I-81 CORRIDOR IMPROVEMENT PLAN

DECEMBER 2018

Office of INTERMODAL Planning and Investment

VDOT

DRPT
Virginia Department of Rail and Public Transportation

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Prepared for

Office of INTERMODAL Planning and Investment

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Virginia Department of Rail and Public Transportation

Prepared by

Kimley»

December 2018

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Abbreviations

AADT – Average annual daily traffic

ACS – American Community Survey

ATM – Active Traffic Management

BCA – Benefit–Cost Analysis

BLS – Bureau of Labor Statistics

BUILD – Better Utilizing Investments to Leverage Development Grant

CEI – Construction and Engineering Inspection

CLRP – Constrained Long–Range Plan

CMS – Changeable Message Sign

CSXT – CSX Class I Railroad

CTB – Commonwealth Transportation Board

DRPT – Department of Rail and Public Transportation

DMV – Department of Motor Vehicles

EIA – Economic Impact Analysis

EPDO – Equivalent Property Damage Only

FHWA – Federal Highway Administration

FRA – Federal Railroad Administration

FTA – Federal Transit Administration

FTE – Full–Time Equivalent

GDP – Gross Domestic Product

GVWR – Gross Vehicle Weight Rating

HCM – Highway Capacity Manual

HOT – High Occupancy Toll

HOV – High Occupancy Vehicle

HRTAC – Hampton Roads Transportation Accountability Commission

HRTF – Hampton Roads Transportation Fund

IDP – Incident Detour Plan

IPROC – Intercity Passenger Rail Operating

IMPLAN – Commercial input–output model

INFRA – Nationally Significant Freight and Highway Projects Grant

NEPA – National Environmental Policy Act

NS – Norfolk Southern Class I Railroad

NVTA – Northern Virginia Transportation Authority

OIPI – Office of Intermodal Planning and Investment

O&M – Operations & Maintenance

PCE – Passenger Car Equivalent

PCES – Project Cost Estimating System

PDC – Planning District Commission

PHD – Person Hours of Delay

PE – Preliminary Engineering

RIA – Rail Industrial Access

RITIS – Regional Integrated Transportation Information System

REF – Rail Enhancement Fund

RNS – Roadway Network System

RPF – Rail Preservation Fund

SSP – Safety Service Patrol

SYIP – Six–Year Improvement Program

TFRA – Toll Facilities Revolving Account

TIFIA – Transportation Infrastructure Finance and Innovation Act

TOC – Traffic Operations Center

TSA – Transportation Satellite Accounts

USDOT – United States Department of Transportation

VIP – Virginia Inland Port

WMATA – Washington Metropolitan Area Transit Authority

VAC – Virginia Administrative Code

VEDP – Virginia Economic Development Partnership

VDOT – Virginia Department of Transportation

VMT – Vehicle Miles Traveled

VRE – Virginia Railway Express

VSP – Department of State Police

VTRC – Virginia Transportation Research Council

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1. Overview

As a critical north-south backbone of the East Coast's freight network, the I-81 corridor is vital to the efficient movement of goods through Virginia. More than one-third of all trucks and nearly 50 percent of the state's value of goods are transported along this 325-mile corridor (*Transearch, 2012*). Within Virginia, I-81 connects with five other interstates and traverses 21 cities and towns, 13 counties, and 25 colleges and universities between the Tennessee and West Virginia border. I-81 also runs parallel to the Blue Ridge Parkway, the nation's most visited national park. See **Figure 1** for additional statistics.

Figure 1. *I-81 Corridor Significance*

11.7
MILLION TRUCKS PER YEAR

$312
BILLION IN GOODS PER YEAR

42%
OF STATEWIDE INTERSTATE TRUCK VMT

45+
CRASHES PER YEAR
(WITH CLEARANCE TIMES GREATER THAN 4 HOURS)

~11,000
CRASHES OVER 5 YEARS

These competing travel demands have created a corridor that is plagued by significant safety and reliability issues. There are more than 2,000 vehicle crashes annually with 26 percent involving heavy trucks, the highest percentage for any interstate in Virginia (*VDOT Roadway Network System*). The resulting travel delay is unpredictable and impacts both heavy commercial vehicle on-time performance and travel for passenger vehicles. For example, in an average year, there are more than 45 major crashes that take more than four hours to clear. The majority of the I-81 corridor is two lanes in each direction—when one lane is blocked there is a 65 percent reduction in capacity (*Highway Capacity Manual 2016*). Contributing factors to the long crash clearance times include: lack of capacity, the rolling terrain, lack of reliable detour routes, and the constrained configuration.

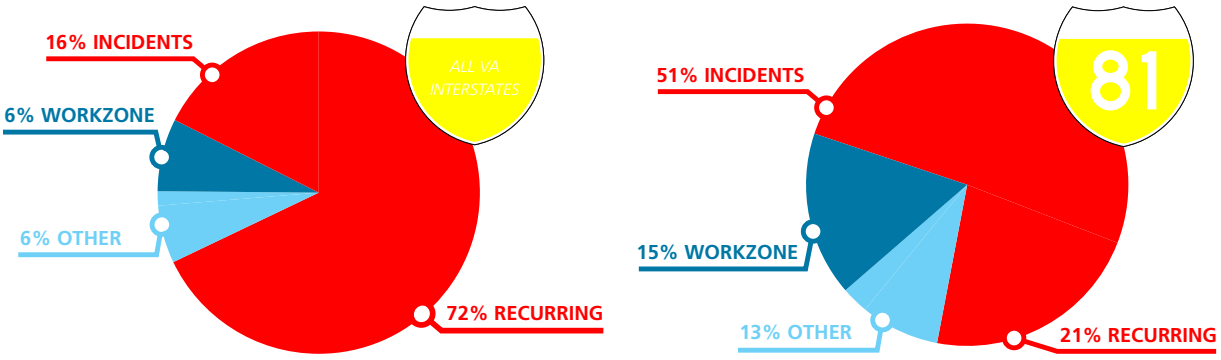
Why the I-81 Corridor Improvement Plan ("the Plan") is Necessary

I-81 is both the main street and key economic artery of western Virginia. Over time, the corridor has been improved to keep up with economic and travel growth. In the last decade, however, as the economy has grown, I-81 has experienced an increase in traffic, resulting in degradation of the overall performance of the corridor. Travel is anticipated to continue to increase on I-81, with truck traffic growing at a faster pace than passenger vehicle traffic. By 2040, it is expected that there will be nearly 20 million truck trips carrying three quarters of a trillion dollars' worth of goods every year (*Transearch, 2012*). Without implementation of an improvement plan, performance conditions along the corridor are expected to continue to degrade as traffic continues to grow.

I-81 suffers from the highest incident-related delay among interstates in Virginia, largely due to the high percentage of trucks, incidents involving trucks, and rolling terrain. Delay, typically expressed in minutes, is generally classified as recurring delay and non-recurring delay. Recurring delay is often encountered during the morning or evening commute and people who travel the area frequently know to plan on stop-and-go traffic conditions. On the other hand, non-recurring delay is associated with random factors, such as incidents (crashes and/or disabled vehicles on the shoulder and short-term work zones). Travelers cannot plan for non-recurring delay; therefore, such events can be more disruptive to travelers than recurring delay.

For all other interstates in Virginia, recurring delay comprises approximately 70 percent and incidents comprise 16 percent of the delay. For I-81, recurring delay represents just over 20 percent, but incidents comprise more than 50 percent of the delay, which indicates a combination of incidents, work zones, and weather have a significant impact on the traveler experience along this corridor (*VDOT Operations Planning and VTRC Analysis, 2018*). These conditions lead to highly unreliable travel times on this vital interstate, impacting both citizens' daily lives and the movement of freight. **Figure 2** summarizes the differences between the delay characteristics on I-81 versus all other interstates in Virginia.

Figure 2. *Delay Experienced on Virginia Interstates Versus I-81*



I-81 was constructed as a four-lane interstate in the 1960s, since then limited sections have been widened to six lanes near Bristol and Wytheville. With the highest per capita interstate truck traffic volume in Virginia and rolling terrain over much of the corridor, truck climbing lanes also have been constructed at strategic locations, such as near Christiansburg and Fairfield, providing an additional lane to traverse uphill grades. The rolling terrain on I-81 causes significant degradation in speed and performance along the corridor, and the impact is particularly borne by trucks (see **Figure 3** for terrain details). From a traffic flow and congestion standpoint, when truck percentage and terrain are considered, a single tractor-trailer truck accounts for the equivalent of as many as four passenger cars on certain segments of the corridor (**Figure 4**).

There are several sections of the corridor that are currently operating at or near capacity, generally focused in areas with higher populations, such as Winchester, Harrisonburg, Staunton, and between Roanoke and Christiansburg. National projections show that, over the next 20 years, miles traveled by trucks will continue to increase annually faster than autos. Given the anticipated growth in truck trips on I-81, travel times along the corridor are expected to continue to increase.

Figure 3. *Elevation and Travel Lanes Along the I-81 Corridor*

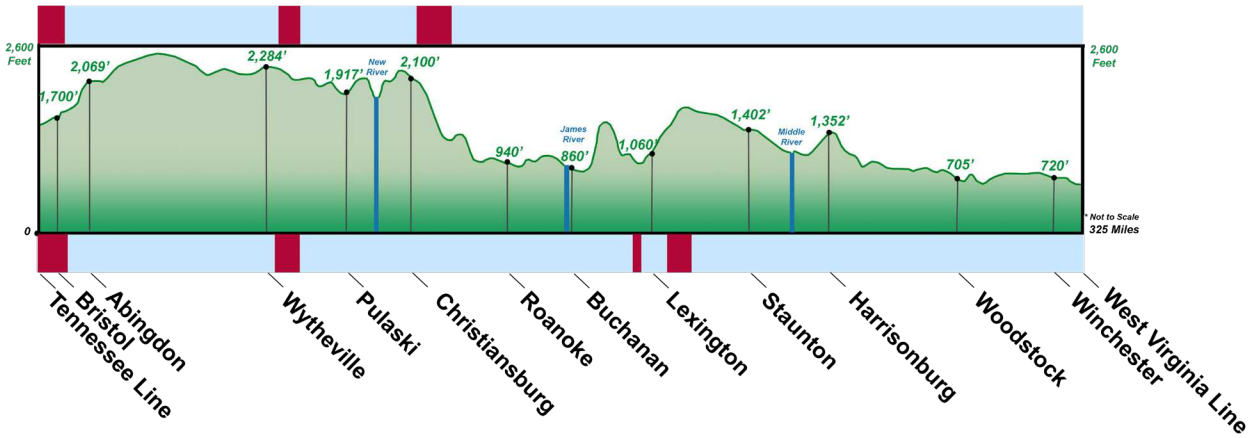
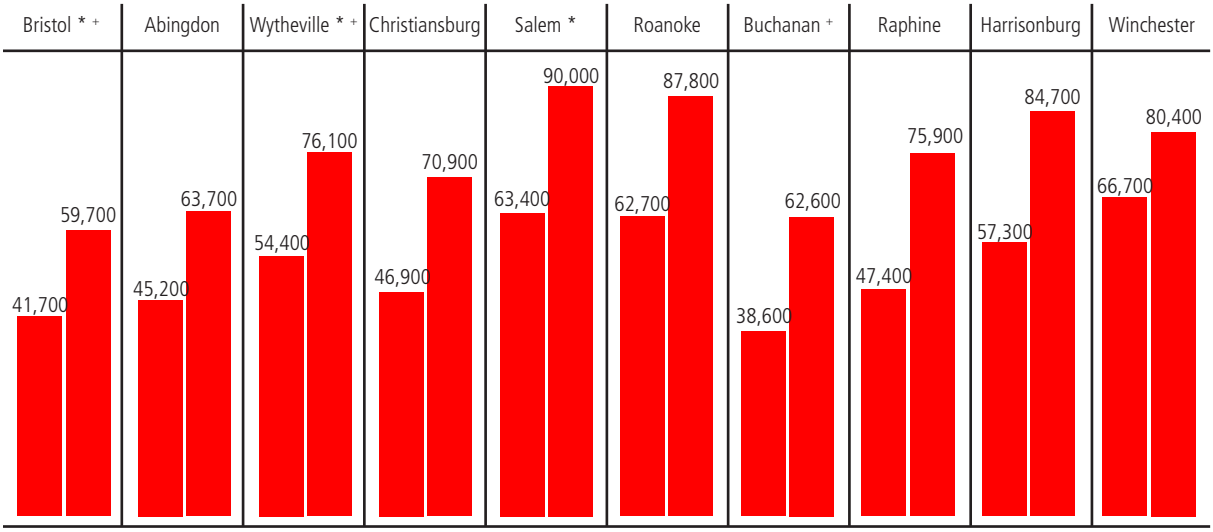


Figure 4. *2016 Average Annual Daily Traffic (AADT) Versus Passenger Car Equivalent (PCE) AADT*



Source: VDOT continuous traffic count stations and Statewide Planning System

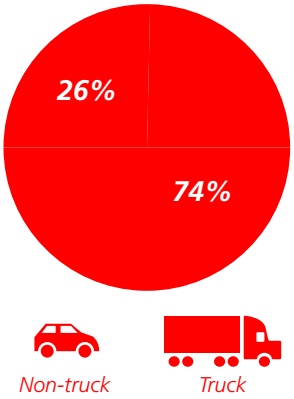
Description: Traffic volume that has been adjusted to account for the effects of the number of trucks and type of terrain

Definition: PCE = Passenger Car Equivalent (factor used to convert trucks into passenger cars)

* Portions of section are three lanes in southbound (*) and/or northbound (+)

From a safety perspective, between 2013 and 2017, there were more than 11,000 vehicle crashes in the corridor, translating to more than 2,000 crashes annually—26 percent involving heavy trucks, the highest percentage for any interstate in Virginia (see **Figure 5**). On average, more than 45 incidents per year require the Virginia Department of Transportation and emergency service personnel more than four hours to clear the roadway to restore operation to all lanes of travel (*VDOT 511*). When a truck crash occurs on I-81, the chance of a lane closure or the need for specialized equipment increases, which contributes to longer incident delay.

Figure 5. *2013-2017 Crash Statistics*



Chapter 743 and the Plan

With the adoption of Chapter 743 of the 2018 Virginia Acts of the General Assembly (see **Appendix A**), the Commonwealth Transportation Board was directed to develop and adopt a plan that included an examination of the entire corridor and methods of financing such improvements. This document represents the Plan adopted by the Board in response to the General Assembly's direction.

Since May 2018, the Commonwealth Transportation Board, Office of Intermodal Planning and Investment, Virginia Department of Transportation, and Virginia Department of Rail and Public Transportation have conducted 12 public meetings and hearings attended by more than 950 individuals, received more than 2,000 public comments, and identified more than $4.3 billion in recommended improvements in the I-81 corridor. Based on public input, applied prioritization methodology, and available market capacity this plan recommends implementing $2.2 billion in improvements during the next 7 to 10 years.

The Plan identifies $2 billion in capital improvements and $200 million dedicated to ongoing initiatives such as immediate operations and incident management improvements (heretofore referred to as operational improvements), truck parking solutions, speed enforcement and multimodal improvements, all of which will rely on technology and other operational strategies. Methods of financing these improvements also are identified and detailed in **Table 14** and **Table 15** shown on **Page 37**.

Chapter 743 directed the Commonwealth Transportation Board to address these problems in its evaluation, development, and adoption of the Plan. The Commonwealth Transportation Board was supported by the Office of Intermodal Planning and Investment, Virginia Department of Transportation, and Virginia Department of Rail and Public Transportation in developing the Plan. These organizations comprised the study team. Five key, interrelated activities were undertaken between May and December 2018:

1. Development and assessment of I-81 performance using established measures
2. Public outreach
3. Determination of contributing factors for areas with performance issues
4. Development of potential solutions (operational and capital)
5. Prioritization of capital improvements.

The Plan first identified the top 20 percent of problem areas along the corridor based on (i) safety, (ii) congestion, and (iii) areas with lane closures greater than one hour. While this was a data-driven process, public comments also were considered. Capital improvements were prioritized based on person-hours of delay, crash frequency, and access to jobs. From an implementation perspective, the critical first step is the application of operational improvements throughout the corridor that can be accomplished within twelve months of the Plan's legislative approval. The capital improvements are intended to build upon these operational improvements.

Beyond the original scope of this project, the Plan includes three key issues that are recommended for further refinement and study by the Commonwealth Transportation Board—speed enforcement, truck parking, and multimodal transportation options. These issues will require extensive coordination with external parties once the Plan is approved by the General Assembly. The speed enforcement and truck parking will be addressed by forming task forces, while Office of Intermodal Planning and Investment and Virginia Department of Rail and Public Transportation will determine the specific multimodal transportation options that will be funded by the Plan. To accomplish and address these key issues, $157 million has been reserved in the first 7-10 years of the Plan. For each issue, a comprehensive strategy and implementation plan with associated funding from the Plan will be developed. Finally, potential funding options for the $2.2 billion Plan are explored and the economic impacts as required by Chapter 743.

Definitions

Two key terms used in Chapter 743 were defined for use in the Plan: heavy commercial vehicle (truck) and commuter. Both of these terms are further defined in more detail.

Heavy Commercial Vehicle. There is no definition of heavy commercial vehicle in Virginia statutes nor is the term clearly defined in federal law. Chapter 743 includes the term, heavy commercial vehicles, but also refers to local truck traffic and through trucks. During meetings with the public and in presentations to the Commonwealth Transportation Board, trucks often became synonymous with heavy commercial vehicles.

49 CFR 523.6 defines a heavy-duty vehicle as "any commercial medium or heavy-duty on-highway vehicle or a work truck, as defined in 49 U.S.C. 32901(a)(7) and (19). For this section, heavy-duty vehicles are divided into four regulatory categories as follows:

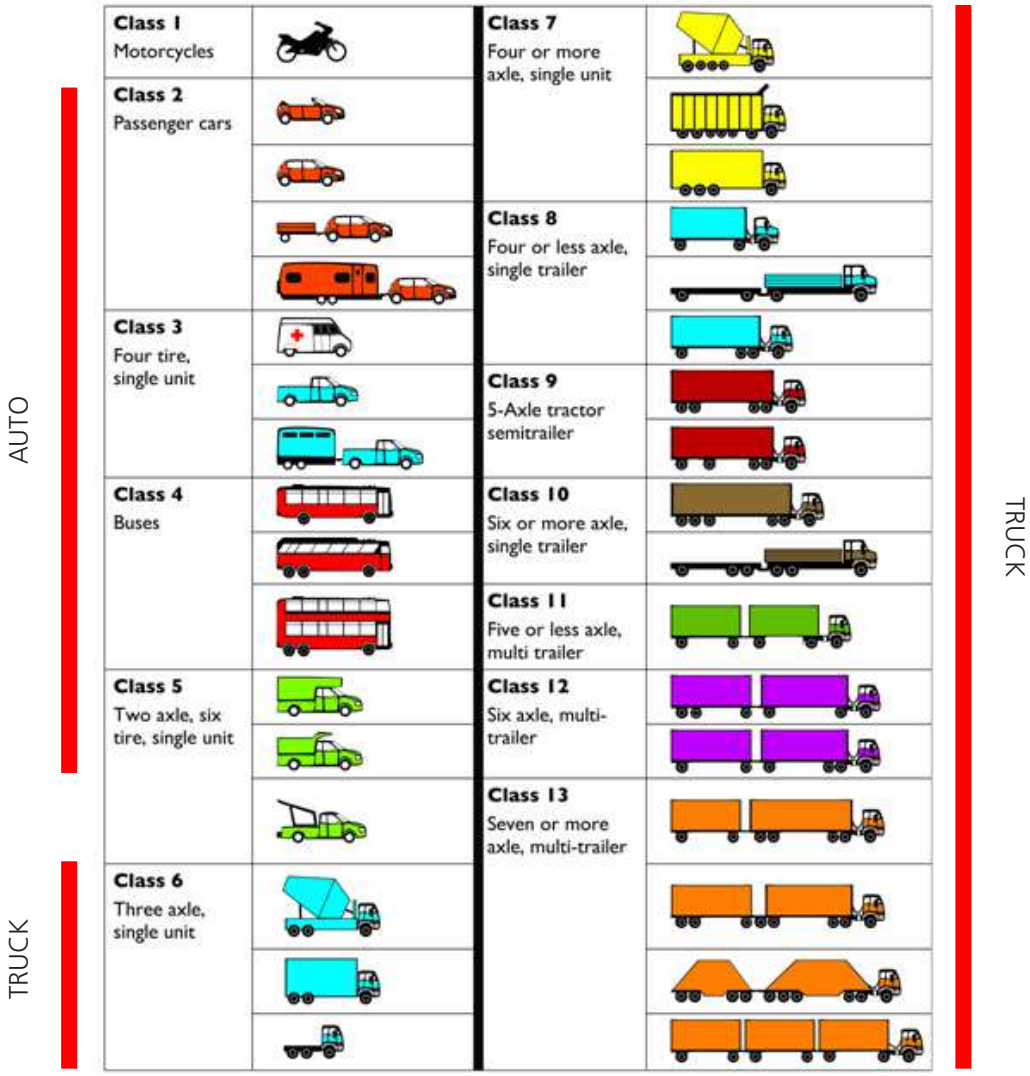
1. Heavy-duty pickup trucks and vans
2. Heavy-duty vocational vehicles
3. Truck tractors with a gross vehicle weight rating above 26,000 pounds
4. Heavy-duty trailers

Furthermore, federal law defines a commercial motor vehicle as any self-propelled or towed motor vehicle used on a highway in interstate commerce to transport passengers or property when the vehicle:

1. Has a gross vehicle weight rating, gross combination weight rating, gross vehicle weight, or gross combination weight of 4,536 kg (10,001 pounds) or more, whichever is greater
2. Is designed or used to transport more than eight passengers (including the driver) for compensation
3. Is designed or used to transport more than 15 passengers, including the driver, and is not used to transport passengers for compensation

With the lack of clarity regarding the definition of a heavy commercial vehicle, the Federal Highway Administration *Traffic Monitoring Guide's* definition and description of vehicle types was adopted for the tolling options. As shown in **Figure 6**, there are 13 vehicle classifications. For this Plan, a heavy commercial vehicle or truck is defined as Federal Highway Administration Classes 6 through 13. Classes 1 through 5 will be referred to as autos.

