Merge from I-270	Merge	84	F	20	B	-76%	I-270 C-D	Freeway	19	C	20	C	7%
I-270 C-D	Freeway	65	F	27	D	-59%	I-270 C-D Merge from I-270	Merge	24	C	20	C	-15%
I-270 C-D Diverge to MD 189	Diverge	43	F	35	D	-19%	I-270 C-D Diverge to I-270	Diverge	25	C	18	B	-29%
I-270 C-D	Freeway	91	F	24	C	-74%	I-270 C-D Diverge to I-270	Diverge	17	B	23	C	34%
I-270 C-D Merge from MD 189	Merge	112	F	12	B	-89%	I-270 C-D	Freeway	16	B	42	E	166%
I-270 C-D	Freeway	62	F	28	D	-55%	I-270 C-D Diverge to MD 28	Diverge	11	B	17	B	53%
I-270 C-D Weave between I-270 (to MD 28 from MD 189)	Weave	67	F	61	F	-9%	I-270 C-D	Freeway	11	A	12	B	17%
I-270 C-D	Freeway	42	E	32	D	-24%	I-270 C-D Merge from WB MD 28	Merge	12	B	23	C	84%
I-270 C-D Diverge to MD 28	Diverge	18	B	26	C	43%	I-270 C-D	Freeway	14	B	6	A	-54%
I-270 C-D	Freeway	28	D	43	E	50%	I-270 C-D Merge from EB MD 28	Merge	26	C	27	C	8%
I-270 C-D Weave between MD 28 Ramps	Weave	28	C	14	B	-51%	I-270 C-D	Freeway	32	D	22	C	-30%
I-270 C-D	Freeway	26	D	19	C	-29%	I-270 C-D Merge from I-270	Merge	41	F	26	C	-37%
I-270 C-D Merge from MD 28 WB	Merge	28	C	32	D	15%	I-270 C-D	Freeway	44	E	24	C	-46%
I-270 C-D Merge from I-270 and Drop Lane	Merge	34	D	13	B	-61%	I-270 C-D Diverge to MD 189	Diverge	25	C	25	C	-1%
I-270 C-D Diverge to I-270	Diverge	53	F	20	C	-62%	I-270 C-D	Freeway	27	D	36	E	33%
I-270 C-D	Freeway	48	F	19	C	-60%	I-270 C-D Merge from MD 189	Merge	27	C	20	C	-25%
I-270 C-D Diverge to Shady Grove Rd	Diverge	14	B	32	D	128%	I-270 C-D Diverge to I-270	Diverge	34	D	20	B	-43%
I-270 C-D	Freeway	130	F	77	F	-41%	I-270 C-D	Freeway	24	C	22	C	-10%
I-270 C- D Merge from I-270 and EB Shady Grove Rd	Merge	140	F	55	F	-61%	I-270 C-D Diverge to WB Montrose Rd	Diverge	18	B	16	B	-9%
I-270 C-D	Freeway	144	F	76	F	-47%	I-270 C-D	Freeway	23	C	28	D	23%
I-270 C-D Merge from WB Shady Grove Rd	Merge	146	F	100	F	-31%	I-270 Weave between Montrose Rd Loops	Weave	41	F	15	B	-64%
I-270 C-D Diverge to I-270	Diverge	129	F	39	E	-69%	I-270 C-D	Freeway	15	B	35	D	131%
I-270 C-D	Freeway	94	F	53	F	-44%	I-270 C-D Merge from EB Montrose Rd	Merge	9	A	35	D	290%
I-270 C-D Diverge to I-370	Diverge	64	F	18	B	-71%	I-270 C-D	Freeway	18	B	12	B	-30%
I-270 C-D	Freeway	120	F	32	D	-73%							
I-270 Merge from I-370 EB	Merge	129	F	39	E	-70%							
I-270 C-D	Freeway	139	F	23	C	-83%							
I-270 C-D Weave from I-370 to I-270	Weave	134	F	18	B	-87%							
I-270 C-D	Freeway	110	F	30	D	-72%							
I-270 C-D Weave from I-270 to MD 117	Weave	114	F	43	F	-62%							
I-270 C-D Diverge to MD 124	Diverge	142	F	23	C	-83%							
I-270 C-D	Freeway	178	F	36	E	-80%							
I-270 C-D Merge from EB MD 124	Merge	168	F	63	F	-62%							
I-270 C-D Merge From WB MD 124	Merge	154	F	23	C	-85%							
I-270 C-D	Freeway	144	F	93	F	-35%							
I-270 C-D Merge from Watkins Mill	Merge	133	F	16	B	-88%							

Table D.8: PM Peak - No Build - I-270 Vehicle Throughput

I-270 Northbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Southbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between I-495 and MD 187	4113	4115	0%	North of I-70	2366	2366	0%
Between MD 187 on and off ramps	3710	3722	0%	Between I-70 on ramps	2703	2703	0%
Between Rockledge Blvd on and off ramps	3540	3544	0%	From I-70 interchange to MD-85	4047	4047	0%
Between Rockledge Dr and I-270 Spur	3873	3865	0%	Between MD-85 on and off ramps	2379	2373	0%
Between I-270 Spur and Montrose Rd	8718	8708	0%	Between MD-85 and MD-80	3075	3064	0%
Between Montrose Rd on and off ramps	5582	5749	3%	Between MD-80 on and off ramps	2415	2410	0%
Between Montrose Rd and MD 189	5102	5473	7%	Between MD-80 and Md-109	2866	2863	0%
Between MD 189 and MD 28	5078	5847	15%	Between MD-109 on and off ramps	2767	2767	0%
Between MD 28 on and off ramps	5014	6216	24%	Between MD-109 and MD-121	2935	2927	0%
Between MD 28 and Shady Grove Rd	4214	5491	30%	Between MD-121 on and off ramps	2413	2407	0%
Between Shady Grove Rd and I-370	3243	4908	51%	Between MD-121 and MD-27	3354	3349	0%
Between I-370 on and off ramps	2749	4953	80%	Between MD-27 on and off ramps	3458	3459	0%
Between I-370 and MD 117	2851	6379	124%	Between MD-27 and MD-118	3773	3763	0%
Between MD 117 and MD 124	2432	4843	99%	Between MD-118 on and off ramps	3719	3718	0%
Between MD-124 on and off ramps	2547	4928	93%	Between MD-118 and Middlebrook Rd	4384	4382	0%
Between Watkins Mill Rd and Middlebrook Rd	4564	7034	54%	Between Middlebrook Rd on and off ramps	4382	4378	0%
Between Middlebrook Rd on and off ramps	4337	6469	49%	Between Middlebrook Rd and MD-124	5462	5475	0%
Between Middlebrook Rd and MD 118	3776	5565	47%	Between MD-124 on and off ramps	4179	4152	-1%
Between MD-118 on and off ramps	3479	5095	46%	Between MD-124 and MD-117	5347	5470	2%
Between MD 118 and MD 27	3770	5114	36%	Between MD-117 and I-370	6905	6964	1%
Between MD-27 on and off ramps	2754	3680	34%	Between I-370 on and off ramps	3456	3468	0%
Between MD 27 and MD 121	3428	4270	25%	Between I-370 on ramp to Shady Grove Rd	4990	5023	1%
Between MD-121 on and off ramps	2299	2833	23%	Between Shady Grove Rd and MD 28	5157	5289	3%
Between MD 121 and MD 109	3931	4385	12%	Between MD 28 on and off ramps	5327	5484	3%
Between MD-109 on and off ramps	3643	3973	9%	Between MD 28 and MD 189	4678	4806	3%
Between MD 109 and MD 80	3831	4117	7%	Between MD 189 and Montrose Rd	4678	4807	3%
Between MD-80 on and off ramps	3186	3402	7%	Between Montrose Rd on and off ramps	5599	5747	3%
Between MD 80 and MD 85	3875	4049	4%	Between Montose Rd and I-270 Spur	7355	7671	4%
Between MD-85 on and off ramps	3257	3373	4%	Between I-270 Spur and Rockledge Blvd	3320	3428	3%
Between MD 85 and I-70	5239	5341	2%	Between Rockledge Blvd on and off ramps	2542	2618	3%
North of I-70	2739	2812	3%	Between MD 187 on and off ramps	3011	3090	3%
				Between MD 187 and I-495	3393	3462	2%
I-270 Spur Northbound				**I-270 Spur Southbound**			
Between I-495 and Democracy Blvd	4568	4535	-1%	Between I-270 Split and HOV on ramp	3187	3604	13%
Between Democracy Blvd on and off ramps	4101	4071	-1%	Between HOV on ramp and Democracy Blvd	2329	3286	41%
Between Democracy Blvd and I-270 Split	4833	4825	0%	Between Democracy Blvd on and off ramps	1856	2750	48%
				Between Democracy Blvd and I-495	2227	3361	51%

Table D.9: PM Peak - No Build - I-270 Local Vehicle Throughput

I-270 Local Northbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change	I-270 Local Southbound	No Build VISSIM Throughput	Alternative VISSIM Throughput	% Change
Between Montrose Rd EB off ramp and and EB on ramp	1766	1770	0%	Between I-370 on ramp and I-270 off ramp	3064	3066	0%
Between Montrose Rd EB on ramp and WB off ramp	2079	2093	1%	Between I-270 off ramp and Shady Grove off ramp	1525	1531	0%
Between Montrose Rd WB off ramp and on ramp	1811	1838	1%	Between Shady Grove off ramp and Shady Grove WB on ramp	811	815	0%
Between Montrose Rd WB on ramp and I-270 on ramp	3211	3458	8%	Between Shady Grove WB and EB on ramps	1431	1637	14%
Between I-270 on ramp and MD 189 off ramp	3392	3728	10%	Between Shady Grove on ramp and I-270 on ramp	1957	2290	17%
Between MD 189 ramps	2697	3042	13%	Between I-270 on ramp and I-270 off ramp1	2571	2896	13%
Between MD 189 off ramp and I-270 on ramp	3503	3950	13%	Between I-270 off ramp1 and I-270 off ramp2	1808	2002	11%
Between I-270 on ramp and I-270 off ramp	4032	4640	15%	Between I-270 off ramp2 and MD 28 off ramp	1648	1813	10%
Between I-270 off ramp and MD 28 EB off ramp	3156	3610	14%	Between MD 28 off ramp and MD 28 WB on ramp	1153	1265	10%
Between MD 28 EB off ramp to MD 28 EB on ramp	2855	3251	14%	Between MD 28 WB on ramp and MD 28 EB on ramp	1423	1528	7%
Between MD 28 EB on ramp and MD 28 WB off ramp	2994	3383	13%	Between MD 28 EB on ramp and I-270 on ramp	2987	3090	3%
Between MD 28 WB off ramp and MD 28 WB on ramp	1879	2128	13%	Between I-270 on ramp and MD 189 off ramp	3660	3776	3%
Between MD 28 WB on ramp and I-270 on ramp	2552	2848	12%	Between MD 189 on and off ramps	2740	2825	3%
Between I-270 on ramp and I-270 off ramp	3027	3664	21%	Between MD 189 on ramp and I-270 off ramp	3316	3404	3%
Between I-270 off ramp and Shady Grove off ramp	1718	2151	25%	Between I-270 off ramp and Montrose Rd off ramp	2399	2466	3%
Between Shady Grove off ramp and I-270 on ramp	468	688	47%	Between Montrose Rd off ramp and Montrose Rd WB on ramp	2155	2214	3%
Between I-270 on ramp and Shady Grove WB on ramp	2182	3373	55%	Between Montrose Rd WB on ramp and EB off ramp	2705	2817	4%
Between Shady Grove WB on ramp and I-270 off ramp	2671	4205	57%	Between Montrose Rd EB off and on ramps	1525	1604	5%
Between I-270 off ramp and I-370 off ramp	2310	3690	60%	Between Montrose Rd EB off ramp and I-270	1845	1924	4%
Between I-370 off ramp and I-370 EB on ramp	529	980	85%				
Between I-370 EB and WB on ramps	896	2149	140%				
Between I-370 WB on ramp and I-270 off ramp	1577	4001	154%				
Between I-270 off ramp and I-270 on ramp	1008	2479	146%				
Between I-270 on ramp and MD 117 off ramp	1386	4157	200%				
Between MD 117 off ramp and MD 124 off ramp	920	2907	216%				
Between MD 124 off ramp and MD 124 EB on ramp	346	1195	245%				
Between MD 124 EB and WB on ramps	651	1689	159%				
Between MD 124 on ramp I-270	812	1216	50%				

Table D.10: PM Peak - No Build - I-270 On Ramp Queue Length - Northbound

I-270 Northbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
Rockledge Dr on ramp	1	1	67%	192	178	-7%
MD 189 C-D on ramp	610	0	-100%	4780	0	-100%
MD 28 C-D on ramp	994	0	-100%	4333	0	-100%
Shady Grove Rd C-D on ramp	1762	0	-100%	4090	0	-100%
I-370 C-D on ramp	3386	33	-99%	5049	362	-93%
MD 124 C-D on ramp	4875	0	-100%	5069	131	-97%
MD 118 on ramp	0	2	1223%	43	234	445%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 121 on ramp	0	0	0%	4	59	1232%
MD 109 on ramp	0	0	0%	0	0	0%
MD 80 on ramp	0	0	0%	0	0	0%
MD 85 on ramp	0	0	0%	0	0	0%
I-270 Spur Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd EB on ramp	0	0	0%	9	5	-42%
Democracy Blvd WB on ramp	0	0	0%	0	0	0%
I-495 Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Cabin John Pkwy on ramp	46	37	-20%	903	739	-18%
MD 190 on ramp	0	0	-100%	48	0	-100%
I-270 C-D Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Montrose Rd EB on ramp	0	0	0%	0	0	0%
Montrose Rd WB on ramp	916	1	-100%	2556	107	-96%
I-270 on ramp	0	0	0%	0	0	0%
MD 189 on ramp	104	2	-98%	1084	312	-71%
I-270 on ramp	1	0	-100%	109	0	-100%
MD 28 EB on ramp	0	0	0%	0	0	0%
MD 28 WB on ramp	38	0	-100%	652	0	-100%
Shady Grove Rd EB on ramp	1396	340	-76%	4077	1207	-70%
I-270 on ramp	1555	43	-97%	5058	494	-90%
Shady Grove Rd WB on ramp	739	2	-100%	1949	189	-90%
I-370 EB on ramp	1319	0	-100%	2422	0	-100%
I-370 WB on ramp	1606	0	-100%	2548	0	-100%
I-270 on ramp	4357	641	-85%	5055	3162	-37%
MD 124 EB on ramp	1831	1	-100%	2796	95	-97%
MD 124 WB on ramp	98	3	-97%	700	212	-70%
Watkins Mill Rd on ramp	2665	0	-100%	3270	0	-100%

Table D.11: PM Peak - No Build - I-270 Off Ramp Queue Length - Northbound

I-270 Northbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 187 off ramp NB	39	36	-7%	309	298	-4%
MD 187 off ramp SB	0	0	0%	0	0	0%
Rockledge Dr off ramp	1	1	-14%	88	85	-3%
Tower Oaks Blvd off ramp	37	36	-1%	219	233	6%
Montrose Rd off ramp EB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
MD 189 off ramp WB	26	28	5%	174	156	-10%
MD 189 off ramp EB	0	1	58%	78	119	52%
MD 28 off ramp EB	35	40	14%	215	209	-3%
MD 28 off ramp WB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Redland Blvd	0	0	0%	0	0	0%
Shady Grove Rd off ramp WB	40	48	22%	253	235	-7%
Shady Grove Rd off ramp EB	0	0	0%	0	0	0%
I-370 off ramp WB	8	23	184%	162	362	123%
I-370 off ramp EB	0	0	0%	0	0	0%
MD 117 off ramp	1835	122	-93%	2770	737	-73%
MD 124 off ramp	55	254	366%	626	1054	68%
Watkins Mill Rd off ramp	45	2500	5419%	627	5043	704%
Middlebrook Rd EB off ramp	0	0	0%	0	0	0%
Middlebrook Rd WB off ramp	0	0	0%	0	0	0%
MD 118 WB off ramp - Seneca Meadows	0	0	-100%	8	0	-100%
MD 118 WB off ramp	0	0	0%	0	34	0%
MD 118 EB off ramp	0	0	-100%	16	0	-100%
MD 27 off ramp WB	44	56	28%	252	270	7%
MD 27 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp WB	70	90	28%	314	730	132%
MD 121 off ramp EB	2	19	780%	94	580	518%
MD 109 off ramp EB	26	28	10%	251	261	4%
MD 109 off ramp WB	0	0	0%	0	0	0%
MD 80 off ramp EB	21	22	8%	233	264	14%
MD 80 off ramp WB	0	0	57%	24	41	69%
MD 85 NB off ramp	1	0	-70%	53	34	-35%
MD 85 SB off ramp	1	1	-13%	141	117	-17%
I-270 Spur Northbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Clara Barton Pkwy off ramp EB	0	0	0%	0	5	0%
Clara Barton Pkwy off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp EB	0	0	0%	0	0	0%
MD 190 off ramp WB	5	2	-57%	354	182	-49%
Democracy Blvd off ramp WB	41	42	2%	194	198	2%
Democracy Blvd off ramp EB	17	17	1%	120	115	-4%

Table D.12: PM Peak - No Build - I-270 On Ramp Queue Length - Southbound

I-270 Southbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 on ramp	0	0	-100%	12	0	-100%
MD 80 on ramp	0	0	0%	0	0	0%
MD 109 on ramp	0	0	0%	0	0	0%
MD 121 WB on ramp	0	0	0%	0	0	0%
MD 121 EB on ramp	0	0	0%	0	0	0%
MD 27 WB on ramp	0	0	0%	0	0	0%
MD 27 EB on ramp	0	0	0%	0	0	0%
MD 118 WB on ramp	0	0	0%	0	0	0%
MD 118 EB on ramp	0	0	0%	0	0	0%
Middlebrook Rd on ramp	0	0	0%	0	0	0%
Watkins Mill Rd on ramp	0	0	0%	0	0	0%
MD 124 WB on ramp	1368	0	-100%	3492	0	-100%
MD 117 on ramp	29	1	-98%	837	122	-85%
I-370 C-D on ramp	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp North	0	0	0%	0	0	0%
Shady Grove Rd C-D on ramp South	0	0	0%	0	0	0%
MD 189 C-D on ramp	0	0	0%	0	0	0%
Montrose Rd C-D on ramp	0	0	0%	0	0	0%
Rockledge Dr on ramp	0	0	0%	0	0	0%
MD 187 on ramp	0	0	0%	0	0	0%
I-270 Spur Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd on ramp	698	0	-100%	1919	20	-99%
I-495 Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 Spur on ramp	4555	670	-85%	5065	3350	-34%
MD 190 on ramp	184	17	-91%	956	467	-51%
I-270 C-D Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
I-270 on ramp	0	0	-100%	10	0	-100%
I-370 on ramp	0	0	-95%	80	16	-80%
Shady Grove Rd WB on ramp	0	0	0%	0	0	0%
Shady Grove Rd EB on ramp	0	0	0%	0	0	0%
I-270 on ramp	0	0	0%	0	0	0%
MD 28 WB on ramp	0	0	0%	0	0	0%
MD 28 EB on ramp	0	3	669%	63	310	389%
I-270 on ramp	0	0	0%	0	0	0%
MD 189 on ramp	0	0	0%	0	0	0%
Montrose Rd WB on ramp	1	1	-57%	115	115	0%
Montrose Rd EB on ramp	0	0	0%	0	0	0%

Table D.13: PM Peak - No Build - I-270 Off Ramp Queue Length - Southbound

I-270 Southbound	No Build VISSIM Average Queue (feet)	Alternative VISSIM Average Queue (feet)	% Change	No Build VISSIM Maximum Queue (feet)	Alternative VISSIM Maximum Queue (feet)	% Change
MD 85 SB off ramp	22	11	-51%	383	210	-45%
MD 85 NB off ramp	17	72	337%	354	808	128%
MD 80 off ramp	2	2	6%	204	200	-2%
MD 109 off ramp WB	1	0	-11%	88	68	-22%
MD 109 off ramp EB	0	0	0%	0	0	0%
MD 121 off ramp EB	217	251	16%	970	1041	7%
MD 121 off ramp WB	0	5	1121%	137	273	99%
MD 27 off ramp EB	22	24	8%	137	136	-1%
MD 27 off ramp WB	1	0	-100%	65	0	-100%
MD 118 off ramp EB	24	22	-5%	142	131	-7%
MD 118 off ramp WB	0	0	-19%	23	13	-42%
Watkins Mill Rd off ramp	103	109	6%	384	459	20%
MD 124 off ramp EB	185	160	-14%	731	725	-1%
MD 124 off ramp WB	17	28	69%	445	607	36%
I-370 off ramp WB	147	1059	618%	725	3354	363%
I-370 off ramp EB	0	0	0%	0	0	0%
Shady Grove Rd off ramp - Omega Drive	1	0	-18%	52	52	1%
Shady Grove Rd off ramp	0	0	0%	0	0	0%
MD 28 off ramp	3	4	45%	149	153	2%
MD 189 off ramp EB	108	122	13%	433	484	12%
MD 189 off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp WB	0	0	0%	0	0	0%
Montrose Rd off ramp EB	4	6	61%	337	577	71%
Rockledge Dr off ramp	155	201	30%	641	757	18%
I-270 Spur Southbound	**No Build VISSIM Average Queue (feet)**	**Alternative VISSIM Average Queue (feet)**	**% Change**	**No Build VISSIM Maximum Queue (feet)**	**Alternative VISSIM Maximum Queue (feet)**	**% Change**
Democracy Blvd off ramp EB	20	30	48%	136	152	12%
Democracy Blvd off ramp WB	0	0	0%	0	0	0%
MD 190 off ramp WB	80	100	25%	797	898	13%
MD 190 off ramp EB	0	0	0%	0	0	0%
Clara Barton Pkwy WB off ramp	0	0	265%	6	11	81%

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	60.8	E	NB Left	134	78	463	889	E	115.6	F
				NB Through	570	38	463	889	D		
				NB Right	935	72	443	912	E		
	SB	179.8	F	SB Left	153	131	1021	1231	F		
				SB Through	874	186	1021	1231	F		
				SB Right	74	209	1021	1231	F		
	EB	35.0	C	EB Left	55	84	32	144	F		
				EB Through	24	81	32	144	F		
				EB Right	169	13	32	144	B		
	WB	163.6	F	WB Left	561	181	536	762	F		
				WB Through	30	166	536	762	F		
				WB Right	224	119	536	762	F		
2- MD 85 at I-270 NB on and off ramp											
2	NB	58.5	E	NB Left	1136	58	700	1857	E	48.2	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	32.6	C	SB Left	0	0	0	0	A		
				SB Through	743	33	132	737	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	17.3	B	NB Left	0	0	0	0	A	19.5	B
				NB Through	1975	17	181	1210	B		
				NB Right	0	0	0	0	A		
	SB	44.0	D	SB Left	173	44	74	582	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	68.0	F	NB Left	74	103	368	830	F	51.3	D
				NB Through	1450	66	367	830	E		
				NB U-Turn	0	0	0	0	A		
	SB	31.9	C	SB Left	105	83	53	246	F		
				SB Through	940	30	105	1039	C		
				SB Right	923	28	92	1030	C		
	EB	63.3	E	EB Left	949	66	196	744	E		
				EB Through	43	51	196	744	D		
				EB Right	28	1	196	744	A		
	WB	53.0	D	WB Left	44	78	60	230	E		
				WB Through	79	81	60	230	F		
				WB Right	94	18	60	230	B		
5- MD 80 at I-270 NB on and ramp											
5	NB	-0.9	A	NB Left	1	9	0	4	A	11.5	B
				NB Through	2	0	0	4	A		
				NB Right	7	-3	0	4	A		
	SB	12.8	B	SB Left	479	16	27	238	B		
				SB Through	22	16	27	238	B		
				SB Right	149	3	0	0	A		
	EB	13.6	B	EB Left	97	14	24	208	B		
				EB Through	0	0	8	0	A		
				EB Right	5	10	37	239	B		
	WB	10.7	B	WB Left	15	14	0	38	B		
				WB Through	670	18	66	419	B		
				WB Right	612	2	0	0	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	3.4	A	NB Left	55	5	3	239	A	5.9	A
				NB Through	0	0	0	0	A		
				NB Right	605	3	3	239	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	7.1	A	EB Left	0	0	0	0	A		
				EB Through	382	8	4	111	A		
				EB Right	66	4	4	119	A		
	WB	8.4	A	WB Left	0	0	0	0	A		
				WB Through	446	8	3	163	A		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	7.9	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	15.2	C	SB Left	317	16	34	268	C		
				SB Through	0	0	0	0	A		
				SB Right	25	6	1	162	A		
	EB	2.5	A	EB Left	80	2	0	47	A		
				EB Through	0	0	0	0	A		
				EB Right	83	3	0	0	A		
	WB	0.4	A	WB Left	0	0	0	0	A		
				WB Through	222	0	0	0	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	4.9	A	NB Left	63	8	3	120	A	1.8	A
				NB Through	0	0	0	0	A		
				NB Right	36	0	0	63	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.9	A	EB Left	0	0	0	0	A		
				EB Through	166	0	0	0	A		
				EB Right	34	4	0	0	A		
	WB	1.4	A	WB Left	137	1	0	58	A		
				WB Through	110	2	0	30	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	29.4	D	NB Left	590	33	112	604	C	47.0	D
				NB Through	795	28	112	604	C		
				NB Right	64	16	119	630	B		
	SB	22.6	C	SB Left	28	15	19	219	B		
				SB Through	300	24	31	223	C		
				SB Right	9	13	34	244	B		
	EB	14.9	B	EB Left	4	40	8	196	D		
				EB Through	24	41	15	229	D		
				EB Right	248	12	27	261	B		
	WB	117.1	F	WB Left	349	162	304	715	F		
				WB Through	75	73	304	714	E		
				WB Right	186	51	327	739	D		
10- MD 121 at I-270 NB on and off ramp											
10	NB	22.1	C	NB Left	372	59	77	320	F	18.1	B
				NB Through	0	0	0	0	A		
				NB Right	785	4	1	73	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	11.8	B	EB Left	0	0	0	0	A		
				EB Through	651	18	38	367	C		
				EB Right	336	1	0	0	A		
	WB	20.0	C	WB Left	219	60	86	412	F		
				WB Through	682	7	86	412	A		
				WB Right	0	0	0	0	A		

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	22.3	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	62.3	E	SB Left	271	85	226	977	F		
				SB Through	0	0	0	0	A		
				SB Right	254	39	0	49	E		
	EB	6.5	A	EB Left	0	0	0	0	A		
				EB Through	717	6	16	229	A		
				EB Right	0	0	0	0	A		
	WB	13.2	B	WB Left	0	0	0	0	A		
				WB Through	520	27	46	382	D		
				WB Right	538	0	0	0	A		
12- MD 27 at Observation Dr											
12	NB	37.7	D	NB U-Turn	0	0	0	0	A	24.8	C
				NB Through	94	55	22	98	E		
				NB Right	61	11	22	98	B		
	SB	41.3	D	SB Left	146	44	38	216	D		
				SB Through	57	62	43	250	E		
				SB Right	188	33	69	287	C		
	EB	18.6	B	EB Left	189	33	70	458	C		
				EB Through	2012	17	71	459	B		
				EB Right	97	16	84	497	B		
	WB	27.9	C	WB Left	41	24	149	731	C		
				WB Through	1695	29	149	731	C		
				WB Right	69	9	149	731	A		
13- MD 27 at I-270 NB off ramp											
13	NB	47.2	D	NB Left	303	47	52	260	D	6.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	1512	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	4.9	A	WB Left	0	0	0	0	A		
				WB Through	1791	5	37	726	A		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	5.2	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	50.1	D	SB Left	174	50	33	150	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.8	A	EB Left	0	0	0	0	A		
				EB Through	1677	2	4	89	A		
				EB Right	0	0	0	0	A		
	WB	3.7	A	WB Left	0	0	0	0	A		
				WB Through	1541	4	12	384	A		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	31.1	C	NB Left	77	30	107	545	C	70.1	E
				NB Through	1196	31	116	545	C		
				NB Right	55	29	123	558	C		
	SB	56.5	E	SB Left	157	74	381	1298	E		
				SB Through	1468	58	381	1298	E		
				SB Right	225	33	368	1291	C		
	EB	40.4	D	EB Left	125	53	34	129	D		
				EB Through	49	36	30	124	D		
				EB Right	62	18	23	156	B		
	WB	163.8	F	WB Left	104	99	1056	1511	F		
				WB Through	127	110	1056	1511	F		
				WB Right	665	184	1056	1511	F		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	4.9	A	NB Left	97	14	2	77	B	9.0	A
				NB Through	1309	4	11	182	A		
				NB Right	1	-1	19	235	A		
	SB	7.4	A	SB Left	15	8	19	307	A		
				SB Through	1226	7	22	307	A		
				SB Right	11	5	25	340	A		
	EB	14.0	B	EB Left	23	59	14	138	E		
				EB Through	0	65	14	138	E		
				EB Right	312	11	14	138	B		
	WB	53.8	D	WB Left	103	65	43	243	E		
				WB Through	7	69	39	242	E		
				WB Right	30	13	48	262	B		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	13.8	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	26.5	C	EB Left	493	26	43	299	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	10.0	A	WB Left	0	0	0	0	A		
				WB Through	283	2	1	139	A		
				WB Right	1361	12	46	611	B		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	7.1	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	37.7	D	SB Left	169	37.7	27	145	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	5.5	A	EB Left	0	0.0	0	0	A		
				EB Through	1407	5.5	13	384	A		
				EB Right	0	0.0	0	0	A		
	WB	5.1	A	WB Left	0	0.0	0	0	A		
				WB Through	1499	5.1	10	218	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	26.2	C	NB Left	53	72	43	241	E	43.0	D
				NB Through	53	70	43	241	E		
				NB Right	227	5	5	87	A		
	SB	165.9	F	SB Left	436	156	419	656	F		
				SB Through	14	205	419	656	F		
				SB Right	126	195	419	656	F		
	EB	22.6	C	EB Left	125	31	89	536	C		
				EB Through	1415	22	89	536	C		
				EB Right	21	20	89	536	B		
	WB	24.3	C	WB Left	15	30	107	749	C		
				WB Through	1399	28	107	749	C		
				WB Right	367	8	107	749	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	9.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	20.5	C	SB Left	124	36	23	150	D		
				SB Through	0	0	0	0	A		
				SB Right	186	10	23	150	B		
	EB	6.0	A	EB Left	14	11	15	149	B		
				EB Through	1053	6	15	149	A		
				EB Right	0	0	0	0	A		
	WB	8.8	A	WB Left	0	0	0	0	A		
				WB Through	1313	9	27	253	A		
				WB Right	17	7	42	302	A		