Figure 6. *Federal Highway Administration Vehicle Classifications*



Commuter. The term, commuter, also is not legally defined in federal or state transportation laws; it is considered a common word—a person and/or vehicle that travels back and forth regularly. A review of Virginia's *Administrative Code* found one description of commuter—the George P. Coleman Bridge (24VAC30-620-30I)—which defines a commuter as three round trips in 90 days in a 2-axle vehicle.

Reviews also were conducted of U.S. Census Bureau data. No articulated definition of commuter was found; however, the Bureau's *American Community Survey* defined certain types of commuters based on both travel time and distance. The types of commuters include the following:

- Long-distance commuting: traveling 50 or more miles to work
- Extreme commuting: traveling 90 or more minutes to work
- Mega commuting: traveling 90 or more minutes and 50 miles

The general parameters of mega commuting were applied to meet the statutory requirement of Chapter 743 so that the evaluation "not consider tolls on commuters using Interstate 81". Commuter is further defined as a passenger vehicle, motorcycle, bus, recreational vehicle, or two-axle, six-tire single unit truck or smaller. For example, a car traveling from Roanoke to Staunton—more than 85 miles with a travel time of more than 90 minutes—would be considered a commuter under this definition. Ultimately the Plan did not require a formal definition of "commuter" as both financing options were able to comply with the provisions of Chapter 743 without requiring a specific definition.

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2. I-81 Corridor Improvement Problem Identification

Assessment of I-81 Corridor Performance

The study team used four performance measures to help identify which parts of the I-81 corridor had the most significant issues related to congestion and safety. These four performance measures were calculated separately for each mile in both directions of the I-81 corridor. The top 20 percent of miles, in each direction, and for each performance measure were considered as the focus areas for developing the Plan.

The performance measures were:

1. **Crash frequency:** Road segments with a higher than average number of crashes during the last 5 years when compared to other segments in the I-81 corridor. This performance measure is the number of crashes per 100 million vehicle miles traveled. *Source: 2013-2017 VDOT data*
2. **Crash severity:** Road segments with a higher than average number of fatal and severe injury crashes during the last 5 years when compared to other segments in the I-81 corridor. This performance measure reflects the equivalent number of property damage only crashes per mile per year and is calculated by weighting crashes with fatalities and serious injuries higher than those with property damage only. *Source: 2013-2017 VDOT data*
3. **Person-hours of delay:** Road segments that operate below the posted speed limit for a portion of the day. Delay is caused by the impacts of congestion, incidents, and weather events. This performance measure is the total annual hours of delay per mile. *Source: 2016-2017 Regional Integrated Transportation Information System data*
4. **Incident/crash lane closure of greater than 1 hour:** Road segments with the highest number of incidents/crashes that lead to at least one lane of the interstate being closed for an hour or more. This performance measure reflects the number of incidents or crashes per year per mile. *Source: 2016-2017 VDOT 511 and Traffic Operations Center*

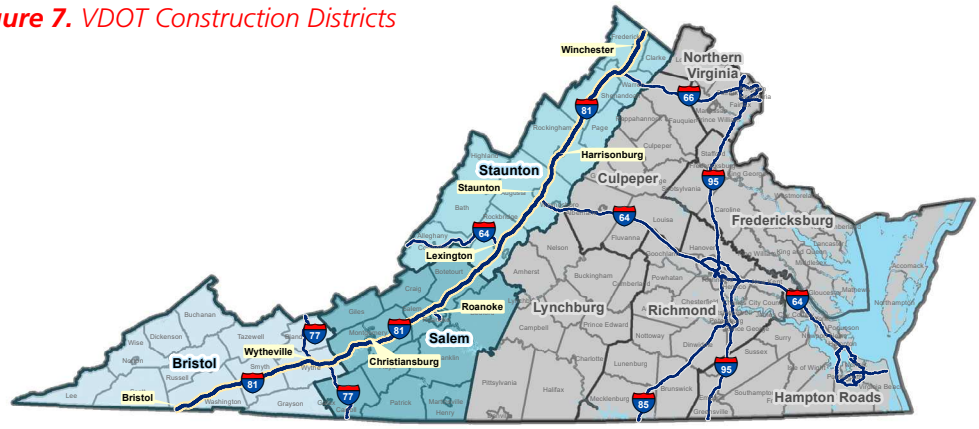
Performance measures were evaluated at the corridor level. The top 20 percent of locations for congestion and safety were identified and presented at a series of public meetings along the corridor in June 2018. The I-81 corridor is located within three Virginia Department of Transportation districts: Bristol, Salem, and Staunton (see **Figure 7**) and the mileage in each district is summarized in **Table 1**.

Detailed performance measures ranking data can be found in **Appendix B**.

Table 1. *Number of Miles in Each District*

District	Length (miles)
Bristol	87.5
Salem	87.0
Staunton	150.5

Figure 7. *VDOT Construction Districts*



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3. Public Outreach

Public involvement was the second component of developing the Plan. Throughout the study, public involvement was encouraged. Public meetings, hearings, and meetings with interest groups (chambers of commerce, environmental, manufacturing, and trucking) were held throughout the corridor along with Commonwealth Transportation Board updates.

A website, **www.VA81corridor.org**, was created to provide information and to gather input from stakeholders including local governments, the trucking industry, other businesses, and citizens. In addition, an email address was established for receiving comments and a public phone number was made available.

During the public meetings and hearings, attendees were able to view maps of the corridor in their respective district, listen to a presentation about the plan and its progress, and ask questions. The presentations were made available on the website as well. The website also included an online mapping tool that allowed a comment to be made about a specific location. At the four public meetings in June 2018, attendees participated in an interactive exercise to review I-81 performance measures, validate safety and congestion concerns, and identify other issues in the corridor by placing colored dots on the display boards. In addition to validating site-specific conditions, many of the public comments related to corridor-wide issues and shared similar themes. These comments were consolidated and divided into three categories; congestion, safety, and policy as shown in **Figure 8**.

From the June public meetings, more than 30 percent of the safety-related comments indicated a lack of speed enforcement. Speed enforcement, use of the left lane only for passing, and the speed differential between trucks and autos were recurring comments throughout the series of meetings in June, August, and October. Further research of the speed enforcement issues raised found that the levels of speed enforcement vary in the corridor. Addressing these concerns will require a coordinated effort by law enforcement. Therefore, the study team recommends the creation of a Speed Enforcement Task Force to examine the concerns and develop strategies for implementation.

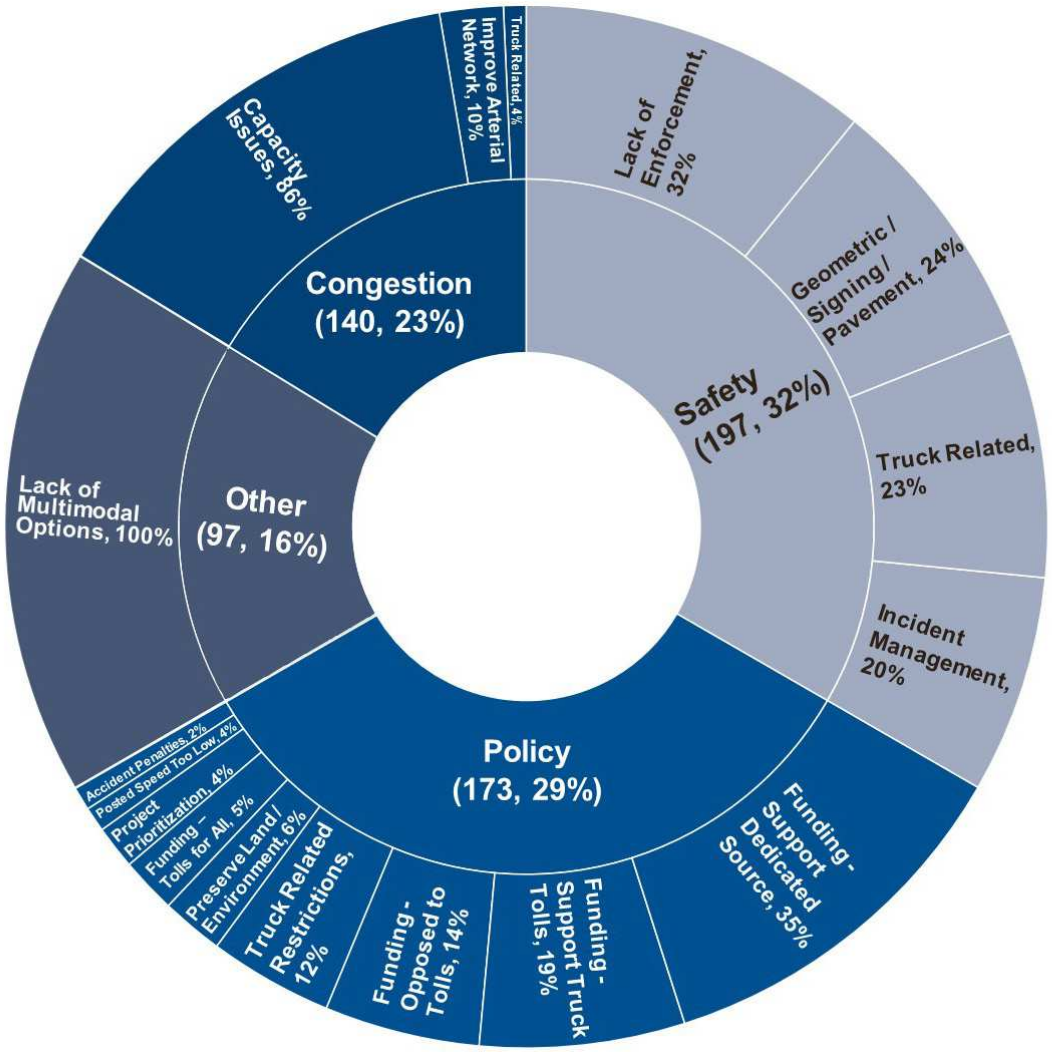
12	Public Input Meetings
5	CTB Updates
2,000 +	Comments from the Public
950 +	Meeting Attendees

Identified problems, safety, congestion, and other issues

Proposed targeted solutions and potential funding options

Prioritized solutions and identified potential funding options and economic impacts

Figure 8. *Summary of Public Comments (June 1-September 30)*



Additional Outreach

The study team provided regular updates regarding progress on the Plan to the Commonwealth Transportation Board between May and December. The purpose of these meetings was to:

- Keep the decision-making body informed of progress on the Plan
- Provide an opportunity for questions and answers on specific aspects of the Plan
- Receive guidance on the Plan development

December 4
October 29
September 17
July 17
May 15

Each of the presentations is available on the Commonwealth Transportation Board's website at **www.ctb.virginia.gov**. The study team also met with several stakeholders throughout the corridor including chambers of commerce, manufacturing and trucking associations, and environmental groups.

Public meeting materials can be found in **Appendix C** and an overview of public meeting comments can be found in **Appendix D**.

4. Performance Analysis Results

The traveling public on other interstates, such as I-95, I-66, I-395, and I-495 generally expect delays—particularly surrounding the peak morning and afternoon commuting hours. Incident delay on these roadways, however, is much lower, ranging from 4 to 15 percent. This contrasts with motorist experiences on the I-81 corridor, where more than half of the delay is related to incidents as previously shown in **Figure 2**. Finding solutions to non-recurring delay is challenging and requires a comprehensive and coordinated approach. For each of the three districts, performance was measured in both the northbound and southbound direction. Two examples of the types of data used for determining the performance on the corridor are shown in **Figure 9** (equivalent property damage only per mile) and **Figure 10** (person-hours of delay between interchanges per one-mile segment).

Recurring and non-recurring congestion exists in locations throughout the corridor. Capital improvements will help address recurring congestion but will not address all non-recurring congestion, so operational improvements are required to help reduce the severity of the remaining incidents. While recurring delay can often be addressed by adding capacity and reducing travel demand, non-recurring congestion requires a combination of operational and capital solutions. Potential improvements not only need to provide the traveling public with more opportunities to maneuver to avoid congestion and crashes, but when a crash does occur, systems need to be in place to warn motorists of the hazard(s) and to provide them with information to make informed travel decisions and options to avoid the incident area.

The study team developed targeted solutions following the calculation of key segments with performance measure issues along the corridor, the validation of the performance data identified by the public in each district, and the subsequent performance analysis results. The Plan proposes a comprehensive suite of improvements to address performance issues and contributing factors that improve reliability of I-81.

Figure 9. *Equivalent Property Damage Only (EPDO) – One-Mile Segments*

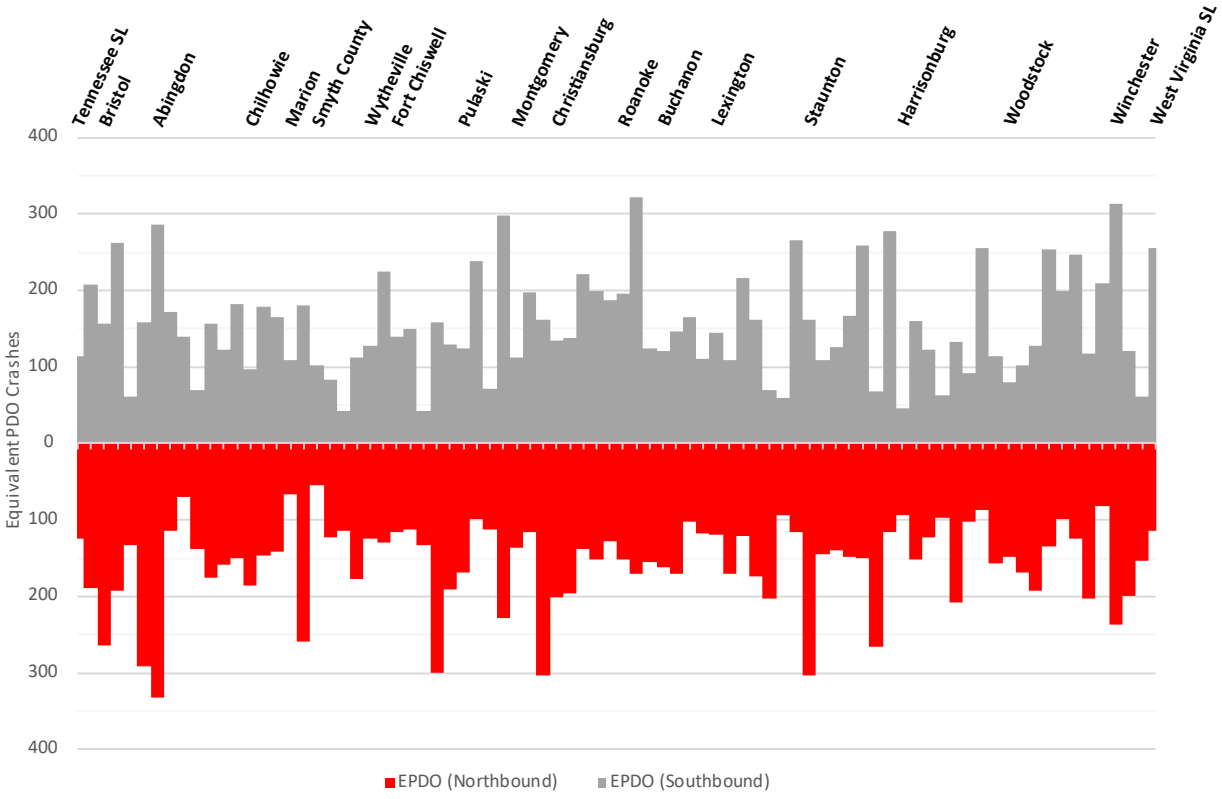
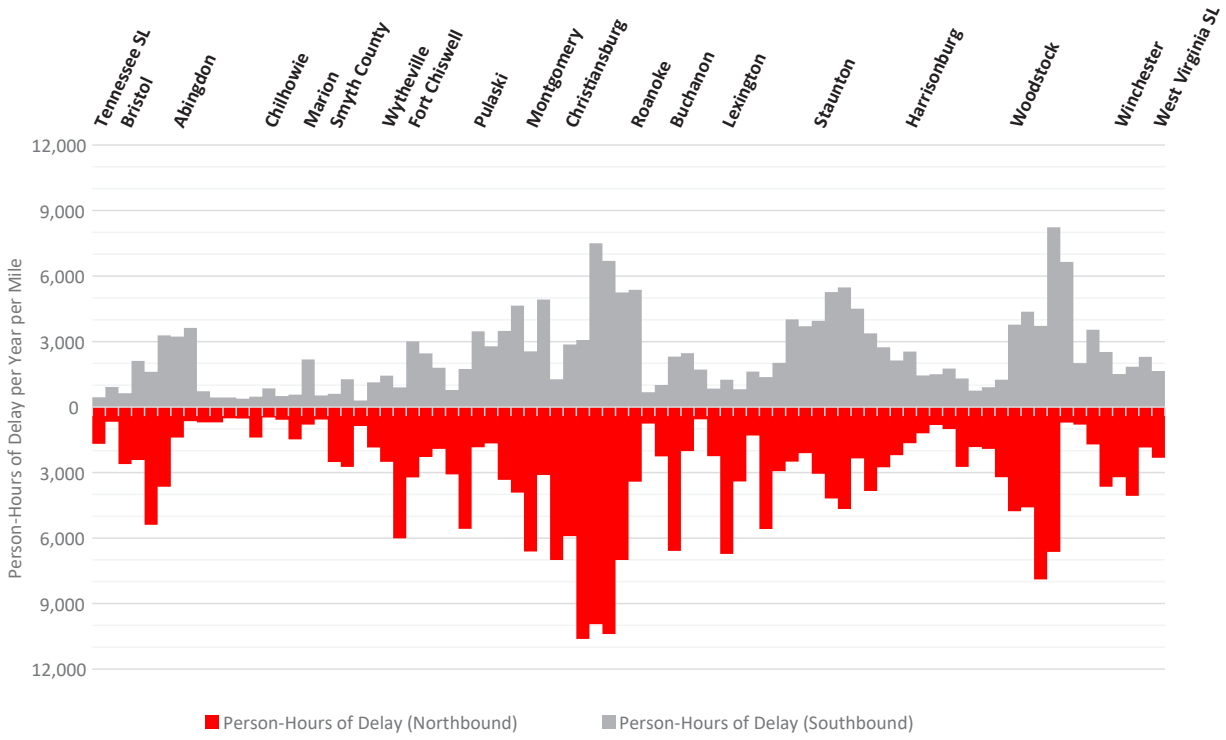


Figure 10. *Person-Hours of Delay per Year Between Interchanges – Average per One-Mile Segment*



5. Development of Targeted Improvements

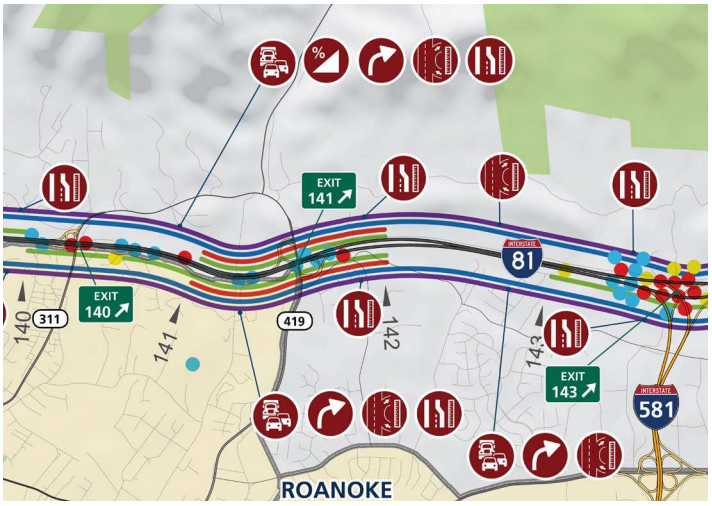
Once the segments with the highest levels of safety and congestion were identified—along with potential contributing factors and public feedback—the study team began identifying potential improvements, considering locations identified during the June 2018 public meetings. The solutions included two types of improvements:

1. Operational
2. Capital

Both types of improvements are necessary to address problems in the corridor. Using a step-wise approach, the study team reviewed data and feedback in one-mile segments throughout the corridor. During this thorough analysis and review process, the study team identified more than $43 million in operation improvements on I-81 and on parallel routes and about 100 capital improvements with an estimated cost of $4.3 billion.