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21				NB Left	0	0	0	0	A	4.6	A
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	2.7	A	EB Through	742	3	4	110	A		
				EB Right	0	0	0	0	A		
				WB Left	438	8	5	236	A		
	WB	7.8	A	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22				NB Left	200	46	83	309	D	13.7	B
	NB	48.4	D	NB Through	1	55	83	309	D		
				NB Right	236	50	83	309	D		
				SB Left	32	47	8	72	D		
	SB	30.1	C	SB Through	2	38	8	72	D		
				SB Right	24	7	19	110	A		
				EB Left	4	11	28	285	B		
	EB	8.0	A	EB Through	1125	8	28	285	A		
				EB Right	198	7	28	285	A		
				WB Left	210	21	28	289	C		
	WB	8.6	A	WB Through	1437	7	28	289	A		
				WB Right	3	3	28	289	A		
23- MD 124 at MD 355											
23				NB Left	490	115	682	1082	F	78.6	E
	NB	130.8	F	NB Through	1162	138	680	1079	F		
				NB Right	7	85	0	0	F		
				SB Left	180	92	146	490	F		
	SB	44.6	D	SB Through	698	66	146	490	E		
				SB Right	720	12	44	383	B		
				EB Left	291	68	108	598	E		
	EB	27.2	C	EB Through	1615	25	108	598	C		
				EB Right	338	3	28	551	A		
				WB Left	0	0	0	0	A		
	WB	126.4	F	WB Through	1645	129	683	946	F		
				WB Right	88	83	0	3	F		
24- MD 124 at I-270 SB on and off											
24				NB Left	55	84	67	182	F	63.0	E
	NB	95.9	F	NB Through	21	127	67	182	F		
				NB U-Turn	0	0	0	0	A		
				SB Left	547	95	190	736	F		
	SB	55.4	E	SB Through	8	98	190	736	F		
				SB Right	456	7	13	379	A		
				EB Left	0	0	0	0	A		
	EB	101.1	F	EB Through	1409	100	584	1113	F		
				EB Right	22	162	604	1137	F		
				WB Left	5	78	653	2194	E		
	WB	21.7	C	WB Through	1192	22	653	2194	C		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25				NB Left	54	158	328	743	F	50.1	D
	NB	78.5	E	NB Through	686	93	328	743	F		
				NB Right	461	48	29	665	D		
				SB Left	134	61	153	737	E		
	SB	37.8	D	SB Through	969	41	153	737	D		
				SB Right	182	5	0	0	A		
				EB Left	153	80	152	574	E		
	EB	44.9	D	EB Through	1156	41	152	576	D		
				EB Right	57	37	156	603	D		
				WB Left	315	71	205	1006	E		
	WB	42.6	D	WB Through	1069	38	205	1006	D		
				WB Right	99	1	0	0	A		
26- MD 117 at Bureau Dr											
26				NB Left	98	76	81	296	E	37.8	D
	NB	50.3	D	NB Through	35	77	81	296	E		
				NB Right	272	38	81	296	D		
				SB Left	284	95	132	405	F		
	SB	80.7	F	SB Through	23	83	132	405	F		
				SB Right	83	32	132	405	C		
				EB Left	52	54	165	806	D		
	EB	30.3	C	EB Through	1683	30	166	806	C		
				EB Right	6	18	160	795	B		
				WB Left	14	35	185	997	D		
	WB	31.9	C	WB Through	1272	34	186	998	C		
				WB Right	213	19	211	1046	B		
27- MD 117 at I-270 SB off ramp											
27				NB Left	0	0	0	0	A	12.8	B
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB			SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB	3.7	A	EB Through	944	4	6	464	A		
				EB Right	0	0	0	0	A		
				WB Left	306	41	98	848	E		
	WB	40.7	E	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28				NB Left	0	0	0	0	A	24.3	C
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	97	91	1950	2779	F		
	SB	89.3	F	SB Through	0	0	0	0	A		
				SB Right	374	89	1949	2779	F		
				EB Left	3	120	90	983	F		
	EB	17.3	B	EB Through	947	17	90	983	B		
				EB Right	0	0	0	0	A		
				WB Left	0	0	0	0	A		
	WB	7.3	A	WB Through	1403	7	52	390	A		
				WB Right	0	0	52	390	A		
29- MD 117 at Perry Pkwy											
29				NB Left	19	59	17	125	E	49.4	D
	NB	40.8	D	NB Through	26	59	17	124	E		
				NB Right	34	17	27	145	B		
				SB Left	241	198	280	446	F		
	SB	162.4	F	SB Through	21	220	280	446	F		
				SB Right	121	82	280	446	F		
				EB Left	223	69	74	337	E		
	EB	21.1	C	EB Through	778	8	74	337	A		
				EB Right	30	7	60	321	A		
				WB Left	37	108	248	736	F		
	WB	41.4	D	WB Through	1260	42	248	736	D		
				WB Right	382	33	248	736	C		
30- Shady Grove Rd at I-270 NB off ramp											
30				NB Left	0	0	0	0	A	30.1	C
	NB	7.6	A	NB Through	914	8	87	483	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	44.7	D	SB Through	1013	45	163	681	D		
				SB Right	0	0	0	0	A		
				EB Left	0	0	0	0	A		
	EB			EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
				WB Left	267	52	48	264	D		
	WB	51.6	D	WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
31	NB	31.3	C	NB Left	0	0	0	0	A	29.5	C
				NB Through	1229	31	435	1759	C		
				NB Right	0	0	0	0	A		
	SB	5.6	A	SB Left	0	0	0	0	A		
				SB Through	676	6	7	154	A		
				SB Right	0	0	0	0	A		
	EB	55.6	E	EB Left	232	54	43	211	D		
				EB Through	0	0	0	0	A		
				EB Right	304	57	62	297	E		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
32	NB			NB U-Turn	0	0	0	0	A	7.9	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	37.2	D	SB Left	406	46	71	322	D		
				SB Through	0	0	0	0	A		
				SB Right	97	3	0	28	A		
	EB	2.8	A	EB Left	0	0	0	0	A		
				EB Through	1560	1	0	0	A		
				EB Right	932	6	16	224	A		
	WB	6.7	A	WB Left	0	0	0	0	A		
				WB Through	1642	7	20	253	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
33	NB	36.9	D	NB Left	0	0	41	226	A	39.9	D
				NB Through	185	49	49	235	D		
				NB Right	123	18	49	235	B		
	SB	137.2	F	SB Left	14	160	361	412	F		
				SB Through	0	0	0	0	A		
				SB Right	219	136	361	412	F		
	EB	20.0	B	EB Left	283	61	94	334	E		
				EB Through	920	7	94	334	A		
				EB Right	0	0	0	0	A		
	WB	41.7	D	WB Left	40	37	168	432	D		
				WB Through	1279	42	144	396	D		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
34	NB	36.7	D	NB Left	43	45	12	90	D	13.2	B
				NB Through	14	48	9	90	D		
				NB Right	19	9	9	101	A		
	SB	3.4	A	SB Left	18	41	7	83	D		
				SB Through	13	48	7	83	D		
				SB Right	408	0	3	48	A		
	EB	11.6	B	EB Left	410	23	37	417	C		
				EB Through	644	5	6	200	A		
				EB Right	55	5	10	236	A		
	WB	18.0	B	WB Left	14	19	52	406	B		
				WB Through	842	18	51	406	B		
				WB Right	18	12	67	440	B		
35- MD 189 at I-270 Ramps											
35	NB	47.1	D	NB Left	225	47	41	196	D	42.5	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	54.4	D	SB Left	348	54	124	453	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	28.0	C	EB Left	479	32	91	341	C		
				EB Through	373	23	91	341	C		
				EB Right	0	0	0	0	A		
	WB	50.8	D	WB Left	443	54	111	336	D		
				WB Through	428	47	111	336	D		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
36	NB	45.9	D	NB Left	238	57	142	506	E	52.4	D
				NB Through	694	51	142	506	D		
				NB Right	176	12	142	506	B		
	SB	82.8	F	SB Left	250	101	295	794	F		
				SB Through	926	78	312	780	E		
				SB Right	0	0	0	0	A		
	EB	38.7	D	EB Left	153	72	123	486	E		
				EB Through	552	38	123	486	D		
				EB Right	204	15	123	486	B		
	WB	39.5	D	WB Left	157	72	141	743	E		
				WB Through	775	41	141	743	D		
				WB Right	315	19	141	743	B		
37- Montrose Rd at Tower Oaks Blvd											
37	NB	0.4	A	NB Left	0	0	0	0	A	32.4	C
				NB Through	0	0	0	0	A		
				NB Right	537	0	0	0	A		
	SB	143.6	F	SB Left	87	49	213	902	D		
				SB Through	0	0	0	0	A		
				SB Right	305	171	269	899	F		
	EB	6.9	A	EB Left	0	0	0	0	A		
				EB Through	1868	7	39	520	A		
				EB Right	0	0	0	0	A		
	WB	40.0	D	WB Left	79	37	39	520	D		
				WB Through	2426	41	277	780	D		
				WB Right	261	30	277	780	C		
38- Tower Oaks Blvd at I-270 off rmap											
38	NB	23.3	C	NB Left	707	24	50	240	C	17.3	B
				NB Through	0	0.0	43	232	A		
				NB Right	26	7.0	50	240	A		
	SB	9.8	A	SB Left	8	18.4	1	39	B		
				SB Through	0	0.0	1	39	A		
				SB Right	9	2.2	0	23	A		
	EB	10.8	B	EB Left	1	11.5	16	177	B		
				EB Through	363	11.2	16	177	B		
				EB Right	37	7.0	11	167	A		
	WB	12.7	B	WB Left	139	16.3	16	145	B		
				WB Through	203	10.4	16	145	B		
				WB Right	3	3.4	3	100	A		
39- Montrose Rd at Tower Oaks Blvd											
39	NB	20.0	C	NB Left	97	42	83	387	D	45.0	D
				NB Through	773	32	83	387	C		
				NB Right	621	2	0	0	A		
	SB	32.1	C	SB Left	210	63	76	334	E		
				SB Through	506	23	74	333	C		
				SB Right	131	15	72	340	B		
	EB	133.4	F	EB Left	104	112	358	697	F		
				EB Through	518	136	360	698	F		
				EB Right	44	149	382	722	F		
	WB	36.9	D	WB Left	542	46	109	374	D		
				WB Through	456	42	110	374	D		
				WB Right	315	13	129	404	B		
40- Rockledge Blvd at I-270 NB on and off ramp											
40	NB	132.4	F	NB Left	0	0	0	0	A	112.4	F
				NB Through	335	121	557	836	F		
				NB Right	854	137	557	836	F		
	SB	85.9	F	SB Left	0	0	89	217	A		
				SB Through	352	86	89	217	F		
				SB Right	0	0	0	0	A		
	EB	93.5	F	EB Left	6	184	288	804	F		
				EB Through	459	148	288	804	F		
				EB Right	304	10	0	0	B		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	30.3	C	NB Left	343	30	76	273	C	48.1	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	53.0	D	WB Left	355	59	195	867	E		
				WB Through	890	51	195	867	D		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	66.6	E	NB Left	216	39	567	1282	D	128.7	F
				NB Through	2309	68	567	1282	E		
				NB Right	200	76	567	1282	E		
	SB	187.6	F	SB Left	205	172	2555	2693	F		
				SB Through	1151	185	2555	2693	F		
				SB Right	306	209	2555	2693	F		
	EB	112.4	F	EB Left	302	66	540	1403	E		
				EB Through	534	136	541	1404	F		
				EB Right	118	121	564	1428	F		
	WB	195.5	F	WB Left	465	191	1941	2142	F		
				WB Through	674	211	1941	2142	F		
				WB Right	166	145	1941	2142	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	16.8	B	NB Left	566	35	117	404	C	20.4	C
				NB Through	2515	13	117	404	B		
				NB Right	0	0	0	0	A		
	SB	25.1	C	SB Left	0	0	0	0	A		
				SB Through	1290	25	66	269	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	60.3	E	WB Left	59	60	47	317	E		
				WB Through	67	60	47	317	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	40.0	E	NB Left	0	0	0	0	A	36.9	D
				NB Through	2426	40	155	739	D		
				NB Right	0	0	0	0	A		
	SB	18.1	B	SB Left	147	56	67	271	E		
				SB Through	1203	13	67	271	B		
				SB Right	0	0	0	0	A		
	EB	58.2	E	EB Left	652	60	143	560	E		
				EB Through	0	0	143	560	A		
				EB Right	179	53	82	486	D		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	20.6	C	NB Left	492	37	123	826	D	29.8	C
				NB Through	2174	17	124	827	B		
				NB Right	18	14	145	860	B		
	SB	34.2	C	SB Left	21	62	111	472	E		
				SB Through	1186	39	111	472	D		
				SB Right	173	1	69	465	A		
	EB	50.0	D	EB Left	431	60	146	519	E		
				EB Through	50	68	146	519	E		
				EB Right	484	39	146	519	D		
	WB	17.1	B	WB Left	7	29	6	108	C		
				WB Through	16	33	6	108	C		
				WB Right	36	8	3	97	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	45.3	D	NB Left	154	45	28	136	D	3.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.2	A	EB Left	0	0	0	0	A		
				EB Through	1127	1	3	66	A		
				EB Right	0	0	0	0	A		
	WB	1.1	A	WB Left	0	0	0	0	A		
				WB Through	2241	1	3	84	A		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	8.4	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.5	A	EB Left	0	0	0	0	A		
				EB Through	1336	5	19	232	A		
				EB Right	0	0	0	0	A		
	WB	10.1	B	WB Left	543	35	59	404	D		
				WB Through	1827	3	49	383	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	8.8	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	37.4	D	SB Left	154	51	28	143	D		
				SB Through	0	0	0	0	A		
				SB Right	59	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.8	A	WB Left	0	0	0	0	A		
				WB Through	1827	4	19	305	A		
				WB Right	156	29	116	746	C		
50- MD 190 at Burdette Rd											
50	NB	76.4	E	NB Left	27	79	18	118	E	36.6	D
				NB Through	7	69	18	118	E		
				NB Right	6	75	18	118	E		
	SB	37.5	D	SB Left	45	77	25	148	E		
				SB Through	9	72	25	148	E		
				SB Right	122	20	25	148	C		
	EB	21.6	C	EB Left	138	99	113	625	F		
				EB Through	1297	14	113	625	B		
				EB Right	31	4	99	653	A		
	WB	45.7	D	WB Left	13	114	390	1119	F		
				WB Through	2161	46	390	1119	D		
				WB Right	65	35	390	1119	C		

Table D.14: PM Peak - No Build - Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51	NB			NB Left	0	0	0	0	A	17.6	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	65.7	E	EB Left	254	66	101	343	E		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	9.3	A	WB Left	0	0	0	0	A		
				WB Through	1471	9	49	692	A		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52	NB	70.5	E	NB Left	225	70	84	800	E	12.3	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	3.6	A	EB Left	0	0	0	0	A		
				EB Through	1062	4	8	176	A		
				EB Right	0	0	0	0	A		
	WB	10.0	A	WB Left	0	0	0	0	A		
				WB Through	1641	10	30	635	A		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53	NB	0.5	A	NB Left	28	1	0	0	A	26.9	C
				NB Through	314	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	52.6	D	SB Left	364	52	120	414	D		
				SB Through	232	53	120	414	D		
				SB Right	20	50	120	414	D		
	EB	32.0	C	EB Left	27	30	95	436	C		
				EB Through	800	32	95	436	C		
				EB Right	45	32	95	436	C		
	WB	20.8	C	WB Left	255	75	124	491	E		
				WB Through	914	18	124	491	B		
				WB Right	693	5	124	491	A		
54- MD 124 at I-270 NB off ramp											
54	NB	31.3	C	NB Left	0	0	0	0	A	23.6	C
				NB Through	0	0	0	0	A		
				NB Right	556	31	56	630	C		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	21.1	C	EB Left	0	0	0	0	A		
				EB Through	1661	21	57	938	C		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55	NB	46.2	D	NB Left	0	0	0	0	A	11.2	B
				NB Through	0	0	0	0	A		
				NB Right	313	46	51	205	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.5	A	EB Left	0	0	0	0	A		
				EB Through	1128	2	4	59	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
56- Watkins Mill Rd at I-270 SB off ramp/Parkview Ave											
56	NB	71.3	E	NB Left	145	53	170	656	D	87.9	F
				NB Through	0	0	0	0	A		
				NB Right	342	79	170	656	E		
	SB	42.7	D	SB Left	410	63	107	388	E		
				SB Through	110	59	107	388	E		
				SB Right	441	20	107	388	C		
	EB	143.5	F	EB Left	0	0	0	0	A		
				EB Through	1216	144	961	1246	F		
				EB Right	4	136	961	1246	F		
	WB	41.9	D	WB Left	62	85	49	220	F		
				WB Through	295	33	47	219	C		
				WB Right	0	0	0	0	A		
57- Watkins Mill Rd at I-270 NB on ramp											
57	NB	40.5	D	NB Left	77	65	56	638	E	72.4	E
				NB Through	0	0	0	0	A		
				NB Right	193	31	56	638	C		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	26.1	C	EB Left	644	66	146	438	E		
				EB Through	1051	2	146	438	A		
				EB Right	0	0	0	0	A		
	WB	157.1	F	WB Left	0	0	0	0	A		
				WB Through	684	122	651	866	F		
				WB Right	343	227	651	866	F		
58- Watkins Mill Rd at I-270 SB on ramp											
58	NB			NB Left	0	0	0	0	A	16.5	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	17.2	B	EB Left	0	0	0	0	A		
				EB Through	1691	19	150	598	B		
				EB Right	286	8	150	598	A		
	WB	14.8	B	WB Left	409	27	46	464	C		
				WB Through	352	1	46	464	A		
				WB Right	0	0	0	0	A		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
1- MD 85 at Sam's Club Drive											
1	NB	61.3	E	NB Left	131	84	450	901	F	116.9	F
				NB Through	570	38	450	901	D		
				NB Right	930	72	423	924	E		
	SB	179.1	F	SB Left	152	134	1014	1236	F		
				SB Through	874	185	1014	1236	F		
				SB Right	73	201	1014	1236	F		
	EB	34.7	C	EB Left	55	84	31	146	F		
				EB Through	24	81	31	146	F		
				EB Right	169	12	31	146	B		
	WB	170.0	F	WB Left	552	189	546	771	F		
				WB Through	29	162	546	771	F		
				WB Right	222	125	546	771	F		
2- MD 85 at I-270 NB on and off ramp											
2	NB	54.6	D	NB Left	1120	55	691	2322	D	44.9	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	30.2	C	SB Left	0	0	0	0	A		
				SB Through	736	30	126	767	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
3- MD 85 at I-270 SB on and off ramp											
3	NB	17.4	B	NB Left	0	0	0	0	A	19.4	B
				NB Through	1947	17	175	1297	B		
				NB Right	0	0	0	0	A		
	SB	41.3	D	SB Left	171	41	56	486	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
4- MD 85 at Crestwood Blvd											
4	NB	81.6	F	NB Left	73	114	420	896	F	55.5	E
				NB Through	1431	80	420	897	E		
				NB U-Turn	0	0	0	0	A		
	SB	32.3	C	SB Left	106	77	50	250	E		
				SB Through	946	30	130	1018	C		
				SB Right	929	29	117	1007	C		
	EB	62.4	E	EB Left	949	65	191	684	E		
				EB Through	43	50	191	684	D		
				EB Right	28	1	191	684	A		
	WB	54.9	D	WB Left	45	79	62	238	E		
				WB Through	77	82	62	238	F		
				WB Right	94	21	62	238	C		
5- MD 80 at I-270 NB on and ramp											
5	NB	-0.6	A	NB Left	2	0	0	4	A	11.6	B
				NB Through	2	3	0	4	A		
				NB Right	7	-2	0	4	A		
	SB	12.8	B	SB Left	508	16	29	270	B		
				SB Through	24	16	29	270	B		
				SB Right	159	3	0	15	A		
	EB	14.2	B	EB Left	97	14	26	237	B		
				EB Through	0	0	8	0	A		
				EB Right	5	8	38	267	A		
	WB	10.9	B	WB Left	15	12	0	30	B		
				WB Through	670	19	68	467	B		
				WB Right	612	2	0	0	A		
6- MD 80 at I-270 SB on and off ramp											
6	NB	3.4	A	NB Left	55	4	3	235	A	5.9	A
				NB Through	0	0	0	0	A		
				NB Right	604	3	3	235	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	7.0	A	EB Left	0	0	0	0	A		
				EB Through	381	7	4	95	A		
				EB Right	66	4	3	104	A		
	WB	8.3	A	WB Left	0	0	0	0	A		
				WB Through	456	8	3	174	A		
				WB Right	0	0	0	0	A		
7- MD 109 at I-270 NB on and off ramp											
7	NB			NB Left	0	0	0	0	A	8.3	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	15.5	C	SB Left	342	16	37	278	C		
				SB Through	0	0	0	0	A		
				SB Right	24	5	0	149	A		
	EB	2.5	A	EB Left	80	2	0	57	A		
				EB Through	0	0	0	0	A		
				EB Right	83	3	0	0	A		
	WB	0.4	A	WB Left	0	0	0	0	A		
				WB Through	222	0	0	0	A		
				WB Right	0	0	0	0	A		
8- MD 80 at I-270 SB on and off ramp											
8	NB	4.9	A	NB Left	64	8	3	101	A	1.9	A
				NB Through	0	0	0	0	A		
				NB Right	37	0	0	16	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.9	A	EB Left	0	0	0	0	A		
				EB Through	166	0	0	0	A		
				EB Right	34	4	0	0	A		
	WB	1.5	A	WB Left	137	1	0	62	A		
				WB Through	109	2	0	39	A		
				WB Right	0	0	0	0	A		
9- MD 121 at Gateway Center Dr											
9	NB	36.4	E	NB Left	653	40	163	682	D	50.7	D
				NB Through	896	35	163	682	D		
				NB Right	74	20	173	708	B		
	SB	22.6	C	SB Left	27	14	18	208	B		
				SB Through	303	24	30	215	C		
				SB Right	9	9	33	236	A		
	EB	14.5	B	EB Left	4	40	8	233	D		
				EB Through	24	40	14	233	D		
				EB Right	248	12	27	265	B		
	WB	120.5	F	WB Left	348	163	306	772	F		
				WB Through	76	84	306	771	F		
				WB Right	185	56	329	796	E		
10- MD 121 at I-270 NB on and off ramp											
10	NB	22.3	C	NB Left	450	57	96	736	F	19.4	B
				NB Through	0	0	0	0	A		
				NB Right	968	6	15	537	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	13.5	B	EB Left	0	0	0	0	A		
				EB Through	649	20	44	364	C		
				EB Right	336	1	0	23	A		
	WB	21.4	C	WB Left	219	63	90	451	F		
				WB Through	677	8	90	451	A		
				WB Right	0	0	0	0	A		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
11- MD 121 at I-270 SB on and off ramp											
11	NB			NB Left	0	0	0	0	A	24.1	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	69.6	E	SB Left	269	92	258	1048	F		
				SB Through	0	0	0	0	A		
				SB Right	251	45	4	200	E		
	EB	6.3	A	EB Left	0	0	0	0	A		
				EB Through	717	6	16	203	A		
				EB Right	0	0	0	0	A		
	WB	14.5	B	WB Left	0	0	0	0	A		
				WB Through	595	27	55	402	D		
				WB Right	535	0	0	0	A		
12- MD 27 at Observation Dr											
12	NB	38.1	D	NB U-Turn	0	0	0	0	A	25.7	C
				NB Through	94	55	22	98	D		
				NB Right	61	13	22	98	B		
	SB	41.2	D	SB Left	146	44	38	216	D		
				SB Through	57	62	43	250	E		
				SB Right	188	33	68	287	C		
	EB	20.2	C	EB Left	211	33	88	520	C		
				EB Through	2255	19	90	521	B		
				EB Right	109	18	103	559	B		
	WB	29.3	C	WB Left	41	25	156	704	C		
				WB Through	1695	30	156	704	C		
				WB Right	68	9	156	704	A		
13- MD 27 at I-270 NB off ramp											
13	NB	44.6	D	NB Left	390	45	64	278	D	7.6	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	0.1	A	EB Left	0	0	0	0	A		
				EB Through	1514	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	5.9	A	WB Left	0	0	0	0	A		
				WB Through	1794	6	48	822	A		
				WB Right	0	0	0	0	A		
14- MD 27 at I-270 SB off ramp											
14	NB			NB Left	0	0	0	0	A	5.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	51.0	D	SB Left	172	51	35	149	D		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.9	A	EB Left	0	0	0	0	A		
				EB Through	1677	2	5	132	A		
				EB Right	0	0	0	0	A		
	WB	3.3	A	WB Left	0	0	0	0	A		
				WB Through	1627	3	11	393	A		
				WB Right	0	0	0	0	A		
15- MD 27 at Crystal Rock Dr											
15	NB	31.4	C	NB Left	77	32	109	562	C	69.2	E
				NB Through	1196	31	118	561	C		
				NB Right	55	29	124	574	C		
	SB	55.4	E	SB Left	165	75	387	1334	E		
				SB Through	1521	57	387	1334	E		
				SB Right	232	30	373	1328	C		
	EB	40.7	D	EB Left	125	54	35	131	D		
				EB Through	49	36	30	126	D		
				EB Right	62	18	23	160	B		
	WB	162.4	F	WB Left	104	91	1037	1518	F		
				WB Through	127	108	1037	1518	F		
				WB Right	665	184	1037	1518	F		
16- MD 118 at Seneca Meadows Pkwy											
16	NB	5.2	A	NB Left	111	14	2	91	B	9.1	A
				NB Through	1426	5	12	281	A		
				NB Right	1	3	22	335	A		
	SB	7.5	A	SB Left	16	9	20	320	A		
				SB Through	1226	8	22	320	A		
				SB Right	11	5	26	352	A		
	EB	14.1	B	EB Left	23	58	14	147	E		
				EB Through	0	65	14	147	E		
				EB Right	312	11	14	147	B		
	WB	53.9	D	WB Left	103	65	43	243	E		
				WB Through	7	69	39	242	E		
				WB Right	30	13	48	262	B		
17- MD 118 at I-270 NB on ramp											
17	NB			NB Left	0	0	0	0	A	13.5	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	25.8	C	EB Left	492	26	43	344	C		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	9.8	A	WB Left	0	0	0	0	A		
				WB Through	283	2	0	7	A		
				WB Right	1364	11	43	470	B		
18- MD 118 at I-270 SB off ramp											
18	NB			NB Left	0	0	0	0	A	8.0	A
				NB Through	0	0.0	0	0	A		
				NB Right	0	0.0	0	0	A		
	SB	36.6	D	SB Left	168	36.6	26	135	D		
				SB Through	0	0.0	0	0	A		
				SB Right	0	0.0	0	0	A		
	EB	5.9	A	EB Left	0	0.0	0	0	A		
				EB Through	1409	5.9	13	390	A		
				EB Right	0	0.0	0	0	A		
	WB	6.9	A	WB Left	0	0.0	0	0	A		
				WB Through	1730	6.9	17	378	A		
				WB Right	0	0.0	0	0	A		
19- MD 118 at Aircraft Dr											
19	NB	26.3	C	NB Left	53	71	43	226	E	42.9	D
				NB Through	52	69	43	226	E		
				NB Right	227	6	5	123	A		
	SB	164.8	F	SB Left	438	151	419	658	F		
				SB Through	14	221	419	658	F		
				SB Right	127	205	419	658	F		
	EB	22.7	C	EB Left	125	36	88	558	D		
				EB Through	1415	22	88	558	C		
				EB Right	21	20	88	558	B		
	WB	26.1	C	WB Left	16	29	132	872	C		
				WB Through	1581	30	132	872	C		
				WB Right	412	10	132	872	A		
20- Middlebrook Rd at Observation Dr											
20	NB			NB Left	0	0	0	0	A	8.9	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	20.5	C	SB Left	125	36	23	150	D		
				SB Through	0	0	0	0	A		
				SB Right	186	10	23	150	B		
	EB	6.4	A	EB Left	15	8	17	194	A		
				EB Through	1202	6	17	194	A		
				EB Right	0	0	0	0	A		
	WB	8.5	A	WB Left	0	0	0	0	A		
				WB Through	1313	9	26	265	A		
				WB Right	17	7	41	314	A		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
21- Middlebrook Rd at I-270 SB on ramp											
21	NB			NB Left	0	0	0	0	A	4.5	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	2.6	A	EB Left	0	0	0	0	A		
				EB Through	742	3	4	104	A		
				EB Right	0	0	0	0	A		
	WB	7.8	A	WB Left	438	8	5	236	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
22- Middlebrook Rd at Waring Station Rd											
22	NB	48.4	D	NB Left	200	46	83	303	D	14.1	B
				NB Through	1	55	83	303	D		
				NB Right	236	50	83	303	D		
	SB	30.8	C	SB Left	32	48	8	72	D		
				SB Through	2	38	8	72	D		
				SB Right	24	8	20	110	A		
	EB	8.1	A	EB Left	4	13	28	311	B		
				EB Through	1125	8	28	311	A		
				EB Right	198	8	28	311	A		
	WB	9.8	A	WB Left	246	26	43	360	C		
				WB Through	1674	7	43	360	A		
				WB Right	3	2	43	360	A		
23- MD 124 at MD 355											
23	NB	114.9	F	NB Left	493	86	578	1032	F	60.7	E
				NB Through	1148	127	576	1030	F		
				NB Right	7	87	0	0	F		
	SB	59.9	E	SB Left	179	110	200	489	F		
				SB Through	688	85	200	489	F		
				SB Right	710	23	103	477	C		
	EB	31.0	C	EB Left	465	76	206	933	E		
				EB Through	2683	29	206	933	C		
				EB Right	561	5	73	860	A		
	WB	72.3	E	WB Left	0	0	0	0	A		
				WB Through	1844	75	413	925	E		
				WB Right	103	28	7	376	C		
24- MD 124 at I-270 SB on and off											
24	NB	61.1	F	NB Left	52	61	22	98	E	33.2	C
				NB Through	21	63	22	98	E		
				NB U-Turn	0	0	0	0	A		
	SB	47.6	D	SB Left	562	80	165	731	F		
				SB Through	8	88	165	731	F		
				SB Right	456	7	23	538	A		
	EB	30.8	C	EB Left	0	0	0	0	A		
				EB Through	1889	31	222	1044	C		
				EB Right	37	31	236	1068	C		
	WB	23.5	C	WB Left	5	64	122	855	E		
				WB Through	1261	23	122	855	C		
				WB Right	0	0	0	0	A		
25- MD 117 at MD 124											
25	NB	152.3	F	NB Left	47	305	519	755	F	64.4	E
				NB Through	591	171	519	755	F		
				NB Right	387	105	28	593	F		
	SB	49.2	D	SB Left	129	95	199	712	F		
				SB Through	959	51	199	712	D		
				SB Right	181	7	0	0	A		
	EB	51.6	D	EB Left	155	75	176	610	E		
				EB Through	1143	49	176	612	D		
				EB Right	57	46	188	639	D		
	WB	35.3	D	WB Left	396	59	228	1029	E		
				WB Through	1312	32	228	1029	C		
				WB Right	128	1	0	0	A		
26- MD 117 at Bureau Dr											
26	NB	51.9	D	NB Left	97	82	83	305	F	49.6	D
				NB Through	35	84	83	305	F		
				NB Right	274	37	83	305	D		
	SB	93.1	F	SB Left	280	106	149	400	F		
				SB Through	22	108	149	400	F		
				SB Right	83	45	149	400	D		
	EB	54.8	D	EB Left	48	118	301	915	F		
				EB Through	1608	53	301	915	D		
				EB Right	6	36	292	905	D		
	WB	36.3	D	WB Left	19	50	301	1055	D		
				WB Through	1653	38	302	1056	D		
				WB Right	279	24	330	1104	C		
27- MD 117 at I-270 SB off ramp											
27	NB			NB Left	0	0	0	0	A	74.1	F
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	67.7	F	EB Left	0	0	0	0	A		
				EB Through	919	68	554	1151	F		
				EB Right	0	0	0	0	A		
	WB	96.7	F	WB Left	264	97	268	1073	F		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
28- MD 117 at I-270 NB off ramp											
28	NB			NB Left	0	0	0	0	A	41.7	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	34.5	C	SB Left	264	27	130	749	C		
				SB Through	0	0	0	0	A		
				SB Right	969	37	130	748	D		
	EB	72.2	E	EB Left	3	197	548	1005	F		
				EB Through	914	72	548	1005	E		
				EB Right	0	0	0	0	A		
	WB	26.1	C	WB Left	0	0	0	0	A		
				WB Through	1229	26	172	394	C		
				WB Right	0	0	172	394	A		
29- MD 117 at Perry Pkwy											
29	NB	48.1	D	NB Left	18	83	17	133	F	69.6	E
				NB Through	26	59	17	133	E		
				NB Right	33	21	27	153	C		
	SB	152.8	F	SB Left	242	190	266	456	F		
				SB Through	20	216	266	456	F		
				SB Right	119	66	266	456	E		
	EB	20.8	C	EB Left	244	74	82	336	E		
				EB Through	879	7	82	336	A		
				EB Right	33	5	68	320	A		
	WB	87.8	F	WB Left	33	142	462	752	F		
				WB Through	1096	93	462	752	F		
				WB Right	327	64	462	752	E		
30- Shady Grove Rd at I-270 NB off ramp											
30	NB	6.8	A	NB Left	0	0	0	0	A	13.6	B
				NB Through	1061	7	16	216	A		
				NB Right	0	0	0	0	A		
	SB	9.9	A	SB Left	0	0	0	0	A		
				SB Through	1363	10	48	536	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	50.9	D	WB Left	327	51	58	247	D		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
31- Shady Grove Rd at I-270 SB off ramp											
31				NB Left	0	0	0	0	A	15.6	B
	NB	6.8	A	NB Through	1528	7	30	419	A		
				NB Right	0	0	0	0	A		
				SB Left	0	0	0	0	A		
	SB	5.2	A	SB Through	870	5	8	159	A		
				SB Right	0	0	0	0	A		
				EB Left	233	57	48	202	E		
	EB	57.2	E	EB Through	0	0	0	0	A		
				EB Right	303	57	61	262	E		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
32- MD 28 at I-270 SB off ramp											
32				NB U-Turn	0	0	0	0	A	8.4	A
	NB			NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	444	46	78	325	D		
	SB	37.6	D	SB Through	0	0	0	0	A		
				SB Right	104	3	0	64	A		
				EB Left	0	0	0	0	A		
	EB	2.9	A	EB Through	1560	1	0	0	A		
				EB Right	932	6	15	209	A		
				WB Left	0	0	0	0	A		
	WB	7.1	A	WB Through	1847	7	24	291	A		
				WB Right	0	0	0	0	A		
33- MD 28 at I-270 on and off ramps											
33				NB Left	0	0	46	220	A	46.2	D
	NB	37.2	D	NB Through	214	49	54	229	D		
				NB Right	138	19	54	229	B		
				SB Left	20	156	353	417	F		
	SB	140.0	F	SB Through	0	0	0	0	A		
				SB Right	291	139	353	417	F		
				EB Left	285	76	123	349	E		
	EB	23.9	C	EB Through	948	8	123	349	A		
				EB Right	0	0	0	0	A		
				WB Left	41	40	191	442	D		
	WB	47.3	D	WB Through	1281	48	166	405	D		
				WB Right	0	0	0	0	A		
34- MD 189 at Great Falls Rd											
34				NB Left	43	45	12	95	D	14.0	B
	NB	36.6	D	NB Through	14	48	9	94	D		
				NB Right	19	8	9	105	A		
				SB Left	18	41	7	83	D		
	SB	3.2	A	SB Through	13	46	7	83	D		
				SB Right	415	0	0	0	A		
				EB Left	431	24	41	535	C		
	EB	12.2	B	EB Through	675	5	6	199	A		
				EB Right	58	5	11	235	A		
				WB Left	15	19	53	373	B		
	WB	19.6	B	WB Through	853	20	53	373	B		
				WB Right	18	14	69	407	B		
35- MD 189 at I-270 Ramps											
35				NB Left	247	45	43	178	D	42.0	D
	NB	45.3	D	NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
				SB Left	356	58	139	504	E		
	SB	57.9	E	SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
				EB Left	483	31	91	350	C		
	EB	27.1	C	EB Through	373	23	91	350	C		
				EB Right	0	0	0	0	A		
				WB Left	448	54	112	291	D		
	WB	49.2	D	WB Through	436	44	112	291	D		
				WB Right	0	0	0	0	A		
36- MD 189 at Wooton Pkwy											
36				NB Left	237	56	141	505	E	53.6	D
	NB	45.6	D	NB Through	694	50	141	505	D		
				NB Right	176	12	141	505	B		
				SB Left	251	108	308	797	F		
	SB	85.4	F	SB Through	934	79	328	784	E		
				SB Right	0	0	0	0	A		
				EB Left	152	73	126	464	E		
	EB	39.4	D	EB Through	554	39	126	464	D		
				EB Right	205	15	126	464	B		
				WB Left	163	73	154	653	E		
	WB	41.0	D	WB Through	793	43	154	653	D		
				WB Right	325	20	154	653	B		
37- Montrose Rd at Tower Oaks Blvd											
37				NB Left	0	0	0	0	A	23.1	C
	NB	0.4	A	NB Through	0	0	0	0	A		
				NB Right	538	0	0	0	A		
				SB Left	87	50	29	271	D		
	SB	62.6	E	SB Through	0	0	0	0	A		
				SB Right	311	66	90	277	E		
				EB Left	0	0	0	0	A		
	EB	7.2	A	EB Through	1899	7	42	510	A		
				EB Right	0	0	0	0	A		
				WB Left	80	41	42	510	D		
	WB	31.9	C	WB Through	2683	33	208	774	C		
				WB Right	289	24	208	774	C		
38- Tower Oaks Blvd at I-270 off rmap											
38				NB Left	705	24	50	254	C	17.0	B
	NB	23.2	C	NB Through	0	0.0	43	246	A		
				NB Right	27	7.3	50	254	A		
				SB Left	9	17.0	1	40	B		
	SB	9.9	A	SB Through	0	0.0	1	39	A		
				SB Right	9	2.8	0	24	A		
				EB Left	1	12.8	16	175	B		
	EB	10.5	B	EB Through	363	10.8	16	175	B		
				EB Right	37	7.2	11	166	A		
				WB Left	151	15.6	16	146	B		
	WB	12.1	B	WB Through	214	9.7	16	147	A		
				WB Right	3	4.1	3	103	A		
39- Montrose Rd at Tower Oaks Blvd											
39				NB Left	97	42	84	393	D	43.6	D
	NB	20.4	C	NB Through	773	32	84	393	C		
				NB Right	621	2	0	0	A		
				SB Left	211	65	77	343	E		
	SB	33.2	C	SB Through	506	24	76	342	C		
				SB Right	131	16	74	361	B		
				EB Left	105	101	323	684	F		
	EB	120.9	F	EB Through	527	124	324	685	F		
				EB Right	44	128	346	708	F		
				WB Left	577	46	118	419	D		
	WB	37.4	D	WB Through	481	43	119	419	D		
				WB Right	334	15	139	449	B		
40- Rockledge Blvd at I-270 NB on and off ramp											
40				NB Left	0	0	0	0	A	118.0	F
	NB	135.9	F	NB Through	337	124	569	843	F		
				NB Right	858	140	569	843	F		
				SB Left	0	0	88	211	A		
	SB	86.9	F	SB Through	350	87	88	211	F		
				SB Right	0	0	0	0	A		
				EB Left	6	168	339	920	F		
	EB	104.5	F	EB Through	460	165	339	920	F		
				EB Right	313	14	0	0	B		
				WB Left	0	0	0	0	A		
	WB			WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
41- Rockledge Blvd at I-270 SB on and off ramps											
41	NB	30.6	C	NB Left	343	31	76	262	C	46.7	D
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	51.2	D	WB Left	349	55	185	744	E		
				WB Through	879	50	185	744	D		
				WB Right	0	0	0	0	A		
42- MD 187 at Tuckerman Ln											
42	NB	56.9	E	NB Left	214	32	473	1256	C	127.3	F
				NB Through	2311	58	473	1256	E		
				NB Right	201	74	473	1256	E		
	SB	186.2	F	SB Left	208	172	2557	2692	F		
				SB Through	1165	183	2557	2692	F		
				SB Right	312	208	2557	2692	F		
	EB	129.8	F	EB Left	298	70	629	1435	E		
				EB Through	528	160	630	1436	F		
				EB Right	118	147	653	1460	F		
	WB	196.8	F	WB Left	463	190	1944	2143	F		
				WB Through	671	214	1944	2143	F		
				WB Right	165	146	1944	2143	F		
43- MD 187 at I-270 NB on and off ramps											
43	NB	15.4	B	NB Left	562	32	111	413	C	19.3	B
				NB Through	2501	12	111	413	B		
				NB Right	0	0	0	0	A		
	SB	24.6	C	SB Left	0	0	0	0	A		
				SB Through	1297	25	64	258	C		
				SB Right	0	0	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	59.6	E	WB Left	60	61	44	305	E		
				WB Through	68	58	44	305	E		
				WB Right	0	0	0	0	A		
44- MD 187 at I-270 NB on and off ramps											
44	NB	38.1	E	NB Left	0	0	0	0	A	37.4	D
				NB Through	2409	38	144	607	D		
				NB Right	0	0	0	0	A		
	SB	18.6	B	SB Left	148	54	70	308	D		
				SB Through	1208	14	70	308	B		
				SB Right	0	0	0	0	A		
	EB	65.9	E	EB Left	653	67	169	653	E		
				EB Through	0	0	169	653	A		
				EB Right	180	63	95	551	E		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
45- MD 187 at Rock Spring Dr											
45	NB	19.6	B	NB Left	492	36	115	768	D	29.2	C
				NB Through	2183	16	116	769	B		
				NB Right	18	12	136	802	B		
	SB	34.5	C	SB Left	21	58	113	528	E		
				SB Through	1191	39	113	528	D		
				SB Right	174	1	78	522	A		
	EB	49.0	D	EB Left	432	60	143	519	E		
				EB Through	50	66	143	519	E		
				EB Right	485	38	143	519	D		
	WB	16.8	B	WB Left	7	28	6	108	C		
				WB Through	16	32	6	108	C		
				WB Right	36	8	3	97	A		
47-Democracy Blvd at I-270 NB off ramp											
47	NB	46.0	D	NB Left	154	46	29	132	D	3.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.2	A	EB Left	0	0	0	0	A		
				EB Through	1193	1	3	51	A		
				EB Right	0	0	0	0	A		
	WB	0.9	A	WB Left	0	0	0	0	A		
				WB Through	2241	1	2	53	A		
				WB Right	0	0	0	0	A		
48- Democracy Blvd at I-270 SB on ramp											
48	NB			NB Left	0	0	0	0	A	6.6	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	5.3	A	EB Left	0	0	0	0	A		
				EB Through	1424	5	20	251	A		
				EB Right	0	0	0	0	A		
	WB	7.4	A	WB Left	567	22	41	294	C		
				WB Through	1827	3	32	273	A		
				WB Right	0	0	0	0	A		
49- Democracy Blvd at I-270 SB off ramp											
49	NB			NB Left	0	0	0	0	A	8.0	A
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	39.2	D	SB Left	188	54	38	159	D		
				SB Through	0	0	0	0	A		
				SB Right	73	2	0	0	A		
	EB			EB Left	0	0	0	0	A		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	4.0	A	WB Left	0	0	0	0	A		
				WB Through	1827	4	21	290	A		
				WB Right	184	1	0	49	A		
50- MD 190 at Burdette Rd											
50	NB	77.2	E	NB Left	27	80	18	118	E	38.3	D
				NB Through	7	69	18	118	E		
				NB Right	6	75	18	118	E		
	SB	35.6	D	SB Left	44	76	25	144	E		
				SB Through	9	73	25	144	E		
				SB Right	122	18	25	144	B		
	EB	26.9	C	EB Left	138	112	149	672	F		
				EB Through	1289	18	149	672	B		
				EB Right	31	4	144	699	A		
	WB	45.4	D	WB Left	13	113	397	1117	F		
				WB Through	2153	45	397	1117	D		
				WB Right	65	37	397	1117	D		