A data-driven approach was used by the study team to develop recommended operational and capital improvements in the corridor. **Figure 13** shows an example of how a combination of the performance measures, public input, and contributing factors were used to generate proposed capital improvements. The left graphic shows all of the contributing factors and the right side shows the recommended improvements. A similar approach was used to identify the operational improvements.

Figure 11. *Recommended Capital Improvement Identification Process*



LEGEND: Contributing Factors and Public Feedback

Targeted Issues
By direction (as presented at the June public meetings)
- Crash Frequency
- Crash Severity
- Person-Hours of Delay
- Incident/Crash Lane Closure > 1 Hour

Public Issues Identified
- Safety
- Congestion
- Other

Contributing Factors
- Traffic Volume
- Grade
- Curve
- Ramp Spacing
- Merge/Diverge Area

Reference
- Mile Marker (MM)
- Incorporated City/Town
- County/Independent City Boundary

LEGEND: Improvements

Infrastructure
- +1 Widen by One Lane
- Extend Acceleration/ Deceleration Lane
- Curve Improvement
- Add Truck Climbing Lane
- Add Auxiliary Lane
- +S Shoulder Widening

Operations

I-81 Mainline		Other Routes	
EXISTING	PROPOSED	EXISTING	PROPOSED
Changeable Message Signs (CMS)	Changeable Message Signs (CMS)	Changeable Message Signs (CMS)	Changeable Message Signs (CMS)
Cameras	Cameras	Cameras	Cameras

Recommended Improvements
- Recommended for Funding
- Not Recommended for Funding

Funded Projects
- Recently Constructed or Under Construction
- Funded Project

Operational Improvements

Given the prevalence of non-recurring delay on I-81 and lack of travel time reliability, the study team developed a corridor-wide, performance-driven operations and incident management plan (referred to as the operational improvements plan) with the objective of getting traffic moving again once incidents happen. The operational improvements plan will serve as the basis for any potential capital improvement package going forward, with each element specifically designed to detect, respond, inform travelers of, and/or clear incidents.

To prioritize the locations that could have the greatest impact on the corridor, the study team began the operational improvement identification process using one of the aforementioned performance measures: number of lane-impacting incidents/crashes lasting greater than one hour. Areas with the highest concentration of incidents and/or crashes that last longer than an hour would likely benefit the most from operational improvements in the area.

Key components of the operational improvements include additional traffic cameras to detect; changeable message signs and improvements to parallel facilities to inform; expanded safety service patrols to respond; and contract emergency clearance services to clear incidents and re-open travel lanes. Each of these components contributes to getting traffic moving and they must work in coordination. The implementation of this program will significantly improve operations during incidents on the I-81 corridor. The program also will reduce the time drivers are stuck in congestion and will help keep traffic moving along the interstate and the parallel routes throughout the I-81 corridor. **Figure 12** summarizes the coordinated approach to the enhanced operational improvement plan throughout the corridor.

The operational improvements plan can be implemented within twelve months of adoption of the Plan. It has an estimated implementation cost of $39 million in FY 2020 and ongoing operations and maintenance expenses of approximately $6.5 million beginning in FY 2021. The details of this estimate are shown in **Table 2**.

Figure 12. *A Coordinated Approach to Incident Management*

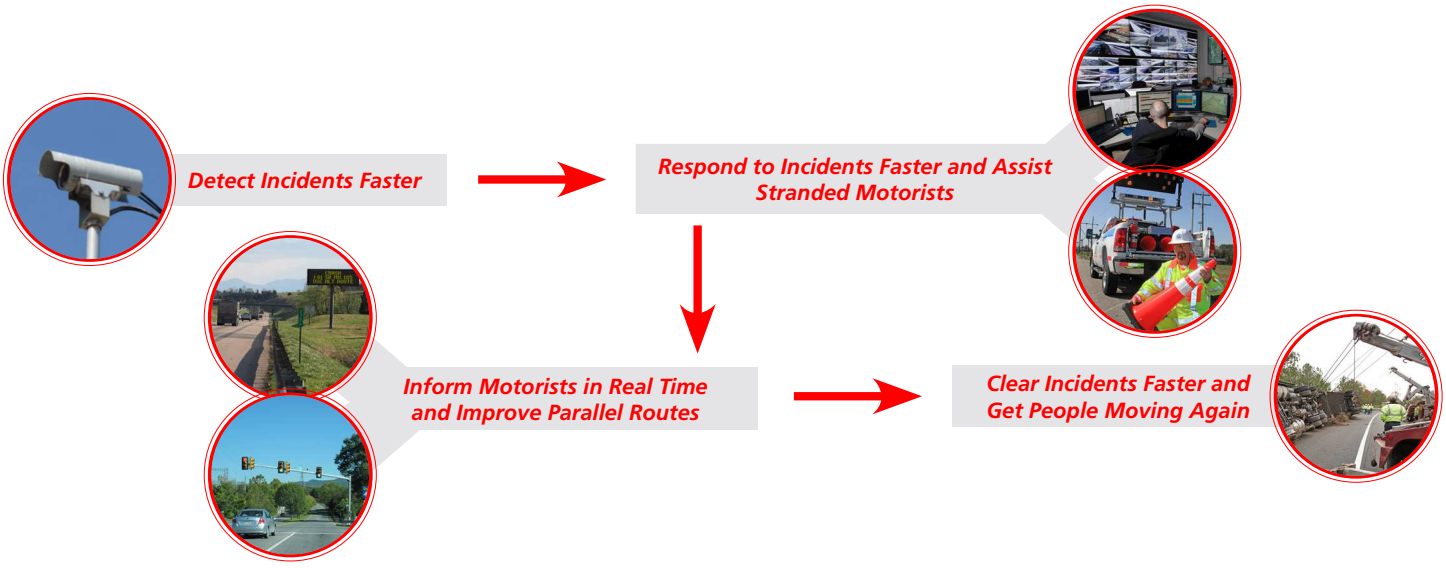
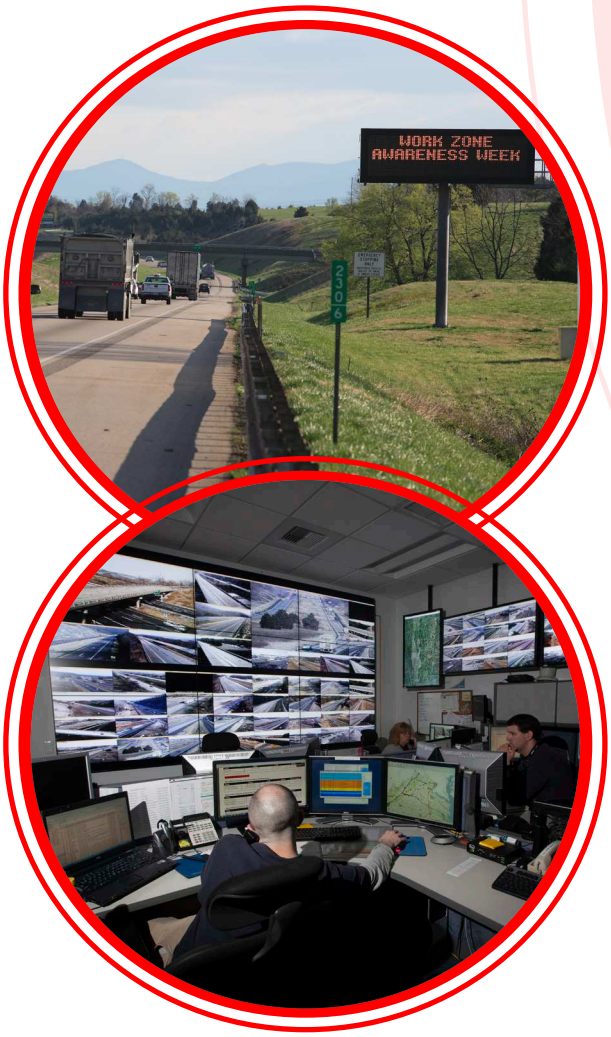


Table 2. *Operational Improvements Plan Cost Estimate (in millions)*

Improvement	Estimated Implementation Cost	Estimated Annual O&M Cost
Expand traffic cameras & changeable message signs	$11.25	$0.62
Enhanced safety service patrols	—	$2.23
Contract emergency clearance	—	$3.50
Parallel facilities Improvements	$28.04	$0.21
TOTAL	**$39.29**	**$6.56**

Active Traffic Management



According to Federal Highway Administration, active traffic management 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. Active traffic management increases throughput and safety using integrated systems with new technology, including automation of deployment to expedite responsiveness. Active traffic management strategies can be deployed to meet system-wide needs of incident management, traveler information, and safety resulting in synergistic performance gains (United States Department of Transportation Office of Operations). The Virginia Department of Transportation will expand active traffic management for the I-81 mainline by adding more traffic cameras and changeable message signs to detect incidents and inform drivers. Additional cameras will serve as "eyes on the road" and help detect incidents faster. Additional changeable message signs will then communicate these incidents to travelers, informing them in real-time of delays while also providing proactive information in advance, such as estimated travel time and alternate routes.

Advance detection and warning of major incidents will help travelers make alternative plans to avoid traffic backups. Active traffic management also will lead to fewer secondary crashes, since traffic volumes in backups are reduced as travelers divert to alternate routes or delay their trip, and travelers remaining along the I-81 upstream are more likely to be aware of downstream stopped traffic.

The cameras and changeable message signs also will provide better situational awareness for traffic operation center operators to provide faster and more accurate travel information and to request resources for faster incident response. Incident duration and delay can be reduced using an active traffic management program that leverages expanded camera and changeable message signs deployments.

Acrice Traffic Management Data-Driven Implementation Strategies

For Detection

- Place cameras at locations that have the highest incident rates to detect incidents faster
- Place cameras at all interchanges to detect incidents faster and monitor detours

For Informing the Public

- Place changeable message signs on I-81 before major detour routes that intersect the corridor to inform motorists
- Place changeable message signs on the busiest interstate and arterial feeder roads to I-81 with volumes greater than 7,600 vehicles per day to inform motorists and facilitate detour routing
- Place changeable message signs on I-81 between interchanges in urban settings with reduced speed limits or closely spaced interchanges (Roanoke Valley, Harrisonburg, and Winchester) to inform motorists in real time

Status

As of November 2018, there are currently 67 message signs on the I-81 mainline and the routes connecting to I-81, and 132 cameras along the corridor.

Recommendations

- Place 24 additional changeable message signs on the mainline
- Place 10 additional changeable message signs on feeder routes
- Place 37 additional cameras at interchanges
- Place eight additional cameras at high-incident locations

Safety Service Patrols

Safety service patrols are safety vehicles that travel the interstate and provide services to stranded motorists. These safety vehicles reduce incident detection, response, and clearance times by aiding stranded motorists and providing traffic control at incident locations. They also are actively seeking events on the interstate and are often the first to arrive on the scene of an incident. Safety service patrols can move fender benders from travel lanes and call appropriate resources and start on-site traffic control. These safety vehicles have been shown to reduce incident duration and reduce the likelihood of secondary crashes.

Data-Driven Implementation Strategies

- Identify coverage areas where there is both frequent delay and a high number of incidents
- Address coverage gaps
- Reorganize the program based on incidents and delay data

Status

Safety service patrol coverage currently exists along all I-81 except for four gaps. The coverage length and times vary. All coverage areas do cover daytime operations.

Recommendations

- Implement a new safety service patrol route for I-81 in Augusta County to address a coverage gap. Augusta County has the highest number of lane-impacting incidents on I-81.
- Separate the existing Roanoke County/Botetourt County coverage area into two areas. One area will cover I-81 and I-581 in Roanoke County. A separate area will be created to cover all of Botetourt County to remove a coverage gap. The current delay per mile is higher through the Botetourt County coverage gap than any other area in the corridor.
- Separate the Frederick County/Warren County safety service patrol coverage area, the longest safety service patrol route, which currently covers I-81 and I-66 into two areas; one area for I-81 alone and a second for I-66 to improve patrol frequency.

Contract Emergency Clearance

The number of lane-impacting incidents has been steadily increasing since 2010. A contract emergency clearance towing program could reduce the durations of these incidents. The Virginia Department of Transportation will establish contract emergency clearance towing services to ensure a consistent level of service to clear lanes faster. Contract emergency clearance provides a dedicated response time and dedicated clearance services with proper equipment. These services can move large vehicles, including trucks, out of travel lanes to reduce incident duration for complicated events and to get traffic moving again. With this program in place, incident duration could be reduced by 25 percent.

Data-Driven Implementation Strategies

- Provide consistent incident clearance along I-81
- Ensure the contract emergency clearance can clear trucks 24 hours a day, 7 days a week

Status

The Virginia State Police maintains a list of qualified towing providers for the I-81 corridor. The number of towing and recovery firms is not consistent along the corridor.

Recommendation

Add four additional towing contracts to meet the increasing need. This is based on the number of incidents that blocked lanes for more than two hours from 2015 to date as summarized below:

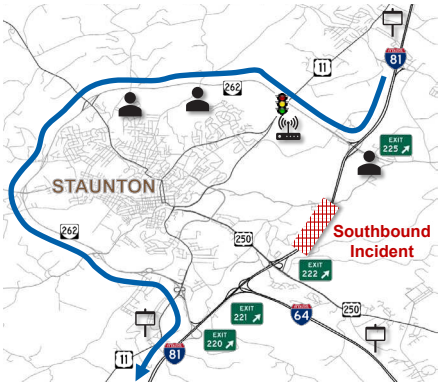
- Bristol District: 128 incidents
- Salem District: 206 incidents
- Staunton District North (Frederick, Shenandoah, and Rockingham Counties): 149 incidents
- Staunton District South (Augusta and Rockbridge Counties): 126 incidents

Detour Routes and Improvements to Parallel Facilities

Facilities that are parallel to the I-81 corridor can serve as relief or an alternative route for travelers when there are incidents on the interstate, particularly those requiring lane closures on the mainline. Should the General Assembly pursue a tolling option on the corridor, truck restrictions will likely be placed on parallel routes. It is anticipated that these restrictions would be lifted by law enforcement during emergencies. Incident detour plans were developed for an incident occurring between every exit ramp on the interstate in the northbound and southbound directions as well as directly at each exit. The incident detour plans identified facilities that are parallel to I-81 that can be used to reroute traffic off the mainline in the case of a lane-closing incident. These plans are intended to alleviate incident delay, secondary crashes, and subsequent congestion. The incident detour plans primarily propose traffic control personnel and signing recommendations (including portable changeable message signs) necessary to accommodate and guide the detoured traffic. An example incident detour plan is shown in **Figure 13**.

To support the improvement identification efforts for the I-81 corridor, the parallel facilities along I-81, such as US 11, US 460, Route 262, and Route 37, also were evaluated for additional improvements that may be necessary to facilitate traffic flow during an incident. The portions of the I-81 mainline that experienced the highest incident-related delay were used to focus on the identification of critical corresponding parallel facilities. Based on a review of existing data, potential improvements were identified for the parallel facilities including safety, traffic signal, intersection, and arterial improvements.

Figure 13. *Sample Detour Plan for a Southbound Incident Between Exit 225 and Exit 222*



Message Signs
Inform the public of a change in traffic patterns during an incident

Traffic Control Personnel
Provide manual control of intersections during an incident

Traffic Signal Operations
Provide remote capabilities to traffic signals to adapt to incident traffic patterns

These improvements will provide full-time benefits to the localities and travelers along the parallel facilities daily. For example, many of the improvements were identified as countermeasures to existing safety issues and crash patterns along the parallel facilities. Improved traffic signal equipment and communications will enhance everyday operations and optimize traffic progression along the parallel facilities.

The operational improvements were confirmed with Virginia Department of Transportation district staff and were prioritized using both the likelihood of a lane closure incident along the corresponding section of I-81 and the impact the proposed improvement would have on incident-rerouted traffic.

incident detour plans

VDOT (regions, districts, and residencies)
Virginia State Police
Local Agencies
- public works/ engineering
- law enforcement
- fire and emergency management

Capital Improvements

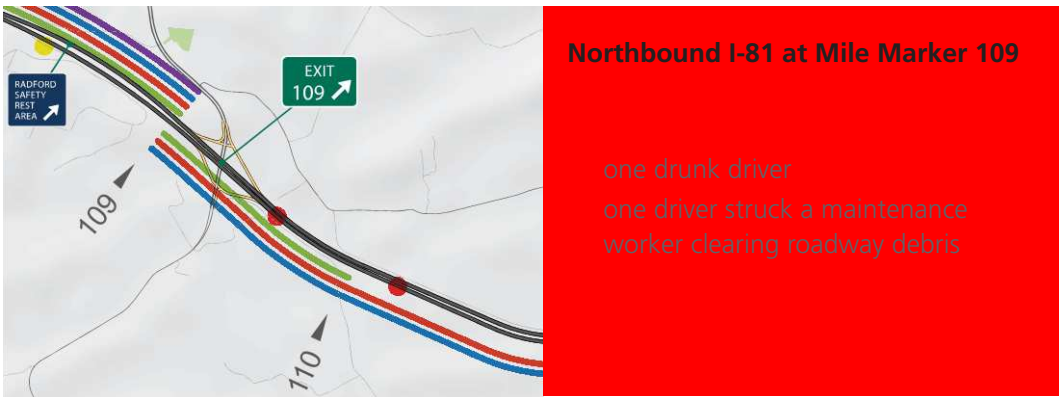
The study team used the performance data and public feedback to identify and analyze additional hotspots—in the top 20th percentile of worst miles in the corridor—to determine the potential factors contributing to crashes and delay. In addition, the study team also reviewed the following five contributing factors to develop potential capital improvement recommendations.

1. **Traffic Volume:** Traffic volumes were considered high when peak traffic volumes exceeded 1,700 passenger car equivalent vehicles per hour per lane. Traffic volumes were derived from published 2017 VDOT ADT traffic volumes and a factor of 1.7 was used to convert heavy commercial vehicle volumes to passenger car equivalent volumes. No adjustment for grade was used for determining passenger car equivalent volumes.
2. **Grade:** Contour elevations for the I-81 corridor were evaluated to determine areas with steep grades.
3. **Curve:** Areas with tight horizontal curves were noted using aerial and street-level imagery.
4. **Ramp Spacing:** Locations where the distance between an on-ramp and the next off-ramp was less than two miles.
5. **Merge/Diverge Area:** Locations where an acceleration and/or deceleration lane length was less than 1,300 feet.

The study team then used the performance measures, contributing factors, and public input to develop potential capital improvements. The team reviewed projects already funded and programmed in the Six-Year Improvement Program to determine how those projects may help improve conditions in the corridor. The study team also examined recently constructed projects to determine how those projects may resolve issues in the corridor and whether crashes and delays in those areas may have been due to construction work zones.

The study team reviewed crash data for the entire corridor in both directions to determine where the highest crash frequency and crash severity occurred. Descriptions from crash reports were used to determine the cause of crashes and what solutions, if any, could mitigate the crash pattern. Crashes involving vehicles changing lanes, sideswipes, and rear-end collisions, and in some cases running off the road may be linked to deficiencies in the roadway that could be mitigated by geometric improvements. Animal crashes can be addressed by the installation of fencing or crossings. Crash patterns linked to behavioral issues, such as driver inattention, or mechanical failure cannot be remedied by changes to the roadway. For example, no project was proposed at northbound I-81 at mile marker 109 due to the presence of behavioral issue crashes as seen in **Figure 14**. A summary of the crash data for each mile marker is available as part of the Technical Appendix.

Figure 14. *Example of Behavior-Related Crashes*



The analysis team found that delays associated with long-term lane closures could be related to:

- number and severity of crashes
- long distances between interchanges
- narrow shoulders that make emergency vehicle access and response difficult

Areas of short-term recurring delay were due to:

- high traffic volumes, particularly in peak commuting periods

Traffic volumes were evaluated to help understand if long-term lane closures were tied to capacity or safety issues.

Table 3 describes the types of capital improvements considered and their associated benefits. In addition to the types of solutions shown, there were a few locations where potential solutions were developed to address specific constraints. These included improvements with interchange connections, such as I-77 in Wytheville and I-66 south of Middletown.

Further analysis and consideration of each improvement will take into account the many historic and natural resources in the I-81 corridor. During the preliminary engineering phase of project development when the environmental impact analyses are conducted, the potential impacts of proposed improvements on these resources must be carefully evaluated (including as part of any required reviews under Section 106 of the National Historic Preservation Act and/or Section 4(f) of the Department of Transportation Act), and any anticipated adverse effects must be avoided or minimized to the greatest possible extent. Examples of areas where particular care is needed include Cedar Creek and Belle Grove National Historic Park and the City of Winchester.

In addition, the potential impacts of proposed improvements on natural resources in the I-81 corridor—including wetlands, streams, forests, and farmland—were not evaluated as part of this study. Before these improvements are advanced further, many will require comprehensive review under federal and state environmental review and permitting processes (such as those under the National Environmental Policy Act, Clean Water Act, Clean Air Act, and Endangered Species Act). These processes may result in certain projects not being advanced as initially proposed, or substantially modified to avoid or mitigate adverse impacts.

Table 3. *Types of I-81 Capital Improvements*

Type of Improvement	Locations to Consider	Benefit
	Where spacing between an on-ramp and the subsequent off-ramp is less than two miles Where there are many crashes between exits Where there are large volumes between interchanges	Reduces the potential for crashes caused by traffic entering and exiting the interstate Gives entering and exiting traffic more space to maneuver Provides an outside lane for vehicles to stay in between closely-spaced ramps.
Widen by One Lane: an extra lane constructed for multiple miles to increase the capacity of the interstate.	• Where there are high person-hours of delay and incidents/ crashes with a lane closure • Where there are high traffic volumes • Where there are long distances that vehicles need to pass, merge, or travel through multiple interchanges	• Reduces the likelihood of congestion by providing additional roadway capacity • Decreases clearance time for of incidents and crashes by providing more space to clear crashes • Reduces the potential for crashes by allowing more space for vehicles to maneuver
	Where there is an uphill grade Where there are many truck crashes and rear-end crashes Where there is a speed differential between trucks and cars	Reduces the potential for crashes due to the impacts of slow-moving vehicles Provides space for slow-moving vehicles to move to the right on uphill grades to improve speeds and safety for all vehicles
Acceleration and Deceleration Lane Extensions: longer lengths to accelerate when entering the interstate and decelerate when exiting the interstate.	• Where there are many crashes involving lane merges and crash hotspots in acceleration/ deceleration lane influence areas • Where acceleration/ deceleration lane lengths are less than the VDOT standards	• Reduces the potential for crashes caused by slower moving traffic entering or exiting the interstate • Provides more time for entering vehicles to match the speed of the interstate traffic and exiting vehicles to slow down to safely exit the interstate
	Where there is high-crash frequency or severity with roadway departure crashes Where the shoulder width is deficient Where there are long stretches of two lane interstate between interchanges with a history of incidents.	Reduces the potential for roadway departure crashes by giving drivers a wider shoulder for recovery Decreases impact of incidents and crashes by providing shoulder space to clear crashes and improves emergency vehicle response times
Curve Improvements: a variety of improvements that reduce the potential for crashes through horizontal curves, such as LED-lit chevron signs, high-friction surface treatments, and drainage improvements.	• Where there is high-crash frequency or severity in a horizontal curve • Where there are many roadway departure crashes	• Reduces the potential for roadway departure crashes in horizontal curves • Provides low-cost, high benefit countermeasures that can be constructed quickly

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6. Development of Cost Estimates

To facilitate the analysis and prioritization of recommended capital improvements, planning level cost estimates for each individual improvement were developed as described below. In a few cases, work that was done on potential improvements identified during the Commonwealth Transportation Board project selection beginning in FY 2017 were used as a basis for cost estimates.

Planning level cost estimates were developed by the study team in cooperation with Virginia Department of Transportation engineering staff. Corridor-wide construction contract costs per mile or cost per unit were established to assist in the development of costs for linear improvements such as widenings, truck climbing lanes, and auxiliary lanes. A summary of per mile and per unit line item costs was created to estimate the construction costs for the capital improvements.

Using assumed unit construction costs, each linear improvement was segmented at bridges, interchanges, or other identifiable landmark (such as locations of inside widening, outside widening, or partial inside and outside widening). The appropriate costs per mile or unit were then applied to each segment to develop a total construction cost for each improvement. In a few cases, Virginia Department of Transportation staff provided individual cost estimates for bridges based on prior due diligence or project development. For the non-linear improvements, such as acceleration/deceleration length extensions, shoulder widenings, and curve improvements, the construction contract costs were developed using a combination of the VDOT Project Cost Estimating System and unit cost breakdowns from historical bid tabulation data, recent construction bids, and the Statewide Planning Cost Estimate tool.

Once the construction costs for each improvement were determined, the study team developed estimates for preliminary engineering, construction engineering and inspection, and right-of-way and utilities using a percentage of the construction cost. The percentage for preliminary engineering was fixed at 15 percent of the construction cost regardless of project type or size; whereas, the right-of-way and utilities estimate was based on the developed condition of the project context (e.g., rural or urban) and whether the inside or outside widening would be needed for the improvement. For construction engineering and inspection, 15 percent of construction estimate was used.

Table 4 summarizes the percentages applied to arrive at the preliminary engineering and construction engineering and inspection costs and **Table 5** shows the percentages applied to obtain the right-of-way and utilities costs.

Table 4. *Determination of Preliminary Engineering and CEI Cost*

Cost Estimating Phase	*Percent of Construction*	*Notes*
Preliminary Engineering	15%	Use construction contract cost
Construction Engineering and Inspection	15%	Use construction contract cost plus noise wall cost

Table 5. *Determination of Right-of-Way and Utilities Cost*

Location	Percent of Construction
Urban Inside	5%
Urban Outside	15%
Rural Inside	2%
Rural Outside	8%

In addition, the study team evaluated the developed condition of the land outside the right-of-way to determine whether sound barriers, including noise walls, were likely. The potential length of noise wall was estimated including both sides of the interstate, at a cost of $3.6 million per mile or $45 per square foot for a 15-foot tall noise wall one mile in length. Once the noise wall construction cost was identified, this cost was added to the construction cost. While noise wall cost estimates were incorporated in the construction cost, the process of determining the type of sound barrier and its location requires public input.

The total planning level cost for each improvement was then determined by summing the costs for construction (including noise wall cost), construction engineering and inspection, preliminary engineering, and right-of-way and utilities. Finally, the study team, in close coordination with Virginia Department of Transportation staff, conducted reviews of the cost estimating methodology and cost estimates for the individual improvements to ensure that all cost estimates were reasonable and included necessary elements. Additional documentation on cost estimation for the Plan is available as part of the Technical Appendix.

7. Prioritization of Capital Improvements

Prioritization Process

Chapter 743 requires that the identified improvements be "evaluated using the statewide prioritization process pursuant to § 33.2-214.1 of the Code of Virginia." This statute states that prioritization is an objective and quantifiable analysis that considers added benefit in terms of congestion mitigation, economic development, accessibility, safety, environmental quality, and land use divided by the requested funding. This process, commonly known as SMART SCALE, was implemented by the Commonwealth Transportation Board in 2015.

The SMART SCALE process was not replicated in its entirety for this Plan; instead the study team applied practical and applicable measures from the SMART SCALE process. The operational improvements were assumed to be a stand-alone fundamental Plan element and were excluded from the prioritization.

The SMART SCALE process includes considerations that were not applicable to recommendations along the I-81 corridor including multimodal, pedestrian facilities, access type, and partial funding provided by applicants. The Plan prioritization process only compares I-81 project recommendations against other potential I-81 project recommendations. Additionally, the SMART SCALE support for economic development heavily relies on applicant data input and was not included in this process. Area type weighting was not applied in the Plan since the majority of projects are in Category D (rural areas), with a small percent occurring in Category C or B (urban areas in the corridor).

The basic project components required for the Plan prioritization process were improvement type (listed in **Table 3**), location and length of improvent, and project cost. SMART SCALE also requires that project benefits be analyzed relative to project cost. The Plan prioritization similarly analyzes identified improvement benefits relative to cost.

Performance Measures

The study team first reviewed the current SMART SCALE performance measures to determine which measures would provide the most discernible differences between the recommended improvements. Measures were excluded that did not draw clear distinctions among the recommended improvements or required significant local information (economic development). The measures ultimately selected in prioritization were safety, congestion, and accessibility. **Table 6** depicts the selection of SMART SCALE measures recommended for the I-81 prioritization process.

- **safety:** reduction in the number of fatal and injury crashes (40 percent)
- **congestion mitigation:** decrease in person-hours of delay (40 percent)
- **accessibility:** access to jobs (15 percent)
- **access to jobs:** for disadvantaged populations (5 percent)

Prioritization of Identified Improvements

Under SMART SCALE, projects are considered between two programs—the District Grant Program and High-Priority Projects Program. In the District Grant Program, candidate projects and strategies from localities within a district compete for prioritization against projects and strategies within the same district. Under the High-Priority Projects Program, projects and strategies compete for prioritization against projects and strategies submitted statewide.

The prioritization process for the Plan follows a similar structure, creating two funding programs—a district allocation based on corridor miles where projects were evaluated at the district level and a corridor-wide priority allocation.

Once the performance measures and weights were identified, the prioritization of identified improvements was undertaken. Following discussions with the engineering and construction industry, it was determined that approximately $2 billion in I-81 capital improvements could be accommodated during the next 7 to 10 years. This took into consideration the existing Six–Year Improvement Program workload including several major projects, such as I-66 Outside the Beltway and the Hampton Roads Bridge-Tunnel, which will compete for resources in the engineering and construction sectors.

Table 6. *SMART SCALE Measures Used in Scoring*

SMART SCALE MEASURE	Safety	Congestion Management	Accessibility	Land Use	Environment	Economic Development	Weighting Factor
Reduce Number of Fatal and Injury Crashes	Y						40%
Reduce Fatal and Injury Crash Rate	N						-
Increase Person Throughput		N					-
Decrease in Person-Hours of Delay		Y					40%
Access to Jobs			Y				15%
Access to Jobs for Disadvantaged Populations			Y				5%
Access to Multimodal Choices			N				-
Transportation Efficient Land Use				N			-
Increase in Transportation Efficient Land Use				N			-
Air Quality					N		-
Impact to Natural Resources					N		-
Project Support for Economic Development						N	-
Intermodal Access and Efficiency						N	-
Travel Time Reliability						N	-
TOTAL WEIGHTING							**100%**

Like SMART SCALE, once the cost estimates were completed and the $2 billion funding assumption established for the first 10 years, the recommended capital improvements were selected based on sorting by the highest benefit/cost score.

The assumed $2 billion in funding used a two-step process for determining the improvements. The $2 billion in funding was divided 50/50 between a district allocation and a corridor-wide allocation. The first step was to sub-allocate the district $1 billion share by the centerline miles in each district on I-81. Identified improvements in each district were sorted based on their respective benefit/cost score and defined as a "project." The second step was to allocate the corridor-wide priority funding, which used the remaining $1 billion. Unfunded projects that remained after the first step in all three districts were sorted by benefit/cost score until the $1 billion was allocated.

Projects Recommended for Funding

The development process for this Plan initially identified 106 projects for consideration. After the prioritization process and receipt of additional public input as well as that of the Commonwealth Transportation Board, a total of 63 projects have been prioritized for funding, for a total of $2 billion. These 63 projects represent the priorities out of the 106 total projects initially identified for consideration in the three Virginia Department of Transportation districts.

- Bristol District: 27 projects estimated at $285 million
- Salem District: 13 projects estimated at $875 million
- Staunton District: 23 projects estimated at $838 million

A summary of the Plan recommended capital improvements by project type and district is included in **Table 7**. Each district improvement is summarized in **Tables 8 - 10**. **Appendix E** includes prioritization details of the capital improvements.

Table 7. *Summary of Recommended Capital Improvements in each VDOT District*

District	Number of Projects by Type								
	Widening	Auxiliary Lane	Truck Climbing Lane	Acceleration Lane Extension	Deceleration Lane Extension	Curve Improvement	Shoulder Widening	Total Number of Projects	Total Cost (millions $)
Bristol	1	3	3	6	10	4	0	27	**$285.2**
Salem	4	0	0	4	2	3	0	13	**$875.3**
Staunton	4	1	2	10	4	1	1	23	**$838.1**

It is important to note that the recommended projects take into account the projects already in the Six-Year Improvement Program, which are summarized in **Appendix F**. **Appendix G** contains maps and tables summarizing the recommended improvements in each district.

Table 8. *Summary of Capital Improvements – Bristol District*

Jurisdiction	Mile Marker (from/to)			Improvement Description	Total Project Cost (PE, RW, and Construction)*
Abingdon	17.9	to	17.9	MM 18 curve improvement (flashing chevron)	$163,000
Abingdon/Washington County	19.2	to	19.4	Extend deceleration lane	$1,548,000
Washington County	32.3	to	33.5	Add truck climbing lane	$20,652,000
Chilhowie/Smyth County	39.5	to	40.6	Add truck climbing lane	$18,420,000
Smyth County	38.9	to	39.1	Extend deceleration lane	$1,988,000
Marion/Smyth County	45.5	to	45.6	Extend deceleration lane	$9,888,000
Marion/Smyth County	48.0	to	48.9	Extend acceleration lane	$5,569,000
Wytheville	67.3	to	67.4	Extend deceleration lane	$2,873,000
Wytheville	67.6	to	67.6	MM 68 curve improvement (flashing chevron)	$163,000
Wytheville	72.5	to	73.3	Extend deceleration lane	$31,086,000
Wytheville	73.0	to	I-77 42.9	Extend I-77 deceleration lane and reconfigure off-ramp	$19,459,000
Wythe County	84.5	to	84.2	Extend deceleration lane	$3,016,500
Wythe County	81.8	to	81.6	Extend deceleration lane	$29,736,000
Wytheville	73.7	to	73.2	Add auxiliary lane between Exit 73 and Exit 72	$23,200,000
Smyth County	54.3	to	54.1	Add auxiliary lane between Exit 54 and Smyth Safety Rest Area	$5,520,000
Marion/Smyth County	47.7	to	47.4	Extend acceleration lane	$4,266,000
Marion/Smyth County	43.1	to	42.6	Extend acceleration lane	$3,654,000
Wythe County	I-77 41.0	to	I-77 40.9	Add auxiliary lane between Exit 40 on I-77 and Exit 72 on I-81 and extend acceleration lane	$43,500,000
Smyth County	39.5	to	39.4	Extend deceleration lane	$964,500
Smyth County	39.1	to	38.8	Extend acceleration lane	$2,179,000
Washington County	34.0	to	33.0	Add truck climbing lane	$14,100,000
Washington County	26.9	to	26.6	Extend deceleration lane	$5,528,000

Table 8. *Summary of Capital Improvements – Bristol District* (*continued*)

Jurisdiction	*Mile Marker (from/to)*			*Improvement Description*	*Total Project Cost (PE, RW, and Construction)**
Washington County	26.3	to	26.2	Extend acceleration lane	$2,005,000
Washington County	21.5	to	21.5	MM 22 curve improvement (flashing chevron)	$163,000
Abingdon	17.6	to	17.6	MM 18 curve improvement (flashing chevron)	$163,000
Abingdon	17.0	to	16.6	Extend acceleration lane	$3,622,500
Bristol/Washington County	9.7	to	8.1	Widen to three lanes	$31,813,000

* PE = Preliminary Engineering; RW = Right-of-Way and Utilities

Table 9. *Summary of Capital Improvements – Salem District*

Jurisdiction	Mile Marker (from/to)			Improvement Description	Total Project Cost (PE, RW, and Construction)*
Pulaski County	88.0	to	88.0	MM 88 curve Improvement (flashing chevron)	$163,000
Pulaski County	90.2	to	90.7	Extend acceleration lane (Exit 89)	$4,784,500
Radford/Montgomery County	105.5	to	106.0	Extend acceleration lane	$6,567,000
Christiansburg/Montgomery County	116.2	to	128.4	Widen to three lanes from MM 116 to Exit 128	$201,210,000
Montgomery County/Roanoke County/Salem	128.4	to	137.1	Widen to three lanes from Exit 128 to Exit 137	$185,958,000
Botetourt County	162.4	to	162.9	Extend acceleration lane	$1,976,500
Botetourt County	171.7	to	175.6	MM 172-176 curve improvement (flashing chevron)	$163,000
Botetourt County	175.3	to	171.4	MM 176-172 curve Improvement (flashing chevron)	$163,000
Botetourt County	158.4	to	158.2	Extend Troutville Safety Rest Area deceleration lane	$1,267,000
Botetourt County	158.0	to	157.2	Extend Troutville Safety Rest Area acceleration lane	$5,640,500
Pulaski/Pulaski County	94.2	to	93.7	Extend acceleration lane	$3,838,000
Salem/Roanoke County	137.1	to	141.8	Widen to three lanes between Exit 137 and Exit 141	$231,005,000
Roanoke/Roanoke County	144.2	to	151.3	Widen to three lanes between MM 144 and Exit 150	$232,595,000

* PE = Preliminary Engineering; RW = Right-of-Way and Utilities

Table 10. *Summary of Capital Improvements – Staunton District*

Jurisdiction	Mile Marker (from/to)			Improvement Description	Total Project Cost (PE, RW, and Construction)
Lexington/Rockbridge County	189.0	To	189.4	Extend acceleration lane	$2,188,000
Raphine/Rockbridge County	205.3	To	205.7	Extend acceleration lane	$2,354,000
Augusta County	232.4	To	232.8	Extend acceleration lane at Mt. Sydney Rest Area	$1,097,000
Weyers Cave/Augusta County	233.3	To	237.4	Add truck climbing lane	$96,391,000
Shenandoah County	268.8	To	268.9	Extend deceleration lane	$1,000,000
Toms Brook/Shenandoah County	290.6	To	291.1	Extend acceleration lane	$3,237,000
Middletown/Frederick County	302.5	To	302.9	Extend acceleration lane	$2,418,000
Middletown/Frederick County	302.1	To	302.2	Extend deceleration lane	$1,047,000
Frederick County	303.7	To	303.9	Extend deceleration lane at truck scales	$1,980,000
Shenandoah County	299.2	To	295.7	Widen to three lanes	$95,082,000
Strasburg/Shenandoah County	296.7	To	296.3	Extend acceleration lane	$1,609,000
Woodstock/Shenandoah County	283.3	To	282.9	Extend acceleration lane	$2,354,000
Edinburg/Shenandoah County	279.2	To	278.7	Extend acceleration lane	$2,248,000
Mount Jackson/Shenandoah County	272.3	To	272.3	MM 273 curve improvement (flashing chevron)	$163,000
Weyers Cave/Augusta County	236.5	To	234.6	Add truck climbing lane	$21,964,000
Augusta County	232.9	To	232.7	Extend deceleration lane at Mt. Sidney Safety Rest Area	$1,057,000
Augusta County	232.5	To	231.9	Extend acceleration lane at Mt. Sidney Safety Rest Area	$4,188,000
Staunton/Augusta County	221.5	To	221.2	Add auxiliary lane between Exit 221 and Exit 220	$13,012,000
Raphine/Rockbridge County	205.2	To	204.7	Extend acceleration lane	$3,237,000
Rockbridge County	204.5	To	195.1	Widen shoulder between MM 204 and MM 195 (includes 2.8 miles in northbound direction)	$69,827,000

Table 10. *Summary of Capital Improvements – Staunton District* (*continued*)

Jurisdiction	*Mile Marker (from/to)*			*Improvement Description*	*Total Project Cost (PE, RW, and Construction)*
Staunton/Augusta County	221.8	To	225.3	Widen to three lanes between Exit 221 and Exit 225	$112,332,000
Harrisonburg/Rockingham County	242.2	To	248.1	Widen to three lanes from Exit 243 to Exit 248	$239,956,000
Winchester/Frederick County	313.8	To	317.5	Widen to three lanes between Exit 313 and Exit 317	$159,193,000

* PE = Preliminary Engineering; RW = Right-of-Way and Utilities

8. Financing Options

Chapter 743 of the 2018 General Assembly provided direction on the financing options that were to be considered as part of the Plan. The legislation directed that the Commonwealth Transportation Board evaluate the feasibility of using toll financing and other financing means. In addition, the legislation stated that the Plan could consider tolls on heavy commercial vehicles and high occupancy toll lanes but could not consider options that toll all users or that toll commuters. As the study team evaluated financing options, high occupancy toll lanes were removed from consideration, since there were no pre-existing high occupancy vehicle lanes and traffic patterns did not support this option.