Table D.15: PM Peak - No Build - Alternative Intersection Delay and Level of Service

Intersection	Approach	Approach Delay	Approach LOS	Movement	Volume	Delay	Ave. Queue	Max Queue	LOS	Intersection Delay	Intersection LOS
51- MD 190 at I-270 NB on ramp											
51	NB			NB Left	0	0	0	0	A	17.6	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	67.5	E	EB Left	253	68	106	376	E		
				EB Through	0	0	0	0	A		
				EB Right	0	0	0	0	A		
	WB	8.9	A	WB Left	0	0	0	0	A		
				WB Through	1468	9	46	750	A		
				WB Right	0	0	0	0	A		
52- MD 190 at I-270 SB off ramp											
52	NB	74.0	E	NB Left	234	74	104	902	E	12.8	B
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	3.4	A	EB Left	0	0	0	0	A		
				EB Through	1062	3	8	180	A		
				EB Right	0	0	0	0	A		
	WB	10.2	B	WB Left	0	0	0	0	A		
				WB Through	1634	10	29	631	B		
				WB Right	0	0	0	0	A		
53- MD 190 at Seven Locks Rd											
53	NB	0.5	A	NB Left	28	1	0	0	A	26.9	C
				NB Through	314	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB	52.6	D	SB Left	364	52	120	414	D		
				SB Through	232	53	120	414	D		
				SB Right	20	52	120	414	D		
	EB	31.8	C	EB Left	27	29	95	438	C		
				EB Through	800	32	95	438	C		
				EB Right	45	32	95	438	C		
	WB	21.0	C	WB Left	254	77	126	566	E		
				WB Through	910	18	126	566	B		
				WB Right	696	5	126	566	A		
54- MD 124 at I-270 NB off ramp											
54	NB	39.6	D	NB Left	0	0	0	0	A	44.1	D
				NB Through	0	0	0	0	A		
				NB Right	1690	40	257	1057	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	48.0	D	EB Left	0	0	0	0	A		
				EB Through	1997	48	407	1257	D		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
55- Democracy Blvd at I-270 NB off ramp											
55	NB	47.4	D	NB Left	0	0	0	0	A	11.0	B
				NB Through	0	0	0	0	A		
				NB Right	313	47	51	209	D		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	1.5	A	EB Left	0	0	0	0	A		
				EB Through	1194	1	4	60	A		
				EB Right	0	0	0	0	A		
	WB			WB Left	0	0	0	0	A		
				WB Through	0	0	0	0	A		
				WB Right	0	0	0	0	A		
56- Watkins Mill Rd at I-270 SB off ramp/Parkview Ave											
56	NB	147.7	F	NB Left	138	64	431	706	E	111.3	F
				NB Through	0	0	0	0	A		
				NB Right	317	184	431	706	F		
	SB	45.5	D	SB Left	402	67	114	463	E		
				SB Through	110	60	114	463	E		
				SB Right	444	23	114	463	C		
	EB	192.0	F	EB Left	0	0	0	0	A		
				EB Through	982	192	1029	1250	F		
				EB Right	3	147	1029	1250	F		
	WB	50.0	D	WB Left	90	89	84	279	F		
				WB Through	452	42	82	277	D		
				WB Right	0	0	0	0	A		
57- Watkins Mill Rd at I-270 NB on ramp											
57	NB	115.3	F	NB Left	247	65	2498	5044	E	93.1	F
				NB Through	0	0	0	0	A		
				NB Right	639	135	2498	5044	F		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	49.7	D	EB Left	522	110	272	445	F		
				EB Through	943	16	272	445	B		
				EB Right	0	0	0	0	A		
	WB	133.1	F	WB Left	0	0	0	0	A		
				WB Through	722	158	651	873	F		
				WB Right	381	86	651	873	F		
58- Watkins Mill Rd at I-270 SB on ramp											
58	NB			NB Left	0	0	0	0	A	26.3	C
				NB Through	0	0	0	0	A		
				NB Right	0	0	0	0	A		
	SB			SB Left	0	0	0	0	A		
				SB Through	0	0	0	0	A		
				SB Right	0	0	0	0	A		
	EB	34.1	C	EB Left	0	0	0	0	A		
				EB Through	1463	38	288	577	D		
				EB Right	238	11	288	577	B		
	WB	12.7	B	WB Left	427	28	50	451	C		
				WB Through	543	1	50	451	A		
				WB Right	0	0	0	0	A		

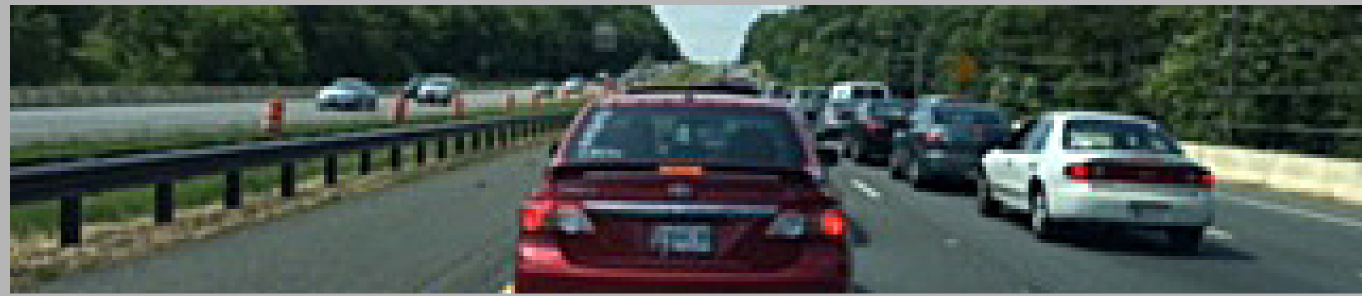
Table D.16: PM Peak - No Build - I-270 Vehicle Network Performance

	No Build	Alternative	% Change
Total Delay	36,237,078	26,529,454	-27%
Average Delay per Vehicle	307	222	-28%
Total Travel Time	67,865,560	60,983,640	-10%
Vehicles (Arrived)	95,124	101,071	6%
Latent Demand	8,861	7,272	-18%
Latent Delay	13,484,325	13,192,752	-2%
Total Distance	477,455	520,433	9%
Average Speed	25	31	21%

WELLINGTON POWER CORPORATION
177 THORN HILL ROAD | WARRENDALE, PA 15086

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS



IS 270 – Innovative CongestionManagement Contract

MONTGOMERY AND FREDERICK COUNTIES

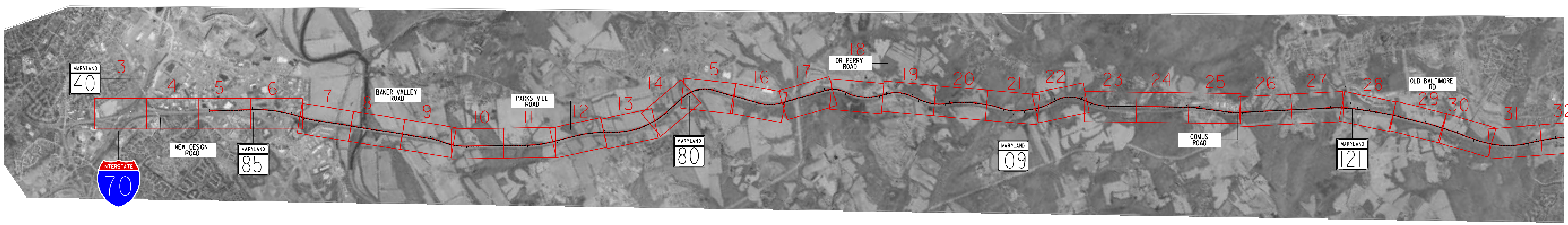
CONTRACT # MO0695172 | JANUARY 19, 2017

APPENDIX

2 OF 2

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS



SEE SHEET 02

ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:58 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

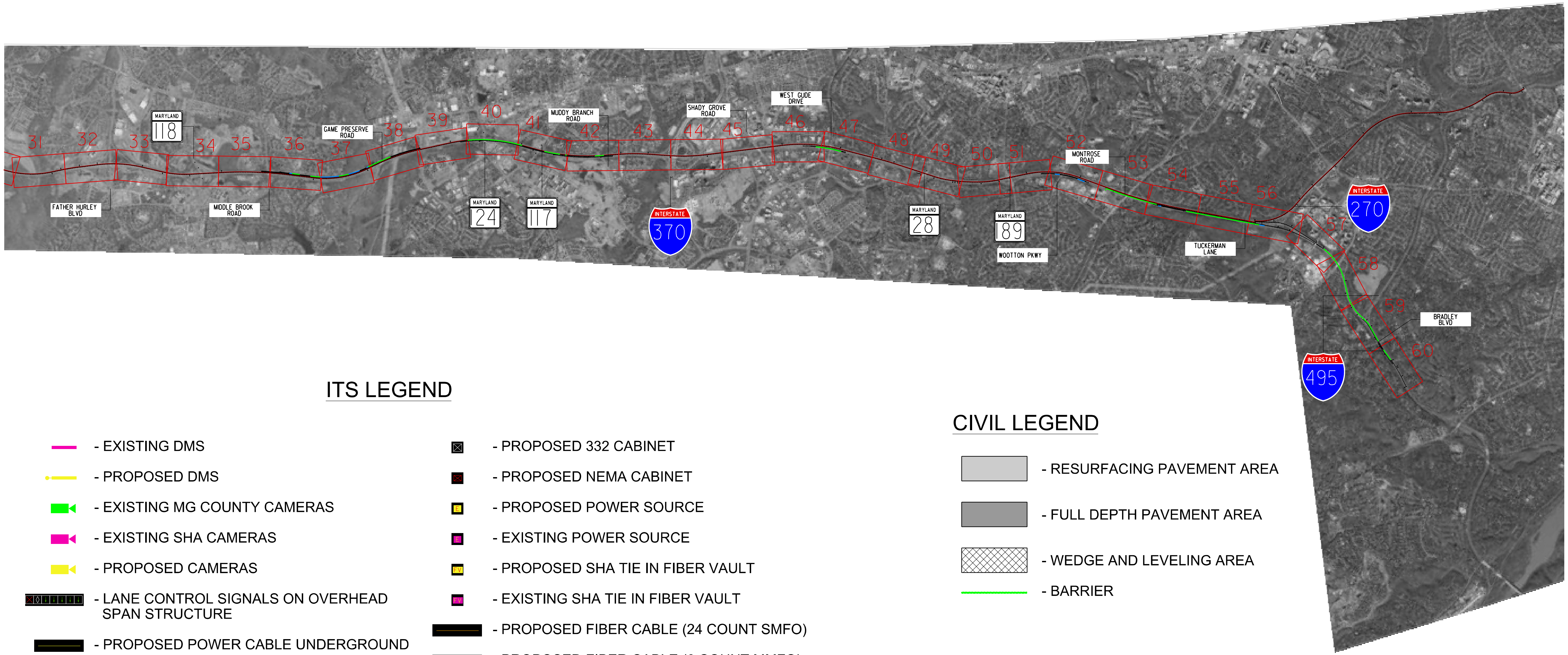
DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO. 01 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 09:59 AM

SEE SHEET 01



ITS LEGEND

- EXISTING DMS
- PROPOSED DMS
- EXISTING MG COUNTY CAMERAS
- EXISTING SHA CAMERAS
- PROPOSED CAMERAS
- LANE CONTROL SIGNALS ON OVERHEAD SPAN STRUCTURE
- PROPOSED POWER CABLE UNDERGROUND
- PROPOSED 332 CABINET
- PROPOSED NEMA CABINET
- PROPOSED POWER SOURCE
- EXISTING POWER SOURCE
- PROPOSED SHA TIE IN FIBER VAULT
- EXISTING SHA TIE IN FIBER VAULT
- PROPOSED FIBER CABLE (24 COUNT SMFO)
- PROPOSED FIBER CABLE (6 COUNT MMFO)