As previously discussed, approximately $2.2 billion in improvements are recommended for the entire I-81 corridor. This includes $2.0 billion for capital improvements and $200 million for operational improvements, truck parking solutions, speed enforcement, and multimodal improvements. This $2.2 billion is in addition to the $225 million in I-81 and Route 11 improvements already funded in the current Six–Year Improvement Program adopted by the Commonwealth Transportation Board.

Based on the financial analyses, two alternatives appear to provide the necessary financing to address the initial $2.2 billion of improvements – a) imposition of two taxes in Planning District Commissions 3 through 7 and/or b) tolling of vehicles with the option of autos paying a fixed yearly fee for an auto annual pass. All financing options require General Assembly approval. Annual revenues in the first full year range from $145 to $165 million depending on the financing option.

For the financial analyses, two key assumptions are that 1) any tax option would be similar to those approved by the General Assembly for the Northern Virginia and Hampton Roads regions and 2) any toll on heavy commercial vehicles (trucks) will not exceed $0.17 per mile based on the initial economic impact analysis assumptions developed as part of this Plan. To facilitate both the Commonwealth Transportation Board and General Assembly's review, all key financing assumptions are explained in this section.

Based on the financial analyses, neither the projected taxes nor toll revenues can provide sufficient pay-as-you-go funding for the $2.2 billion required by the Plan within the next 7 to 10 years. The Plan's capital improvements require debt and loan financing. Without dedicated funding and financing, the projects will have to compete for transportation funding along with other projects throughout the Commonwealth.

With new sources of dedicated revenue, all revenues and financing options will be dedicated to programs and projects that benefit the users of I-81, including those that positively impact traffic reliability, safety, and travel times for the users of I-81. All revenue and financing options—regional taxes, tolling, or a combination of taxes and tolls to repay long-term debt—require General Assembly approval before they can be implemented. Based on the Virginia *Constitution* and court case precedent, regional taxes may be used for transportation projects benefitting the geographic area where the taxes are imposed, while tolls must be used for the benefit of the toll paying user along the I-81 Corridor.

Potential Tax Options for Financing the Plan

The potential tax options are summarized in **Table 11**. The General Assembly has authorized regional motor vehicle fuel tax, retail sales, and use tax in Northern Virginia and Hampton Roads which are managed by regional authorities. If the same taxes were imposed in Planning District Commissions 3 to 7, combined,

they are forecasted to generate sufficient revenues to 1) pay debt service on the issuance of $1.5 billion in 35-year bonds and 2) provide sufficient pay-as-you-go revenue to complete the $2.2 billion in improvements within the 7- to 10-year window. Further, the options are expected to generate sufficient revenue to pay the on-going operational improvements operations and maintenance costs, Department of Taxation and Department of Motor Vehicles collection costs, regional authority costs, and fund additional improvements in the I-81 corridor in later years. Details of the potential tax financing option are provided in **Appendix H**.

Table 11. *Potential Tax Options for Plan Improvements (in millions)*

Tax Option Imposed in Region	Rate	Estimated Annual Revenue Generated 2020	Estimated Annual Revenue Generated 2025	35-Year Bonds Assumed to be Issued
Retail Sales and Use Tax	0.7%	$105	$116	$ -
Motor Vehicle Fuels Tax	2.1%	$60	$63	$ -

Potential Tolling Options

In keeping with the requirements in Chapter 743, four potential tolling options were examined for the Plan:

1. Trucks only
2. Trucks and non-commuters
3. Variable tolling between daytime and nighttime for trucks and non-commuters
4. Variable tolling with an Auto Annual Pass

Table 12. *Tolling Option Which Best Meets Plan Requirements (in millions)*

Toll Option Description	Truck Rate (per mile)	Auto Rate (per mile)	Variable	Auto Annual Pass	Estimated Toll Revenue 2020	Estimated Toll Revenue 2025
Variable Daytime and Nighttime* with Auto Annual Pass	15¢ daytime 7.5¢ nighttime	7.5¢ daytime 5¢ nighttime	Yes	$30	$145	$166

* For the analysis, daytime tolling is between the hours of 6:00 a.m. to 9:00 p.m. and nighttime tolling is between the hours of 9:00 p.m. to 6:00 a.m.

Of these four tolling options, options 2 through 4 best meet public input, federal and state tolling parameters, and generate sufficient revenue to meet the $2.2 billion needs. Option 4 is included in the Plan (shown in **Table 12**). The detailed financial analysis in **Appendix H** is based on tolling Option 4, which generates the lowest revenue of options for options 2 through 4, yet still provides adequate revenues to finance the $2.2 billion package.

The toll revenues also will be used to support the ongoing costs of the operational improvements, tolling operational costs, and to pay debt service on toll revenue bonds. The forecast suggests that some pay-as-you go funding also will be available.

Existing Transportation Funding Programs

Toll Facilities Revolving Account. The Toll Facilities Revolving Account was first established in 1986 and is used to finance and/or refinance existing and potential toll facilities. Toll Facilities Revolving Account funds allocated by the Commonwealth Transportation Board intended for planned or operating toll facilities are considered advance funding and are expected to be repaid. For example, both I-66 Inside the Beltway in Northern Virginia and I-64 Toll Lanes in Hampton Roads received Toll Facilities Revolving Account advance funding to finance the tolling infrastructure and related implementation costs. As of October 1, 2018, the Toll Facilities Revolving Account has $43 million available for allocation. This Plan assumes that $43 million will be allocated by the Commonwealth Transportation Board in FY 2019 to fund tolling implementation if I-81 tolling is authorized by the General Assembly. The repayment of the $43 million also is included in the detailed analysis in FY 2027 and 2028.

Operations and Maintenance. While annual operations and maintenance spending for the I-81 corridor is not a part of this Plan, it is important to recognize that today the Virginia Department of Transportation spends an average of $48 million a year from its Maintenance Program budget (Program 604 in the Appropriation Act) for I-81 traffic and incident management, routine maintenance, guardrail repair, shoulder improvements and paving overlays, and other non-capacity building activities. As the I-81 capital improvements are completed, the Maintenance Program budget will absorb the operations and maintenance spending associated with them.

Regional Transportation Taxes

Two taxes have been examined as potential financing options for the Plan. These are the additional state motor vehicle fuels tax (2.1 percent at the wholesale distributor level) and sales and use tax (0.7 percent) that are currently imposed in two of the 21 Planning District Commissions as approved by the General Assembly. There is no statutory sunset or termination of these additional taxes and existing statute allows them to be enacted in additional planning districts if authorized by the General Assembly.

In 2014, the General Assembly established the Hampton Roads Transportation Accountability Commission in Planning District Commission 23, joining the Northern Virginia Transportation Authority in Planning District Commission 8, as two political subdivisions heavily involved in transportation project planning, financing, and prioritization in their respective regions.

The Hampton Roads Transportation Accountability Commission is empowered to procure, finance, build, and operate highway, bridge, and tunnel projects as well as impose tolls in Planning District 23 using the Hampton Roads Transportation Fund established by HB 2313 (2013). HB 2313 also established new funding sources including additional 0.7 percent retail sales and use tax and a 2.1 percent motor vehicle fuels tax applied at the wholesale level. The Hampton Roads Transportation Accountability Commission uses the Hampton Roads Transportation Fund monies and tolls to issue bonds (and make debt service payments) for construction projects on new or existing highways, bridges, and tunnels.

For the Northern Virginia Transportation Authority, in 2013, HB 2313 established the Northern Virginia Transportation Authority Fund. While the Northern Virginia Transportation Authority receives the additional 0.7 percent retail sales and use tax, the 2.1 percent motor vehicle fuels tax is collected on behalf of and used by the Northern Virginia Transportation Commission to fund transit in the region. For Northern Virginia, this additional motor vehicle fuels tax has been in place since 1981.

The Commonwealth imposes and collects the taxes for both the Hampton Roads Transportation Accountability Commission and the Northern Virginia Transportation Authority; therefore, the taxes are appropriated by the General Assembly and allocated by the Commonwealth Transportation Board to the Hampton Roads Transportation Accountability Commission and Northern Virginia Transportation Authority

funds. For FY 2019, the Commonwealth Transportation Board allocated tax revenues of $280.4 million to the Northern Virginia Transportation Authority and $191.1 million to the Hampton Roads Transportation Accountability Commission.

PDCs 3 through 7 include the I-81 corridor (see **Figure 15**). As shown in **Table 13**, these regional taxes are forecasted to generate a total of $165 million in the first year of collection. Forecasted revenue estimates by year can be found in **Appendix H**.

To forecast the potential tax revenues, certain assumptions were made. The first assumption was to base the forecast on the Commonwealth's December 2017 revenue estimate for 2018-2023, with annual growth assumptions for the next 5 years based on legislative updates during the 2018 General Assembly session and FY 2018 year-end actuals. These updates were presented to the House Appropriations and Senate Finance Committees in August 2018. For motor vehicle fuels tax, the average growth rate is 1.02 percent and for retail sales and use tax, 2 percent.

Figure 15. *Map of Planning Districts*

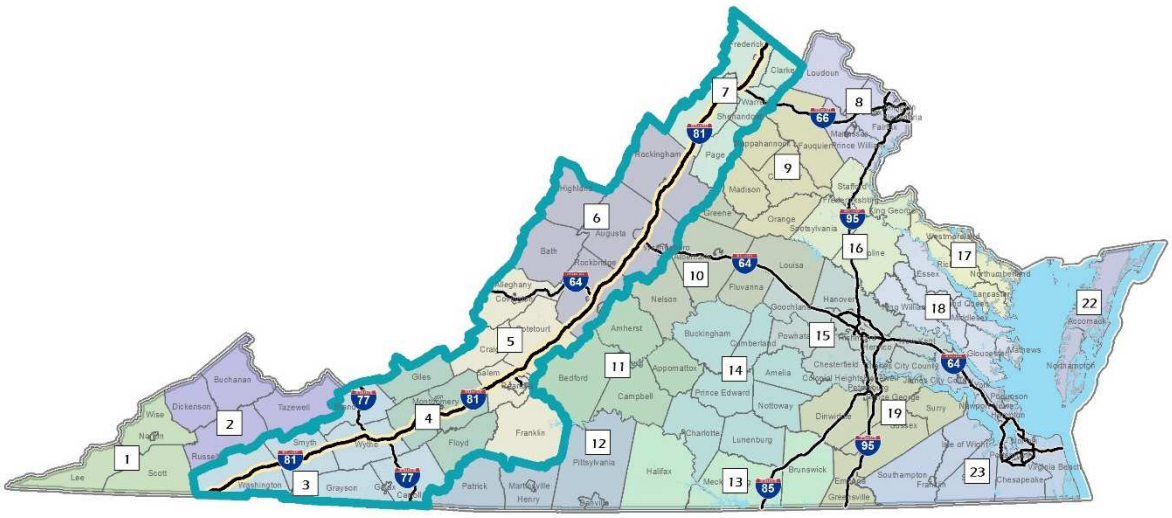


Table 13. *Regionally Imposed Tax Options for Plan Improvements (in millions)*

Tax Option	Rate	Estimated Annual Revenue Generated FY 2020	Estimated Annual Revenue Generated FY 2025	Code of Virginia Citation
Retail Sales and Use Tax	0.7%	$105	$116	§§ 58.1-603.1, 58.1-604.01, 58.1-604.1, 58.1-614
Motor Vehicle Fuels Tax	2.1%	$60	$63	§§ 58.1-2295, 58.1-2299.20

Beyond these first years, the Virginia Department of Transportation's Constrained Long-Range Plan revenue estimate growth rates were assumed. The Constrained Long-Range Plan is a federally required plan that outlines both available revenues and planned improvements for 20 years or more and incorporates projections from the Department of Taxation and Department of Motor Vehicles. For motor vehicle fuels tax, the assumed average annual growth rate was 0.46 percent through FY 2040 and 0.47 percent from FY

2041 through FY 2050. Beyond FY 2050, a 0.55 percent growth rate is assumed. For retail sales and use tax, a 2 percent annual growth rate is assumed throughout the forecast period.

Toll revenue bonds are 9c debt of the Commonwealth and therefore, are able to obtain the highest credit rating (i.e. Aaa/AAA/AAA) and thus gaining the lowest interest rates and requiring a lower debt service coverage test, as more fully described in the subsequent section of this report. A credit structure similar to the bonds issued by HRTAC is also assumed for this analysis and such credit is able to achieve a double-A rating. A double-A rated debt secured by regional taxes have a higher interest rate and require additional debt service coverage. As a result, in order to support a double-A rated debt with a higher coverage ratio, more regional tax revenues are needed to pay debt service compared to 9c debt service

Traffic growth, the location of toll gantries, and toll payment options are key assumptions in estimating toll revenues and subsequently toll financing. No toll rate increases beyond the initial toll rates have been assumed in this Plan for any of the tolling scenarios presented. A toll rate of 15 cents per mile has been assumed for trucks and with variable tolling, a nighttime toll rate of 7.5 cents per mile.

It is important to note there is no consistency among states regarding how they classify vehicles as commuters, autos, or trucks. Selected states that provide some clear guidance are summarized in .

State	*Auto*	*Truck*

Source: Maryland Transportation Authority; West Virginia, Pennsylvania, and Ohio Turnpike Authorities

Traffic growth assumptions drive toll revenue growth. For the Plan, auto traffic growth increases each year by 0.7 percent. For Trucks, the year-over-year growth rate is 1.7 percent. Truck growth is based on the Freight Analysis Framework which estimates commodity movements by truck over the corridor. The Freight Analysis Framework, produced through a partnership between the Bureau of Transportation Statistics and the Federal Highway Administration, integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. Starting with data from the 2012 Commodity Flow Survey and international trade data from the Census Bureau, the Freight Analysis Framework incorporates data from agriculture, extraction, utility, construction, service, and other sectors. Auto growth is based on the average historical pattern.

The potential toll gantry locations were selected by identifying appropriate locations between urbanized areas along the I-81 corridor, near the intersection of I-81 with other interstates, travel data, and a distance of at least 40 miles between gantries. In addition, toll gantries are located near major reconstruction and/or bridge improvement projects. This Plan assumes six gantry locations in each direction. While this Plan assumed six locations, prior to any tolling implementation additional analysis will be required once the parameters of any tolling authorization from the General Assembly and Federal Highway Administration are known.

Basis for Types of Tolling Considered. In accordance with §33.2-119 of the Code of Virginia, General Assembly approval is required prior to the imposition and collection of any toll for use of all or any portion of I-81. To comply with Chapter 743 in the development of this Plan, the assumption is that I-81 tolling has been approved. This approval includes the Commonwealth Transportation Board's compliance with §33.2-309 of the Code of Virginia which requires any imposition of tolls for use of the interstate system to be for the stated purpose of:

- Financing interstate construction and reconstruction
- Promoting efficiency
- Reducing traffic congestion
- Improving air quality

Furthermore, the Code requires any tolling to use high-speed automated toll collection technology that allows vehicles to travel through the toll facility without stopping to make payments. In other words, no toll booths will be constructed for I-81 toll collection.

Any tolling on I-81 must comply with federal requirements. The federal requirements are defined in four programs as shown in **Table 15**. Any I-81 tolling should qualify for three of the four tolling programs. While Chapter 743 stated that high occupancy toll lanes could be considered for this analysis, there are no existing high occupancy vehicle lanes on I-81 to use nor does the traffic levels warrant congestion pricing with a bifurcated roadway system as that used in Northern Virginia on I-495 and I-95. Therefore, this federal toll program is not appropriate for I-81. The federal Value Pricing Pilot Program best meets legislative intent, addresses the statutory goals, and focuses on safety and delay by incentivizing use I-81 during nighttime hours.

Toll Payment Options. The Commonwealth has long-standing experience with tolling and has been innovative in implementing new technologies and strategies that work for each toll facility. Virginia toll roads are part of the E-ZPass network which extends from Maine to Florida and as far west as Illinois. The E-ZPass open road technology allows a vehicle typically equipped with a transponder or similar technology to travel under a tolling gantry at or close to the speed limit, be identified as an E-ZPass customer, and have the appropriate toll deducted. Transponders and their supporting back room software systems can be programmed to charge the user a variable toll rate based on the time of day and many other combinations. It is assumed that if tolling is implemented on I-81, E-ZPass transponders will be the primary method of paying tolls.

In addition, this Plan assumes that each toll gantry will be equipped to capture license plate images of those vehicles that do not have another means of being identified for toll payment without having to stop and make a payment ("video tolling"). The process of identifying the vehicle and performing paper billing for a video toll have higher costs than an E-ZPass transponder transaction and it is assumed those processing costs will be passed on to the vehicle owner as a processing fee. North Carolina and Maryland toll roads use a combination of E-ZPass and video tolling. Both states have a higher toll rate for video tolling than E-ZPass tolling. The West Virginia Turnpike also has toll booths where a toll road user can pay a cash toll. The cash toll is higher than the West Virginia E-ZPass rate.

Table 15. *Federal Tolling Programs*

Program	Key Requirements	I-81 Corridor Qualify?
Value Pricing Pilot Program	Tolls may be imposed on existing toll-free highways, bridges, and tunnels so long as variable pricing is used to manage demand	Yes, implement nighttime and daytime toll rates to encourage more efficient use of 81 and reduce existing and future congestion
Interstate System Reconstruction and Rehabilitation Pilot Program	Convert existing interstate system into a toll facility in conjunction with needed reconstruction and rehabilitation that is only possible with the collection of tolls	Yes, on October 2, 2018 FHWA issued a solicitation for applications for three available slots in this program on a first-come, first serve basis
Section 129 (General Toll Program)	Initial construction of new lanes on highways, bridges, and tunnels and reconstruction, restoration, or rehabilitation of an interstate as long as number of toll-free lanes are not reduced	Yes, if toll gantries are near or on reconstructed or rehabilitated bridges
Section 166 (HOV/HOT Lanes)	Allow toll-paying vehicles that do not meet minimum occupancy standards to use HOV lanes	No, no existing HOV lanes

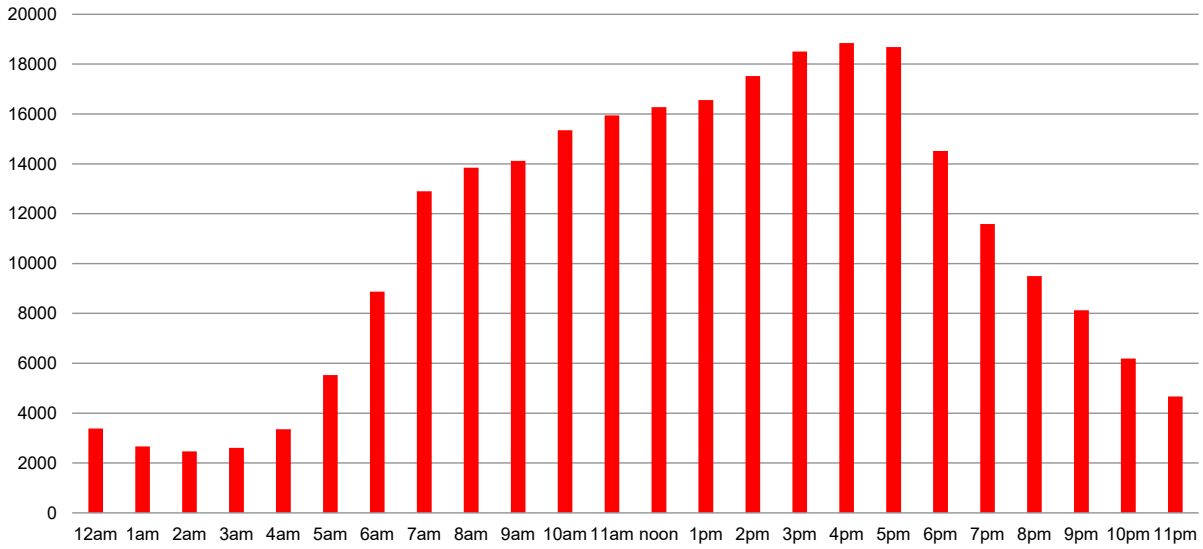
Toll Rates. One toll rate is assumed for both E-ZPass and video tolling in this Plan. As stated previously, tolling Option 4 was selected for evaluation since it was considered the most conservative tolling option—it generated the least revenue while still being able to fund the recommended $2.2 billion improvement package as shown in **Table 16**. Variable tolling between daytime and nighttime would meet the requirements for the Value Pricing Pilot Program.

Table 16. *Considered Toll Rate Options*

Toll Option Description	Truck Rate	Auto Rate	Variable	Auto Annual Pass
Trucks Only	15¢	NA	No	No
Trucks and Auto Non-Commuters	15¢	10¢	No	No
Variable Daytime and Nighttime* with Auto Non-Commuters	15¢ daytime 7.5¢ nighttime	10¢ daytime 5¢ nighttime	Yes	No
Variable Daytime and Nighttime* with Auto Annual Pass	15¢ daytime 7.5¢ nighttime	7.5¢ daytime 5¢ nighttime	Yes	$30

*For the purposes of this analysis, daytime tolling applies to the hours between 6:00 a.m. and 9:00 p.m. and nighttime tolling applies to the hours between 9:00 p.m. and 6:00 a.m. **Figure 16** shows time of day traffic volumes in the corridor.
NA = Not applicable

Figure 16. *I-81 Traffic by Time of Day During a 24-Hour Period**



*Time of Day studies at key locations throughout the corridor

Source: VDOT continuous traffic count stations

Some toll roads have "revenue maximization" as a goal; meaning that the highest toll rate that does not discourage use of the toll road is implemented. For this Plan, revenue maximization was not a goal. The analyses completed in several traffic and revenue studies suggests that a truck toll rate of up to 30¢ per mile would meet the goals in §33.2-309 of the Code of Virginia and maximize revenues. As shown in **Table 16**, the proposed truck toll rate is 15 cents per mile (and 7.5 cents per mile at nighttime) and an auto toll rate does not exceed two-thirds of the truck toll rate. **Table 17** outlines the toll rate setting goals and strategies for I-81.

For a truck travelling the 325-mile corridor, a 15 cents toll rate per mile would equate to $48.75 during the daytime and 7.5 cents per mile nighttime toll rate would equate to $24.38. Another comparison is that this tolling approach generates revenue equating to a statewide diesel tax of 11 percent compared to the current 6 percent—a 5 percent increase and the equivalent of 37 cents per gallon tax.

Based on the analyses conducted, almost all trucks using I-81 are Federal Highway Administration Class 8 or higher (see **Figure 6** for classifications). Cost responsibility studies and other pavement impact research concludes that one 5-axle truck impacts the infrastructure of an interstate the same as at least 5,600 passenger vehicles. The pavement cost of each 5-axle truck was estimated in 2008 to be 2.1 cents per mile per axle or $11,760 per truck. While cost impacts are greater, compared to surrounding states and tolling authorities, there is not as significant toll rate difference between autos and trucks as outlined in this Plan.

Table 17. *Toll Rate Setting Goals and Strategies for I-81*

<table>
<tr><th>Goal</th><th>Implementation Strategy</th></tr>
<tr><td>Financing construction and reconstruction</td><td>• Toll rates generate sufficient revenues to finance the I-81 Corridor Improvement Plan</td></tr>
<tr><td>Reduce traffic congestion</td><td>• Time of day variable tolling modifies driver behavior to encourage Truck off-hour usage
• Establish toll rates and other programs that discourage diversion</td></tr>
<tr><td>Promote efficiency</td><td>• Time of day variable tolling modifies driver behavior; toll collection is through multiple methods that require no stopping</td></tr>
<tr><td>Equity</td><td>• Toll rates will be the same no matter how the toll is paid (transponder or video toll)
• Use of video tolling will result in a processing fee because of higher collection costs</td></tr>
<tr><td>Federal approval</td><td>• Toll rate setting and implementation will comply with federal requirements</td></tr>
<tr><td>Consider current toll rates of peers/ surrounding entities – per mile toll rate</td><td>
<table>
<tr><th>Facility</th><th>Truck Toll (4-axle)</th><th>Auto Toll</th></tr>
<tr><td>West Virginia Turnpike</td><td>18¢</td><td>4.4¢</td></tr>
<tr><td>North Carolina Triangle Expressway</td><td>69¢</td><td>17¢</td></tr>
<tr><td>Pennsylvania Turnpike</td><td>22¢</td><td>10¢</td></tr>
<tr><td>Maryland I-95</td><td>73¢</td><td>11¢</td></tr>
</table>
These states vary toll rates based on method of payment; rates shown are for in-state E-ZPass transponders—the lowest toll rate available.
</td></tr>
</table>

Source: Maryland Transportation Authority, West Virginia, Pennsylvania, and North Carolina Turnpike Authorities

Proposed Auto Annual Pass Fee

A concept that has been explored is to allow autos to pay an annual fee for unlimited use of I-81 (the "Auto Annual Pass") instead of defining commuter now and having toll gantry locations change based on future direction and analyses. An auto would have the option to register for the pass at the Department of Motor Vehicles and receive a pre-programmed "I-81 Sticker" that would record the free passage electronically using technology like E-ZPass transponders. Stickers would not transfer between vehicles, so each vehicle would be registered as an auto to receive free passage on I-81. If an auto owner had an existing Virginia E-ZPass account, upon payment of the annual fee, the Virginia E-ZPass transponder would be programmed to record the annual fee payment, so no toll would be charged until the annual renewal date and no I-81 sticker would be required.

The Auto Annual Pass would be available to all autos, both those who could meet the definition of commuter and those autos who use the corridor for longer distances including the estimated 15 percent of autos that are from out of state. If the auto is not registered in the Auto Annual Pass program, it would pay the applicable full auto toll rate and be identified through its E-ZPass transponder or billed through video tolling, including the processing fee.

West Virginia, Pennsylvania, Maryland, and other states offer some type of toll discount programs for passenger vehicles. They also assume differing toll rates for E-ZPass, video tolling, and/or cash for passenger vehicles and trucks in some cases. Examples of these various discount programs are shown in **Table 18**.

State Debt and Federal Financing Options

As stated previously, the Plan requires $2.2 billion in funding for improvements, which includes $2.0 billion for capital improvements and $200 million for operational improvements and other initiatives as well as the operations and maintenance costs of the operational improvements.

A key consideration in debt financing for this Plan is ensuring that the issued debt does not impact the Commonwealth's debt capacity; such that the ability to issue bonds supported by Commonwealth revenues (General Fund, transportation funds, and so forth) will not be reduced because of any bonds issued for I-81 improvements.

Issue Toll Revenue Bonds. The Commonwealth has had the distinction of being one of a handful of states that has a Triple-A bond rating, held since 1938. The Triple-A bond rating allows the state's agencies and authorities to borrow prudently from the bond capital markets at the lowest interest rates. A part of Virginia's success in maintaining this rating is the State's Debt Capacity Advisory Committee, comprised of legislative and executive leadership, who annually review the Commonwealth's tax-supported debt and advises the Governor and General Assembly on the maximum amount of new tax-supported debt that can be authorized and issued for the next two years. In December 2017, the Committee estimated that up to $580 million in FY 2018 and FY 2019 could be authorized and issued for higher education, parks, transportation, and public safety among others.

Projects financed with tolls do not impact the state's debt capacity because they must generate enough revenue to be self-sufficient—pay all their debt service and associated costs. These bonds are considered general obligation bonds pursuant to Article X, **Section 9**(c) of the Constitution of Virginia ("9c bonds"). These bonds do not require voter approval but do require a two-thirds majority approval by each house of the General Assembly. Because the bonds have a general obligation ("GO") pledge of all Commonwealth revenues, the General Assembly approved debt authorization requires the Governor to opine that net project revenues will be sufficient to pay the debt service on the bonds. Therefore, the bond indentures for any Virginia Department of Transportation-owned toll facilities require the Commonwealth Transportation Board to set toll rates for all classes of vehicles which will provide sufficient revenues to meet its obligations. Because of this strong commitment, the Commonwealth's toll revenue bonds are rated Aaa/AAA/AAA resulting in the lowest interest rates for long-term borrowing.

Table 18. *Examples of Toll Discount Programs in Other States*

State	Program Name	Description
West Virginia Autos	Single Fee Discount Plan Flat Rate Discount Program	➡ Limited to private passenger vehicles (passenger cars, pickup trucks, motorcycles, and passenger vans under 7'6") ➡ $24 fee for 3-year unlimited use if enrolled prior to January 1, 2019 plus $13 transponder fee. The 3-year period ends December 31, 2021 ➡ After January 1, 2019, it's a $25 annual fee for unlimited use plus $13 transponder fee ➡ Revised program was put in place following the Turnpike Authority's decision to double toll rates in the corridor to support asset management and West Virginia's Roads to Prosperity Program. The prior program included an annual fee of $285 for unlimited use of the turnpike
West Virginia Trucks	Commercial Discount Plans	➡ Discount for commercial trucks (2-axle or higher) will be charged an E-ZPass toll rate instead of the cash rate. Requires a West Virginia E-ZPass transponder for the lowest of the E-ZPass toll rate
Maine	E-Z Discount Program and Flat Rate Discount Program	➡ Limited to Maine E-ZPass transponder account holders with up to a 50 percent discount off total monthly fare when taking 40 or more one-way trips. For 30-39 one-way trips, it's a 25 percent discount
Pennsylvania	E-ZPass Discount Program Commercial Truck Volume Discount	➡ Commercial vehicles can earn a 3 percent discount if the amount of monthly tolls is $20,000 and over ➡ Commercial vehicles include Class 1 passenger vehicles if for business purposes and most motor homes; must have annual usage of $5,000 and a surety bond to participate in the volume discount program but can only receive discount if more than $20,000. Monthly charges must be paid by 24th of the month to receive discount
Rhode Island	E-ZPass Resident Plan and Gross Vehicle Weight Plan E-ZPass Unlimited Plan Frequent User Plan	➡ All plans require a Rhode Island Turnpike and Bridge Authority E-ZPass transponder. For a 2-axle vehicle discount, the vehicle must weigh less than 7,000 pounds with no trailer. The Resident Plan toll rate is 8.3¢. Gross Vehicle Weight Plan is for a 2-axle resident passenger with vehicle weight 7,001 to 8,000 lbs. Rate is 8.3¢ ➡ Unlimited Plan toll rate is $40 every 30 days for the New-Port/Pell Bridge—no residency requirement ➡ Frequent User Plan is $5.46 for six crossings; for non-residents only in a 30-day period

Table 18. *Examples of Toll Discount Programs in Other States* (*continued*)

State	Program Name	Description
Rhode Island	RhodeWorks Bridge Tolling Program	➡ Tolls only classes 8-13 tractor trailers as defined in 23 CFR 658.5 pulling a trailer or trailers. Tolls collected are used to repair the bridge or bridge group associated with that location ➡ Plans call for tolls to be collected along six major highway corridors at 12 locations. Currently, tolls have been imposed at two locations on I-95. Tolls will vary from $2.00 to $9.50. ➡ For those with E-ZPass, tolls are limited to once per day, per direction, and a cap of $20 for a through-trip on I-95 and a daily cap of $40 per day no matter how many toll gantries a tractor trailer goes through or on what highway

Based on the analyses completed to date, toll options 2-4 shown in **Table 16** are forecasted to generate sufficient revenues to finance $2 billion in improvements with 9c bonds with repayment over 35 years. For purposes of the Plan, toll Option 4 was selected and used to develop the detailed debt scenario included in the **Appendix J**. Toll rate Option 4 is variable daytime and nighttime tolling with a $30 Auto Annual Pass. The toll rates are:

- Trucks – 15 cents per mile daytime and 7.5 cents per mile nighttime
- Autos – 7.5 cents per mile daytime and 5 cents per mile nighttime.

This Plan assumes the General Assembly will authorize the toll revenue debt for a term not to exceed 39 years and provide flexibility for multiple debt issues.

Authorize Regional Tax-Supported Bonds. With the authorization of any additional tax in a region, the General Assembly will establish a regional fund into which the revenues will be deposited. In Northern Virginia and Hampton Roads, legislation also established transportation authorities to manage the regional fund and other related powers to issue debt and provide other means of financing transportation projects. The assumption is that the General Assembly would take similar actions for the I-81 corridor and establish a regional transportation authority encompassing Planning District Commissions 3 through 7 along with the imposition of the additional motor vehicle fuels and retail sale and use taxes.

These taxes are expected to generate sufficient revenues to finance the $2.2 billion in improvements. Based on the debt issuance experience of both the Hampton Roads Transportation Accountability Commission and Northern Virginia Transportation Authority, the debt issued is expected to have a strong credit rating as well—two notches below the toll revenue bonds: Aa2/AA/AA. The bonds would have no impact on the Commonwealth's debt capacity nor would they impact any locality in the region's debt capacity or bond ratings.

Because the Commonwealth would collect the taxes, the revenue is annually appropriated by the General Assembly and the Commonwealth Transportation Board allocates the revenue to the regional authority into a non-reverting fund. For purposes of any debt issue, the revenues and fund are considered pledged revenues.

Consider Federal Transportation Financing Program. The federal Transportation Infrastructure Finance and Innovation Act was established to leverage federal resources for transportation infrastructure by providing direct loans, loan guarantees, and standby lines of credit to projects of national and regional significance. Projects in Virginia that have received Transportation Infrastructure Finance and Innovation Act loans include Transform 66 – Outside the Beltway, Dulles Corridor Metrorail, 495 Express Lanes, 95 Express Lanes, Downtown/Midtown Tunnels, and Pocahontas Parkway in the Richmond area.

Transportation Infrastructure Finance and Innovation Act loans can be an attractive financing method because it can delay the repayment of a portion of the loan for up to 5 years after the construction of a project is complete, allowing the project's revenue source to stabilize. In addition, Transportation Infrastructure Finance and Innovation Act loan repayments can be "sculpted" so that the debt service payments are lower in the early years. Traditionally, state debt issuances have level debt service payments—meaning the payment is the same each year. The Commonwealth, the regional authority, or a private entity can apply for a Transportation Infrastructure Finance and Innovation Act loan. The Commonwealth cannot apply without General Assembly authorization to do so.

Transportation Infrastructure Finance and Innovation Act loans are traditionally limited to 33 percent of the reasonably anticipated eligible project costs—or approximately $670 million. To be approved for Transportation Infrastructure Finance and Innovation Act financing, the project must have pledged, dedicated revenue source(s), meet applicable federal requirements, and have at least two investment grade ratings. This Plan assumes that a $650 million Transportation Infrastructure Finance and Innovation Act loan is secured in FY 2021 and repayment begins in FY 2025. Based on current interest rate information for Transportation Infrastructure Finance and Innovation Act loans, 9c debt, and regional debt the Transportation Infrastructure Finance and Innovation Act loan has a lower borrowing rate of almost 1/2 percent.

Federal law does allow some flexibility in Transportation Infrastructure Finance and Innovation Act loan parameters including lifting the limitation from 33 percent to up to 49 percent of the reasonably anticipated eligible project costs for projects in rural areas with a cost of between $10 and $75 million. This provision also gives flexibility to the interest rate that must be paid. If the Plan is approved, the study team will explore whether any of the I-81 Corridor Improvement Plan qualifies for this flexibility and its potential use.

Apply for Federal Discretionary Grant Opportunities. There are two federal grant opportunities that could provide funding to the Plan. The first opportunity, the Nationally Significant Freight and Highway Projects (INFRA) program, is a multiyear grant program to fund critical freight and highway projects. For individual projects (not an entire corridor), up to 60 percent of the total project cost can be covered by the discretionary program. The second opportunity, the Better Utilizing Investments to Leverage Development (BUILD) grants, provides capital funding to projects that are difficult to fund through traditional federal programs. BUILD is intended to support innovative projects and generate economic development and improve access to reliable, safe, and affordable transportation. As of November 2018, project applications are not being accepted for either grant opportunity.

I-81 Corridor Improvement Plan Financing Summary

Shown in **Table 19** is a summary of the sources and uses of the variable toll financing with an Auto Annual Pass fee option (Option 4) and a regional financing option. This summary outlines the first 10 years of the Plan. Additional information can be found in **Appendix H**.

Table 19. *Summary of I-81 Corridor Improvement Plan Financing Options (in millions, rounded)*

Toll Financing with Variable Tolling and Auto Annual Pass (Option 4)				
Toll Revenues	$72.9*	$634.8	$857.9	$1,565.6
Bond Proceeds	-	$1,343.8	$206.0	$1,549.8
TFRA	$43.0**	-	-	$43.0
Capital Improvements	-	$1,228.7	$765.0	$1,994.0
Tolling Infrastructure and TFRA Repayment	$43.0	-	$43.0	$86.0
Immediate Operational, Task Forces, Multi-Modal Improvements	$39.3	$115.2	$45.5	$200.0
O&M***	$11.2	$67.0	$93.0	$171.2
Debt Service and Transaction Costs	-	$66.9	$391.5	$458.4
Unallocated Reserved Revenue	$22.3	$85.4	$141.1	$248.8

Regional Tax Financing — Motor Vehicle Fuels and Retail Sales and Use Taxes				
Taxes	$165.2	$689.0	$921.7	$1,775.8
Bond Proceeds	-	$1,343.9	$206.1	$1,550.0
Capital Improvements	-	$1,228.7	$765.3	$1,994.0
Immediate Operational, Task Forces, Multi-Modal Improvements	$39.3	$115.2	$45.5	$200.0
O&M****	$9.4	$39.9	$55.6	$104.9
Debt Service and Transaction Costs	-	$68.8	$389.8	$458.6
Unallocated Reserved Revenue	$116.5	$164.8	$287.0	$568.3

*Assumes tolling begins January 2020 – second half of FY 2020
**Toll Facilities Revolving Account requires repayment
***O&M includes operational improvements and tolling
****O&M includes operational improvements and tax collection

9. Economic Impact Analysis

Chapter 743 directs that the Plan will "assess the potential economic impacts on Virginia agriculture, manufacturing, and logistics sector companies utilizing the I-81 corridor from tolling only heavy commercial trucks." The following overview summarizes the methodology used to develop the Economic Impact Analysis for the Plan. The economic impacts estimated using this methodology are the result of the direct effects generated by changes to the transportation costs experienced by trucks along I-81 and internalized by trucking companies as a result of both the deployment of the improvements along the entire corridor and the introduction of tolling for trucks on this interstate. These impacts were calculated using IMPLAN (I/O model) multipliers, which is an industry standard tool that analyzes extensive databases concerning economic factors, multipliers, and demographic statistics. The detailed economic impact analysis is in **Appendix M**.