CIVIL LEGEND

- RESURFACING PAVEMENT AREA
- FULL DEPTH PAVEMENT AREA
- WEDGE AND LEVELING AREA
- BARRIER

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

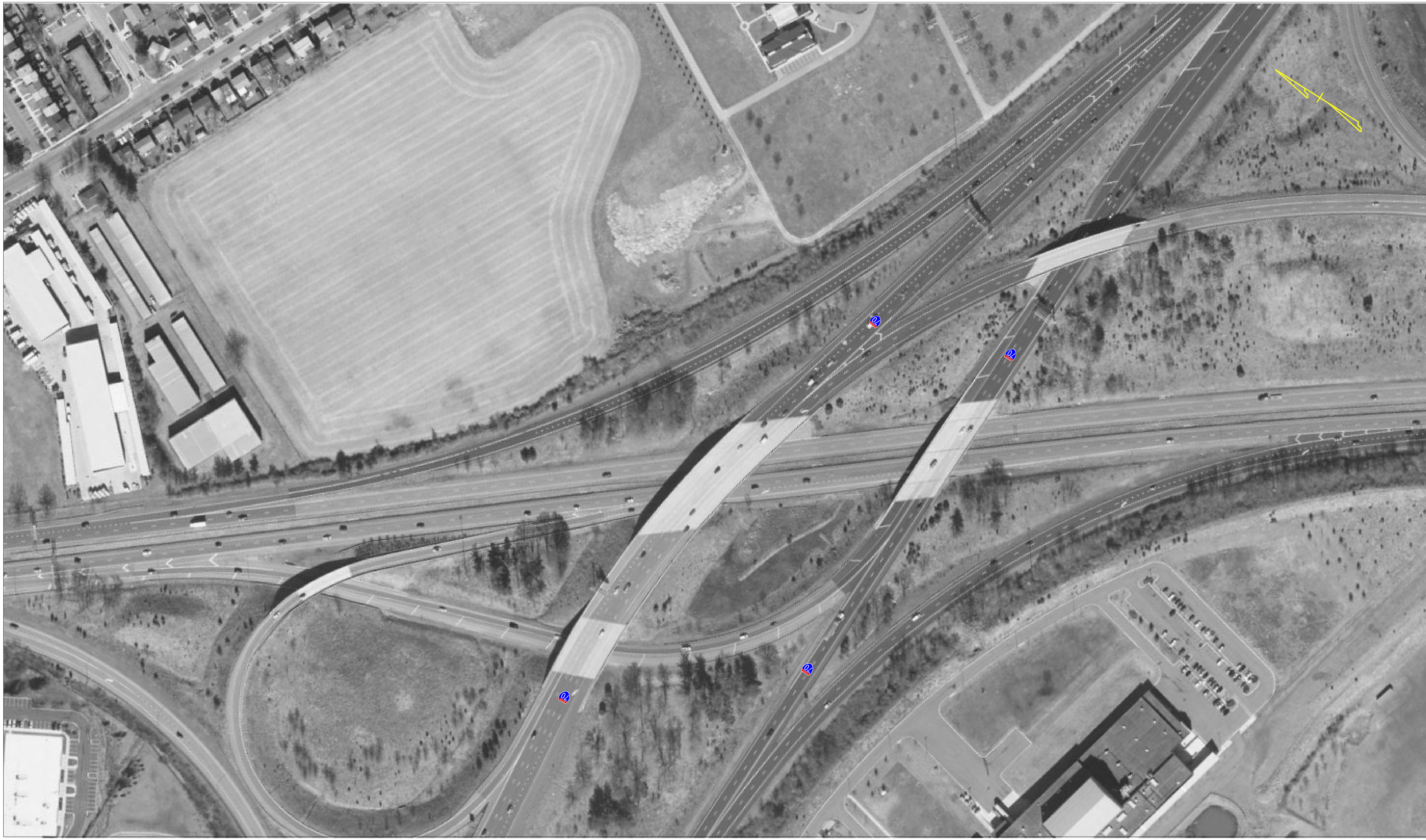
NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 3000'

SHEET NO. 02 OF 60



SEE SHEET 04

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:02 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 03 OF 60

SEE SHEET 03

SEE SHEET 05

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:04 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 04 OF 60

SEE SHEET 04

SEE SHEET 06

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:07 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

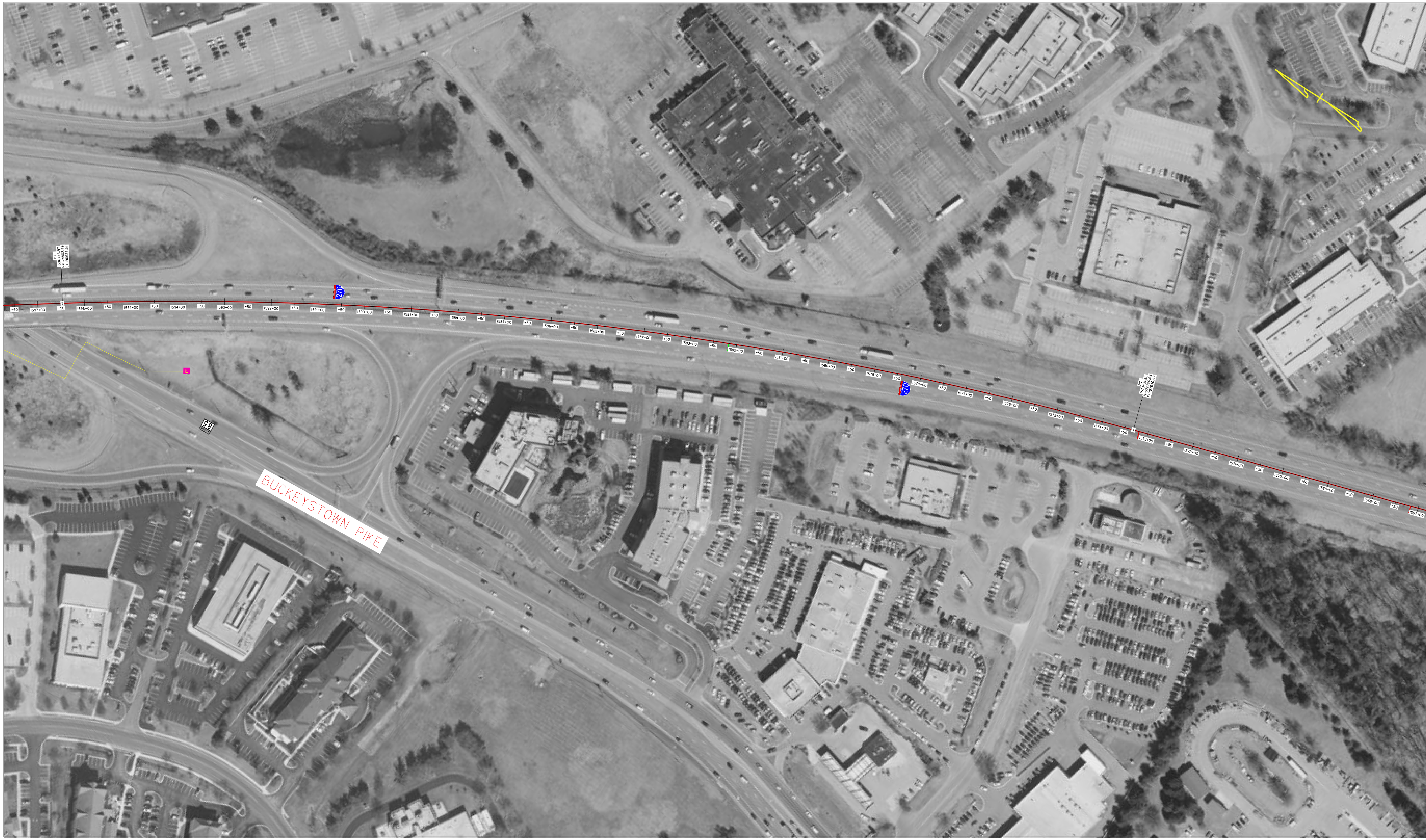
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 05 OF 60

SEE SHEET 05



SEE SHEET 07

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:09 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 06 OF 60

SEE SHEET 06

SEE SHEET 08

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:11 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 07 OF 60

SEE SHEET 07

SEE SHEET 09

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:13 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 08 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:15 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 09 OF 60

SEE SHEET 09

SEE SHEET 11

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:17 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 10 OF 60

SEE SHEET 10

SEE SHEET 12

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:20 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 11 OF 60

SEE SHEET 11

SEE SHEET 13

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:22 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION
I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.
License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 12 OF 60

SEE SHEET 12

SEE SHEET 14

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:23 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 13 OF 60

SEE SHEET 13

SEE SHEET 15

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:25 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 14 OF 60

SEE SHEET 14

SEE SHEET 16

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:27 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

DRAWING NO.

SHEET NO. 15 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:30 AM

SEE SHEET 15

SEE SHEET 17

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO.
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	16 OF 60

SEE SHEET 16

SEE SHEET 18

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:33 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO. 17 OF 60
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	

SEE SHEET 17

SEE SHEET 19

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:36 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 18 OF 60

SEE SHEET 18

SEE SHEET 20

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:38 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 19 OF 60

SEE SHEET 19

SEE SHEET 21

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:41 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

DRAWING NO.

SHEET NO. 20 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:44 AM

SEE SHEET 20

SEE SHEET 22

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 21 OF 60

SEE SHEET 21

SEE SHEET 23

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:47 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 22 OF 60

SEE SHEET 22

SEE SHEET 24

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:50 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV

CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 23 OF 60

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 24 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:52 AM

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:54 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 25 OF 60

SEE SHEET 25

SEE SHEET 27

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 10:57 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 26 OF 60

SEE SHEET 26

SEE SHEET 28

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:53 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 27 OF 60

SEE SHEET 27

SEE SHEET 29

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:54 AM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP
CONST. REVIEW BY
DRAWN BY DNP
DATE 01/19/17
CHECKED BY DV
SCALE 1" = 200'

DRAWING NO.

SHEET NO. 28 OF 60

SEE SHEET 28

SEE SHEET 30

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:55 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

DRAWING NO.

SHEET NO. 29 OF 60

SEE SHEET 29

SEE SHEET 31

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:56 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO. 30 OF 60
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	

SEE SHEET 30

SEE SHEET 32

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 11:58 AM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 31 OF 60

SEE SHEET 31

SEE SHEET 33

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:00 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 32 OF 60

SEE SHEET 32

SEE SHEET 34

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:02 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV

CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 33 OF 60

SEE SHEET 33

SEE SHEET 35

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:03 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 34 OF 60

SEE SHEET 34

SEE SHEET 36

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 35 OF 60

SEE SHEET 35

SEE SHEET 37

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:05 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 36 OF 60

SEE SHEET 36

SEE SHEET 38

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:06 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

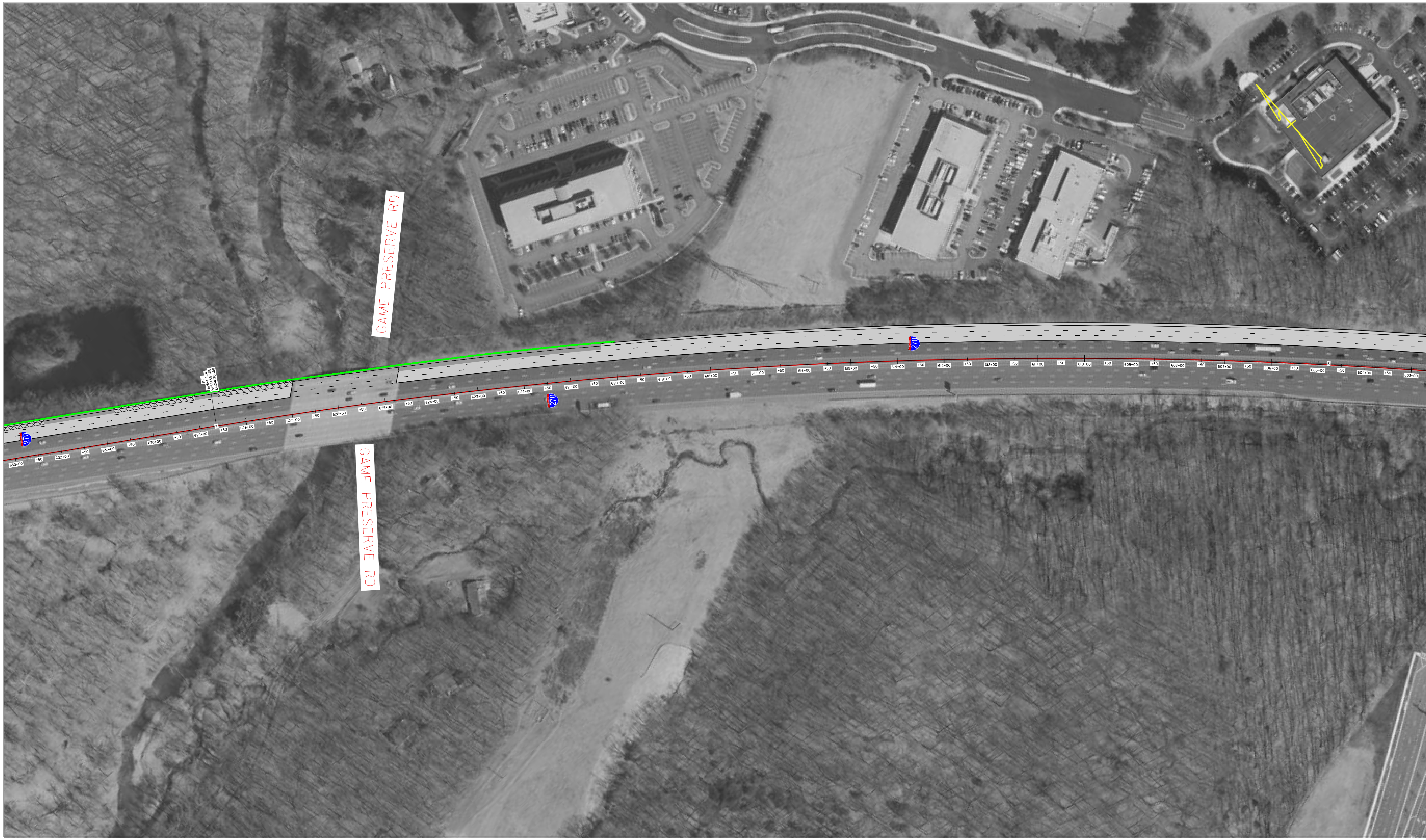
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 37 OF 60

SEE SHEET 37



SEE SHEET 39

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:07 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 38 OF 60

SEE SHEET 38

SEE SHEET 40

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:09 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

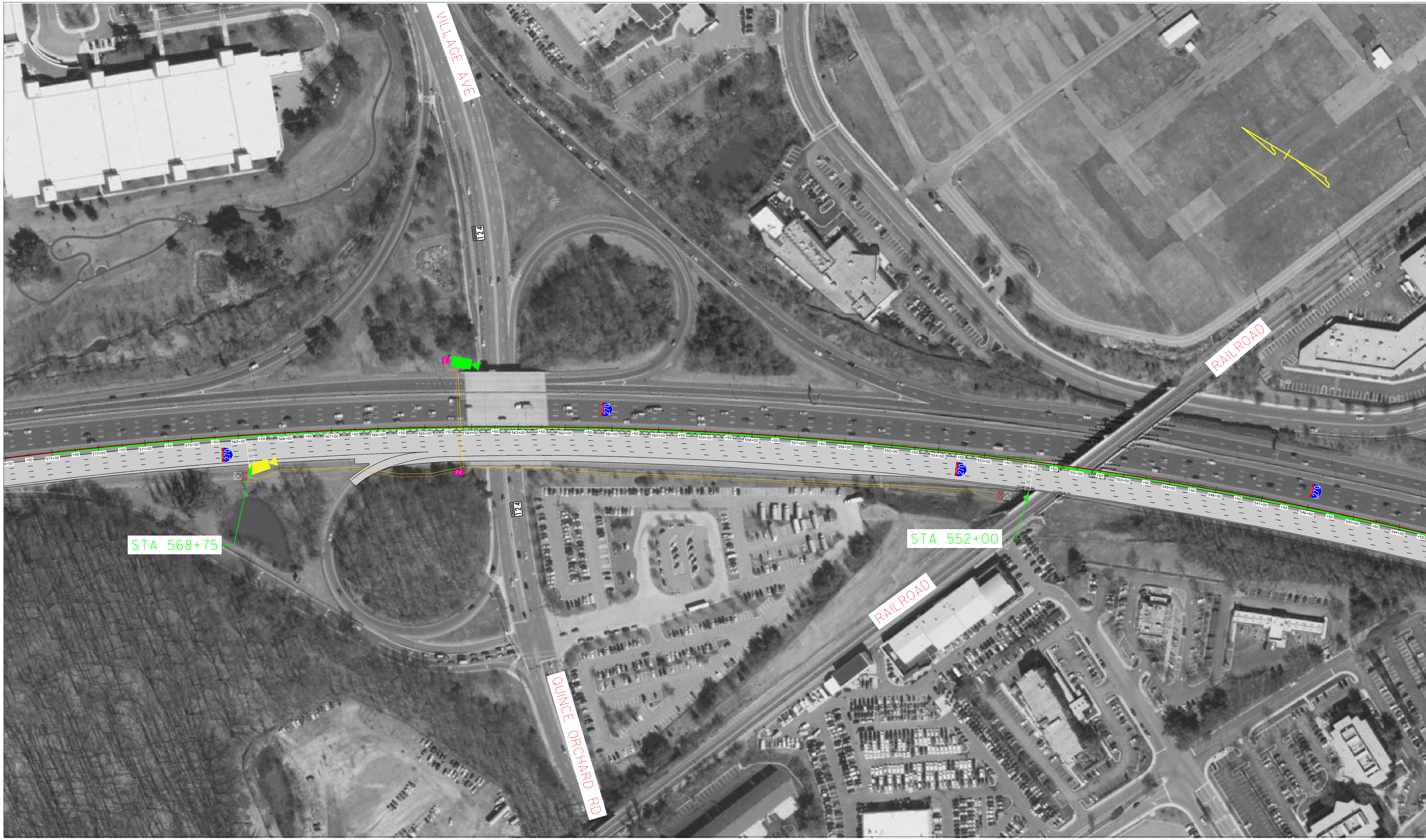
NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

DRAWING NO.

SHEET NO.
39 OF 60



BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:10 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 40 OF 60

SEE SHEET 40

SEE SHEET 42

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:11 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

DRAWING NO.

SHEET NO. 41 OF 60

SEE SHEET 41

SEE SHEET 43

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:12 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 42 OF 60

SEE SHEET 42

SEE SHEET 44

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:14 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

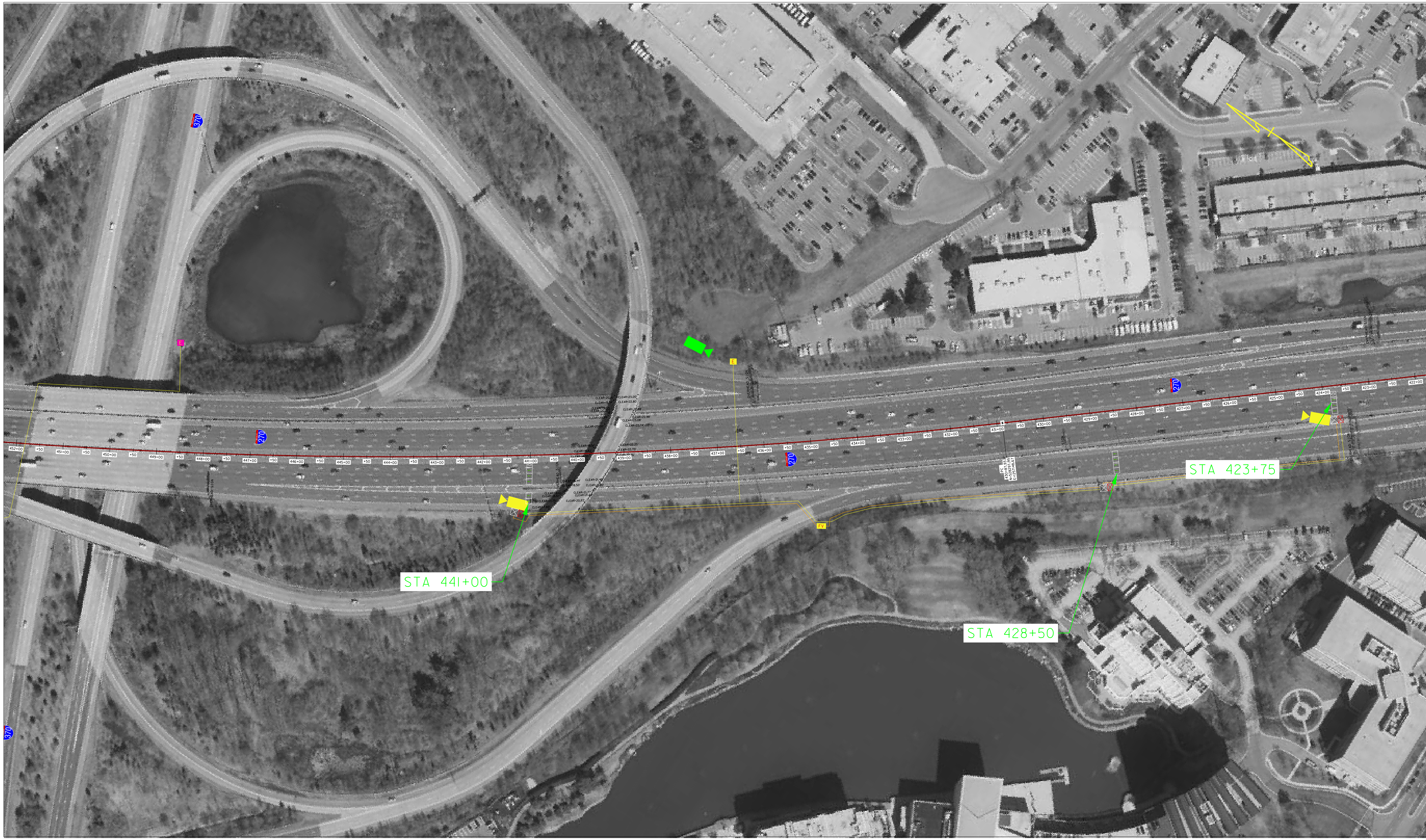
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 43 OF 60

SEE SHEET 43



SEE SHEET 45

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:15 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

DRAWING NO.

SHEET NO. 44 OF 60

SEE SHEET 44

SEE SHEET 46

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:16 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 45 OF 60

SEE SHEET 45

SEE SHEET 47

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:16 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO. 46 OF 60
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:17 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 47 OF 60

SEE SHEET 47

SEE SHEET 49

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:18 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

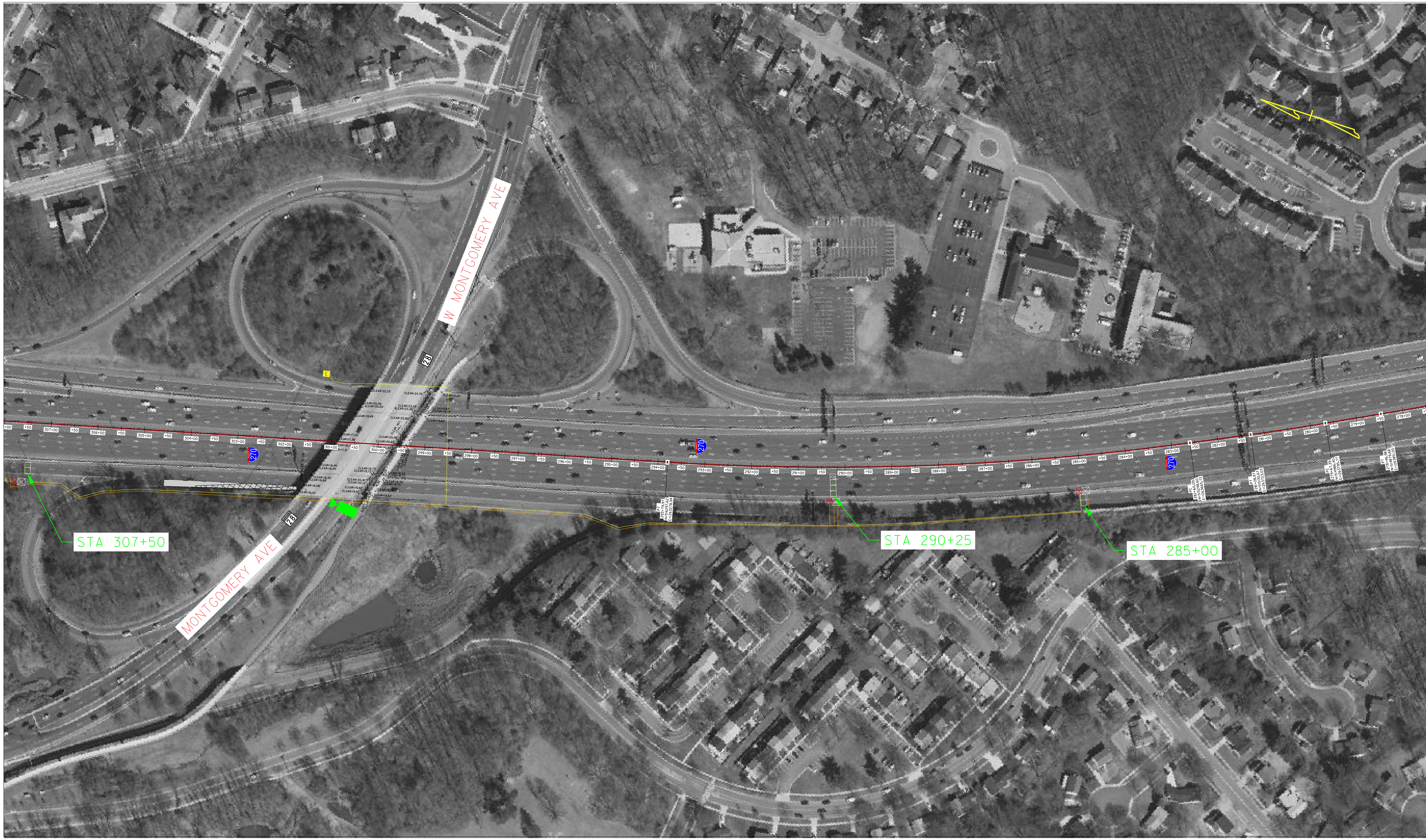
NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV	SHEET NO. 48 OF 60
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'	

SEE SHEET 48



SEE SHEET 50

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:19 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 49 OF 60

SEE SHEET 49

SEE SHEET 51

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:20 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

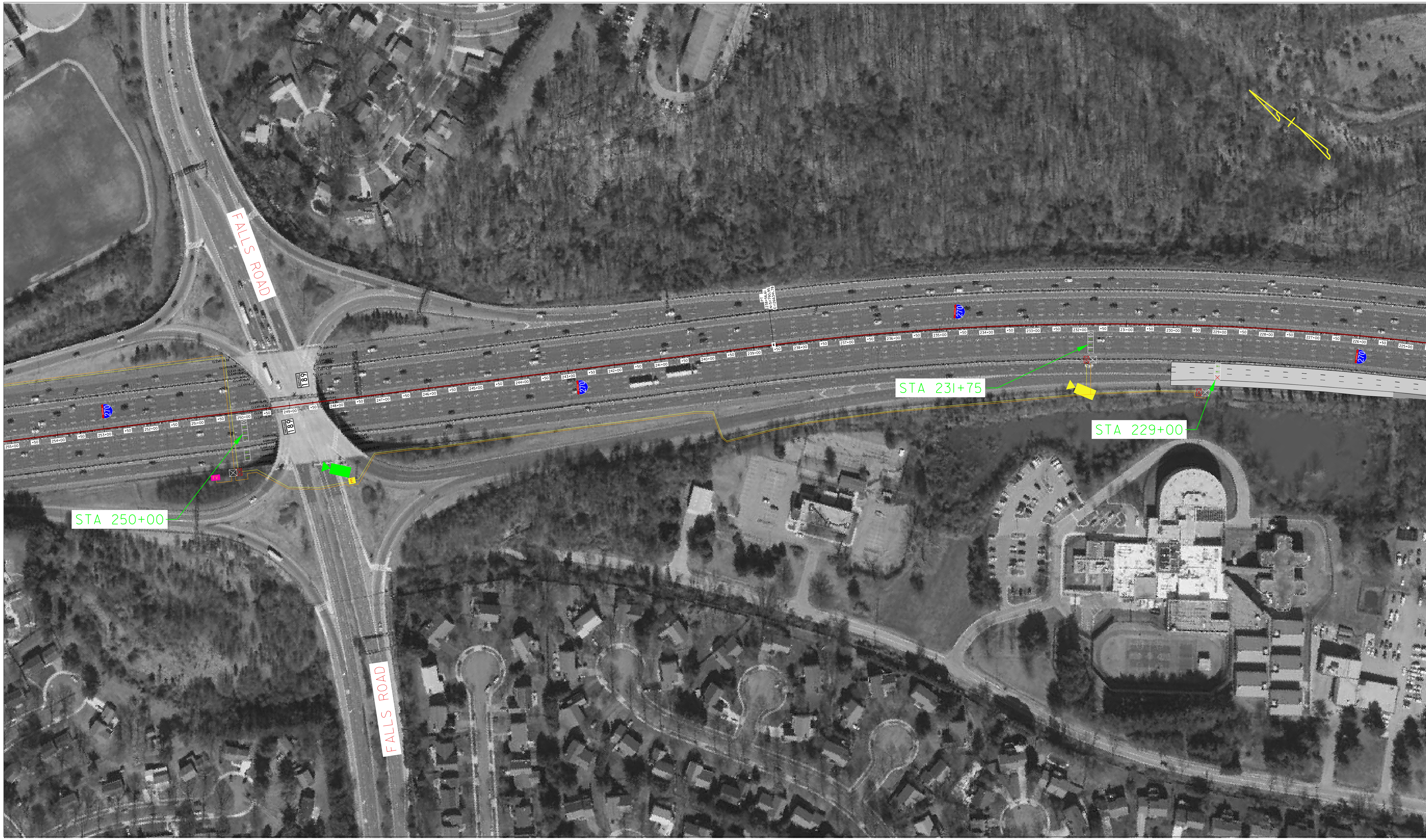
NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DESIGNED BY DNP
DRAWN BY DNP
CHECKED BY DV
CONST. REVIEW BY
DATE 01/19/17
SCALE 1" = 200'

DRAWING NO.

SHEET NO. 50 OF 60



JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 51 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:37 PM

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:21 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 52 OF 60

SEE SHEET 52

SEE SHEET 54

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:22 PM

JACOBS

Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 53 OF 60

SEE SHEET 53

SEE SHEET 55

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:23 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 54 OF 60

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 55 OF 60

SEE SHEET 55

SEE SHEET 57

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:24 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
I	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 56 OF 60

SEE SHEET 56

SEE SHEET 58

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:25 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 57 OF 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:25 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 58 OF 60

SEE SHEET 58

SEE SHEET 60

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:26 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. Expiration Date

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP | DRAWN BY DNP | CHECKED BY DV
CONST. REVIEW BY | DATE 01/19/17 | SCALE 1" = 200'

SHEET NO. 59 OF 60

SEE SHEET 59

BY: PATELDH - DATE: TUESDAY, JANUARY 17, 2017 AT 12:29 PM

JACOBS
Jacobs Engineering Group Inc.
100 South Charles Street
Tower Two, Suite 1000
Baltimore, Maryland 21201
410-837-5840 Fax: 410-837-3277

PROFESSIONAL CERTIFICATION

I HEREBY CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MARYLAND.

License No. ______ Expiration Date ______

SHA
Maryland Department of Transportation
State Highway Administration

ADDENDUMS & REVISIONS

NO.	DESCRIPTION	BY	DATE
1	I-270 ICM DB BID DESIGN	-	DATE

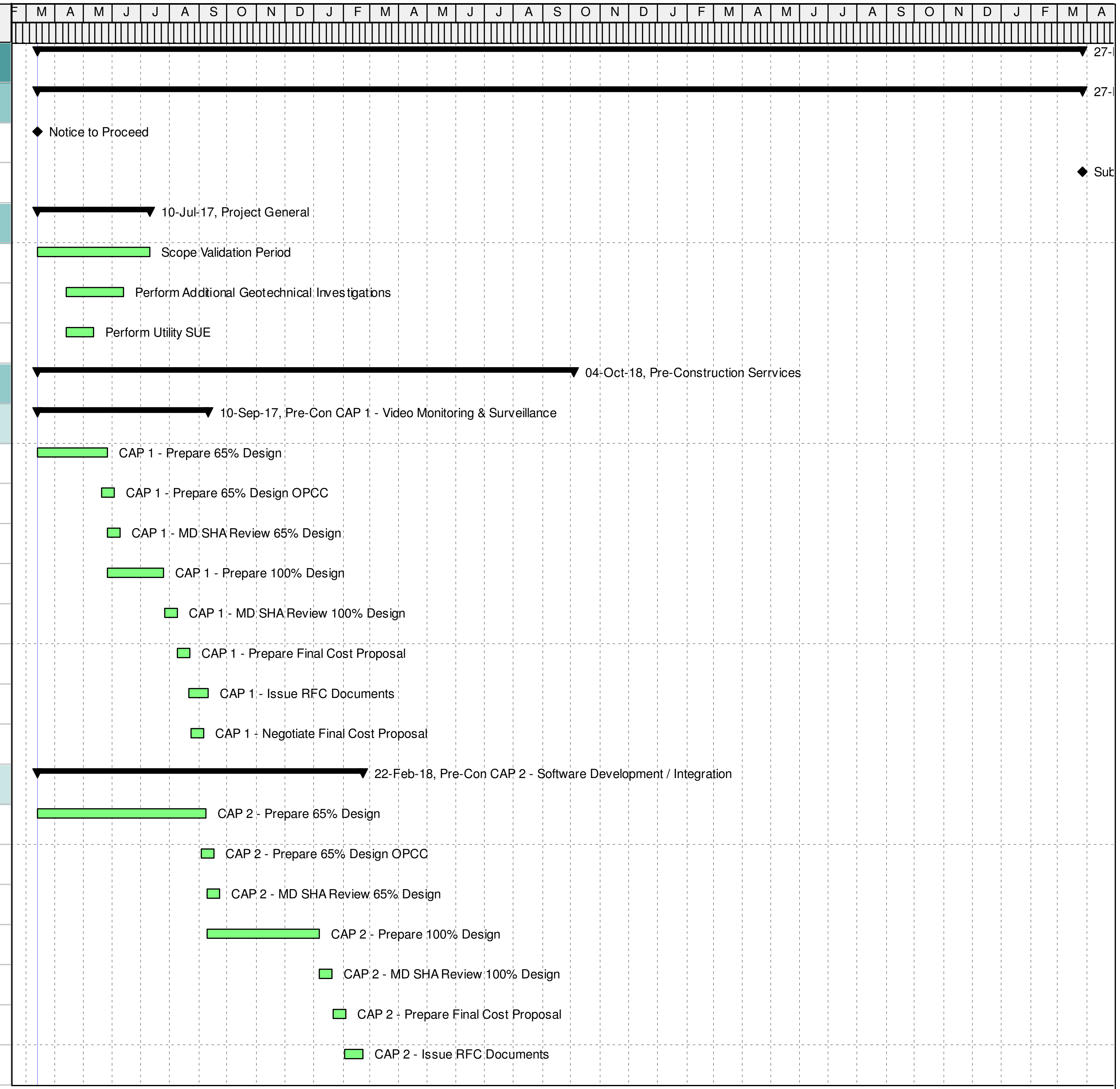
MARYLAND STATE HIGHWAY ADMINISTRATION
I-270 ICM DB TRAFFIC IMPROVEMENTS

DRAWING NO.