Economic Impact Analysis Results for I-81 from Changes to Transportation Costs

The Economic Impact Analysis was conducted on the $2.2 billion package of improvements to the I-81 corridor. Additionally, the tolls were assumed to be a 15 cents per mile truck toll. The final results are shown in **Table 20**.

Table 20. *Economic Impact Analysis Final Results (in millions)*

Share of Transportation Cost Reduction Accruing in Virginia	Share of Toll Impacting Virginia	Net Reduction in Truck Transportation Cost ($2017)
$3,419	$2,303	$1,116

The Economic Impact Analysis methodology used in this study uses the direct effect (or change) on internalized truck transportation costs that result from the improvements proposed along I-81 and from the introduction of the toll for trucks as its main input. To estimate the direct effect (or change) on internalized truck transportation costs, the methodology combines inputs generated from a corridor-wide Benefit-Cost Analysis,[1] several matrices from the Transportation Satellite Accounts,[2] and socio-economic information from the Bureau of Labor and Statistics for the Commonwealth of Virginia.

Once the direct effect (or change) on internalized truck transportation costs is determined, employment, direct output impact, and direct earning impacts are calculated using economic multipliers from a commercially-available input-output model.[3] The result is the calculation of the direct, indirect, and induced effects of the change on internalized truck transportation costs on the following impact metrics: output, value added, labor income, and employment.[4]

The calculated impacts are identified for the logistics, manufacturing, and agriculture sectors in Virginia. The impact on the Virginia economy also is calculated.

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1 The methodology to conduct the Benefit-Cost Analysis is reported separately.

2 Transportation Satellite Accounts were developed by the Bureau of Transportation Statistics of the US Department of Transportation and the Bureau of Economic Analysis of the US Department of Commerce. The TSAs measure the contribution of both for-hire and in-house transportation. (https://www.bts.gov/satellite-accounts)

3 The I-O model used in this study is the one created by the IMPLAN® system (http://www.implan.com/), which is standard for the industry and is widely used to conduct EIAs.

4 Multipliers, expressed as a rate of change, describe how for a given change in a particular industry a resultant change will occur in the overall economy.

Step 1: Estimation of trucking net change in transportation costs from improvements and tolling

The first piece of the analysis consisted of estimating the net reduction to trucking companies' costs resulting from the future planned improvements on I-81. This involved estimating the reduction in their pecuniary costs due to the capital and operational improvements and netting that from the toll amount the trucks would have to pay to use I-81. This was done through a corridor-wide Benefit-Cost Analysis using travel demand model results provided by the Virginia Department of Transportation and the relevant benefit categories. The resulting cost reductions estimated by the Benefit-Cost Analysis were then summed to estimate the total reduction in trucking costs due to the capital and operational improvements, which are as follows:

1. Truck travel time savings due to capital improvements
2. Truck travel time savings due to operational improvements (faster removal of crashes
3. Truck travel time savings due to reduced delays resulting from fewer accidents
4. Reduction in vehicle operating costs (including fuel) due to capital improvements (faster removal of crashes)
5. Reduction in vehicle operating costs (including fuel) due to reduced delays because of faster removal of crashes
6. Reduction in vehicle operating costs (including fuel) due to reduced delays because of fewer crashes
7. Reduction in monetary cost of crashes due to capital improvements

These reductions in trucking costs were estimated for the 2025-2044 period using a Benefit-Cost Analysis framework. The framework assumes all capital and operational improvements are deployed by year 2030. However, since tolling on I-81 is assumed to begin in 2020 and continue beyond 2044, the trucking cost reductions were extrapolated from the Benefit-Cost Analysis framework to cover a 40-year period of analysis, spanning from 2020 until 2060. The trucking cost reductions are expressed in 2017 dollars.

For the final Economic Impact Analysis, toll Option 4 shown in **Table 16**, is used with a 15 cents per mile daytime truck toll rate and 7.5 cents per mile nighttime truck toll rate. Any truck toll is an increase in the transportation costs for the trucks using I-81; therefore, the reduction in the previously described truck transportation costs should be netted out of the increase in truck transportation cost resulting in a net change to these costs due to the improvements and the introduction of tolling.

The Economic Impact Analysis then focused on the impacts of the changes in truck transportation costs to industries located in Virginia. Therefore, the change in truck transportation costs were estimated only for those trucks that move goods into or out of Virginia. Using information from Transearch, a comprehensive US and cross-border freight database developed by IHS Markit, the reduction in truck transportation costs for trucks that move goods into or out of Virginia corresponds to 40 percent of the total reduction in truck transportation costs estimated in this step. Similarly, toll revenue that accrues to truck trips originating or ending in Virginia corresponds to 30 percent of the truck toll revenues used in this step. In-state trucks are expected to pay less in toll revenue due to shorter distances traveled on the I-81 corridor versus long-haul truck trips.

Based on the aforementioned measures, throughout the 40-year span of the analysis, the net reduction in truck transportation costs for trucks that serve industries in Virginia is approximately $1.1 billion. The transportation cost reduction is higher than the toll cost by a factor of 1.49 , which is described in more detail in **Appendix H**.

Step 2: Transform the net change in transportation costs into direct impacts to relevant industries

The Economic Impact Analysis involves the estimation of three types of effect, commonly referred to as direct effect, indirect effect, and induced effect.

- **Direct effect:** Refers to the economic activity occurring because of direct spending or hiring by businesses or agencies located in the study area (e.g., number of people employed in industries such as logistics, manufacturing, and agriculture that are affected by improvements and tolling along I-81)
- **Indirect effect:** Refers to the economic activity resulting from purchases by local firms who are the suppliers to the directly affected businesses or agencies (e.g., spending by suppliers of industries such as logistics, manufacturing, and agriculture that are affected by improvements and tolling along I-81)
- **Induced effect:** Represents the increase in economic activity, over and above the direct and indirect effects, associated with increased labor income that accrue to workers (of industries such as logistics, manufacturing, and agriculture that are affected by improvements and tolling along I-81 and all their suppliers, in this case) and is spent on household goods and services purchased from businesses within the impact area

These effects are summed to create the total economic impact. Indirect and induced effects are sometimes referred to as multiplier effects since they can make the total economic impact substantially larger than the direct effect alone.

The multipliers are used in conjunction with the economic impact categories discussed in the previous section to calculate the effects described in this section. The multipliers are generated by the IMPLAN® software program. The multipliers are sector-specific and can be found for direct, indirect, induced, and total impacts.

Step 3: Transform the direct impacts into economic impacts

Once it was identified how each industry sector would react to the reduction in transportation costs (i.e., once the direct impact was estimated for each industry), IMPLAN multipliers were used to determine how do those direct impacts "trickle down" through the economy and what additional output, value added, employment, and labor income are generated by them.

Typically, economic impacts are measured in terms of industry output, value added, and employment. While output is the broadest measure of economic activity and refers to the total volume of sales, value added is the value a company adds to a product or service. Value added is measured as the difference between the amount a company spends to acquire its inputs and the value of its goods at the time they are sold to other users. Therefore, value added can be thought of as a measure of the contribution to the gross domestic product made by an establishment or an industry. The total value added within a region is equivalent to the gross regional product and includes employee compensation, proprietary income, other property type income (e.g., rents received on property), and indirect business taxes (e.g., sales tax).

: broadest measure, refers to total volume of sales

: measured as the difference between the amount a company spends to acquire inputs and value of its goods at the time they are sold

: includes labor income (employee compensation and proprietary income) and jobs (number of jobs created in a year, expressed as job-years)

With respect to employment, two impact metrics are calculated: labor income and jobs. Labor income includes employee compensation and proprietary income. Employee compensation consists of wage and salary payments as well as benefits (health, retirement, etc.) and employer paid payroll taxes (employer side of social security, unemployment taxes, etc.). Proprietary income consists of payments received by self-employed individuals (such as doctors and lawyers) and unincorporated business owners. The job impact indicator measures the number of jobs created for a full year. These impacts should not be interpreted as full-time equivalent as they reflect the mix of full- and part-time jobs that is typical for each industry. They also should not be interpreted as permanent jobs either, but rather as job-years. A job-year can be defined as one person employed for one year, whether part-time or full-time.

For each measure, the multipliers estimate direct, indirect, induced, and total impacts. The results of the Economic Impact Analysis are presented in **Table 21** for each industry (logistics, manufacturing, and agriculture) and for the entire Virginia economy, expressed in 2017 dollars (in millions for the values in dollars).

Table 21. *Estimated Economic Impacts*

Logistics				
Output	$7.46	$3.65	$3.13	$14.2
Value added	$3.30	$2.15	$1.84	$7.3
Labor income	$2.70	$1.34	$1.01	$5.0
Employment	53.9	22.0	21.9	97.8
Manufacturing				
Output	$218.82	$64.55	$42.93	$326.3
Value added	$78.30	$34.63	$25.25	$138.2
Labor income	$33.12	$21.92	$13.79	$68.8
Employment	466.4	332.2	299.7	1,098.3
Agriculture				
Output	$12.85	$4.51	$2.81	$20.2
Value added	$4.35	$2.29	$1.65	$8.3
Labor income	$2.43	$1.22	$0.90	$4.6
Employment	159.9	29.7	19.6	209.2
All Sectors (Economy-Wide)				
Output	$968.12	$343.88	$385.36	$1,697.4
Value added	$582.59	$206.94	$231.90	$1,021.4
Labor income	$359.99	$127.87	$143.29	$631.2
Employment	5,893.7	2,093.5	2,346.0	10,333.1

It is expected that throughout the 40-year period the total output of all industries across Virginia will increase by approximately $1.7 billion because of the net truck transportation cost reductions realized from the Plan (i.e., compared to a situation where neither improvements nor tolling occur). The $1.7 billion represents the multiplicative effect that the reduced truck transportation costs of $1.1 billion have on Virginia's economy. However, the additional economic output in the order of $1.7 billion does not mean that all the industries located in Virginia will benefit by that same amount. When the $1.7 billion of estimated state-wide output increase was apportioned to the different industries located in the Commonwealth, it was estimated that approximately $326.3 million correspond to output increases in the manufacturing sector, $14.2 million to the logistics sector, and $20.2 million to agriculture (the remaining amount is spread out across all other industries located in Virginia).

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10. Ongoing Initiatives

During the development of the Plan, a few key issues requiring extensive coordination with external parties were highlighted by public feedback and direction from the Commonwealth Transportation Board. These issues included: truck parking, speed enforcement, and multimodal improvements. Given the need for continuing coordination and advancement of strategies, recommendations include the establishment of two task forces that would meet regularly to identify and address needs in the corridor. As part of this plan, $157 million has been set aside in the first 7-10 years to fund the results of these efforts.

Truck Parking

The I-81 corridor is heavily used as a long-haul route for the movement of goods. Due to the length of the corridor within the Commonwealth, truck drivers often stop for gas and long-term parking. To comply with the federal hours of service regulations, truck drivers must park their vehicles and rest at certain intervals to ensure they are not driving while fatigued. When adequate truck parking is not available, drivers continue to drive or park in non-designated areas such as highway shoulders, interchange ramps, shopping centers, or vacant lots. These options are not a safe choice. A truck parking evaluation, performed as part of the Plan, identified a 950-truck-parking space deficiency (see **Appendix I** for the I-81 Truck Parking Study).

Recommended in the Plan is the creation of an I-81 corridor truck parking task force comprised of members representing the Virginia Department of Transportation, Department of Motor Vehicles, private travel center owners, economic development authorities, trucking associations, and representatives from local and regional governments and planning agencies. The purpose of the task force would be to:

- Identify site-specific issues and overcome obstacles to parking development
- Investigate opportunities to fund the expansion of public and private truck parking facilities in targeted locations
- Develop a truck parking information system for public rest areas initially and examine opportunities to partner with the private sector
- Implement mobile technology to assist truck drivers with finding available and reserved parking

Speed Enforcement

A theme that emerged during the public outreach process was an overall lack of speed enforcement on the I-81 corridor. Many comments focused on the northern end of the corridor needing additional speed enforcement. During the August public meetings, comments were specifically sought on reducing the posted speed and support for additional speed enforcement on I-81. While only 43 percent of respondents supported reducing the speed limit, more than 70 percent of respondents indicated that they would support additional speed enforcement.

Recommended in the Plan is the establishment of an I-81 corridor speed enforcement task force comprised of members representing the Commonwealth Transportation Board, Department of State Police, and local law enforcement to determine strategies for enhanced speed enforcement. The task force would examine differences in current speed enforcement practices and evaluate technological solutions to assist in those practices.

Multimodal Improvements

Another theme that emerged from the public outreach process was the need to invest in multimodal improvements benefitting the I-81 corridor. To fully develop the multimodal capital improvements a cooperative process involving railroad industry, Amtrak, local governments, intercity bus operators, and regional planning bodies is necessary. Over the coming months, the Office of Intermodal Planning and Investment and Virginia Department of Rail and Public Transportation will undertake this process which will refine and fully develop the specific multimodal improvements that will be funded by the plan. The Plan includes potential multimodal improvements as laid out in each of the areas below – increased passenger rail service, intercity bus service and freight rail improvements.

Norfolk Southern operates the Crescent Corridor, its primary north-south rail route, which generally parallels I-81 and US 29. As shown in **Figure 17**, rail moves more than 70 million tons of freight annually on lines that parallel and complement the I-81 highway corridor—equal to approximately 3.4 million individual truck shipments.

Figure 17. *Corridor Freight Flows by Rail*

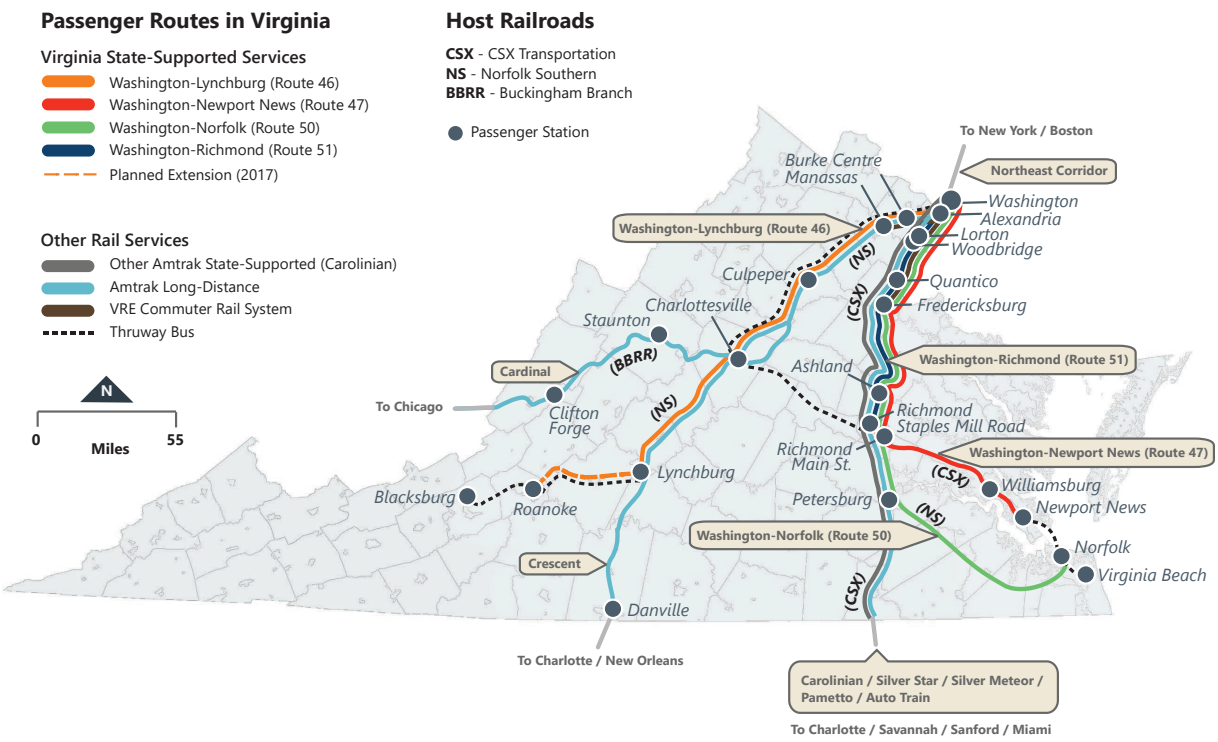
The Crescent Corridor provides intermodal and merchandise freight service between the southeast and northeast markets, including service to Virginia's Inland Port at Front Royal. Virginia's Inland Port is an intermodal facility that transfers containers brought by rail from the Port of Virginia to trucks or new trains to reach their final destinations. The Heartland Corridor is the primary east-west route for Norfolk Southern, generally paralleling US 460, and is the primary east-west intermodal train corridor connecting the Port of Virginia to major markets in the Midwest.

CSX Transportation-owned tracks cross the I-81 corridor south of Lexington along its Coal Network Corridor. This is CSX Transportation's primary east-west route from the coalfields of West Virginia to Newport News, running along the James River for most of its route. CSX Transportation's Shenandoah Subdivision operates in Frederick County north and south through the town of Winchester and up to West Virginia.

In the Shenandoah Valley between the areas of Staunton and Winchester, shortline railroads Chesapeake and Western, Shenandoah Valley Railroad, and Winchester and Western Railroad provide last-mile connections for mainly agricultural goods from Norfolk Southern's Crescent Corridor and CSX Transportation's Shenandoah Subdivision.

Regular passenger rail service has recently returned to the I-81 corridor as shown in **Figure 18**. Roanoke is the southern terminus for daily round trip Amtrak Northeast Corridor service that stops in Lynchburg, Charlottesville, Culpeper, Manassas, and Alexandria and on to Washington, D.C., New York, and Boston. Amtrak also provides long-distance service to Staunton and Clifton Forge three times per week on the New York to Chicago Cardinal route.

Figure 18. *Current Passenger Rail Service*



Commonwealth Investments in the Rail Network

In accordance with law and Commonwealth Transportation Board direction, the Virginia Department of Rail and Public Transportation partners with railroads on infrastructure improvements that promote a balanced transportation system, facilitate freight and passenger movement, and connect to businesses shipping goods by rail.

Since 2006, the Commonwealth Transpotation Board has allocated approximately $200 million to various Norfolk Southern rail improvements in the I-81 corridor. The $200 million investment includes:

- $70.1M in Rail Enhancement projects that is used by the Class 1 railroads
- $9.3M in Rail Preservation projects for state of good repair along shortline railroads
- $12.3M in Rail Industrial Access projects which connects businesses to the rail network along Class 1 and shortline railroads
- $100M in IPROC funds for passenger rail improvements
- $3.6M in AMTRAK operating support

These investments increase capacity and network reliability, and include multiple sidings and double track projects, bridge and tunnel improvements for double stack clearance, and multiple crossovers for increased network fluidity. The Commonwealth Transportation Board allocations were spent in conjunction with Norfolk Southern's $2.5 billion, 11-state Crescent Corridor improvement project, and provides dual benefit for freight and passenger rail service.

The Commonwealth Transportation Board's $200 million investment also helped to reduce emissions and costs that stem from accidents, congestion, and pavement maintenance. Through benefit cost analysis, the Virginia Department of Rail and Public Transportation calculated an annual economic benefit to Virginia of $1.2 billion, saving nearly $34 million in annual pavement maintenance costs.

Approximately $100 million of the investment paid for infrastructure for freight capacity which in turn made it possible for passenger trains to run on the same tracks. This led to restoration of Amtrak service to Roanoke for the first time in four decades. Passenger service returned to Roanoke in October of 2017 as an extension of Amtrak Route 46 and attracted more than 200,000 riders in its first year. The Commonwealth supports operating and equipment capital costs of approximately $11 million annually for this service. Ticket revenue for fiscal year 2018 was more than $14 million.

The Commonwealth Transportation Board continues to invest in the rail network in the I-81 corridor through the Rail Enhancement Fund Program. Projects undertaken using Rail Enhancement Funds are required to create public benefits in Virginia that exceed the investment from the fund and are monitored for performance for 3 years post-construction. Norfolk Southern reported a total of 641,665 rail carloads in 2017 as part of the Rail Enhancement Fund performance monitoring requirement for two recently completed projects. Looking ahead, Norfolk Southern's Equilateral Switch Replacement Project (various locations in the corridor) is currently programmed for construction using Rail Enhancement Funds. Together, these Rail Enhancement Fund projects improve capacity and network fluidity in the corridor.

Shortline railroads provide the first and last mile of service between industries and the Class 1 railroads. The Commonwealth Transportation Board's investment in the shortline network through the Rail Enhancement Fund supports state of good repair and economic development for the Commonwealth's shortline railroads and the rural areas they serve. The shortlines along the I-81 corridor reported a total of 14,187 rail carloads for FY 2018 as a part of the Rail Enhancement Fund performance monitoring requirement.

Future Rail Investment Opportunities

The Commonwealth's statewide rail plan has identified several opportunities for expanded freight and passenger rail in the region (**http://www.drpt.virginia.gov/rail/reference-materials/virginia-state-rail-plan/**). The rail plan has identified opportunities for passenger rail expansions in the I-81 corridor, including extending Roanoke service south to the New River Valley. However, due to Norfolk Southern freight congestion issues outside of Virginia on the same tracks shared by passenger trains, the timing and ability to expand passenger service is unknown. This Plan assumes that beginning in FY 2023 through FY 2030, more than $8 million annually will be available for expanded passenger rail and intercity bus services.

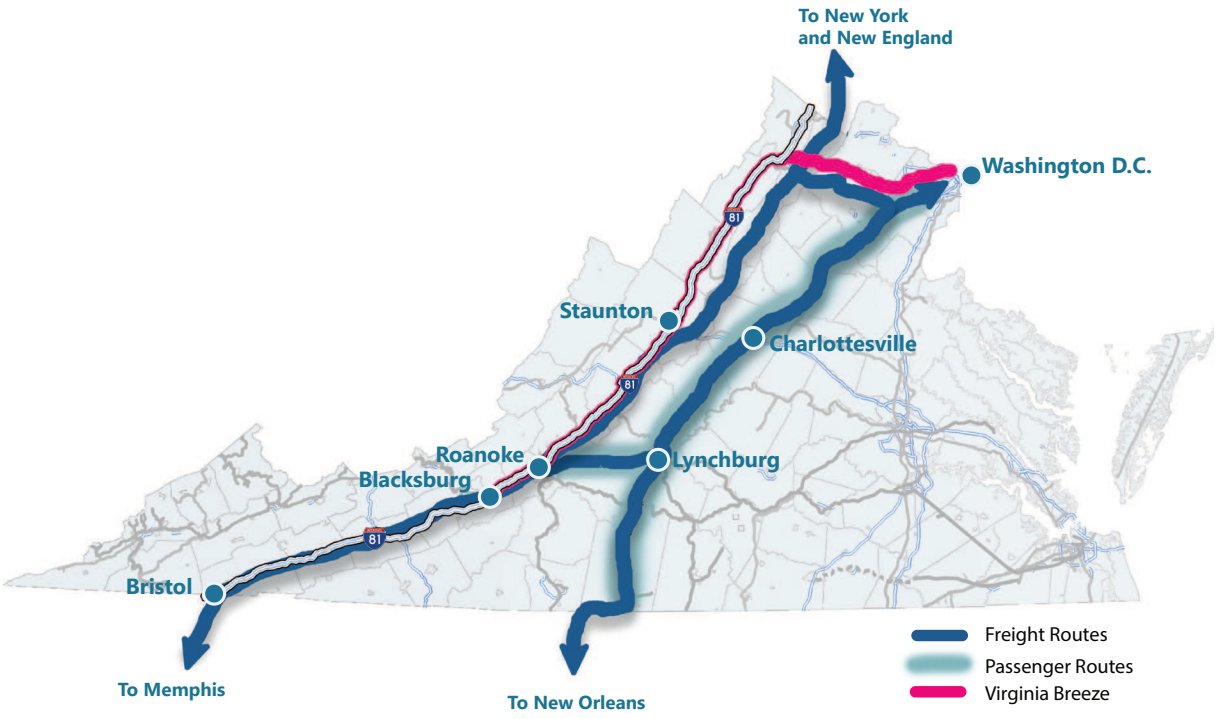
While not in the I-81 corridor, the top priority rail project in Virginia—expanding the Long Bridge over the Potomac River—will help to fix the freight and passenger rail bottleneck that constrains future rail services throughout the Commonwealth. Expanding the bridge will be required to add more passenger trains in the I-81 corridor and more Virginia Railway Express (VRE) trains along the Manassas VRE line. Virginia is working with the Federal Railroad Administration, Washington, D.C. Department of Transportation, and VRE to complete the environmental process and funding is secured for design and early phases of construction. The Commonwealth will continue to seek projects of mutual benefit to freight and passenger rail and strive to identify those projects in partnership with host railroads.

Virginia Breeze Intercity Bus Service

The Virginia Breeze intercity bus service provides a critical transportation connection for rural Virginia communities and universities along the I-81 corridor. Daily service between Blacksburg and Union Station in Washington, D.C. as shown in **Figure 19** started in December 2017. There are several stops in the New River Valley, Shenandoah Valley, and Northern Virginia including Christiansburg, Lexington, Staunton, Harrisonburg, Front Royal, Dulles Airport, and Arlington. It connects to the national bus, airline, and rail networks as well as regional transit networks like the Washington Metropolitan Area Transit Authority Metrorail.

The Virginia Breeze is funded through the Federal Transit Administration's 5311 Intercity Bus Program, and ticket revenues. Additional weekend service was added recently to meet increasing demand and a study is underway to identify potential expansion routes. In its first 10 months of service, the Virginia Breeze intercity bus carried more than 14,000 riders between stops in the I-81 corridor and Washington, D.C., 243 percent greater than projected.

Figure 19. *Cargo and Freight Transportation Routes in or Adjacent to the I-81 Corridor*



Economic Development

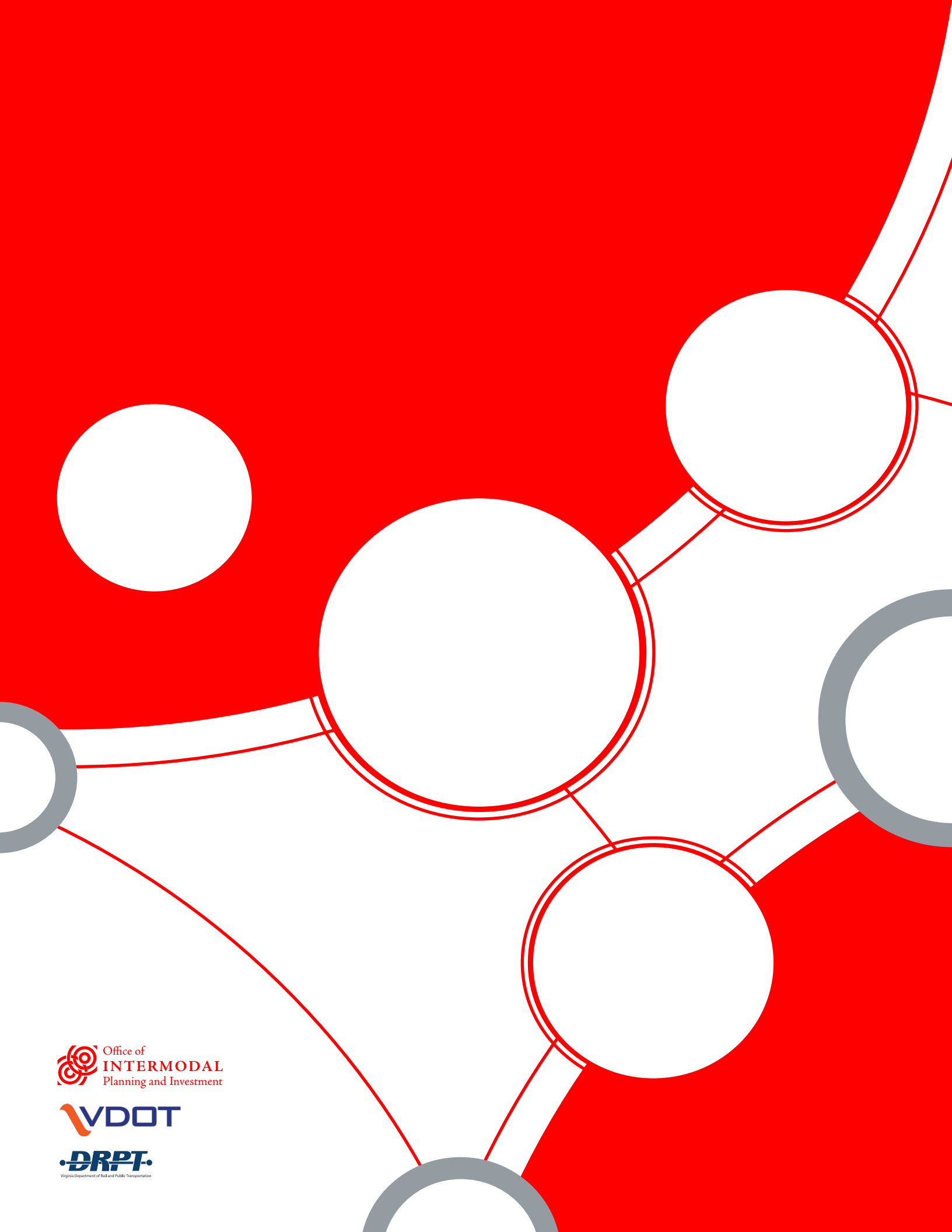
The Virginia Department of Rail and Public Transportation works with the Virginia Economic Development Partnership and local economic development entities in Virginia to promote the Virginia Department of Rail and Public Transportation's Rail Industrial Access program which provides grant funding for rail access to new or expanding industries in the Commonwealth Rail Industrial Access grant funds off-set the upfront cost for businesses to use the rail network, which diverts truck trips from Virginia's congested highways, such as I-81. The Rail Industrial Access program has been used as a tool for the shortlines to encourage businesses to develop along their rail lines and serves as an incentive the state can offer when rail has a competitive shipping advantage for specific industries. Additionally, the Virginia Economic Development Partnership and Virginia Department of Rail and Public Transportation also are working with Class I railroads and shortlines to build a database of certified rail-served sites to better advertise opportunities for economic development along Virginia's railroad network.

This Plan recommends that further exploration of multimodal improvements occur with Office of Intermodal Planning and Virginia Department of Rail and Public Transportation providing staff support. In addition, the financial analysis reserves $157 million from this exploration along with the work of the enforcement and truck parking task forces.

11. Next Steps

The following actions will be undertaken by the study team, Commonwealth Transportation Board, and General Assembly:

- The Commonwealth Transportation Board adopted the I-81 Corridor Improvement Plan at their December 5, 2018 meeting
- The I-81 Corridor Improvement Plan will be submitted to the General Assembly by January 9, 2019
- The General Assembly will consider the Plan submitted by the Commonwealth Transportation Board


Office of
INTERMODAL
Planning and Investment
VDOT
DRPT
Virginia Department of Rail and Public Transportation

Appendices

A - Chapter 743 *(follows)*

B - Performance Measures Ranking Data

http://www.virginiadot.org/projects/resources/81/Appendix_B_-_I-81_Performance_Measures.pdf

C - Public Meeting Boards

- June

  http://www.virginiadot.org/projects/resources/81/Appendix_C1_-_I-81_June_Meetings_Boards.pdf

- August

  http://www.virginiadot.org/projects/resources/81/Appendix_C2_-_I-81_August_Public_Meetings_Boards.pdf

- October

  http://www.virginiadot.org/projects/resources/81/Appendix_C3_-_I-81_October_Public_Meetings_Boards.pdf

D - Public Meeting Comments Overview

http://www.virginiadot.org/projects/resources/81/Appendix_D_-_I-81_Public_Meeting_Comment_Summary.pdf

E - Improvement Prioritization Scoring Results

http://www.virginiadot.org/projects/resources/81/Appendix_E_-_I-81_Improvements_Scorecards.pdf

F - Six-Year Improvement Program Projects

http://www.virginiadot.org/projects/resources/81/Appendix_F_-_Six-Year_Improvement_Program_Project_Activity_List.pdf

G - Recommended Improvement Plan Boards

http://www.virginiadot.org/projects/resources/81/Appendix_G_-_I-81_Recommended_Improvement_Plan_Boards.pdf

H - Economic Impact Analysis

http://www.virginiadot.org/projects/resources/81/Appendix_H_-_VDOT_I-81_Economic_Impact_Analysis_Report.pdf

I - Truck Parking Study

http://www.virginiadot.org/projects/resources/81/Appendix_I_-_I-81_Truck_Parking_Report.pdf

J - PRAG Financial Analysis

http://www.virginiadot.org/projects/resources/81/Appendix_J_-_PRAG_Financial_Analysis.pdf

Appendix A

Chapter 743

Appendix A contains Chapter 743 of the 2018 Acts of the Virginia General Assembly in its entirety.

Chapter 743 of the 2018 Acts of the Virginia General Assembly requires that:

§ 1. That the Commonwealth Transportation Board (the Board) be directed to study financing options for Interstate 81 corridor improvements.

*In conducting its study, the Board shall evaluate the feasibility of using toll financing to improve Interstate 81 throughout the Commonwealth. Such evaluation shall not consider options that toll all users of Interstate 81, and shall not consider tolls on commuters using Interstate 81, but may consider high-occupancy toll lanes established pursuant to § **33.2-502** of the Code of Virginia and tolls on heavy commercial vehicles. The Board, with the support of the Office of Intermodal Planning and Investment, shall develop and adopt an Interstate 81 Corridor Improvement Plan (Plan). Such Plan shall include the examination of the entire length of Interstate 81 and the methods of financing such improvements, and such Plan may include tolls imposed or collected on heavy commercial vehicles but shall not include tolls on commuters using Interstate 81.*

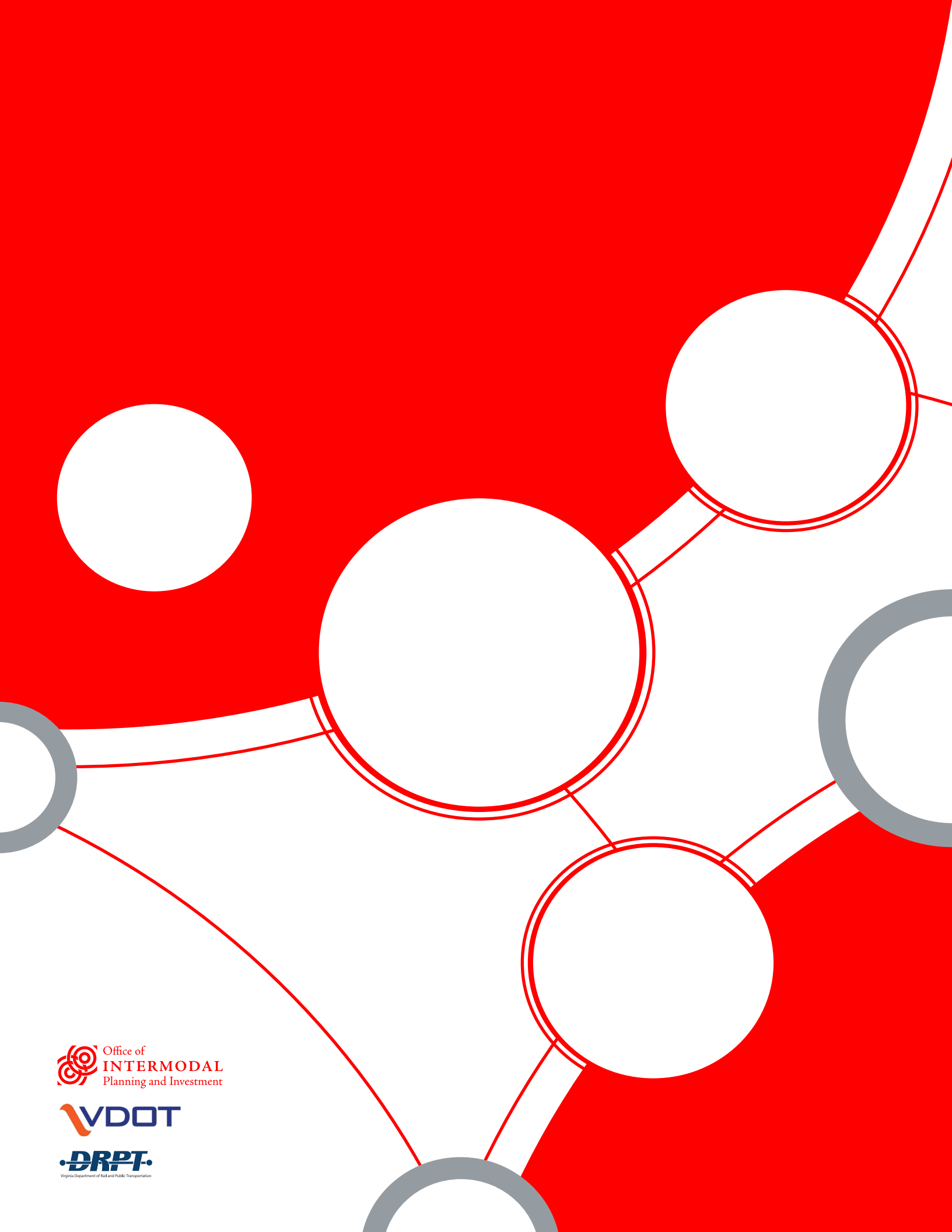
At a minimum, in the development of such Plan, the Board shall:

1. *Designate specific segments of the Interstate 81 corridor for improvement;*
2. *Identify a targeted set of improvements for each segment that may be financed or funded in such segment and evaluated using the statewide prioritization process pursuant to § 33.2-214.1 of the Code of Virginia;*
3. *Ensure that in the overall plan of expenditure and distribution of any toll revenues or other financing means evaluated, each segment's total long-term benefit shall be approximately equal to the proportion of the total of the toll revenues collected that are attributable to such segment divided by the total of such toll revenues collected;*
4. *Study truck travel patterns along the Interstate 81 corridor and analyze policies that minimize the impact on local truck traffic;*
5. *Identify incident management strategies corridor-wide;*
6. *Ensure that any revenues collected on Interstate 81 be used only for the benefit of that corridor;*
7. *Identify actions and policies that will be implemented to minimize the diversion of truck traffic from the Interstate 81 corridor, including the prohibition of through trucks on parallel routes;*
8. *Determine potential solutions to address truck parking needs along the Interstate 81 corridor; and*
9. *Assess the potential economic impacts on Virginia agriculture, manufacturing, and logistics sector companies utilizing the I-81 corridor from tolling only heavy commercial trucks.*

Technical assistance shall be provided to the Commonwealth Transportation Board by the Department of Transportation, the Department of Motor Vehicles, and the Department of State Police. All agencies of the Commonwealth shall provide assistance to the Commonwealth Transportation Board for this study, upon request.

The Commonwealth Transportation Board shall complete its meetings by November 30, 2018 and shall submit to the Governor and the General Assembly an executive summary and a report of its findings and recommendations for publication as a House or Senate document. The executive summary and report shall be submitted as provided in the procedures of the Division of Legislative Automated Systems for the processing of legislative documents and reports no later than the first day of the 2019 Regular Session of the General Assembly and shall be posted on the General Assembly's website.

That nothing in this act shall be construed to conflict with the exclusive authority of the General Assembly to approve tolling on components of highways, bridges, or tunnels.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INTERMODAL
Planning and Investment
VDOT
DRPT
Virginia Department of Rail and Public Transportation