DESIGNED BY DNP	DRAWN BY DNP	CHECKED BY DV
CONST. REVIEW BY	DATE 01/19/17	SCALE 1" = 200'

SHEET NO. 60 OF 60

Activity ID	Activity Name	Original Duration	Start	Finish
IS 270 - Innovative Congestion Management Tech Proposal Schedule				
Project Milestones				
NTP	Notice to Proceed	0	13-Mar-17	
SC	Substantial Completion (NLT 29MAR20)	0		27-Mar-20*
Project General				
SCOPE	Scope Validation Period	120	13-Mar-17	10-Jul-17
A1010	Perform Additional Geotechnical Investigations	61	13-Apr-17	12-Jun-17
A1120	Perform Utility SUE	30	13-Apr-17	12-May-17
Pre-Construction Serrvices				
Pre-Con CAP 1 - Video Monitoring & Surveillance				
A1040	CAP 1 - Prepare 65% Design	75	13-Mar-17	26-May-17
A1050	CAP 1 - Prepare 65% Design OPCC	14	21-May-17	03-Jun-17
A1060	CAP 1 - MD SHA Review 65% Design	14	27-May-17	09-Jun-17
A1090	CAP 1 - Prepare 100% Design	60	27-May-17	25-Jul-17
A1100	CAP 1 - MD SHA Review 100% Design	14	26-Jul-17	08-Aug-17
A1070	CAP 1 - Prepare Final Cost Proposal	14	09-Aug-17	22-Aug-17
A1110	CAP 1 - Issue RFC Documents	21	21-Aug-17	10-Sep-17
A1080	CAP 1 - Negotiate Final Cost Proposal	14	23-Aug-17	05-Sep-17
Pre-Con CAP 2 - Software Development / Integration				
A2140	CAP 2 - Prepare 65% Design	180	13-Mar-17	08-Sep-17
A2150	CAP 2 - Prepare 65% Design OPCC	14	03-Sep-17	16-Sep-17
A2160	CAP 2 - MD SHA Review 65% Design	14	09-Sep-17	22-Sep-17
A2170	CAP 2 - Prepare 100% Design	120	09-Sep-17	06-Jan-18
A2180	CAP 2 - MD SHA Review 100% Design	14	07-Jan-18	20-Jan-18
A2190	CAP 2 - Prepare Final Cost Proposal	14	21-Jan-18	03-Feb-18
A2200	CAP 2 - Issue RFC Documents	21	02-Feb-18	22-Feb-18



WELLINGTON POWER CORPORATION
ELECTRICAL INFRASTRUCTURE | ENERGY

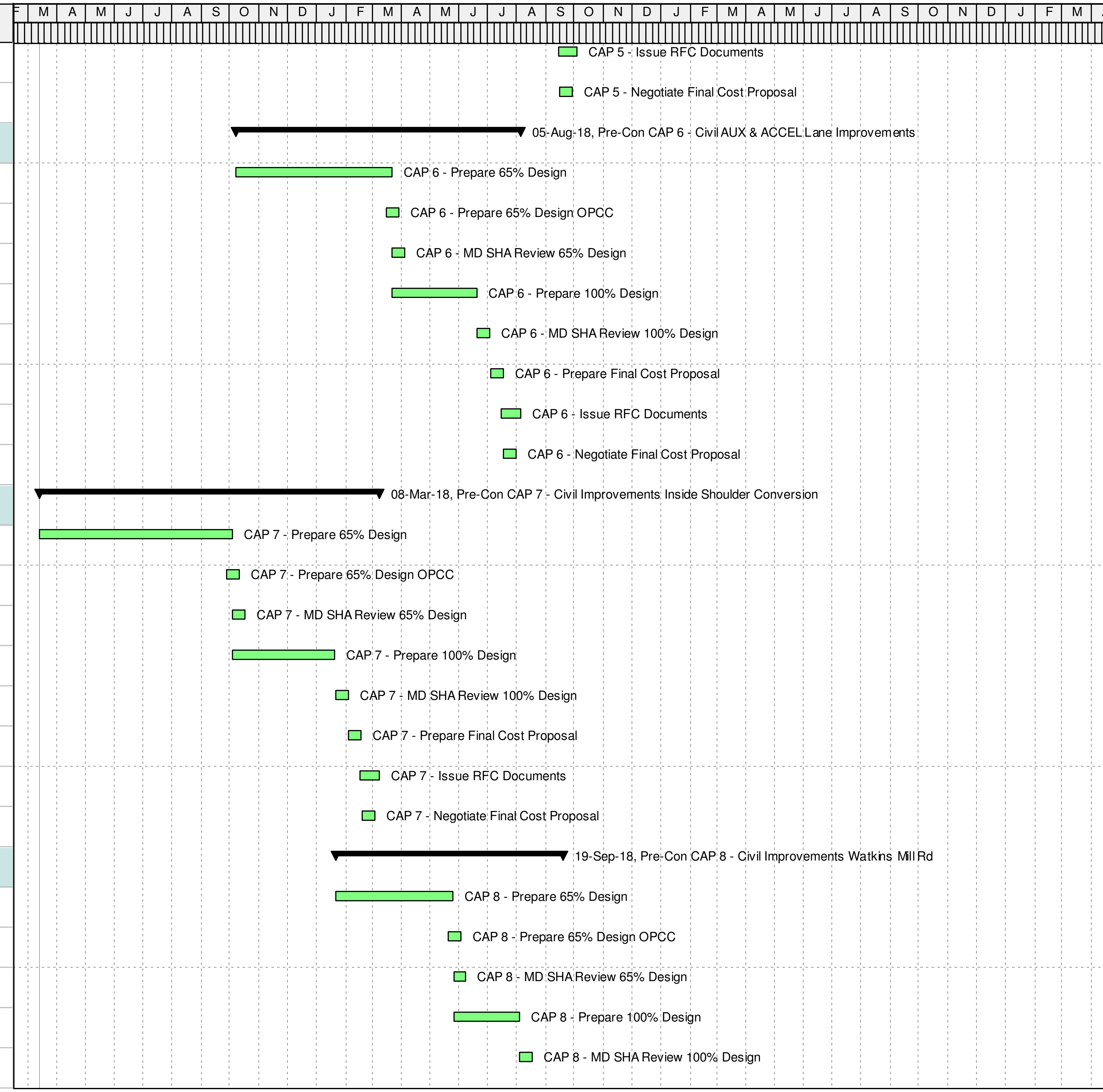
IS 270 - Innovative Congestion Management Tech Proposal Schedule
Page 1 of 4

Remaining Level of Effort — Actual Work — Critical Remaining Work
Actual Level of Effort — Remaining Work — ◆ Milestone

Activity ID	Activity Name	Original Duration	Start	Finish
A2210	CAP 2 - Negotiate Final Cost Proposal	14	04-Feb-18	17-Feb-18
Pre-Con CAP 3 - Civil Improvements, PTS Use, & Lane Re-Assignment				
A2220	CAP 3 - Prepare 65% Design	125	13-Mar-17	15-Jul-17
A2230	CAP 3 - Prepare 65% Design OPCC	14	10-Jul-17	23-Jul-17
A2240	CAP 3 - MD SHA Review 65% Design	14	16-Jul-17	29-Jul-17
A2250	CAP 3 - Prepare 100% Design	70	16-Jul-17	23-Sep-17
A2260	CAP 3 - MD SHA Review 100% Design	14	24-Sep-17	07-Oct-17
A2270	CAP 3 - Prepare Final Cost Proposal	14	08-Oct-17	21-Oct-17
A2280	CAP 3 - Issue RFC Documents	21	20-Oct-17	09-Nov-17
A2290	CAP 3 - Negotiate Final Cost Proposal	14	22-Oct-17	04-Nov-17
Pre-Con CAP 4 - Remaining ATM Deployment				
A2300	CAP 4 - Prepare 65% Design	240	27-May-17	21-Jan-18
A2310	CAP 4 - Prepare 65% Design OPCC	14	16-Jan-18	29-Jan-18
A2320	CAP 4 - MD SHA Review 65% Design	14	22-Jan-18	04-Feb-18
A2330	CAP 4 - Prepare 100% Design	60	22-Jan-18	22-Mar-18
A2340	CAP 4 - MD SHA Review 100% Design	14	23-Mar-18	05-Apr-18
A2350	CAP 4 - Prepare Final Cost Proposal	14	06-Apr-18	19-Apr-18
A2360	CAP 4 - Issue RFC Documents	21	18-Apr-18	08-May-18
A2370	CAP 4 - Negotiate Final Cost Proposal	14	20-Apr-18	03-May-18
Pre-Con CAP 5 - Civil Improvements Outside Shoulder Conversion				
A2380	CAP 5 - Prepare 65% Design	205	08-Oct-17	30-Apr-18
A2390	CAP 5 - Prepare 65% Design OPCC	14	25-Apr-18	08-May-18
A2400	CAP 5 - MD SHA Review 65% Design	14	01-May-18	14-May-18
A2410	CAP 5 - Prepare 100% Design	110	01-May-18	18-Aug-18
A2420	CAP 5 - MD SHA Review 100% Design	14	19-Aug-18	01-Sep-18
A2430	CAP 5 - Prepare Final Cost Proposal	14	02-Sep-18	15-Sep-18

Remaining Level of Effort | Actual Work | Critical Remaining Work | Actual Level of Effort | Remaining Work | Milestone

Activity ID	Activity Name	Original Duration	Start	Finish
A2440	CAP 5 - Issue RFC Documents	21	14-Sep-18	04-Oct-18
A2450	CAP 5 - Negotiate Final Cost Proposal	14	16-Sep-18	29-Sep-18
Pre-Con CAP 6 - Civil AUX & ACCEL Lane Improvements				
A2460	CAP 6 - Prepare 65% Design	165	08-Oct-17	21-Mar-18
A2470	CAP 6 - Prepare 65% Design OPCC	14	16-Mar-18	29-Mar-18
A2480	CAP 6 - MD SHA Review 65% Design	14	22-Mar-18	04-Apr-18
A2490	CAP 6 - Prepare 100% Design	90	22-Mar-18	19-Jun-18
A2500	CAP 6 - MD SHA Review 100% Design	14	20-Jun-18	03-Jul-18
A2510	CAP 6 - Prepare Final Cost Proposal	14	04-Jul-18	17-Jul-18
A2520	CAP 6 - Issue RFC Documents	21	16-Jul-18	05-Aug-18
A2530	CAP 6 - Negotiate Final Cost Proposal	14	18-Jul-18	31-Jul-18
Pre-Con CAP 7 - Civil Improvements Inside Shoulder Conversion				
A2540	CAP 7 - Prepare 65% Design	205	13-Mar-17	03-Oct-17
A2550	CAP 7 - Prepare 65% Design OPCC	14	28-Sep-17	11-Oct-17
A2560	CAP 7 - MD SHA Review 65% Design	14	04-Oct-17	17-Oct-17
A2570	CAP 7 - Prepare 100% Design	109	04-Oct-17	20-Jan-18
A2580	CAP 7 - MD SHA Review 100% Design	14	21-Jan-18	03-Feb-18
A2590	CAP 7 - Prepare Final Cost Proposal	14	04-Feb-18	17-Feb-18
A2600	CAP 7 - Issue RFC Documents	21	16-Feb-18	08-Mar-18
A2610	CAP 7 - Negotiate Final Cost Proposal	14	18-Feb-18	03-Mar-18
Pre-Con CAP 8 - Civil Improvements Watkins Mill Rd				
A2620	CAP 8 - Prepare 65% Design	125	21-Jan-18	25-May-18
A2630	CAP 8 - Prepare 65% Design OPCC	14	20-May-18	02-Jun-18
A2640	CAP 8 - MD SHA Review 65% Design	14	26-May-18	08-Jun-18
A2650	CAP 8 - Prepare 100% Design	70	26-May-18	03-Aug-18
A2660	CAP 8 - MD SHA Review 100% Design	14	04-Aug-18	17-Aug-18

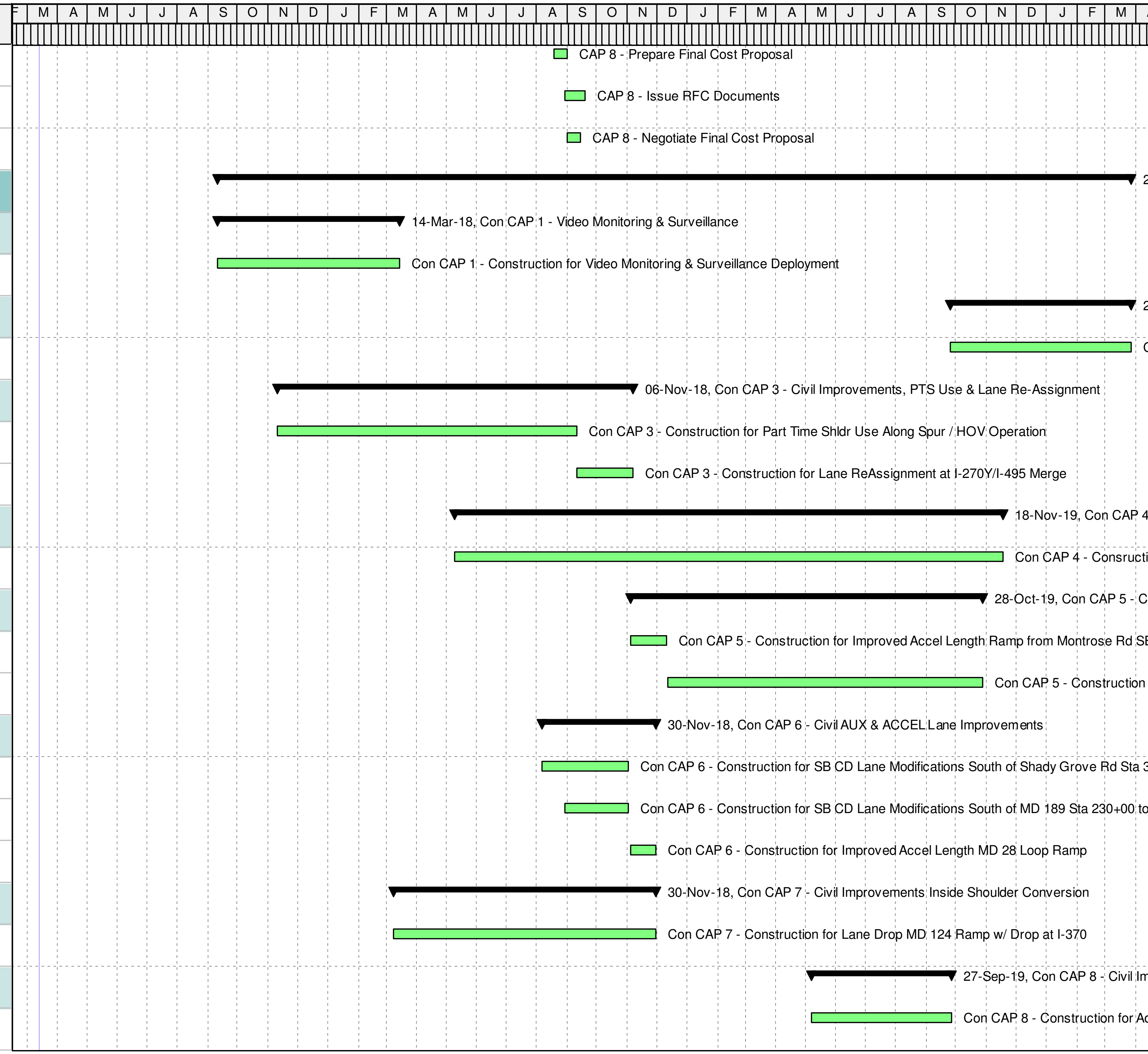


WELLINGTON POWER CORPORATION
ELECTRICAL INFRASTRUCTURE | ENERGY

IS 270 - Innovative Congestion Management Tech Proposal Schedule
Page 3 of 4

Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | Milestone

Activity ID	Activity Name	Original Duration	Start	Finish
A2670	CAP 8 - Prepare Final Cost Proposal	14	18-Aug-18	31-Aug-18
A2680	CAP 8 - Issue RFC Documents	21	30-Aug-18	19-Sep-18
A2690	CAP 8 - Negotiate Final Cost Proposal	14	01-Sep-18	14-Sep-18
Construction Services				
Con CAP 1 - Video Monitoring & Surveillance				
A2110	Con CAP 1 - Construction for Video Monitoring & Surveillance Deployment	130	11-Sep-17	14-Mar-18
Con CAP 2 - Software Development / Integration				
A2120	Con CAP 2 - Software Development / Integration Deployments	130	25-Sep-19	27-Mar-20
Con CAP 3 - Civil Improvements, PTS Use & Lane Re-Assignment				
A2020	Con CAP 3 - Construction for Part Time Shldr Use Along Spur / HOV Operation	211	10-Nov-17	10-Sep-18
A2030	Con CAP 3 - Construction for Lane ReAssignment at I-270Y/I-495 Merge	41	11-Sep-18	06-Nov-18
Con CAP 4 - Remaining ATM Deployment				
A2130	Con CAP 4 - Consruction for Remaining ATM Deployments	390	09-May-18	18-Nov-19
Con CAP 5 - Civil Improvements Outside Shoulder Conversion				
A2070	Con CAP 5 - Construction for Improved Accel Length Ramp from Montrose Rd SB	26	05-Nov-18	11-Dec-18
A2060	Con CAP 5 - Construction for Part Time Shoulder Use Along I-270 Montrose Rd to I-270 Split	224	12-Dec-18	28-Oct-19
Con CAP 6 - Civil AUX & ACCEL Lane Improvements				
A2080	Con CAP 6 - Construction for SB CD Lane Modifications South of Shady Grove Rd Sta 374+00 to 349+50	64	06-Aug-18	02-Nov-18
A2090	Con CAP 6 - Construction for SB CD Lane Modifications South of MD 189 Sta 230+00 to Sta 200+00	46	30-Aug-18	02-Nov-18
A2100	Con CAP 6 - Construction for Improved Accel Length MD 28 Loop Ramp	19	05-Nov-18	30-Nov-18
Con CAP 7 - Civil Improvements Inside Shoulder Conversion				
A2040	Con CAP 7 - Construction for Lane Drop MD 124 Ramp w/ Drop at I-370	187	09-Mar-18	30-Nov-18
Con CAP 8 - Civil Improvements Watkins Mill Rd				
A2050	Con CAP 8 - Construction for Added Lane Merge Watkins Mill Interchange w/ Drop at Loop Ramp to Middlebrook I-270 NB	100	07-May-19	27-Sep-19



Remaining Level of Effort | Actual Work | Critical Remaining Work
Actual Level of Effort | Remaining Work | ◆ Milestone

WELLINGTON POWER CORPORATION
177 THORN HILL ROAD | WARRENDALE, PA 15086

WELLINGTON POWER CORPORATION

IN ASSOCIATION WITH JACOBS